ARINC

COMMUNICATIONS MANAGEMENT UNIT (CMU) MARK 2

ARINC CHARACTERISTIC 758-1

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Prepared by the Airlines Electronic Engineering Committee

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FOREWORD

Activities of AERONAUTICAL RADIO, INC. (ARINC)

and the

Purpose of ARINC Characteristics

Aeronautical Radio, Inc. is a corporation in which the United States scheduled airlines are the principal stockholders. Other stockholders include a variety of other air transport companies, aircraft manufacturers and non-U.S. airlines.

Activities of ARINC include the operation of an extensive system of domestic and overseas aeronautical land radio stations, the fulfillment of systems requirements to accomplish ground and airborne compatibility, the allocation and assignment of frequencies to meet those needs, the coordination incident to standard airborne communications and electronics systems and the exchange of technical information. ARINC sponsors the Airlines Electronic Engineering Committee (AEEC), composed of airline technical personnel. The AEEC formulates standards for electronic equipment and systems for the airlines. The establishment of Equipment Characteristics is a principal function of this Committee.

An ARINC Equipment Characteristic is finalized after investigation and coordination with the airlines who have a requirement or anticipate a requirement, with other aircraft operators, with the Military services having similar requirements, and with the equipment manufacturers. It is released as an ARINC Equipment Characteristic only when the interested airline companies are in general agreement. Such a release does not commit any airline or ARINC to purchase equipment so described nor does it establish or indicate recognition of the existence of an operational requirement for such equipment, not does it constitute endorsement of any manufacturer's product designed or built to meet the Characteristic. An ARINC Characteristic has a twofold purpose, which is:

(1) To indicate to the prospective manufacturers of airline electronic equipment the considered opinion of the airline technical people, coordinated on an industry basis, concerning requisites of new equipment, and

(2) To channel new equipment designs in a direction which can result in the maximum possible standardization of those physical and electrical characteristics which influence interchangeability of equipment without seriously hampering engineering initiative.

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1.0 INTRODUCTION

1.1 Purpose of this Document

This document contains the physical form and fit dimensions, the electrical interface definition, and a description of the functions, operations, and interfaces of the Communications Management Unit (CMU) Mark 2.

The CMU Mark 2 is used to provide management and access to the various Data Link networks and services available to the aircraft. The CMU Mark 2 may also host various applications related to Data Link, including both Company and Air Traffic Services. A brief white paper on the role of the CMU Mark 2 in CNS/ATM is provided in Appendix A.

The CMU Mark 2 is defined in terms of capability levels. There are two classes of capabilities, Level 0-2 define communications service capabilities and Levels A-D define application capabilities, see Section 4.1. The CNS/ATM definition is still in progress.

The CMU level 0-A definition has been completed. Future supplements will complete the definition of the other levels. The text for levels 1-2 and levels B-D is preliminary.

This document assumes that the architecture of the airborne CMU Mark 2, is as shown in the system block diagrams included as attachments. These architectures are consistent with guidelines provided by ARINC Report 660, “CNS/ATM Avionics, Functional Allocation and Recommended Architectures.”

COMMENTARY

> Equipment manufacturers should note that this document aims to encourage them to produce high Mean Time Between Removal (MTBR), high performance equipment. They are at liberty to accomplish this by the use of design techniques they consider to be the most appropriate. Their airline customers are more interested in the end result than in the means to achieve it.

1.2 Organization of this Document

The purpose of this document is to provide general and specific guidance for the development and installation of the CMU Mark 2. As such, this guidance covers the standards necessary to achieve interchangeability, including mechanical packaging and connector. See Section 2, Interchangeability Standards.

Section 3 provides System Design information, including architecture and configurations.

Section 4 identifies the Functional Capabilities that may be provided.

Section 5 describes the Interfaces and Protocols necessary to provide the Functions.

Section 6 addresses Provisions for Maintenance and Test capabilities.

The Attachments contain the referenced Figures and Tables.

For the reader's convenience, a historical record, referenced documents, and a list of acronyms used in this Characteristic are provided in the Appendices.

1.3 Conventions Used In This Document

The following terminology is used in reference to various functions and interfaces:

CMU Mark 2 Levels - Term to categorize functional capabilities and manage configurations. See Section 4.

Optional - This capability may be requested on a customer by customer basis, but may not be available in all designs, such as a design made only for digital aircraft.

Reserved - These capabilities are either to reserve some type of legacy interface for backwards capability, or reserving some type of growth interface for near term capabilities that have been identified, but are not yet available.

User Defined - These capabilities are at the manufacturers discretion to define in conjunction with specific customer needs.

End System - An end system is a function that generates or processes data link messages directly with a specific Intermediate System. In the ATN environment, an End System operates at the transport layer and above.

Intermediate System - An Intermediate System provides communications services to one or more End Systems. Intermediate Systems may communicate with other Intermediate Systems or End Systems.

Router - The Router permits End Systems to connect to other End Systems, whether they are local or remote. The Router function is an Intermediate System.

Bridge - A bridge operates typically at the data link layer between compatible networks. It typically copies/buffers packets from one Local Area Network (LAN) to another.

Gateway - A gateway is a process that allows incompatible networks or upper layer protocols to communicate. In the ATN environment a gateway may be provided by an appropriate ATN End System. Gateways typically deal with interoperability issues and can be quite complex.

Flight Management Computer (FMC) - For purposes of this document, Flight Management Computer is used in a “generic” sense. It could actually be an FMC or GNLU or GNU depending on the aircraft.

1.4 Relationship to Other Documents

This Characteristic introduces functionality, protocols, and interfaces into the CMU Mark 2 often by way of reference. Many of these references are to other documents, including other AEEC Documents. Readers

1.0 INTRODUCTION (cont'd)

1.4 Relationship to Other Documents (cont'd)

should use the most current version of the referenced) document unless a specific version is given. See Appendix C. This Characteristic replaces ARINC Characteristic 748, "Communications Management Unit", which has been obsoleted.

1.5 System Overview

The primary function of the CMU Mark 2 is to provide management and access to the Data Link networks and services available to the aircraft. These may be either Aircraft Communications Addressing and Reporting System (ACARS) and/or Aeronautical Telecommunications Network (ATN) compatible Data Link Networks, and for the transitional cases, may include both.

COMMENTARY

> Airlines and suppliers of airborne subsystems interfacing with the CMU Mark 2 should note that a commitment to the CMU Mark 2 system may have an impact on both airborne and ground based systems. This Characteristic aims at identifying and minimizing these impacts where necessary.

The CMU Mark 2 may host applications related to Data Link, including Airline Operational Communications (AOC), Airline Administrative Communications (AAC), and Air Traffic Services (ATS) communications. Applications related to AOC, AAC, and Air Traffic Services (ATS), may also be hosted in other equipment. Aircraft should be configured to prevent possible conflicts in this case.

It is expected that the CMU Mark 2 may need to be able to accommodate multiple certification levels. Company communications are typically airline specific and the CMU Mark 2 should have sufficient flexibility to accommodate these needs.

ATS communications consist of Air Traffic Control (ATC) and Flight Information Services (FIS). The ATC communications include:

a. Automatic Dependent Surveillance (ADS)

b. Controller Pilot Data Link Communications (CPDLC)

c. Context Management (CM)

The CMU Mark 2 should provide interfaces and be integrated with on-board systems (e.g. MCDUs, alerting systems, printer, etc.) and flight management computers necessary for safe flight crew operation.

Aircraft intended to be equipped with the CMU Mark 2 are expected to have qualified sub-networks to provide the necessary data link communications capability.

ATN provides the capability to transfer binary data, as well as information using any code set, among host computers independent of the underlying sub-network technologies or protocols. In this manner, system interconnectivity is achieved, so that all users are provided a common environment.

The CMU Mark 2 router function is connected to various avionics subsystems via the onboard avionics data buses. Access to the ground networks include the following data link sub-networks: VHF, HF, Satellite, and Gatelink.

The CMU Mark 2 is primarily intended to be a Line Replacement Unit (LRU) based design for replacement or upgrades to existing ARINC 724 and ARINC 724B Management Units (MUs). The CMU Mark 2 is intended to support all Air Transport Category aircraft utilizing LRUs for these functions and is optimized for digital 700 series aircraft with electronic displays.

1.6 Interchangeability

System interchangeability, as defined in Section 2 of ARINC Report 607 "Design Guidance for Avionic Equipment" is desired for the CMU Mark 2. The standards necessary to ensure this level of interchangeability are set forth in Section 2, Interchangeability Standards. c-1

COMMENTARY

> This document specifies standard interwiring that satisfies users' needs over the long-term. ARINC 758 compliance includes the use of the standard interwiring. ARINC 758 retrofit installation may require changes to aircraft wiring or modification to CMU internal wiring to enable it to be installed in existing aircraft that conform to the ARINC 724B interwiring definition. The user community should be aware of the availability in the market place of CMUs that contain ARINC 758 functionality, but include ARINC 724B interwiring.

1.7 Regulatory Approval

This equipment could form part of an ATC data link system where the separation standards are reduced and the safe operation in these conditions is predicated on the reliability of the overall system.

The equipment should meet all applicable ICAO, JAA, and FAA regulatory requirements. This document does not and can not set forth the specific requirements that equipment must meet in order to be assured of approval. Such information should be obtained from the regulatory agencies themselves. See Appendix C for a list of reference documents.

1.8 Integrity and Availability

The anticipated operational use of the system demands the utmost attention to the need for reliability in all phases of system design, production, installation, and operation of the CMU Mark 2. It is not the purpose of this Characteristic to define specific Mean Time Between Failure (MTBF) or Mean Time Between Unscheduled Removal (MTBUR) requirements.
However, it is of paramount importance to the airlines to

operate a trouble free unit with minimum impact on scheduling and maintenance. A special emphasis should be given to total system quality, including built-in testing, ramp testing. and shop testing to increase the MTBUR.

COMMENTARY

> MTBUR has a profound affect on airline operations, despite a high MTBF. It is anticipated that specific reliability expectations will be negotiated between individual airlines and equipment manufacturers. A very high MTBF (e.g. greater than 40,000 flight hours) is expected for the CMU Mark 2. Ideally, MTBUR should approach MTBF.

1.9 Testability and Maintainability

The total system quality should include adequate ability for the operator to test and maintain the CMU Mark 2 effectively. The CMU Mark 2 designer should confer with the user to establish goals and guidelines for testability to minimize unnecessary removals. The use of advanced Built-In Test Equipment, ramp testing equipment, and adequate documentation should help the operators increase MTBUR. For airline operations, MTBUR is at least as important, perhaps more so, than MTBF. Testability should be such to identify the causes of repeat removals and eliminate the cause of unconfirmed faults.

For shop maintainability, the design of physical access and functional partitioning of the CMU Mark 2 should be such to minimize repair time. Where possible, excessive unit disassembly should not be required for internal component replacement. Full and complete documentation included in a Component Maintenance Manual should also facilitate effective maintainability.

1.10 Flight Simulators

Flight simulators are recognized as an important part of the aviation industry. Airlines depend upon simulators for flight crew and maintenance training. The CMU Mark 2 should be designed for use in flight simulators. Airlines typically desire simulators to be available as early as possible to allow for crew training prior to introduction into revenue service. The guidelines of ARINC Report 610A "Guidance for Use of Avionics Equipment and Software in Simulators" apply.

2.0 INTERCHANGEABILITY STANDARDS

2.1 Interchangeability Objectives

This section sets forth the specific form factor, mounting provisions, interwiring, input and output interfaces, and power supply characteristics desired for a CMU Mark 2. These standards permit the parallel, but independent design of compatible equipment and airframe installations.

2.2 Form Factor, Connector, and Index Pin Coding

The CMU Mark 2 should comply with the dimensional standards in ARINC Specification 600, "Air Transport Avionics Equipment Interfaces," for a 4 MCU form factor. The CMU Mark 2 should also comply with ARINC Specification 600 with respect to weight, racking attachments, front and rear projections and cooling.

The CMU Mark 2 should be provided with a low insertion force, size 2 shell ARINC Specification 600 service connector. This connector, which should accommodate service interconnections in its middle plug (MP) and top plug (TP) inserts respectively and power interconnections in its bottom plug (BP) insert should be located on the center grid of the CMU Mark 2's rear panel. Index pin code 58 should be used. See Attachment 2-1, Rear Connector Insert Diagram.

COMMENTARY

> Due to the significant interconnect and planned functional differences the index pin code is intentionally different than prior generation ACARS MUs.

A front panel accessible connector should be provided on the CMU Mark 2 to support on-aircraft Data Loading, when it is installed on aircraft lacking a centralized Data Loading System or no permanently installed access connector to a portable unit exists. A cover should be provided to protect the connector from damage, contamination, etc., while not in use.

COMMENTARY

> If a Portable Data Loader (PDL) is going to be used for on-board data loading, provisions may be needed to supply power to the PDL, perhaps through the front panel connector. If the CMU Mark 2 provides 115 Vac power through this connector, special provisions should be made for safety and short circuits in the design.

An additional front panel connector may also be provided in consideration of a possible connection to an On-Board Local Area Network (OLAN) that complies with ARINC Specification 636, "Onboard Local Area Network (OLAN)."

If bench testing of the CMU Mark 2 with Automatic Test Equipment (ATE) necessitates interconnect capabilities that are not covered by the pin assignments on the service connector set forth in the Attachments, then an auxiliary connector should be provided whose type and location are selected by the equipment manufacturer. The manufacturer should observe the standards of ARINC Specification 600 when choosing the location for the connector. The manufacturer is free to use the auxiliary connector pins as needed. Since the auxiliary connector is not to be used while the CMU Mark 2 is installed in the aircraft, it should be provided with a cover to protect it from damage, contamination, etc., during that time.

COMMENTARY

> The auxiliary connector is specified to permit completion of the interface without recourse to the use of individual "test leads" from the ATE, each of which has to be clipped, or otherwise secured, to a test point on the equipment.

2.3 Power

The CMU Mark 2 should be designed to accept 115 Vac, 400 Hz, single phase ac power as the source of primary power. The primary power input should be protected by circuit breakers 2.0 Amp 115 Vac. |c-1

COMMENTARY

> Separate Pins (BP 2 and BP 3) are also provisioned on the service connector for 28 Vdc primary power. Support for 28 Vdc power is a marketplace item.

Provisions are included for a standby 28 Vdc (aircraft battery) source. This may be used for long term data storage and/or internal clock operation. Equipment manufacturers may elect to draw power from the dc source continuously or to restrict its use to those times when the ac source is unavailable. In no case, however should the dc drain exceed 75 mA. Installation designers should note that the dc power should be provided by a "non-interruptible" source, i.e., not via switching circuits to a battery bus, in emergency conditions. This source is not available on all aircraft.

COMMENTARY

> Equipment designers should note that in the practical aircraft environment, the steady state dc voltage may vary between 18.0 Vdc and 36.0 Vdc, to which the ripple and transient limits referenced should be applied.

|c-1

Aircraft power supply characteristics, utilization, equipment design etc. are set forth in ARINC Specification 413A, "Guidance for Aircraft Electrical Power Utilization and Transient Protection" and ARINC Report 607, "Design Guidance for Avionic Equipment".

There should be no master ON/OFF power switching for the CMU Mark 2. Any user desiring ON/OFF control should provide, through the medium of a switching function installed in the airframe, means of interrupting the primary power to the unit. It is probable, however, that ON/OFF switching is not needed in most installations and that power is wired to the unit from the circuit breaker panel.

2.0 INTERCHANGEABILITY STANDARDS (cont'd)

The CMU Mark 2 should be able to continue operating through any transient under 200 ms.

COMMENTARY

> The 200 ms value is derived from RTCA DO-160C and is based upon power switching times on-board the aircraft that can occur any time.

The CMU Mark 2 should be capable of storing limited information for at least 30 minutes without power applied.

COMMENTARY

> The 30 minute value is derived largely from operational experience. This includes survival during a Ground Power Unit/Auxiliary Power Unit (GPU/APU) power transfer failure which may occur while at the gate, and it is undesirable to either perform re-initialization of the system or to have a loss of data for the current leg that is nearly completed. This is also consistent with the 30 minute aircraft battery life value.

This information could include, but is not limited to, initialization data, received uplink messages, undelivered downlink messages, statistical and BITE information. Data retention should be available in installations with or without the 28 Vdc battery supply bus.

2.4 Standard Interwiring

The standard Interwiring to be installed for the CMU Mark 2 is set forth in Attachment 2-2. This interwiring is designed to provide the degree of interchangeability specified for the CMU Mark 2. See Section 1.6, Interchangeability.

Manufacturers are cautioned not to rely on special wires, cabling or shielding for use with particular units because they may not exist in a standard installation.

COMMENTARY

> Manufacturers are encouraged to utilize only those pins on the service connector designated for ATE purposes, and not make use of pins not currently defined or left for customer definition.

2.5 Environmental Conditions

The CMU Mark 2 should be specified environmentally in terms of the requirements of RTCA Document DO-160C. Attachment 9 tabulates the relevant environmental test categories.

2.6 Cooling

The CMU Mark 2 should be designed to accept, and airframe manufacturers should configure the installation to provide forced air cooling as defined in ARINC Specification 600. The standard installation should provide an air flow rate of 22 kg/hr of 40 degrees C (max.) air and the unit should not dissipate more than 100 watts of energy. The coolant air pressure drop through the equipment should be 25 $\pm$2.5 mm of water. The CMU Mark 2 should be designed to expend this pressure drop to maximize the cooling effect. Adherence to the pressure drop standard is needed to allow interchangeability of the equipment.

COMMENTARY

> Although the CMU Mark 2 is to be packaged in accordance with ARINC Specification 600, some retrofit installations are expected into aircraft racking designed in accordance with ARINC Specification 404A, "Air Transport Equipment Cases and Racking". The cooling provisions of these two racking standards were intentionally established such that ARINC 600 equipment would be compatible with ARINC 404A racking. Thus, the CMU Mark 2 cooling provisions are compatible with ARINC 404A aircraft racking.
>
> The CMU Mark 2 designer should consider that the CMU Mark 2 is expected to operate without substantially lower reliability in an aircraft installation in which cooling is not available.

2.7 Grounding and Bonding

Equipment and airframe manufacturers should follow the guidance material in ARINC Specification 600 Section 3.2.4 and in ARINC Specification 404A in Section 6 and Appendix 2 on the subject of equipment and radio rack grounding and bonding.

2.8 IMA Packaging Considerations

In some aircraft avionics architectures, the CMU Mark 2 functionality, as described in Section 4, may be implemented in Integrated Modular Avionics (IMA) equipment, and integrated with other avionics functions c-1 such as Flight Management, Displays, Central Maintenance, Aircraft Condition Monitoring, etc. Under these circumstances, the form factor, mounting provisions, interwiring, power supply, and physical input and output connector pin assignments may not conform to the characteristics set forth in this section. As these characteristics are generally dependent on the form factor, etc. of the specific IMA implementation and the level of functional integration performed, reference should be made to the specifications for the particular equipment.

2.9 ARINC Standard Interfaces

The standard electrical inputs and outputs from the systems should be in the form of a digital format or switch contact. Standards should be established precisely to assure the desired interchangeability of equipment.

Certain basic standards established herein are applicable to many signals. Signals should conform with the standards set forth in the subsections below, unless specified otherwise in Section 5.

2.0 INTERCHANGEABILITY STANDARDS (cont'd)

2.9.1 ARINC 429 DITS Data Bus

ARINC Specification 429, "Mark 33 Digital Information Transfer System (DITS)" is the controlling document for data word formats, refresh rates, resolutions, etc. Material contained in this document related to these topics is included for reference purposes only. In the event of conflict between this document and ARINC Specification 429, the latter should be assumed to be correct.

2.9.2 Standard "Open"

The standard "open" signal is characterized by a resistance of 100,000 ohms or more with respect to signal common.

COMMENTARY

> In many installations, a single switch is used to supply a logic input to several LRUs. One or more of these LRUs may utilize a pull-up resistor in its input circuitry. The result is that an "open" may be accompanied by the presence of + 27.5 Vdc nominal. The signal could range from 12 to 36 Vdc.

2.9.3 Standard "Ground"

A standard "ground" signal may be generated by either a solid state or mechanical type switch. For mechanical switch-type circuitry, a resistance of 10 ohms or less to signal common would represent the "ground" condition. Semiconductor circuitry should exhibit a voltage of 3.5 Vdc or less with respect to signal common in the "ground" condition.

2.9.4 Standard "Applied Voltage" Output

The standard "applied voltage" is defined as having a nominal value of + 27.5 Vdc. This voltage should be considered to be "applied" when the actual voltage under the specified load conditions exceeds 18.5 volts (+ 36 Vdc maximum) and should be considered to be "not applied" when the equivalent impedance to the voltage source exceeds 100,000 ohms.

2.9.5 Standard Discrete Input

A standard Discrete Input should recognize incoming signals having two possible states, "open" and "ground". The characteristics of these two states are defined in Sections 2.9.2 and 2.9.3 of this Characteristic. The maximum current flow in the "ground" state should not exceed 20 mA.

The "true" condition may be represented by either of the two states (ground or open) depending on the aircraft configuration.

COMMENTARY

> In past installations there have been a number of voltage levels and resistance's for Discrete states. In addition, the assignments of "Valid" and "Invalid" states for the various voltage levels and resistance's were sometimes interchanged, which caused additional complications. In this Characteristic a single definition of Discrete levels is being used in an attempt to "standardize" conditions for Discrete signals.
>
> The voltage levels and resistance's used are, in general, acceptable to hardware manufacturers and airlines. This definition of Discrete is also being used in the other 700-Series Characteristics, however, there are a few exceptions for special conditions.
>
> The logic sources for the Discrete Inputs to the CMU Mark 2 are expected to take the form of switches mounted on the airframe component (flap, including gear, etc.) from which the input is desired. These switches can either connect the Discrete Input pins on the connector to airframe dc ground or leave them open circuit as necessary to reflect the physical condition of the related components.
>
> The CMU Mark 2 is, in each case, expected to provide the dc signal to be switched. Typically, this is done through a pull-up resistor. The CMU Mark 2 input should sense the voltage on each input to determine the state (open or closed) of each associated switch.
>
> The selection of the values of voltages (and resistance's) which define the state of an input is based on the assumption that the Discrete Input utilizes a ground-seeking circuit. When the circuit senses a low resistance or a voltage of less than 3.5 Vdc, the current flow from the input should signify a "ground" state. When a voltage level between 18.5 and 36 Vdc is present or a resistance of 100,000 ohms or greater is presented at the input, little or no current should flow. The input may utilize an internal pull-up to provide for better noise immunity when a true "open" is present at the input. This type of input circuit seems to be the "favorable" among both manufacturers and users.
>
> Because the probability is quite high that the sensors (switches) are providing similar information to a number of users, the probability is also high that unwanted signals may be impressed on the inputs to the CMU from other equipment, especially when the switches are in the open condition. For this reason, equipment manufacturers are advised to base their logic sensing on the "ground" state of each input. Also, both equipment and airframe suppliers are cautioned concerning the need for isolation to prevent sneak circuits from "contaminating" the logic. Typically diode isolation is used in the avionics equipment to prevent this from happening. c-1

2.0 INTERCHANGEABILITY STANDARDS (cont'd)

2.9.6 Standard Discrete Output

A standard Discrete output should exhibit two states, "open" and "ground" as defined in Sections 2.9.2 and 2.9.3. In the "open" state, provision should be made to present an output resistance of at least 100,000 ohms. In the "ground" state provision should be made to sink at least 20 milliamperes of current. Non-Standard current sinking capability may be defined.

COMMENTARY

> Not all Discrete output needs can be met by the Standard Discrete output defined above. Some Discrete outputs may need to sink more current than the standard value specified above.
>
> A Discrete output may need to source current. Discrete outputs which are to source current should utilize the standard "Applied Voltage" output defined in Section 2.9.4. These special cases are noted in the text describing each applicable Discrete output function and in the notes to interwiring.

COMMENTARY

> Although defined here, Discrete outputs which provide a current output rather than a current sink are not "Standard Discrete outputs".

2.9.7 Standard Program Pin Input

Program pins may be assigned on the CMU Mark 2 service connector for the purpose of identifying a specific aircraft configuration or to select (enable) optional performance.

COMMENTARY

> Program pins may be used for a variety of purposes. Program pins enable a piece of equipment to be used over a greater number of airframe types. One way this is done is by identifying the unique characteristics of the airframe in which the unit is installed. Another is to identify the location (left, right, center) of the unit. Often program pins are used to enable (turn on) options for alternate or extended performance characteristics.

The encoding logic of the Program pin relies upon two possible states of the designated input pin. One state is an "open" as defined in Section 2.9.2 of this Characteristic. The other state is a connection (short circuit i.e., 10 ohms or less) to the pin designated as the "Program Common" pin.

COMMENTARY

> Normally, the "primary" location or "usual", "common" or "standard" function is defined by the "open" logic and the optional response is programmed (encoded) by connection to Program Common.

3.0 SYSTEM DESIGN

3.1 System Architecture

This document assumes that the architecture of the airborne CMU Mark 2, is as shown in the system block diagrams included as attachments. These architectures are consistent with guidelines provided in ARINC Report 660.

The CMU Mark 2 communication system architecture consists of a suite of protocols and interfaces selected for the aircraft-ground communications.

The Data Link Infrastructure provides worldwide Data Link Services over a variety of Data Link media and protocols. VHF ACARS is the initial media and protocol, but over time is expected to transition to more advanced protocols, wider coverage areas, and higher speed services. The goal of the CMU Mark 2 is to provide seamless availability for the Data Link Applications. See Attachment 1-1, Data Link Infrastructure.

3.1.1 CMU As End System Architecture

In the CMU as an End System Architecture, the CMU Mark 2 operates as an ATS airborne end system and router. See Attachment 1-2 for a diagram illustrating the architecture for the CMU as an End System. This diagram illustrates both ACARS and ATN end system functions provided by a CMU.

In an ACARS-only (non-ATN) environment, only the protocols and applications outside the heavy line boxes in Attachment 1-2 are provided by the CMU as an ACARS End System. For the supported data link applications, this architecture provides CMU AOC applications and may also provide ATS character-oriented ARINC 623 and/or ARINC 622 bit-oriented CPDLC and ADS applications, using the ACARS Convergence Function (ACF).

When a CMU Mark 2 is updated with ATN protocols, then the ATN protocol stack as well as the new ICAO applications and Network Management may additionally be included in this architecture.

Regardless of whether the CMU Mark 2 operates as an ACARS or ATN end system (or both), if it hosts applications which use internal Flight Management System (FMS) data, then it should support the ARINC 656 Data Management application and the Simple Application Transport Protocol (SATP). Data Management and the SATP are described in ARINC Specification 656, "Avionics Interface Definition for Flight Management and Communications Management Functions", and are used to provide the necessary data parameter transfers from an FMS, GNLU, or GNU. These parameters are used to fully support the ATS applications hosted by the CMU for this architecture. For AOC applications hosted in an external LRU (e.g., FMS), the CMU Mark 2 also provides ACARS routing support via ARINC Specification 619, "ACARS Protocols for Avionic End Systems".

3.1.2 CMU As Router Architecture

In the CMU as Router Architecture, the CMU Mark 2 operates primarily as an airborne router for other onboard end systems, but also operates as an end system for some internal AOC and ATS applications. See Attachment 1-3 for a diagram illustrating the architecture for the CMU as a Router. Attachment 1-3 depicts examples of both ACARS and ATN end system functions, with an FMS providing the primary end system functions for the FANS environment. In this architecture, the FMS may also host some AOC applications.

For the CMU in an ACARS-only (non-ATN) environment, only the protocols and applications outside the heavy line boxes in Attachment 1-3 are provided. In this architecture, the FANS applications - CPDLC, ADS, and AFN - are hosted by onboard LRUs external to the CMU, but are supported by the CMU through the ACARS routing function. The CMU's AOC and ARINC 623 ATS applications are still provided by the CMU in this architecture.

When this architecture is updated with ATN protocols, the CMU Mark 2 is updated as an ATN router. The CMU Mark 2 may also operate as an ATN end system, hosting the ATN Network Management application as well as other potential applications such as Flight Information Service (FIS). The ICAO applications and ICAO upper layers supporting those applications are hosted in an external LRU for this architecture, such as the FMS.

Neither the ARINC 656 Data Management application nor the Simple Application Transport Protocol (SATP) are necessary for this architecture. However, these additional functions may be optionally implemented across the CMU to FMS interface to provide data parameters needed for other internal CMU Mark 2 applications or for other onboard system support, such as ADS-B.

3.1.3 CMU As Remote Stack (Gateway) Architecture

The Remote Stack (or Gateway) architecture is illustrated in the diagram in Attachment 1-4. In this architecture, the CMU operates as the airborne ACARS and/or ATN Communications End System for all onboard ATS data link applications, but ICAO FANS applications and supporting communications are hosted remotely in an external LRU such as the FMS. This architecture also includes gateway functions in the CMU which provide a protocol and application mapping from the supporting communications stack in a CMU Mark 2 to each of the ATS applications located in another LRU.

For the ACARS-only environment, the CMU Mark 2 continues to provide the same ACARS routing function for AOC messages to external onboard LRUs. For the ATN environment, the ATN protocols, including the ICAO upper layers and the ATN Network Management application (depicted in heavy line boxes in Attachment 1-4), are added to the CMU Mark 2. New ICAO applications and their supporting upper layers (as well as existing FANS applications) are located in an external LRU, such as the FMS.

When the CMU Mark 2 operates as an ATN communications end system, it should support the ARINC 656 Simple Application Transport Protocol (SATP), operating over a high speed bus. The SATP provides the primary means to pass protocol and application mappings between the external LRU and the CMU Mark 2. In an

3.0 SYSTEM DESIGN (cont'd)

ACARS environment, a FANS application may also use the SATP interface, or may continue to use the CMU Mark 2's existing ACARS routing function. The Data Management application is optional for this architecture.

3.1.4 CMU/FMS As Integrated Architecture

In an integrated architecture, the CMU Mark 2 functions operate in conjunction with FMS functions, to allow both airborne router and end system functions to be provided in a single LRU. This architecture is similar to the CMU as End System architecture, except that it does not require data parameter transfers across an external avionics bus. Attachment 1-5 illustrates the architecture for the CMU/FMS as Integrated Architecture.

In an ACARS-only environment, only the protocols and applications outside the heavy line boxes are provided by the CMU/FMS. For the ATN environment, the ATN protocols, including the ICAO upper layers, the ICAO applications, and the Network Management application are added to the CMU/FMS.

Neither the ARINC 656 Data Management application nor the Simple Application Transport Protocol (SATP) are required for this architecture since data transfers are accommodated through internal buses.

3.1.5 Data Bus Architecture

Most on-board physical interfaces to the air-to-ground digital communication links are typically ARINC 429, with operation of the Bit Oriented Protocol (BOP) at the link level. See Section 5.3.5, ARINC 429 BOP Protocol. Reference ARINC Specification 429. "Mark 33 Digital Information Transfer (DITS), Part 3, File Data Transfer
c -1 Techniques".

There may be some operational requirements, such as a desired system availability, which lead to dual CMU Mark 2 aircraft installations. See Section 4.15, Dual Installation, and Attachment 1-8.

Applications, sensors, and peripheral interfaces are dependent on both the aircraft and where applications are hosted in a specific configuration.

3.2 System Flexibility

The CMU Mark-2 should be flexible in it's design to meet the ever-changing Data Link environment and to provide a system with beneficial life-cycle costs.

To accommodate this need, the CMU Mark 2 should be designed with sufficient margins of growth (in memory and processor capacity) to accommodate a long term life cycle. The CMU Mark 2 should be designed such that only half of the memory and processor capabilities of the system are used, when performing the expected functions of a Level 1C System, as described in Section 4.1. This spare capacity can be achieved by designing the CMU Mark 2 for future upgrades. If upgrades are needed to achieve this capability, it should be performed such that the existing circuit cards do not have to be replaced. One standard technique for achieving this capability is to not populate Integrated Circuits (ICs) until needed, or replace existing ICs with higher density devices.

The CMU Mark 2 should also support the need for additional capabilities not yet defined, and which may require additional hardware circuitry. To accommodate this, the CMU Mark 2 should be designed to accommodate the future addition of at least one additional circuit card assembly. The addition of new circuitry should support interfacing with rear connector pins which are not yet assigned.

The following sections provide guidance on the functions, protocols, and interfaces where additional functionality is anticipated.

3.2.1 Transitional Considerations

The CMU Mark 2 should provide the flexibility to support the CNS/ATM requirements in the "transition to digital communication" which is expected to occur in a series of upgrades to the CMU Mark 2.

Transitional considerations have been studied by various industry fora and consist of two primary areas: Operational and Technical. Once the operational considerations are defined, the technical considerations should detail how to satisfy those operational requirements.

3.2.1.1 Operational Transitional Considerations

Operational considerations deal primarily with the impact on airspace management and pilot/controller communications, which are now predominately voice communications. Reference RTCA Task Force 2 Final Report "Transition to Digital Communications", RTCA/DO 219 "MOPS for ATC Controller/Pilot Data Link Communications (CPDLC)", and Society of Automotive Engineers (SAE) ARP4791 "Human Engineering Recommendations for Data Link Systems".

New flight deck procedures and improved human/machine interfaces are needed to support Air Traffic Management utilizing primarily data communications. If the CMU Mark 2 is hosting any of these applications, appropriate flight deck interfaces should be provided. These transitions are expected to occur in oceanic airspace first, then enroute, and finally in terminal areas. International airspace users may also need to have airborne communications capabilities compatible with differing Civil Aviation Administration (CAA) boundaries and Flight Information Regions (FIRs) on a flight. c-1

3.2.1.2 Technical Transitional Consideration

Much of the data link communications is used for AOC purposes. The operational portion of this data varies from airline to airline and also changes over time and as new ground based applications are brought on line.

The interfaces and protocols for air-ground communications, end-to-end system communications and interfaces with other on-board systems are expected to evolve to provide the increased reliability, flexibility and functionality needed for CNS/ATM. The CMU Mark 2 should be designed to support this growth, recognizing that as new interfaces and protocols are defined, the CMU Mark 2 should be capable of supporting the new interfaces

3.0 SYSTEM DESIGN (cont d)

3.2.1.2 Technical Transitional Considerations (cont'd)

and protocols, while, maintaining support for the existing interfaces and protocols.

Technical considerations that need to be addressed by both the CMU Mark 2 vendor as well as Airlines, OEMs, Service Providers and others involved in the CMU Mark 2 development and deployment, include:

a. The CMU Mark 2 will most likely need to support simultaneous communications with various ground systems, in which different protocols may be necessary. This need is based on the different capabilities which are expected to exist at the various ground systems. As an example, the CMU Mark 2 may be simultaneously communicating with two different ATC centers, one supporting ATN and the other supporting ARINC 622, while at the same time transmitting AOC messages using ARINC 618. Technical consideration needs to be given to the implementation approach to support this capability and the need for system level link management functions within the CMU Mark 2 to manage the multiple protocols.

b. The CMU Mark 2 is expected to be interoperable with all ATC centers supporting datalink capabilities. Although all ground systems should be developed in accordance with ICAO standards, differences/anomalies should be assumed as systems start to become operational, and entry into service with each new ground system should be carefully monitored by both the Airline, Service Provider and CMU Mark 2 Vendor.

c. The advent of the ATN protocol may result in current AOC/AAC messages (either generated by the CMU Mark 2 or other on-board LRUs) to be incompatible with an existing Airline's host computer system (due to the encapsulation performed for transmitting over an ATN link). Technical considerations should be taken to ensure the Airline and/or Service Providers have made the necessary changes to reformat such messages or adapt the Airline host computer.

d. The definition of ATC applications are expected to continually evolve similar to the same type of evolution experienced with AOC applications. Technical considerations need to be given in the ability to support such changes without imposing significant cost and effort.

e. Additional interfaces are expected to be added to the CMU Mark 2 in phases, with different Airlines integrating in new CNS/ATM equipment at different times, and in different time phases. As an example, new FMCs (or GNLUs/GNUs) may be added before or after the addition of a new display unit; which may be added before or after the installation of Global Positioning System (GPS); which may be added before or after new datalinks such as VHF Data Radios (VDRs). In addition, LRU interfaces are also expected to evolve. As an example, the CMU Mark 2 may initially be installed on aircraft with an ARINC 702 FMC. The FMC interface may evolve from a standard ARINC 429 interface to an ARINC 702A FMC using the ARINC 656 interface. Technical considerations need to be given during the design to support these inevitable permutations, while attempting to maintain a system which can be common across multiple aircraft configurations. The CMU Mark 2 will need to be able to accommodate the differing CMU architectures, as shown in Attachments 1-2 through 1-5.

f. With the advent of CNS/ATM, the number of datalink equipped aircraft and the number of datalink messages are expected to significantly increase during the CNS/ATM transition. Technical considerations need to be given to the optimization and management of the networks to ensure operational performance for ATS communications is maintained. This includes additional considerations in the prioritization and scheduling of AOC/AAC data communications.

3.2.2 Aircraft Variants

Aircraft variants described herein, consist not only of older analog aircraft and digital aircraft, but incorporates the wide ensemble of aircraft in which different avionics interfaces are installed.

The CMU Mark 2 should be designed to support installation on all such aircraft variants, given a minimum equipment configuration, to include: datalink radios; cockpit display units; and the necessary input buses/discretes to support the intended function of the CMU Mark 2. A single hardware solution should be designed to support all such variants.

The CMU Mark 2 should support the differences which exist between the different aircraft variants through the use of configuration information, which can be easily reconfigured on an aircraft-by-aircraft (or aircraft type) basis. This reconfigurable data can be resident in reconfigurable (operational) databases. This data should provide the ability to identify which buses and discretes are used on each aircraft, for receiving the needed data for CMU Mark 2 functions. In addition, this configuration information is expected to identify the type and quantity of devices installed on the aircraft (such as GNLUs, GNUs, FMCs, VDRs, SDUs, MCDUs, DMUs, etc.). A routing capability is defined to transfer ACARS messages directly to SDUs as ARINC 619 ACARS peripherals from airline host computers.

In general, the installation of the CMU Mark 2 on today's digital aircraft present few challenges, since these aircraft already support multiple display units, incorporate a data bus architecture, and provide many of the interfaces required for a Level 0A (and higher) CMU Mark 2, see Section 4.1. These aircraft may need to have additional wiring to support some of the interfaces (and the functions these interfaces provide), as identified in Section 5. In contrast, older analog aircraft which are to be upgraded to support CNS/ATM functions may need more significant changes. This may require major changes to both avionics wiring and flight deck alterations. Flight deck alterations could include such changes as the addition of new Radio Management Panel(s), addition of new display units, and other graphical interfaces for improved flight management and navigation functions. Incorporating new radios (VHF, HF, SDU), FMCs, and other equipment may result in significant changes to the aircraft avionics bay.

The CMU Mark 2 may not be capable of interfacing with all legacy equipment which may be installed on older aircraft. This legacy equipment (such as ARINC 500 series radios), are not considered to provide the needed capability to support CNS/ATM. Such equipment is expected to be replaced with new avionics, at the same time or before, installation of the CMU Mark 2.

3.3 Certification and Partitioning Considerations

The CMU Mark 2 contains evolving functionality. Some of the functions may also have differing levels of certification. Because of this, a partitioned design is expected to provide cost effective mechanisms to support the changes and provide isolation between major functions to assist in certification.

Each software component that is software loaded into a CMU Mark 2 should include a pattern recognition (Checksum, CRC, or other similar error detection) which should be validated by the CMU Mark 2 to verify that the software or database elements are correctly loaded. The specific means by which validation is performed should be compatible with the criticality level of the specific software
c-1 component. The CMU Mark 2 should also verify that all other previously loaded software components are not affected following the load of a specific software component.

The equipment manufacturer should refer to ARINC Report 652, "Guidance for Avionics Software Management" to obtain guidance concerning partitioning software and software configurations.

To support certification of the CMU Mark 2, qualification tests should be performed to validate the operational characteristics of its intended functions. In addition to vendor testing as described in DO-160C and DO-178B, the avionics vendor should conduct various qualification tests developed by OEMs and service providers as part of the activities to obtain certification. Qualification testing is also expected to be necessary for verification of ATS applications and correct operation of ATN software.

The following sections identify specific design guidance
c-1 for the CMU Mark 2 functional partitioning.

3.3.1 AOC Applications

The CMU Mark 2 should provide the capability to support airline-specific functions, which vary from airline to airline. AOC functions include Out-Off-On-In (OOOI) message processing, connecting gate information, flight statistic generation, free text messages, the corresponding AOC cockpit display menu's and downlink messages. The CMU Mark 2 should accommodate the updating of these software functions without impacting ATS and other functions that would be contained in a different software segment. The avionics designer should recognize the need to develop AOC functions such that they can be easily reconfigured by the Airlines. Reconfiguration capabilities should include the ability to modify display formats, printer formats and downlink message formats at a minimum.

3.3.2 ATS Applications

The CMU Mark 2 should provide the capability to update and/or add ATS applications (such as CPDLC, ADS, etc.) via electronic software downloading, such as from a Data Loader. The ATS applications should be partitioned such that changes to the ATS applications do not impact the other partitions and changes to other partitions do not impact the ATS applications.

COMMENTARY

> In the future, functions, processing, and interfaces associated with Air Traffic Services are expected to carry an essential-level certification level.

The CMU Mark 2 should be designed such that it can support both ATS applications contained internally within the CMU Mark 2 as well as ATS applications which are hosted by other on-board systems, such as FMC's, GNUs or GNLUs.

The avionics manufacturer should design the ATS applications such that message formats and display formats can be quickly and easily modified, allowing manufacturers to respond quickly to the changing CNS/ATM environment.

3.3.3 Routing Policy Database

The CMU Mark 2 should accommodate the establishment of a Routing Policy Database. Routing policy information should entail both airline preferences for message routing (such as preferred data links to use over specific geographical regions) as well as network management parameters. The routing policy information should be designed such that it can be added and/or updated via electronic software downloading, such as from a data loader. It should be possible to update the CMU Mark 2 Routing Policy Database without affecting the router software. The Routing Policy Database should support both ACARS and ATN based routing.

The CMU Mark 2 may in the future receive network management parameters dynamically from service providers, and should be considered by the avionics developer during the design.

3.3.4 Configuration Parameters

The CMU Mark 2 should be designed for easy modification or reconfiguration, such that the CMU Mark 2 can be used on multiple aircraft types, with only software loading changes. To accommodate this capability, the CMU Mark 2 should be able to reconfigure various I/O ports to support the differing aircraft interfaces.

The CMU Mark 2 should be capable of updating various tuning parameters (primarily timer values) used within the various protocols, to facilitate future modifications.

3.0 SYSTEM DESIGN (cont d)

3.3.4 Configuration Parameters (cont'd)

The avionics designer should recognize the need to perform such updates without impacting the actual protocol software.

Aircraft level configuration and identity may be loaded from the Aircraft Personality Module (APM) or other on-board digital source. See Section 4.12, Configuration Database.

3.4 Software Data Loading

The CMU Mark 2 should accommodate the ability to update it's operational software programs and databases electronically. The objective of data loading is to facilitate modifications to various software components within the CMU Mark 2 without the need to remove the unit from the aircraft, and to accomplish updates rapidly to avoid disrupting normal aircraft operations. These updates should be accommodated through the use of an ARINC Specification 615 Data Loader. Reference Section 6.3, Dataloading. In addition, the CMU Mark 2 should be capable of supporting the loading of software via an Ethernet interface, according to ARINC Report 615A, "Software Data Loader with Ethernet Interface and High Density Storage Medium" if an Ethernet data loader interface is available.

3.5 Support Tools

The term Support Tools used herein refers to ground-based equipment (software or software and hardware), which is used for the purpose of modifying (reconfiguring) the functionality/configuration of the CMU Mark 2.

To accommodate the updating of software and databases within the CMU Mark 2 (and APM), ground based tools should be developed which allow for the generation of the electronic media, which is subsequently used to load the CMU Mark 2 system. For CMU Mark 2 functions such as AOC and AAC, in which certification levels of the software allow user (airline) modification, the corresponding AOC/AAC support tools should be developed for the intended use by airline personnel**.** The avionics manufacturer should recognize that such ground-based support tools should be developed in a manner which minimizes training of airline personnel and which can be provided at a reasonable cost. The need for airline personnel to understand a programming language to use these tools should be avoided. The avionics manufacturer is recommended to develop airline reconfiguration tools such that they can be operated on computer hardware platforms that are commonly used within the industry.

Support Tools which are used to create/change those databases which affect certification of the CMU Mark 2, such as an ATS database, should be used by the avionics vendor.

The Data Link Service Providers may require that ground based tools which are used to generate databases for the CMU Mark 2 be provided to them for the purpose of qualification testing (and approval) of the tool. This may be required if the modifications can result in changes that have a detrimental impact on air-ground link performance or the processing performed by service providers.

Airlines which perform reconfiguration of the CMU Mark 2 using ground-based tools may be required to submit such changes to service providers for qualification testing (or review), if such changes result in the addition or modification of downlink messages which may impact service provider functions or can adversely affect the performance of the air-ground link.

4.0 FUNCTIONAL CAPABILITY

4.1 Functional Description

This Section describes the functional aspects of the CMU Mark 2 airborne equipment without specific regard to the mechanics of protocols and interfaces, which are used to support those functions. See Section 5, Interfaces and Protocols. For functions related to maintenance and support of the CMU Mark 2, see Section 6, Maintenance and Test.

The CMU Mark 2 major functions are specified in terms of "capability levels" in two groups in order to manage the large number of potential options. The first group consists of CMU Mark 2 Functions providing Data Link Services. The second group contains Applications. The first group is numeric (0-2) and the second group is alpha (A-D). Together they provide a high level capability definition, such as a "Level 2A" CMU Mark 2. Each group of Levels are incremental, unless otherwise stated. That is a Level 1 CMU Mark 2 includes all capabilities of a Level 0 CMU Mark 2 plus additional capabilities.

The following tables provide a quick reference to the levels and associated functional capabilities:

Level	Service Functional Capabilities
0	A CMU Mark 2 that is functionally equivalent to an ARINC 724B ACARS MU, but upgradeable to other levels.
0.1	Level 0 plus includes using a VDR configured to operate in VDR Mode A (ARINC 618 protocol and modulation with ARINC 429 interface between CMU and VDR)
1	Level 0 plus ATN services using VHF, SATCOM, and HF sub-networks, including ARINC 716 VHF radios and Mode 1 AVPAC.
2	Level 1 plus high speed services, such as VDR (Mode 2 and up), Ethernet LAN, and Gatelink.

c-1

Level	Application Functional Capabilities
A	A CMU Mark 2 that provides Airline/AOC applications and ARINC 623 ATS messages.
B	Level A plus ATS applications support and flight deck interfaces compatible with non-radar controlled airspace operations.
C	Level B plus applications support for ATN Operations, including Context Management. In addition, applications and flight deck interfaces compatible with radar/enroute operations.
D	Level C plus ATS applications and flight deck interfaces compatible with terminal and surface operations (tactical).

4.2 Level 0 and Level 0.1 Data Link Functions c-1

A Level 0 CMU Mark 2 provides ACARS only Data Link services as defined in ARINC Specification 618. The VHF modulation is MSK as defined in ARINC Specification 618. The CMU includes an MSK compatible modem for ARINC 716 VHF radio interfacing. c-1

A level 0.1 CMU includes the option to use a VDR configured to operate in Mode A and use the CMU and VDR ARINC 429 interface instead of the ARINC 716 analog interface. Level 0.1 functionality also adds the capability to distinguish between ARINC 741 and ARINC 761 SATCOM and treat them as separate, independent air-ground subnetworks.

COMMENTARY

Using the VDR in Mode A provides the same level of performance as an ARINC 716 transceiver. c-1

The advantages of using the VDR in Mode A are:

a. Less wiring

b. Dual installations are less complex

c. VDR/CMU wiring is ready to evolve to level 1 and 2

d. Restriction on use of transceiver

4.2.1 ACARS "Network" Function

The ACARS Network function provides a character oriented air/ground data link service.

The CMU Mark 2 should be capable of :

a. Interoperability with all available commercial aviation ACARS compatible air-ground networks

b. Providing uplink/downlink queues for each supported media

c. Automatic link establishment, maintenance, and disconnect in the mobile environment of the aircraft

d. Concurrent ACARS services over the different media: VHF, ARINC 741 SATCOM, ARINC 761 SATCOM (level 0.1 only) and HF c-1

e. Routing AOC messages to the appropriate media and queue management in a manner to meet specific airline's needs

f. Routing Data Link messages to and from the ACARS End Systems, including other external on-board systems

g. Buffering capability for at least one complete uplink ACARS message (all blocks) and at least one complete downlink ACARS message (all blocks) for each ACARS End System

4.0 FUNCTIONAL CAPABILITY (cont'd)

4.2.1 ACARS "Network" Function (cont'd)

h. Providing Data Link Status (link available and Join/leave) information to each ACARS End System for message management and crew alerting

i. Providing the necessary interfaces to the on-board radios:

level 0: ARINC 741 SATCOM, VHF, and HF

c-1

level 0.1: ARINC 741 SATCOM, ARINC 761 SATCOM, VHF (including VDR Mode A), and HF

The ACARS Sub-network Air/Ground Protocol and Interfaces should be according to Section 5.1.1, ACARS Air/Ground Protocols.

4.2.2 ACARS VHF Sub-network Function

VHF ACARS operation is supported with a VHF radio (716 or 750) that provides an ARINC 716 interface, this includes an ARINC 750 radio operating in ARINC 716 mode. VHF ACARS operation is also supported by a VDR that supports Mode A. VHF ACARS operation can be implemented with any of the following configurations:

c-1

a. ARINC 716 radio or

b. ARINC 750 radio operating in Mode 0 (ARINC 716 emulation) or

c. ARINC 750 radio operating in Mode A where the VDR hosts the modem (CMU level 0.1)

4.2.2.1 ARINC 716 Support

c-1

To support the use of VHF ACARS operation, the CMU Mark 2 should include an MSK capable modem, discrete outputs and digital tuning bus output. This includes an ARINC 750 radio emulating an ARINC 716 (VDR Mode 0).

c-1

The CMU Mark 2 should provide a digital (ARINC 429) based frequency output. This output is used to automatically set the VHF frequency while the radio is being used for data communications.

COMMENTARY

Should the VHF transceiver that is available for data link need 2x5 frequency tuning, some form of adapter unit may be used, such as a VHF control panel with a digital input (from the CMU Mark 2), and 2x5 output (to the ARINC 566/546 transceiver). However, utilization of these radios for data link is highly discouraged.

c-1

The ACARS VHF Interface should be according to Section 5.2.1.1, VHF Radio Interface. Also, see ARINC Specification 618, "Air-Ground Character-Oriented Protocol Specification."

4.2.2.2 ARINC 750 Mode A Functions (Level 0.1)

To support the use of VHF ACARS operation using an ARINC 750 radio operating in Mode A the CMU Mark 2 should include ARINC 429 inputs and outputs as defined in Sections 5.3.2.6 and 5.3.2.7.

The ACARS VHF Interface should be according to Section 5.2.1.2, VHF Radio Interface. Also, see ARINC Specification 618, "Air-Ground Character-Oriented Protocol Specification" and ARINC Characteristic 750. c-1

Mode A utilizes an ARINC 429 physical layer between the CMU and VDR. The MAC layer is implemented in the VDR according to ARINC Specification 618 and the "LLC" is implemented in the CMU according to ARINC Specification 618**.**

4.2.3 ACARS SATCOM Sub-network Function

To support the use of SATCOM ACARS operation, the CMU Mark 2 should provide ARINC 429 interfaces with satellite sub-systems. Reference ARINC Characteristics 741 and 761.

c-1

4.2.3.1 ACARS ARINC 741 SATCOM Sub-network Function

To support the use of ARINC 741 SATCOM ACARS equipment, the CMU Mark 2 should provide ARINC 429 interfaces as defined in Sections 5.3.2.4, 5.3.2.6 and 5.3.2.7. The CMU should interface with Satellite Data Units (SDU) as defined in ARINC Specification 618 and ARINC Characteristic 741.

Physical interfaces (pins) have been assigned for two high speed ARINC 429 connections and two low speed ARINC 429 connections between the CMU Mark 2 and ARINC 741 SDUs. See Sections 5.3.2.4, 5.3.2.6 and 5.3.2.7.

COMMENTARY

The satellite air/ground protocol is specified in ARINC Characteristic 741 and is implemented within the SDU. The SDU provides this service to the CMU. At this time there are two CMU/SDU protocols defined, which are called Data 2 and Data 3. Data 2 is defined in ARINC Specification 618. Data 3 is defined in ARINC Characteristic 741. See Sections 5.2.2.1 and 5.2.2.2 respectively.

4.2.3.2 ACARS ARINC 761 SATCOM Sub-network Function

To support the use of ARINC 761 SATCOM ACARS equipment, the CMU Mark 2 should provide ARINC 429 interfaces as defined in Sections 5.3.2.4, 5.3.2.6 and 5.3.2.7. The CMU should interface with Satellite Terminal Units (STU) as defined in ARINC Specification 618 and ARINC Characteristic 761. c-1

4.0 FUNCTIONAL CAPABILITY (cont'd)

COMMENTARY

c-1 The satellite air/ground protocols are implemented within the STU. The STU provides this service to the CMU. The implementation supports operation similar to SATCOM Data 2 which utilizes ACARS character oriented messages.

4.2.4 ACARS HF Sub-network Function

To support the use of HF ACARS operation, the CMU Mark 2 should provide ARINC 429 Interfaces with dual ARINC 753 HFDL Systems. See Section 5.2.3. The ACARS HF Interface should be according to ARINC Characteristic 753, "HF Data Link System".

COMMENTARY

c-1 The HF air/ground protocol is specified in ARINC Specification 635, "HF Data Link Protocols," and is implemented within the HFDR. The HFDR provides this service to the CMU Mark 2. An interim implementation supports operation similar to SATCOM Data 2 which utilizes ACARS character oriented messages over the HF bit oriented protocol.

4.3 Level 1 Data Link Functions

A Level 1 CMU Mark 2 provides all Level 0 Services plus ATN capabilities. This should include VDL Mode-1 AVPAC (CSMA), HF, and SATCOM Data-3 support.

4.3.1 ATN Network Function

The CMU Mark 2 should be capable of interoperability with available commercial aviation air-ground sub-networks compatible with the ATN. Management and control information is exchanged between the CMU Mark 2 and each sub-network.

The CMU Mark 2 should be capable of:

a. Interoperability with all available commercial aviation ATN compatible air-ground networks

b. Providing uplink/downlink queues for each supported media

c. Automatic link establishment, maintenance, and disconnect in the mobile environment of the aircraft

d. Concurrent ATN services over the different media (VHF, SAT, and HF)

e. Routing AOC messages to the appropriate media and queue management in a manner to meet specific airline's needs

f. Routing Data Link messages to and from the ATN End Systems, including other external on-board systems

g. Providing Data Link Status (link available) information to each ATN End System for message management and crew alerting

h. Providing the necessary interfaces to the on-board radios (SATCOM, VHF, HF)

i. Meeting the Required Communications Performance (RCP) to support Air Traffic Services Communications and CNS/ATM

4.3.2 ATN Join/Leave Events

Each of the ATN sub-networks is responsible for generating Join and Leave events and sending them to the CMU Mark 2.

The Join event is used to notify the CMU Mark 2 that a new path to a specified ground address is available. The generation of the Join event in VDL and AMSS sub-networks occurs in the airborne sub-network equipment. The Join event is used to trigger the start of ATN air-ground communications using ISO 9542 and ISO 10747. Once a sub-network connection is established, it is necessary for an airborne router to provide its address to the ground.

In some sub-networks, the join event is initiated by the ground equipment. ATN communications are then initiated by the ground equipment. In this case the CMU Mark 2 responds to a connect event from the ground processor to begin ATN air-ground communications using ISO 9542 and ISO 10747.

If the lifetime of the link is about to expire, a new Join event is issued to the CMU Mark 2. The ICAO ATN SARPs suggests values of 600-1200 seconds for the link c-1 lifetime of a mobile air/ground sub-network. This value may be dependent on the operational domain and sector geometry.

The Leave event is issued by the sub-network and sent to the CMU Mark 2 to indicate that a specified ground address is no longer reachable. The CMU Mark 2 uses the reception of a Leave event to update its address tables.

4.3.3 ATN Internetworking Function

When performing the function of an ATN Router, the CMU Mark 2 should operate as an Intermediate System (IS), The ATN Router performs connection-less relaying and routing of data packets according to the ICAO ATN SARPs.

Interconnecting sub-networking is based on source and destination network layer addresses and the user's routing policy. The functional Internetworking capabilities are described in the ICAO ATN SARPs.

c-1

4.3.4 Multiple Network Function (ATN/ACARS)

The communication elements of the CNS/ATM architecture should be able to smoothly transition from character-oriented protocols (ACARS) to bit-oriented protocols (ATN) with minimal software modification. This recognizes ARINC Specifications 622 and 623, and the transition to the Aeronautical Telecommunications Network (ATN).

4.0 FUNCTIONAL CAPABILITY (cont'd)

4.3.4 Multiple Network Function (ATN/ACARS) (cont'd)

COMMENTARY

In some scenarios, overlap of two or more of the protocols may be used.

This transition produces the need for a CMU Mark 2 that can perform both ATN and ACARS services as needed.

The CMU Mark 2 should be capable of supporting a "Multiple Network Function". This allows the CMU Mark 2 to provide independent and concurrent access to the ACARS and ATN Data Link Services.

The CMU Mark 2 should use its Routing Policy Database to perform downlink message routing using the airline preferred service. The CMU Mark 2 should determine when an ATN service should be used instead of ACARS for particular traffic, when both are available.

If the CMU Mark 2 is connected to two independent VHF/VDR radios, it should be capable of supporting independent and concurrent VHF Data links as well. The CMU Mark 2 can support only one ACARS VHF connection due to a single internal modem.

The CMU Mark 2 should be capable of data communications (ACARS and/or AVPAC) with more than one VHF/VDR radio simultaneously, provided at least one of the radio's is an ARINC 750 VDR utilizing the ARINC 429 interface.

The CMU Mark 2 should send and receive ATN and ACARS packets with the SDU and HFDL Systems as needed.

4.4 Level 2 Data Link Functions

COMMENTARY

The CMU Level 2 Services are not specified at this time due to immaturity in their definitions and availability. However, these capabilities are expected to include additional sub-networks and provide higher speed services. These sub-networks are also expected to be ATN compatible. Some of these services may need additional I/O capabilities, such as LAN interface adapters. The Air/Ground Interfaces are expected to remain based on ARINC Specification 429 for the foreseeable future, other than Gatelink.

4.5 Level A Application Functions

4.5.1 ACARS End System Function

The ACARS End System Function is needed in the CMU Mark 2 if it hosts the applications that receive and send ACARS messages via the ACARS "Network" Function Services.

An ACARS End System is any system that is consistent with ARINC Specification 620, "Data Link Ground System Standard and Interface Specification," and ARINC Specification 619, "ACARS Protocols for Avionic End Systems". The message character set is limited and there are specific message size and buffering limitations.

The CMU Mark 2 should support multiple external ACARS End Systems, including two FMCs, four SDUs/STUs, ACMS, CMC, and Cabin Systems. An ARINC 741 SDU may use two types of protocol interfaces over the same physical bus connection to the CMU Mark 2. One interface supports the air/ground sub-network as defined in Section 4.2.3 and the other supports the SDU as an ACARS End System. An ARINC 761 STU may use two types of protocol interfaces over the same physical bus connection to the CMU Mark 2. One interface supports the air/ground sub-network as defined in Section 4.2.3 and the other supports the STU as an ACARS End System. c-1 c-1

COMMENTARY

Some SDUs do not interface with the CMU Mark 2 as an end system.

4.5.2 Non ATS Communications (Character Based)

The CMU Mark 2 provides character based Data Link messages using an ACARS End System Function. In this role, the CMU Mark 2 originates the formats of the messages and is responsible for processing of received messages.

These Data Link messages are used to support various operations, including Aeronautical Operational Communications (AOC), and Aeronautical Administrative Communications (AAC).

AOC Data Link messages include crew initiated and automatic communication with dispatch, maintenance, and other departments of the airline related to operations of the flight.

AAC Data Link messages include crew and cabin personnel communications related to administrative matters, such as crew scheduling and cabin services.

In the ACARS environment, Company Communications are primarily limited to character based messages. See ARINC Specification 620. The message formats are generally unique to a specific airline based on their operational needs. These types of messages include:

a. OOOI reports

b. Weather requests/display/print

c. Maintenance reports, and

d. Flight Plan Messages

The CMU Mark 2 should be able, on an airline/aircraft basis, to:

a. Customize the pilot interface display, printouts, and alerting mechanisms

4.0 FUNCTIONAL CAPABILITY (cont'd)

b. Generate customized messages based on customizable triggers, and

c. Decode and generate Data Link messages as an End System

Some company communications data is passed through to other on-board systems. In this role the CMU Mark 2 is serving as a router/bridge.

4.5.3 ATS Communications

Character based ATS messages can be provided by the CMU Mark 2 according to ARINC Specification 622, "ATS Data Link Applications Over ACARS Ground Network," and ARINC Specification 623, "Character-Oriented Air Traffic Service (ATS) Applications".

ARINC Specification 623 includes ATS applications such as ATIS, PDC, and Oceanic Clearances using character based messages. ARINC Specification 622 contains sections which provide support for ARINC 623 messages. These messages may be relayed and formatted by the airline host or may consist of direct ATS communications.

4.6 Level B Application Functions

A Level B CMU Mark 2 provides extended application support. These extended applications are bit oriented and can include ATS Applications.

Some of these applications are dependent upon the availability of the ARINC 656 Flight Management Interface. See ARINC Specification 656.

The Level B CMU Mark 2 provides current ACARS (level A) application support.

COMMENTARY

c-1 Development of CMU functions is market driven. Therefore, the development of the CMU level B applications is likely to be delayed until there is a market for these applications

4.6.1 ACARS Convergence Function (ARINC 622)

The ACARS Convergence Function (ACF) capabilities should be provided by the CMU Mark 2 when it is hosting Bit-Oriented Applications, such as CPDLC, but using the ACARS Data Link Service. The ACF is fully described in ARINC Specification 622.

The ACF encapsulates and provides an end-to-end integrity CRC of binary oriented Data Link Messages making it compatible with the ACARS character oriented network.

The ACF was developed to allow Bit Oriented ATS applications to be used with the ACARS Data Link Service. However, it may also be used to permit binary data to be exchanged directly with the airline hosts.

4.6.2 Non ATS Communications

The CMU Mark 2 should support both character and bit-oriented Non ATS applications.

Binary data formats offer more efficient packaging (smaller messages) for many data link applications. Binary data is also easier to process by computers and simplifies software designs.

Candidate AOC applications for binary data include encryption, compression, graphics, position data, maintenance data, and exchanging loadable table values.

4.6.3 ATS Communications

The CMU Mark 2 may support a variety of ATS Communications. These include Automatic Dependent Surveillance (ADS), Controller Pilot Data Link Communications (CPDLC), and Flight Information Services (FIS).

COMMENTARY

Equipment manufacturers should note that this document does not detail the operation of the ADS, CM, and CPDLC functions. Conversely, their system functions, so far as they affect the CMU Mark 2 architecture and electrical interfaces, are addressed in Sections 3, 4 and 5.

4.6.3.1 Air Traffic Facilities Notification (ARINC 622)

Air Traffic Services Facilities Notification (AFN) function should be provided by the CMU Mark 2 when it is hosting ATS communications other than ARINC 623 in an ACARS Network Environment. AFN provides a c-1
character based application to provide a log-in and hand-off facility for communications with ATS ground based systems. It also provides aircraft ATS Data Link capabilities status information.

The CMU Mark 2 should be able to determine or access information necessary for ATS Data Link Capabilities status reporting of the ATS applications hosted within the CMU.

COMMENTARY

At this time there is no mechanism defined for centralized reporting of the ATS Data Link Capabilities status of the avionics suite. Each LRU (CMU, FMS, etc) is responsible for reporting its c-1
own ATS Data Link Capabilities status. It is possible that more than one LRU will provide ATS Data Link Capabilities status reporting on the same aircraft due to either poor configuration of the aircraft avionics or distribution of the ATS applications between the CMU and FMS.

The CMU must complete the AFN procedures before it can support the other ATS Data Link Applications. AFN message formats and protocol are specified in ARINC Specification 622.

4.0 FUNCTIONAL CAPABILITY (cont'd)

4.6.3.2 CPDLC Function

The Controller/Pilot Data Link Communications (CPDLC) functions provide the means for controllers/ATC systems and pilots/aircraft systems to communicate using digital data links. It is expected that voice communications will continue to be used for emergency and non-routine ATM operations and serve as a back-up (or secondary) mode to data link. The message sets for Controller Pilot Data Link Communications (CPDLC) messages are in accordance with RTCA DO-219 and the ICAO CNS/ATM-1 SARPs.

Interaction with the crew is needed for CPDLC, including alerting mechanisms, priority management, message display and activation of uplink clearances, and crew initiated responses and requests for clearances.

When the CMU interfaces with a compatible Flight Management Computer and an ARINC 656 interface is provided, then the avionics may be able to:

a. Preview, load and extract routes, and

b. Request, receive and process on-board sensor/status information (primarily from the FMC) to "pre-fill" messages (and display to the crew for verification) to be sent to ATC (this could also be achieved, to a certain extent, using traditional ARINC 429 broadcast data)

4.6.3.3 ADS-A Function

The Automatic Dependent Surveillance Addressable (ADS-A) Function automatically provides flight position and other optional information data in the form of ADS reports upon request from ground-based end system applications (ADSP applications).

The ADS-A Function should be implemented in accordance with RTCA DO-212 Automatic Dependent Surveillance, ARINC Characteristic 745, "Automatic Dependent Surveillance" and ICAO CNS/ATM-1 SARPs.

The CMU Mark 2 will need to acquire necessary information to use in the ADS-A reports. Most of this information is expected to be acquired via the ARINC 656 interface with the FMC, but other implementations are possible.

4.7 Level C Application Functions

The CMU Mark 2 Level C Applications Function provides compatibility for applications in an ATN Environment. In addition, more advanced applications can be added.

4.7.1 ACARS/ATN Gateway Function

The ACARS Gateway Function provides a translation facility that can enable existing ACARS End System equipment and applications to continue to function without replacement or modification for company communications when Data Linked via ATN Services.

ACARS End Systems were designed to send and receive messages across the ACARS air-ground network as defined in ARINC Specifications 618**,** 619 and 620. If these systems need to operate over the ATN without an update, then the CMU Mark 2 should provide the relevant ACARS/ATN Gateway.

For external ACARS End Systems, such as the Airplane Condition Monitoring System (ACMS) or ARINC 702 FMC's, ARINC Specification 619 describes the on-board interface between the CMU Mark 2 and the external ACARS End Systems. The gateway function should be compatible with the ARINC 619 interface.

COMMENTARY

If the avionics end system requires an ACARS/ATN gateway in the CMU, then a corresponding ATN/ACARS Gateway is needed in the ground based system.

The airborne Gateway assumes two possible scenarios for the ground version in order to minimize the complexity of the airborne gateway.

a. ATN packets containing "ARINC 618" like files are delivered direct to an ATN End System Gateway in the airline host. In this case any conversion from an "ARINC 618" air/ground format to a TYPE B ground/ground format or equivalent**,** should be provided by the airline host.

b. The ATN packets containing "ARINC 618" like files are all routed to an ATN End System Gateway in the Data Link Service Provider's network. This gateway extracts normal front end processing as if it was received via the ACARS air/ground sub-network. It is then converted to a TYPE B format and delivered to the airline.

4.7.2 ATN Upper Layers Function

To be supplied by a future supplement.

4.7.3 ATN End System Function

To be supplied by a future supplement.

4.7.4 CM Application

The Context Management (CM) application is used in the ATN environment. It provides for the exchange of relevant address information between an aircraft CM Communications system and a ground CM system peer. Basically, the CM process includes three functions: Log-On, Update, and Contact. The disciplines for Context Management (CM) operation are in accordance with RTCA DO-233 "MOPS for Aircraft Management (CM) Equipment". CM utilizes a crew interface using ICAO names for airport facilities and the flight number designated by the airline.

4.7.5 FIS Application

Flight Information Services (FIS) are part of Air Traffic Services (ATS) communications. The CMU Mark 2 should accommodate the ability to request and display FIS information to the flight crew, such as NOTAMS, ATIS and weather information.

4.7.6 ATS Event Recording

At this time no specific regulatory requirements have been made with regard to on-board recording of ATS Events/Messages. However, in anticipation of that probable event, provisions should be included in the CMU Mark 2 for the ATS applications (when the CMU hosts the applications) to be able to send information to an on-board recorder. This is not a "router" function, but rather it is part of the ATS applications. Provisions for this application have been incorporated in newer Voice Recorders for a "Data Link" input via an ARINC 429 interface. Reference ARINC Characteristic 757 "Cockpit Voice Recorder (CVR)".

4.8 Level D Application Functions

A Level D CMU should provide network management facilities to support increased performance requirements for terminal area ATS Data Link Communications.

4.8.1 ATN Systems Management

Systems Management for ATN systems provides the mechanisms for monitoring, controlling and coordinating system and network resources through the use of OSI protocols. These resources are described as managed objects (MOs) with well defined properties and functions. These MOs are organized into Management Information Bases (MIBs) for each subsystem. The functions include: fault, accounting, configuration, performance, and security management. Systems Management may be distributed, centralized, or local to a specified environment and this distribution depends on the chosen architecture for the ATN subsystem.

Project Paper 639, "Standards for Network Management" defines the general framework for Systems Management, MOs, MIBs, system management functions, and protocols. Project Paper 639 describes the general procedures and guidelines for defining, registering, structuring, and implementing the management infrastructure necessary to design avionics subsystems. Since there are no specific ISO standards regarding the distribution of management agents, vendors are free to develop either n-layer agents or system-level agents for equipment. Vendors should, however, follow the guidance provided in Project Paper 639 to insure consistency in approach.

4.8.1.1 Management Functions

The specific CMU-Mark 2 management functions include:

a. Fault management

b. Accounting management

c. Configuration and name management

d. Performance management

e. Security management

4.8.1.1.1 Fault Management

Fault management facilities allow the network manager to detect problems in the ATN environment. These facilities include mechanisms for the detection, isolation, and correction of abnormal operation in any network component or in any of the OSI layers. Fault management provides procedures to:

a. Detect and report the occurrence of faults. These procedures allow a managed system to notify its manager of the detection of a fault, using a standardized event-reporting protocol.

b. Log the received event report. This log can then be examined and processed.

c. Schedule and execute diagnostic tests, trace faults, and initiate correction of faults. These procedures may be invoked as a result of analysis of event logs.

4.8.1.1.2 Accounting Management

Accounting management facilities allow a network manager to determine and allocate costs and charges for the use of ATN resources. Accounting management provides procedures to:

a. Inform users of costs incurred, using event-reporting and data-manipulation software

b. Enable accounting limits to be set for the use of managed resources, and

c. Enable costs to be combined where multiple resources are used to achieve needed communication

COMMENTARY

> Describe CMU accounting management functions which may concentrate on QOS for various router/communications paths which have varying charges (i.e. VHF vs. SATCOM vs. HF, etc.)

4.8.1.1.3 Configuration and Name Management

Configuration and name management facilities allow network managers to exercise control over the configuration of the network components and ATN layer entities. Configuration may be changed to alleviate congestion, isolate faults, or meet changing user needs. Configuration management provides procedures to:

a. Collect and disseminate data concerning the current state of resources. Locally initiated changes or changes occurring due to unpredictable events are communicated to management facilities by means of standardized protocols

4.0 FUNCTIONAL CAPABILITY (cont'd)

4.8.1.1.3 Configuration and Name Management (cont'd)

b. Set and modify parameters related to network components and ATN layer software

c. Initialize and close down managed objects**Error! Switch argument not specified.**

d. Change the configuration

e. Associate names with objects and sets of objects

COMMENTARY

Describe CMU configuration management entities for CMU resources including hardware/software modules, network connections, physical configurations, virtual configurations, etc.

4.8.1.1.4 Performance Management

Performance management facilities provide the network manager with the ability to monitor and evaluate the performance of system and layer entities. Performance management provides procedures to:

a. Collect and disseminate data concerning the current level of performance of resources

b. Maintain and examine performance logs for such purposes as planning and analysis

COMMENTARY

Describe CMU performance management entities for CMU resources including communications thresholds which influence performance. Timing and delay parameters, as well as communications QOS parameters are candidates (i.e. loss of signal, framing error, local/remote transmitter/receiver error, call establishment, degraded signal, queue size, bandwidth, storage capacity levels, data corruption, etc.).

4.8.1.1.5 Security Management

Security management facilities allow a network manager to manage access and protection of communications resources. Security management provides support for the management of:

a. Authorization facilities

b. Access control

c. Encryption and key management

d. Authentication

e. Security logs

COMMENTARY

Describe CMU security management entities for resource access, router/communications channel access, resource reconfiguration and authentication, log history access, physical violation, etc.

4.8.1.2 Managed Objects/MIB Structure

COMMENTARY

Describe the general classes of managed objects and CMU specific philosophy for organization of MOs/MIBs.

ATN systems management relies heavily on the concepts of object-oriented design. Each resource that is monitored and controlled by ATN systems management is represented by a managed object. A managed object can be defined for any resource that an organization wishes to monitor and/or control. Examples of hardware resources are switches, work stations, PBXs, LAN port cards, and multiplexers. Examples of software resources are queuing programs, routing algorithms and buffer-management routines. Managed objects that refer to resources specific to an individual layer are called (N)-layer managed objects. Managed objects that refer to resources that encompass more than one layer are called system managed objects. A managed object is defined in terms of attributes it possesses, operations that may be performed upon it, notifications that it may issue, and its relationships with other managed objects. In order to structure the definition of a MIB, each managed object is an instance of a managed-object class. A managed-object class is a model or template for managed-object instances that share the same attributes, notifications, and management operations. The definition of a managed-object class, as specified by the template, consists of:

a. Attributes visible at the managed-object boundary

b. System-management operations that can be applied to the managed object2

c. Behavior exhibited by the managed object in response to management operations

d. Notifications that can be emitted by the managed object

e. Conditional packages that can be encapsulated in the managed object, and

f. Position of the managed object in the inheritance hierarchy

4.8.1.3 Common Management Information Service Interface

COMMENTARY

Describe the specific CMU network management service facilities which are invoked with the host manager. This service provides the protocol "link" to the manager for manipulating MOs.

The common management information service (CMIS) defines the services provided for ATN systems management (ref. ISO 9595). These services are invoked by management processes in order to communicate remotely. The table in Attachment 3 lists the CMIS services in terms of service primitives. CMIS services are of two types: confirmed services need a remote management process to send a response to indicate receipt and success or failure of the operation requested; non-confirmed services do not use responses.

Three categories of service are relevant to CMIS:

a. **Association services**: The Common Management Information Service Element (CMISE) user needs to establish an application association to communicate. The CMISE user relies on the Association-Control-Service Element (ACSE) for the control of application associations.

b. **Management-notification service**: This service is used to convey management information applicable to a notification. The definition of the notification and the consequent behavior of the communicating entities is dependent on the specification of the managed object that generated the notification.

c. **Management-operation services**: These six services are used to convey management information applicable to systems-management operations. The definition of the operation and the consequent behavior of the communication entities is dependent on the specification of the managed object at which the operation is directed.

The CMIS provides several structuring facilities:

Multiple responses to a confirmed operation can be linked to the operation by the use of a linked-identification parameter.

Operations can be performed on multiple managed objects, selected to satisfy some criteria and subject to a synchronizing condition.

4.8.1.4 Common Management Information Protocol (CMIP)

The Common Management Information Protocol (CMIP) supports the services provided for ATN systems management by means of a set of protocol data units that implement the CMISE (ref. ISO 9596). These PDUs are transmitted in response to CMISE-service primitives issued by CMISE-service users.

4.9 Military Configuration Functions

The CMU Mark 2 may be used in military aircraft as an aid for efficient operation in civilian airspace.

COMMENTARY

> This configuration of a commercial CMU Mark 2 is expected to be functionally equivalent to a Level 2B unit, except that the on-board interfaces may include MIL-STD-1553B. The requirements of these interfaces are beyond the scope of this document.
>
> The Data Link Radio interfaces are expected to be as identified in this document. An ARINC 750 VDR (not ARINC 716) is the assumed baseline.
>
> Special security (Identification) procedures and encryption techniques may be necessary for handling of ATS Data Link messages with these aircraft.

4.10 Data Management Function

4.10.1 Data Management Overview

In order to host ATS (and some AOC) Data Link Applications, the CMU Mark 2 should have access to data from a wide variety of aircraft systems and sensors. In some cases data may also need to be transferred to another on-board system, such as the Flight Management Computer.

Data Management serves as an internal Data Concentrator to the CMU Mark 2 of airplane related information used by other functions within the CMU Mark 2. This is an abstract concept and no specific implementation is implied.

The Data Management Function provides an internal "database" of information relevant to operation of the CMU Mark 2. This data can be static, determined at power up or initialization (such as the aircraft address) or dynamic data that represents the current state of the airplane (position, fuel, etc.).

In order to provide the necessary flexibility to implement changes and adapt to different aircraft configurations, internal, loadable tables, should be used to describe the "database".

The CMU Mark 2 should be capable of storing and retaining specified operational data and Data Link Messages. The CMU Mark 2 should be capable of automatically clearing certain data at the end of flight.

Dynamic Data, used within the CMU Mark 2, such as altitude, needs to be "refreshed" as it may be used in internal algorithms that generate trigger events, such as sending an automatic downlink to dispatch when descending through 10,000 feet.

The Data Management function gathers information from many various sources and interfaces dependent on airplane model, configuration, and equipage.

Static data is any data that does not typically change from flight to flight on a given aircraft. Static Data is typically stored in the Aircraft Personality Module (APM).

If a peer Data Management Function exists in an external LRU, such as an FMC, then the two Data Management Functions may request and transmit data between each other. This capability is described in ARINC Specification 656 "Avionics Interface for Flight Management and Communications Functions Specification".

4.0 FUNCTIONAL CAPABILITY (cont'd)

4.10.1 Data Management Overview (cont'd)

COMMENTARY

In this case, when a peer data Management Function exists, the CMU Mark 2 Data Management Function would include a "Data Management Application" Client and/or Server as described in ARINC Specification 656. The ARINC Specification 656 Data Management Application is a peer to peer client/server protocol for access and control of data in a remote computer, such as an FMC. The Data Management Function exists in the CMU Mark 2 in all cases. The Data Management Application (client/server) may not exist in the CMU Mark 2 depending on the avionics architecture.

4.10.2 Static Data

Static Data is information and parameters that do not change during flight. This includes Identification Data (ICAO, Registration, etc.) and Aircraft Configuration Data (aircraft type, installation configuration). Static Data is stored in the CMU Configuration Database (See Section 4.12).

4.10.2.1 Identification Data

Identification information is necessary to perform any Data Link Communications. This information is unique to each aircraft and should not change, once loaded.

For ACARS operation, the CMU Mark 2 should have access to the seven character (56 bits) Aircraft Registration Mark and ARINC Specification 618 flight identifier. The ARINC Specification 618 flight identifier is composed of a 2 character airline identifier and a flight number. The CMU Mark 2 should be capable of allowing the airline to quickly modify the airline ID, to support those airlines which share aircraft on a frequent basis.

Some airlines also use a "fleet ID number" scheme independent of tail number. Provisions for a user defined "name" should be provided. This would only be used for airline communications.

c-1 | For ATN and ATS Applications, the CMU Mark 2 should have access to the ICAO 24-bit aircraft address as well as the full ICAO flight identifier. The ICAO flight identifier is composed of a 3 character airline identifier and a flight number as defined in ICAO 4444. The ICAO Flight Identifier and Flight Number are not static data and are not a candidate for storage in an external APM. The three character ICAO airline identifier could be stored in the APM provided that a suitable mechanism is provided for aircraft leasing, code sharing, etc.

For on-board LAN communications, the CMU Mark 2 should have access to the appropriate MAC address for its terminal(s).

The CMU Mark 2 should load the addresses upon power-up. Once the CMU Mark 2 has determined the address, this address should be maintained until the CMU Mark 2 detects installation on a different aircraft.

4.10.2.2 Aircraft Configuration Data

Aircraft configuration data is necessary because the CMU Mark 2 is planned to operate in many different fleet types, with many different configurations. Some examples of configuration data include, but are not limited to: Aircraft Model, Data Link Radio configuration, Printer/CDU Configuration, Cabin System Configuration, and Applications (such as enabling functions for over water operations) Configuration.

This information may also be used by internal BITE processing to ensure that external systems that are not installed or operative on the aircraft do not illicit a fault from the CMU Mark 2.

4.10.3 Dynamic Data

Dynamic data is used primarily to drive the data link applications. The data elements may need to be reformatted, truncated, etc. to be used by the applications. Dynamic data may include, but is not limited to:

a. Flight Number

b. Scheduled Date

c. Departure Station

d. Destination Station

e. Air/Ground Status

f. Doors and Brakes Status

g. Beacon, Landing Lights Status

h. Engine Data/Status

i. Fuel Data/Status

j. Meteorological (wind, temperature, turbulence, humidity)

k. Figure of Merit, RNP, ANP

l. Position (4-D), Velocity, Track

m. Intent, trajectory, trend

n. Selected heading, speed, altitude

o. Connecting LRU status/health

The source of the dynamic data may vary significantly from aircraft to aircraft. The on-board Flight Management System is the best source for the majority of the data. The CMU Mark 2 should be capable of accessing this information from:

a. A peer Data Management Function, such as in a Flight Management Computer, and/or

4.0 FUNCTIONAL CAPABILITY (cont'd)

b. ARINC 429 Data buses (Broadcast words from other systems), and/or

c. Discrete Inputs (such as OOOI Sensors)

Reference ARINC Specification 656, "Avionics Interface Definition for Flight Management and Communications Functions".

The CMU Mark 2 should be capable of clearing as well as preserving dynamic data at the end of a flight. It should provide sufficient sophistication to automatically update data, such as destination, to the new departure station after arrival.

The designer should take into consideration that valid dynamic data is not always available and create a design which can tolerate this condition gracefully. Propagation and use of out of date data should be avoided when possible.

The CMU Mark 2 should also provide the needed flexibility to support the various data needs of the different Airline's AOC functions. This may require the ability to store dynamic data at various events during a flight, such as fuel and engine data at various flight phases, possibly over several flight legs.

4.11 Internal Clock

The CMU Mark 2 should provide a real time clock capability synchronized with UTC. It can be set manually, via uplink, or from an on-board LRU such as GNSS. The CMU Mark 2 should provide the flexibility to the airline to reconfigure the source of the time.

A GNSS Time base should be used as the source of the UTC when available.

The internal clock drift should be less than $\pm$ 1 second over a 24 hour period (without updates) while power is applied. The CMU should detect that its internal clock may not be accurate due to primary power interruptions or elapsed time since an update.

COMMENTARY

> If the CMU Mark 2 receives GNSS time indirectly through other systems, considerations to transport delay should be made. The GNSS time that is received should be adjusted to represent true UTC time.

4.12 Configuration Database

The CMU Mark 2 should include a separate database for Configuration Data, which is used for static data instead of program pins (see Section 4.10). This database should be stored in the CMU Mark 2 nonvolatile memory (NVM).

The CMU Mark 2 Configuration Database may be updated via a number of methods of handling static data as identified in Section 4.12.2.

COMMENTARY

> Alternative memory devices as listed in Section 4.12.2 may be used to store a back up copy of the Configuration Database. In the following sections, use of the term APM refers to any type of alternative memory device that is used.

The CMU Mark 2 should provide a CMU Configuration Database status display page, which displays a Part Number for CMU Mark 2 Configuration Data entered by software load from a diskette, and displays individual data elements entered manually (such as ICAO 24-bit aircraft address). It is recommended that this display be kept to a single page.

4.12.1 Minimum Data Contents

The Configuration Database should include formatting and Header information as specified in ARINC Report 607, "Design Guidance for Avionic Equipment," for an APM. The database should include as a minimum the data elements shown in Attachment 5, Table 5-1. Other data may be included as specified by the supplier, see Attachment 5, Table 5-2 for an example.

4.12.2 Loading/Updating of Configuration Database

Configuration Data may be updated by a combination of software load and manual entries on interactive displays. An update of the Configuration Database should not require reload of other CMU Mark 2 software. To maintain configuration control, update by manual entry should be restricted access and limited to aircraft on ground conditions.

New Configuration Data is first loaded into CMU NVM. Upon update completion, the CMU Mark 2 copies the data to the APM, then proceeds with Database validation, as described in Section 4.12.3.

Different methods may be used to input Configuration Data to the CMU Mark 2. These methods include:

a. Loading the data via an interface to a centralized on-board source directly into non-volatile memory. The port used for this method is aircraft specific

b. Loading the data via an interface to an external APM (See Section 5.3.14 APM Interface)

c. Loading the data as part of the Data Load process from either an external data loader or internal removable mass media directly into non-volatile memory

d. Inputting the data via a control panel device directly into non-volatile memory

However, since the static data includes the address that is used for Air Traffic Services, and this is unique to each and every aircraft, careful consideration should be given to ensure the CMU Mark 2 has a source of the data with sound configuration management procedures and high data integrity (such as using CRC's).

4.0 FUNCTIONAL CAPABILITY (cont'd)

4.12.3 Validation and Automated Correction

At power up or at the end of a Configuration Database update, the CMU Mark 2 should perform a Validation of the databases stored in NVM and in the APM. During this validation routine, the databases are to be assigned a status of Failed, Invalid, or Valid. Non-valid databases should be automatically updated with Validated databases, if available, as described below. The CMU Mark 2 initially performs a CRC check of both the NVM database and the APM database. Any CRC verification failure should be logged and the corresponding database declared Failed.

If the CRC verification passes, the CMU Mark 2 compares the ICAO 24-bit aircraft address stored in NVM and the APM with the ICAO 24-bit aircraft address broadcast from an external source (such as the Mode S transponder). A Database containing an ICAO 24-bit aircraft address different from the broadcast ICAO 24-bit aircraft address is declared Invalid. A database with a matching ICAO 24-bit aircraft address is declared Valid.

If an external source for the ICAO 24-bit aircraft address is not available, the following logic is used to determine validity. If the APM database is not Failed, the APM database is assumed to be Valid. The CMU Mark 2 declares the NVM Database as Valid if the APM's Database is Valid and ICAO 24-bit aircraft address contained in the APM database and NVM database match. Else, the CMU Mark 2 declares the NVM Database as Invalid.

If the NVM Database is Valid and the APM database is Invalid or Failed, the CMU Mark 2 attempts to copy the NVM database into the APM. If successful, the APM provides normal operation. If unsuccessful, the CMU Mark 2 indicates an APM failure, but otherwise provides normal operation.

COMMENTARY

> The use of both CRCs and comparison of embedded ICAO 24-bit aircraft address with an independent ICAO 24-bit aircraft address source allows the CMU Mark 2 operation to continue while an APM is failed.

If the NVM database is Invalid or Failed and the APM Database is Valid, the CMU Mark 2 attempts to copy the APM data into NVM. If successful, the CMU Mark 2 provides normal operation. If unsuccessful, the CMU Mark 2 generates a CMU Failed Status on Label 270, suppresses Data Link transmissions, and displays a status message that requests the CMU Configuration Data be reloaded.

If both the NVM database and the APM database are Invalid or Failed, the CMU Mark 2 should generate a CMU Failed Status on Label 270, suppress Data Link transmissions, and display a status message that requests the CMU Mark 2 Configuration Data be reloaded.

If both the NVM and APM Databases are Valid, the CMU Mark 2 compares corresponding CRCs. If the CRCs match, the CMU Mark 2 provides normal operation. If the CRCs differ, the CMU Mark 2 copies the APM database into the CMU Mark 2 and, if successful, provides normal operation.

4.13 Flight Deck Functions

The CMU Mark 2 should provide the capabilities for control, display, and alerting (visual and aural) as well as support to a cockpit printer.

These functions should be designed consistent with operational use, such as by flight phase and integrated with other systems which may be sharing the displays.

The CMU Mark 2 should provide the facility to internally inhibit inappropriate CMU driven alerting (visual and aural) during designated phases of flight, such as takeoff and landing.

COMMENTARY

> For Data Link Applications support, the goal of the CMU Mark 2 Flight Deck Function should be to provide as consistent an interface with the crew for all Data Link communications (airline and ATS) as possible, regardless of the type of airplane model.
>
> However, since the CMU Mark 2 is intended to be installed in a variety of existing flight deck configurations, considerations to support specific characteristics (including MCDU variations, alternate CDUs, and primary field of view displays) should be given.

4.13.1 Data Link Services Flight Deck Support

The CMU Mark 2 should be able to provide basic Data Link Status to the crews at all times. Primary Field of View annunciation should be used for system failure or loss of data communications.

The Flight Crew should be able to view individual link status and frequencies, where applicable.

The Flight Crew should be able to alter on demand or select new Data Link services or frequencies where applicable. Data Link availability requirements of some applications, such as ATS, may restrict the selections available to the crew.

If providing VHF voice control, the CMU Mark 2 should allow the crew to manage the VHF in a similar manner to a VHF control panel and provide active status of the voice frequency in use.

4.13.2 ATS Flight Deck Support

For ATS End System Functions, the CMU Mark 2 should support a crew interface that enhances crew efficiency and minimize heads down time. Additional general guidance for ATS applications and crew interface is available in FAA Notice 8110.50, "Guidelines for Airworthiness Approval of Airborne Data Link Systems and Applications" or successor Advisory Circular.

4.0 FUNCTIONAL CAPABILITY (cont'd)

For non-tactical ATS messages or in remote operations, the CMU Mark 2 should provide an interface with an alerting system in the Primary Field of View for crew notification as well as aural alerting.

The alerting should support multiple priority levels. Aural alerting should be available on a message by message basis, but care should be taken to avoid excessive aural alerting.

For time-sensitive "tactical" ATS End System Functions, the ATS End System should provide an interface for both message display and response in the Primary Field of View.

The CMU Mark 2 should be capable of operation of multiple displays concurrently if used to host ATS applications.

The CMU Mark 2 should provide access to message logs of both queued ATS messages and received ATS messages.

COMMENTARY

> It is expected that future ATS applications such as terminal area ATS messages, will require Primary Field of View display and response.

4.13.3 AOC Flight Deck Support

AOC Flight Deck Support typically utilizes the same resources (CDU, Printer, etc.) as the ATS applications. However, the AOC applications can operate with reduced Primary Field of View functions and a single CDU is adequate.

COMMENTARY

> In three person crew aircraft retrofits of the CMU Mark 2, airline communications and ATC communications may be handled by different crew members on different display controllers. So the CMU Mark 2 should be able to provide these services independently to crew members.

4.13.4 VHF Voice Flight Deck Support

When the CMU Mark 2 is installed in an aircraft which may call for the VHF data radio to serve in a voice capacity, the CMU Mark 2 should provide for an orderly release of and subsequent re-establishment of data connectivity. CMU Mark 2 VHF data communications are interrupted for the duration of the VHF voice conversation, see ARINC Specification 618.

If the CMU Mark 2 provides VHF voice tuning capabilities, in addition to data frequencies, it also should support the extended VHF range and 8.33 kHz channel spacing tuning.

In addition, the CMU Mark 2 should be capable of providing isolation of the signals controlling the Voice/Data Modes to the associated VHF transceiver. This should be done in a manner that preserves the VHF/control panel approvals for ATC voice operations. These signals include:

a. Voice/Data Mode Output Discrete

b. MSK Audio Inputs and Outputs

c. DFS Port Select Output Discrete

d. Data Key Line Output

See Section 5.2.1.1.9, Voice Mode Isolation Program Pin, and reference Appendix B, ARINC 716 VHF Voice Configuration**.**

4.14 Operation/Initialization

The CMU Mark 2 should conduct a comprehensive built in test whenever Power-up or Reset occurs to determine the health of the CMU Mark 2. See Section 6.1.2.

The CMU Mark 2 should initiate actions (ACARS and/or ATN protocols) to determine system connectivity.

The CMU Mark 2 should perform initialization on the sub-networks in order for the sub-networks to obtain addressing information and begin communication.

4.15 Dual Installation

A dual CMU Mark 2 installation should be supported.

COMMENTARY

> The following information is preliminary and does not fully define the dual CMU Mark 2 architecture.

Two levels of dual functionality may be provided. If the CMU Mark 2 is operating at or below Level B, then only limited information needs to be exchanged between the dual units.

If the CMU Mark 2 is operating above Level B, then a more robust exchange should be provided consistent with Flight Management Systems.

In a dual CMU Mark 2 configuration, the left CMU Mark 2 is considered the normal primary unit. One CMU Mark 2 should be ACTIVE and the other in STANDBY. Only the active CMU Mark 2 should transmit Link and Network Layer data, and be a protocol-active participant with the interfaced air-ground sub-network(s).

Two mechanisms have been provided to control which CMU Mark 2 is active and which is standby:

a. Discrete I/O pins Dual Active/Standby Discrete Out (TP-2J) and Dual Inhibit Discrete In (TP-6D), see Sections 5.3.16.2 and 5.3.16.3

b. Crosstalk bus, see Section 5.3.16.1

4.0 FUNCTIONAL CAPABILITY (cont'd)

4.15 Dual Installation (cont'd)

COMMENTARY

Transfer of active status from one to the other deserves some forethought. Designers should take care to preclude both units from being commanded to be active or standby simultaneously. Timing of the command, turn-on time and turn-off time of the units should be considered.

Pilot control of which CMU Mark 2 is active can be performed on a MCDU screen or optional panel.

Systems interfacing with the CMU Mark 2 which do not support dual CMU Mark 2 inputs, such as the ARINC 716 VHF Communications Transceiver, should interface only with the left CMU Mark 2 as shown in Attachment 1-8. Dual CMU Mark 2 operation over VHF can be achieved with digital (ARINC 429) interfaces with an ARINC 750 VHF Data Radio.

COMMENTARY

Relays and switching devices can be used to provide dual CMU Mark 2 interfaces with systems containing only one input. The relays and switching devices may significantly increase the cost of the installation and adversely affect the system reliability. Such installations are not recommended or defined herein.

4.16 Options and Growth

The CMU Mark 2 is defined to support a variety of aircraft architectures, as well as allowing for the system to be configured to meet the individual needs of each airlines preferences. Within some aircraft architectures, the CMU Mark 2 is expected to perform all of the applications identified in Section 4. In other aircraft configurations, a subset of the applications may reside within the CMU Mark 2, such as the basic message routing, while other avionics perform other functions.

COMMENTARY

Some functions are based on technology that is still in the definition stage. These functions are expected to be offered as upgrades by avionics vendors when such technology is defined. Aspects of the System Design, identified in Section 3, should be considered by the avionics vendor as being part of the basic CMU Mark 2.

4.17 CMU Simulator Functions

The CMU should support all of the simulator functions listed in ARINC Report 610A, Appendix I. The simulator functions are controlled by ARINC
c-1 Specification 429 broadcast words defined in ARINC Report 610A The CMU receives the simulator broadcast words via the interface defined in Section 5.5.2 of this document.

Section 5.5 of this document defines the CMU-simulator interfaces.

The CMU detects that it is installed in a simulator when the Installed in Simulator program pin is grounded (see Section 5.5.1) and the simulator ARINC 429 broadcast words are present (see Section 5.5.2). An Ethernet interface is provided (see Section 5.5.3) for the transfer of air-ground messages.

COMMENTARY c-1

Protocols and message formats are expected to be defined so that the Ethernet link can be used instead of simulating the VHF, satellite, and HF air-ground datalinks.

5.0 INTERFACES AND PROTOCOLS

5.1 Air/Ground Communications - Protocol

The CMU Mark 2 is expected to implement a wide variety of protocols related to aeronautical mobile communications. Most notably, they consist of the ACARS and ATN related protocols.

5.1.1 ACARS Air/Ground Protocols

The ACARS Air/Ground protocols may be used to provide a character-oriented data link service utilizing various air/ground media including VHF, SATCOM, and HF. The air/ground protocol used in sending and receiving ACARS messages is defined in ARINC Specification 618. The CMU should operate in the store and forward mode defined in ARINC Specification 618.

For ARINC 716 VHF ACARS mode of operations, the CMU Mark 2 provides an internal MSK modem. The CMU performs all ACARS link layer and MAC protocols.

c-1 For ARINC 750 VHF Mode A of operation, the VDR provides the MSK modem. As such, an internal MSK modem in the CMU Mark 2 is not needed. In this configuration, the CMU hosts the ACARS link layer sub-layer and the VDR hosts the MAC sub-layer.

Satellite and HF Data Link provide their own "reliable" air/ground protocols. The CMU should exercise the ACARS air/ground protocols defined in ARINC Specification 618 above the Air/Ground Link Layer protocols.

5.1.2 ACARS Ground/Ground Communications

ARINC Specification 620 describes the conversion to/from the ACARS Air/Ground format and the ACARS Ground/Ground format. The Ground/Ground message format is called Type B.

COMMENTARY

Type B ground/ground messages do not use the air/ground multiblock format. The service provider performs the conversion between the Type B ground/ground message and the air/ground messages. See ARINC Specification 620.

5.1.3 ACARS 622 ACF (ATN Bit to ACARS Char)

The ARINC 622 ACARS Convergence Function (ACF) provides a protocol that permits binary data to be transmitted using ACARS and provides additional integrity to the message.

COMMENTARY

This function is quite similar to other commercial communication protocols providing binary services using character protocols such as KERMIT and UUENCODE.

The CMU Mark 2 could utilize the ACF to send Company Communications, but the ACF was developed to support the ATS applications.

Since the ACF provides additional integrity to permit the ACARS network to handle ATS messages, it should be performed by the same host that is generating or decoding the ATS messages.

5.1.4 ATN Air/Ground Protocols

The ATN architecture consists of a suite of protocols selected for the aircraft-ground communications as derived from the OSI Reference Model. This layered architectural model is specially designed to permit greater interconnectability of systems.

The OSI model represents a layered system in which the communications functions are partitioned into a vertical set of layers. Each layer performs a related subset of the functions necessary to communicate with another data system. The OSI model provides the basis for connecting "Open" systems for distributed applications processing.

The lower layers, i.e., the physical, data link and network layers, comprise the network-dependent portion of the ISO protocol architecture.

5.1.4.1 ATN/ACARS Gateway/Envelope

Current avionics end-systems were designed to send and receive messages across the ACARS air-ground network. If these End Systems are not updated to operate within the ATN, the CMU Mark 2 is expected to provide a translation facility, called a Gateway, that can enable the existing equipment to continue to function without replacement.

COMMENTARY

However, in the case where a CMU Mark 2 is sending "ACARS" data over the ATN, this envelope conversion should be considered and could become a CMU Mark 2 function.

ARINC Specification 619 describes the existing interface between the ACARS management unit and its interface avionics. The gateway function is expected to support this interface.

The CMU Mark 2 should determine the appropriate link layer protocol to interface to each end system as specified in ARINC Specification 429.

5.1.4.2 ATN - Upper Layers Protocol

The OSI Upper Layers consist of the Transport Layer, Session Layer, Presentation Layer, and Application Layer. Depending on how the upper layers are implemented, the OSI protocol stack can be a full stack, fast byte stack, or short stack.

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.1.4.2.1 Full Stack

A full stack is the implementation of all of the upper layers on top of the Network Layer. Implementation of the full stack is to be fully compliant with the Protocol Implementation Conformance Statements (PICS) of the standard OSI upper layers. Reference the ICAO ATN SARPs.

COMMENTARY

> The ICAO ATN SARPs recommends not requiring the full OSI upper layer protocol stack for CNS/ATM avionics (or ground) implementations.

5.1.4.2.2 Fast Byte Stack or ICAO U/L

The "Fast Byte Stack", or "ICAO U/L" is a variation of the full stack where only the needed elements of the Application Layer, Presentation Layer and Session Layer are implemented to support the applications. For example, the Network Management Common Management Information Protocol (CMIP) uses the Association-Control-Service-Element (ACSE) and Remote Operation Service Element (ROSE) of the Application Layer which, in turn, uses some of the services of the Presentation Layer. Since the Presentation Layer cannot interface directly to the Transport Layer, some of the Session Layer's services are used.

The upper layers in a fast byte stack, therefore, only consist of a subset of the Application Layer, a subset of the Presentation Layer, and a subset of the Session Layer and the complete Transport Layer. See the ICAO ATN SARPs. Also, see Attachments 1-2 through 1-5, which depict the fast byte stack as "ICAO U/L" for the CNS/ATM End State Architectures (over ATN).

5.1.4.2.3 Short Stack

The short stack consists of the Transport Layer running on top of the Network Layer, Data Link Layer and Physical Layer. There are no Session, Presentation and Application Layers. RTCA specifications DO-212, DO-219, and DO-223 for ADS, CPDLC, and CM (Context Management), respectively, specify implementation of those ATS applications over the short stack.

While RTCA applications such as CM, ADS, and CPDLC, are defined to run with the short stack, the Network Management application uses the Application, Presentation and Session Layers. However, because the full stack implementation of the Session, Presentation and Application Layers is superfluous for the support of CMIP, the fast byte stack (ICAO U/L) is recommended in the ATN environment. In addition, updated ICAO ATS applications are currently being defined which also use a fast byte stack (instead of the full stack).

Therefore, if either Network Management and/or the new ICAO applications are implemented in an avionics (or ground) ATN end system, the fast byte services of the Application, Presentation and Sessions Layers should be used. Other (RTCA-based) ATS applications should directly use the service of the Transport Layers, as defined. Attachments 1-2 through 1-5 illustrate the various applications linkages to the ATN stack for different CNS/ATM architectural configurations.

For the upper layers, the CMU Mark 2 should support both the Connection-Oriented Service and the Connectionless Service, as specified in the ICAO ATN SARPs.

5.1.4.3 ATN - Network/Sub-network Layer Protocol

The CMU Mark 2 should provide the Connectionless Network Service (CLNS - ISO 8473) as described in the ICAO ATN SARPs. The Sub-network Access Protocol (SNACP) is at the sub-network level through the ISO 8208 packet layer protocols.

5.1.4.4 ATN - Internetworking

The CMU Mark 2 should operate as an Intermediate System (IS), performing the function of an ATN Router. The ATN Router performs connectionless relaying and routing of data packets as defined in the ICAO ATN SARPs. The connectionless relaying and routing of data packets is performed across interconnecting sub-networks based on source and destination Network Layer addresses and the user's routing policy.

5.1.4.5 ATN - VHF AVPAC Protocol

The CMU Mark 2 should provide ISO 8208 packet protocol and the Link Management Entity (LME) for the VHF sub-network as defined in ARINC Specification 631, "Aviation VHF Packet Communications (AVPAC) Functional Description."

5.2 Sub-network Interfaces

5.2.1 VHF Radio Interface

The specific VHF interface varies from airline to airline and airplane to airplane. In some cases, portions of the defined interfaces may not be needed. However, the CMU Mark 2 is expected to be capable of supporting the various options. The interfaces (and associated interwiring) used on a given aircraft depend largely upon:

a. Type of radio (ARINC 716/750)

b. Radio configuration (750 Mode 0/Mode A/Mode 1/Mode 2)

c. Voice mode and radio management system issues

d. Air/ground protocols and speeds, including MSK ACARS, AVPAC Mode 1, 2 and 3

The ARINC Characteristic 750 VDR has the capability of providing several modes of operation. The various modes which have been defined are documented in ARINC Characteristic 750. The CMU controls which mode is to be used and mode switching may be dynamic depending on the services provided along the route.

5.0 INTERFACES AND PROTOCOLS (cont'd)

c-1 When the CMU is connected to an ARINC Characteristic 750 VDR, then the CMU can control whether the VDR responds to the analog interface (Mode 0) or the ARINC 429 interface (all other modes at this time) with bit 15 in the CMU Label 270 status word. By providing explicit direction to the VDR regarding which interface (ARINC 429 or analog) is to be used, it is possible to install the CMU/VDR ARINC 429 bus wiring (see Sections 5.3.2.4, 5.3.2.6, and 5.3.2.7) in anticipation of future use, yet still use the analog interface.

5.2.1.1 ARINC 716 VHF Transceiver Interface

5.2.1.1.1 ARINC 716 Modem Interface

c-1 If the aircraft is configured to communicate using radios designed to ARINC Characteristic 716 functionality, the CMU Mark 2 should include an MSK (minimum shift keying) modem (modulator/demodulator). Bit 15 of the CMU status word, Label 270 (see Attachment 6, Table 6-8) c-1 should be set to 0 so that when a VDR is installed, it responds to the analog interface and ignores the ARINC 429 data interface (not to be confused with the tuning interface, Section 5.2.1.1.7).

COMMENTARY

> ARINC 750 VHF Data Radios are highly desired for all installations in the CNS/ATM environment. However, provisions are permitted to allow other radios to be used.
>
> The CMU Mark 2 does not support VHF radios designed to ARINC Characteristic 546, "Airborne VHF Communications Transceiver System," or ARINC 566A, "Mark 3 VHF Communications Transceiver" due to inadequate radio performance for Data Link communications.

The CMU Mark 2 MSK modem interfaces with the VHF transceivers via a twisted shielded pair over which 1200 and 2400 Hz MSK audio tones are exchanged.

The characteristics of the audio signals, the MAC sublayer, and the ACARS Frame layer are described in ARINC Specification 618.

5.2.1.1.2 Voice/Data Mode Monitor Input Discrete

The CMU Mark 2 should provide a discrete input (TP-7E) to monitor whether the VHF air/ground link is in Data Mode or Voice Mode. A "Standard Ground" indicates the CMU Mark 2 should operate in Data mode, and a "Standard Open" indicates the CMU Mark 2 should operate in Voice Mode. Standard Ground and Standard Open signals are defined in Section 2.9, ARINC Standard Interfaces.

In installations in which the CMU Mark 2 controls the VHF transceiver, TP-7E is typically strapped to connector pin TP-7F on the aircraft side of the connector.

5.2.1.1.3 Remote Voice/Data Select Input Discrete

The CMU Mark 2 should change from VHF Data mode to VHF Voice Mode and vice versa whenever a momentary airframe dc ground is applied to the Remote Voice/Data Mode Select Discrete Input located on service connector pin TP-5J.

"Momentary" is defined as application of a "Standard Ground" for 50 milliseconds or more. At all other times, this pin should see a "Standard Open" circuit. Standard Ground and Standard Open signals are defined in Section 2.9, ARINC Standard Interfaces. One source of this input could be a push-button switch on the VHF COMM transceiver control panel.

5.2.1.1.4 Voice/Data Mode Annunciation Output Discrete

The Voice/Data Mode Annunciation Output Discrete (TP-7F) is used to indicate whether the VHF transceiver associated with the CMU Mark 2 is to operate in Voice or Data Mode. This discrete may also be used to control the keying mode of the ARINC 716 VHF transceiver. Its operation is defined in ARINC Specification 618.

This Discrete should consist of a "Standard Ground" when the VHF transceiver is to operate in the Data Mode or "Standard Open" when the VHF transceiver is to operate in the Voice mode. Standard Ground and Standard Open signals are defined in Section 2.9, ARINC Standard Interfaces.

5.2.1.1.5 Remote Voice/Data Mode Annunciation Output Discrete

A Remote Voice/Data Status Annunciator Output Discrete having identical logic to pin TP-7F should appear at CMU Mark 2 connector pin TP-5K for the purpose of operating a status annunciator. The switching component in the CMU Mark 2 should be capable of handling 250 milliamperes of current in the "ground" state and holding off 36 Vdc in the "open" state. c-1

COMMENTARY

> The current handling capabilities of this discrete output are an exception to the Standard Ground and Standard Open outputs defined in Sections 2.9.2 and 2.9.3. The more stringent criteria are due to the potential for the CMU Mark 2 to be installed on aircraft in which the output is used to sink lamp current directly, rather than control a lamp driver.

5.2.1.1.6 DFS Port Selection Output Discrete

A DFS Port Select Output Discrete (TP-7C) provides tuning source selection to the VHF transceiver. The DFS Port Selection Output discrete should be a "Standard Ground" whenever the CMU Mark 2 expects to be the source of the ARINC 716 VHF frequency to that transceiver. It should be a "Standard Open" whenever control is relinquished to an external tuning

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.2.1.1.6 DFS Port Selection Output Discrete (cont'd)

system or dedicated control head. Standard Ground and Standard Open signals are defined in Section 2.9, ARINC Standard Interfaces.

5.2.1.1.7 DFS ARINC 429 Tuning Interface

Digital (ARINC 429) Tuning information should be passed from the CMU Mark 2 to the VHF transceiver via a twisted shielded pair using the broadcast protocol of ARINC Specification 429 when providing ARINC 716 tuning data to the VHF transceiver. This output is primarily used to supply data frequencies, but may also be used to provide voice frequencies. See Section 5.3.3.2.

COMMENTARY

> ARINC 716/750 transceivers with 25 kHz channels only respond to Label 030 for frequency tuning.
>
> ARINC 716/750 transceivers which have been modified to support 8.33 kHz channels respond to Label 047 and Label 030. Label 030 is used to supply data frequencies to the VHF transceivers and 25 kHz voice channel frequencies.

5.2.1.1.8 VHF Data Key Output Discrete

A VHF Data Key Line Output Discrete (TP-5H) and Return (TP-7K) provide radio keying. Operation of the VHF Data Key Line Discrete Output is defined in ARINC Specification 618.

The VHF Data Key Line Output Discrete should be a "Standard Ground" whenever the CMU Mark 2 is providing MSK signals to the VHF transceiver. It should be a "Standard Open" to end data transmission. Standard Ground and Standard Open signals are defined in Section 2.9, ARINC Standard Interfaces.

5.2.1.1.9 Voice Mode Isolation Program Pin

The Voice Mode Isolation Program Pin is assigned to pin MP-09D. Its operation is defined in ARINC Characteristic 724B, "Aircraft Communications Addressing and Reporting System (ACARS)". A "Standard Program Pin Ground" is used to indicate that the VHF Isolation function is active as defined in ARINC Characteristic 724B. Standard Program Pin Ground and Open signals are defined in Section 2.9, ARINC Standard Interfaces.

5.2.1.1.10 Voice Channel Frequency Control Program Pin

The Voice Channel Frequency Control Program Pin is assigned to pin TP-11C. Its operation is defined in ARINC Specification 618. A "Standard Program Pin Ground" is used to indicate that the CMU Mark 2 is used to provide Voice frequencies to the transceiver. A "Standard Program Pin Open" indicates an external control source is available for VHF Voice tuning. Standard Program Pin Ground and Open signals are defined in Section 2.9, ARINC Standard Interfaces.

5.2.1.1.11 8.33 kHz Tuning Discrete Input Pin

The 8.33 kHz Tuning Discrete Input Pin is assigned to CMU pin MP-2B. A "Standard Ground" is used to indicate that the VHF transceiver supports 8.33 kHz voice channels when ARINC 429 Label 047 is used (see ARINC Characteristic 716). A "Standard Open" indicates that the transceiver only supports 25 kHz channels.

Standard Ground and Open signals are defined in Section 2.9, ARINC Standard Interfaces.

5.2.1.2 ARINC 750 VHF Transceiver (Level 0.1)

The ARINC 750 VHF Transceiver supports several modes of operation as defined in ARINC Characteristic 750. All modes, except Mode 0 (ARINC 716 emulation), are expected to use the ARINC 429 CMU-VDR physical and link layer interface as defined in ARINC Characteristic 750 and Sections 5.2.1.2.1 and 5.2.1.2.2 of this document. When the CMU interface uses the ARINC 429 interface instead of the analog interface, then bit 15 of the CMU status word, Label 270 (see Attachment 6, Table 6-8) should be set to 1 to direct the VDR to respond to the ARINC 429 data interface and ignore the analog interface.

A CMU Mark 2 designed to level 0.1 or higher should support the ACARS ARINC 618 protocol protocols over the air/ground link via an ARINC 429 CMU-VDR interface. A CMU Mark 2 designed to level 1 or higher should also support low speed AVPAC protocols over the air/ground link via an ARINC 429 CMU-VDR interface. A CMU Mark 2 designed to level 2 or higher should also support high speed AVPAC protocols over the air/ground link via an ARINC 429 CMU-VDR interface.

The CMU-VDR digital interface is described in ARINC Characteristic 750, "VHF Data Radio."

5.2.1.2.1 Physical Interface

The CMU-VDR physical layer interface is an ARINC 429 data bus operating at high speed. Word size, voltage thresholds, and electrical interface specifications are per ARINC Specification 429. The minimum word gap between two words should be as defined in ARINC Characteristic 750.

5.2.1.2.2 Link Layer Interface

The CMU should use the high speed version 1 ARINC 429 BOP to exchange command, control, and data packets as described in ARINC Characteristic 750. In addition to sending and receiving ACARS blocks using the high speed version 1 ARINC 429 BOP, additional support for this interface is provided by ARINC 429 discrete data words sent between the MU and VDR as specified in ARINC Characteristic 750, Section 5.5.

5.0 INTERFACES AND PROTOCOLS (cont'd)

For BOP transmissions from the MU to VDR, the MU should use the System Address Label (SAL) reported by the VDR in its Label 172 data word output to the MU.

VDR	SAL
1	250 octal
2	251 octal
3	252 octal

All BOP transmissions from a VDR to a MU should use SAL 304 octal. The master MU should accept a received SAL of 304 octal regardless of installed position, 1 or 2.

The CMU and VDR use a tailored set of timer values and protocol events in order to provide the performance (primarily minimum propagation delay) to support the air/ground link with a modified version 1 of ARINC 429 BOP. All protocol events for the MU/VDR ARINC 429 version 1 interface should be according to the definitions in ARINC Characteristic 750. All timer values for the MU/VDR interface should be the modified definitions in ARINC Characteristic 750.

c-1 In addition, the following BOP Protocol Options should be used by the MU for the VDR interface (reference ARINC Characteristic 750):

Option	Description	Default
O1	Half or Full Duplex	Half
O2	High or Low Speed Bus	High
O3	Automatic CTS When Ready	Yes
O4	Accept Automatic CTS	Yes
O5	SYS Priority to Resolve Conflict	CMU
O6	Reserved	
O7	Reserved	
O8	Use of SOLO Word	Yes
O9	Reserved	
O10	Destination Code Required	Yes
O11	Bit-Protocol Verification (ALO/ALR Protocol Determination)	Yes
O12	Use Subsystem SAL from ALO word	No

Reception of a SYN word should cause the receiving system to abort any reception or terminate any transmission in progress. In addition, if the system was transmitting, it should re-initiate transmission of the file that was aborted.

On power-up, systems should transmit ALO words as opposed to sending NAK or SYN. All systems are to respond with an ALR if an ALO is received, as defined in O11.

5.2.1.2.3 ARINC 750 Status Exchange

The CMU Mark 2 should receive broadcast ARINC 429 data words (Label 270) containing the Voice/Data Mode status from each interfacing VDR. Labels 172 (VDR System Address Label) and 377 (VDR Equipment Identifier) are also available. See ARINC Characteristic 750 for the definition of these ARINC 429 word formats.

The CMU Mark 2 should transmit broadcast ARINC 429 data words (Label 270 and 172), containing the CMU Mark 2 status information and CMU System Address Label respectively, to the VDRs on the COMM output buses.

5.2.1.2.4 ARINC 750 Control and Configuration

The MU and VDR exchange the messages defined in ARINC Characteristic 750. The messages defined in Sections 3 and 5 are used to control and configure the VDR. ARINC Characteristic 750 contains an attachment for each air-ground protocol and the corresponding attachment defines the messages for that protocol. Each message transmitted by the CMU triggers a response message from the VDR. The CMU should wait for the response message before sending the next message. The c-1
VDR should transmit the response message within the time indicated in ARINC Characteristic 750.

5.2.1.2.4.1 VDR Configuration

The VDR supports several modes of operation. Therefore, the initial step in CMU-VDR communication is to establish the desired mode of operation, which is referred to as air-ground protocol negotiation or VDR configuration. VDR configuration is performed every time the VDR transitions to Data Mode, either from power up or from Voice mode.

ARINC Characteristic 750, Sections 3 and 5, define the primitives used to perform VDR configuration. Air-ground protocol negotiation is defined in ARINC Characteristic 750, Sections 3 and 5. The next step after air-ground protocol negotiation is initialization of the VDR with the data used for operation by the selected protocol.

VDR configuration is performed using general data format GFI 2, and destination code 00_h. Solo words and file transfer are used as indicated in ARINC Characteristic 750, Section 5, to perform the VDR configuration. At this time messages with GFI values other than 2 are considered errors and are ignored, other than error processing.

COMMENTARY

When the CMU resets and the VDR does not, then it is possible for the CMU to receive protocol messages even though the CMUs state indicates

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.2.1.2.4.1 VDR Configuration (cont'd)

COMMENTARY (cont'd)

that a protocol has not been selected yet. Likewise, if the VDR resets and the CMU does not, then it is possible for the CMU to transmit protocol messages before it detects the change in VDR state because there can be up to a 1 second delay in the annunciation of the change in VDR status. The CMU and VDR designers should consider this.

5.2.1.2.4.2 VDR Protocol Initialization

After the VDR configuration has been determined then the initialization data used by the selected protocol is transferred to the VDR.

5.2.1.2.4.2.1 VDR Mode A (ACARS Protocol)

When Mode A (ACARS protocol) is selected then the initialization is performed as defined in ARINC Specification 618, Section 11. ARINC Characteristic 750, Attachment 11, lists the various message formats that have been defined for MU-VDR communication when the ACARS protocol is used. VDR initialization is performed using general data format GFI F_h, extended GFI $F2_h$ and destination codes 00_h and 01_h. VDR initialization is performed every time the VDR transitions to Data mode, either from power up or from Voice mode, or after a loss of VDR bus activity. c-1

The extended GFI code $F2_h$ indicates that the ACARS protocol message set, as defined in ARINC Characteristic 750, Attachment 11, is being used. In the ACARS protocol message set, destination code 00_h is used to identify control messages and destination code 01_h is used to identify data (uplink/downlink) messages.

Messages with GFI values other than 2_h or F_h are considered errors and are ignored, other than error processing. Messages with GFI value F_h and extended GFI values other than $F2_h$ are considered errors when the ACARS protocol has been selected and are ignored, other than error processing. Destination codes other than 00_h and 01_h are considered errors when the ACARS protocol has been selected and are ignored, other than error processing.

COMMENTARY

The CMU designer may choose to respond to invalid extended GFI codes by resetting the VDR, or re-configuring the VDR, or ignoring this unlikely event. Other protocols, such as AVPAC use a different extended GFI value.

The CMU initializes the VDR with the operational parameters (frequency, prekey, modulation) and addresses (aircraft registration, flight identifier and broadcast address). At a minimum, the CMU uses the PARAM_REQ message and the ADDR_REQ message to initialize the ACARS protocol. See ARINC Specification 618, Attachment 13, Figures 13-3 and 13-4.

5.2.1.2.4.2.2 VDR Modes 1 and 2 (AVPAC Protocol)

When the AVPAC protocol is selected by the CMU then the initialization is performed as defined in ARINC Specification 631. ARINC Characteristic 750, Attachment 10, lists the various message formats that have been defined for MU-VDR communication when the AVPAC protocol is used. VDR initialization is performed using general data format GFI F_h and extended GFI $F1_h$. VDR initialization is performed every time the VDR transitions to Data Mode, either from power up or from Voice mode. c-1

The extended GFI code $F1_h$ indicates that the AVPAC protocol message set, as defined in ARINC Characteristic 750, Attachment 10, is being used. Messages with GFI values other than 2 or F_h are considered errors and are ignored, other than error processing. Messages with GFI value F_h and extended GFI values other than $F1_h$ are considered errors when the AVPAC protocol has been selected and are ignored, other than error processing.

5.2.1.3 VHF Loadable Options

Due to the broad nature of VHF related options, the CMU Mark 2 should be able to support additional configuration functions through loadable options. Most of the functions are assumed to be stored in the APM. However, other methods could also be used such as MCDU data entry or stored internal to the CMU Mark 2. ARINC Specification 618, Section 6, outlines some of these VHF Configuration options, as well as the following information:

The CMU Mark 2 may need to know whether the ARINC 716 VHF transceiver supports 8.33 kHz channels or only 25 kHz channels. See Section 5.2.1.1.11

The CMU Mark 2 may need to know whether voice tuning capabilities should be provided and any associated timers. c-1

COMMENTARY

Typical aircraft wiring does not allow the CMU to provide the voice tuning for the ARINC 750 VHF transceiver.

When the CMU Mark 2 is installed with multiple VDRs, it should be able to determine which one should be primarily used for data communications.

5.2.2 SDU ARINC 741 Interface

Satellite data communications are conducted via an interface with a Satellite Data Unit (SDU). The CMU Mark 2 should be capable of interfacing with two SDUs as defined in ARINC Characteristic 741. Dual SDUs operate in a master/slave mode, where only the master SDU exchanges air/ground packets with the CMU Mark 2. The SDUs determine which unit is master and which unit is slave and conveys this information to the CMU Mark 2 in the SDU status word. The CMU Mark 2 recognizes which SDU is master and utilizes its services to communicate with the ground.

The connections defined in Section 5.3.2.4 are used when the CMU Mark 2 interfaces with SDUs via a low speed ARINC 429 bus. The connections defined in Sections 5.3.2.6 and 5.3.2.7 are used when the CMU Mark 2 interfaces with SDUs using high speed ARINC 429 buses. When 2 SDUs are connected to the CMU Mark 2, then both SDUs use similar ARINC 429 interfaces, i.e., both low speed or both high speed.

Data 2 and Data 3 modes of operation have been defined. Both modes can operate simultaneously.

5.2.2.1 SATCOM Data 2

The Data-2 CMU-SDU protocol is defined in ARINC Specification 618. Data 2 is an ACARS packet based sub-network developed to facilitate integration into the existing ACARS VHF network. The complete CMU-SDU interface for Data 2 is defined in ARINC Characteristic 741 or ARINC Specification 618 either explicitly or by reference. ARINC Specification 618 also contains the packet formats exchanged between the CMU Mark 2 and its peer on the ground.

5.2.2.2 SATCOM Data 3

The Data 3 CMU-SDU protocol is defined in ARINC Characteristic 741. Data 3 is a bit-oriented, ATN compatible sub-network. The complete CMU-SDU Data 3 interface is defined in ARINC Characteristic 741 either explicitly or by reference.

5.2.2.3 SDU as an End System

The CMU Mark 2 also supports the SDUs as an end system. The CMU Mark 2 can route uplinks to each SDU and the CMU Mark 2 can route downlinks from both SDUs. ARINC Characteristic 741 and ARINC Specification 619 define the SDUs as an end system with the CMU Mark 2.

Dual SDUs are considered separate end systems and can generate and receive messages as an end system regardless of master/slave status.

5.2.3 HF Data Link ARINC 753 Interface

HF Data Link (HFDL) is conducted via an interface with an HF Data Radio (HFDR) or HF Data Unit (HFDU). The HF Data Radio and HF Data Unit are described in ARINC Characteristic 753. The HF Data Link air/ground protocols are defined in ARINC Specification 635.

HF Data Link supports the transmission of both enveloped ACARS messages and ATN sub-network access according to ISO 8208. The HFDL asserts its protocol support in its Label 270 word to the CMU Mark 2. Some HFDL's may only have enveloped ACARS message capabilities. In addition to ACARS messages and ATN packets, status, and command and control messages may also be sent between the CMU Mark 2 and HFDLs. c-1

The CMU-HFDL link layer interface uses the ARINC 429 Bit Oriented Protocol (BOP*)* to exchange information and packets with the HFDL. Link Layer options are specified in ARINC Characteristic 753. The CMU Mark 2 should use the HFDL transmitted Label 172 to acquire the SAL of the HFDL attached to a specific I/O port. The HFDL equipment should normally be connected to the COMM Link General Bus #4 ports. The HFDL SAL's are 340 for HFDL #1 and 344 for HFDL #2. An ARINC 429 BOP GFI of "1110_b" is used for Enveloped ACARS, "0100_b" for 8208, and "0010_b" for command and control with the CMU Mark 2. c-1

The CMU-HFDL physical layer interface is an ARINC 429 data bus operating at low speed. The CMU Mark 2 is capable of interfacing with two HFDLs on its COMM Link Bus #4 as defined in Section 5.3.2.4. Dual HFDLs both operating in Data Mode should operate in a master/slave mode, where only the master HFDL exchanges air/ground packets with the CMU Mark 2. The CMU Mark 2 contains logic to determine which HFDL is master and which HFDL is slave. The master/slave control information is conveyed to the HFDLs via the Label 276 word transmitted by the CMU Mark 2. See Section 5.2.3.7.

5.2.3.1 HFDL Air/Ground Messages

The CMU-HFDL ACARS interface is described in ARINC Specification 618. c-1

The CMU-HFDL ATN ISO 8208 Interface is described in ARINC Characteristic 753.

5.2.3.2 HFDL Configuration Management

The CMU Mark 2 should utilize its Configuration Management Data Base to determine:

a. The number of HFDLs installed in the aircraft

b. The CMU Mark 2 data bus (port) being used

The CMU Mark 2 determines whether Data Link capable HF radios are installed based on information stored in the Configuration Management Data Base and reports status on its Label 276 output word. Bit 22 indicates the installation status of HFDL 1 and Bit 23 indicates the installation status of HFDL 2. A bit value of 1 indicates that a Data Link capable HF radio is installed in that position. A bit value of 0 indicates either no HFDL is installed in that position or the HFDL installed in that position does not support datalink operation.

Installation status of the HFDL is determined solely from the configuration data base. ARINC 429 activity is not used in calculating HFDL installation status. ARINC 429 information (bus activity and Label 172) may be used by the CMU Mark 2 to determine which port the HFDL's are attached to in a particular installation.

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.2.3.3 Reserved

This section is retained as a placeholer.

5.2.3.4 HF Data Link Fault Status Determination

Each CMU Mark 2 determines fault status for HF Data Link by looking for failures reported from each installed HFDR, or by absence of activity on the HFDR ARINC 429 interface. The CMU Mark 2 reports the status on Label 276, Bits 24 (HFDR 1) and 25 (HFDR 2).

See Attachment 4, Tables 4-1 through 4-4 for the HF Data Link Fault Status Determination logic to be implemented in the CMU Mark 2.

CMU #1 uses Bits 12 and 16 from each HFDR and ARINC 429 activity from each HFDR to determine the Fault status for each HFDR that is installed.

CMU #2 uses Bits 16 and 19 from each HFDR and ARINC 429 activity from each HFDR to determine the Fault status for each HFDR that is installed.

c-1 Faults are only reported for HFDRs which are considered installed according to the definition in Section 5.2.3.2.

5.2.3.5 HF Link Status Determination

The CMU Mark 2 is responsible for monitoring and annunciation of the HFDL link status. Air/ground message traffic is only routed to the HFDL when an active HF data link is indicated as available.

The CMU Mark 2 annunciates HFDL Link status on both its MCDU and through digital annunciations (Label 270). See Attachment 6.

For ATN communications, the CMU Mark 2 processes HF "Join/Leave" events broadcast by the HFDL in order to update the CMU Router tables.

5.2.3.6 HF in Voice Reporting

c-1 The CMU Mark 2 reports the Voice/Data Mode of each HFDR 1 and HFDR 2 on Label 276, Bits 20 and 21, respectively. HF data communication may not be possible during HF Voice operations.

COMMENTARY

c-1 It should be noted that HF radios utilize a single antenna and only one HF radio can transmit at a time. Long voice transmissions from the aircraft will suspend all HF data communications. Bits 13 and 14 in the Label 270 word from each HFDR may be utilized to monitor this type of event, which reports the HF transmission status to the CMU Mark 2.

See Attachment 4, Tables 4-5 and 4-6 for the HFDR Voice/Data Mode Determination logic to be implemented in the CMU Mark 2. Note that HF Voice/Data Mode determination is performed by the CMU Mark 2 regardless of whether the HFDR is installed.

5.2.3.7 HFDR Master/Slave Determination Logic

In dual HF Data Radio installations, the CMU Mark 2 is responsible for determining the Master/Slave status of each HFDR.

The CMU Mark 2 conveys the Master/Slave status to each installed HF Data Radio on Label 276, Bits 26 (HFDR 1) and 27 (HFDR 2).

If only one HFDR is Installed, that HFDR is designated Master and the other is designated Slave.

If no HFDRs are Installed, both HFDRs are designated Slave.

If both HFDRs are Installed, then HFDR 2 should be designated as the opposite Master/Slave state of HFDR 1. See Attachment 4, Table 4-7 for the HFDR Master/Slave Determination logic to be implemented in the CMU Mark 2.

COMMENTARY

The Master/Slave logic is used by some Warning Alert systems to determine when to annunciate HF Data Link Failures, for airplane configurations that alert failure of only the Master HFDR. To enable the appropriate Alerting, the CMU Mark 2 consequently declares a failed HFDR in Data Mode as Master if the other HFDR is in Voice Mode, and declares it as Slave if the other HFDR is in Data Mode. c-1

5.2.3.8 HFDR/HFDU BITE Support

The CMU Mark 2 may be used in some installations to provide maintenance support as the HFDR/HFDU has no significant display capability. At a minimum the CMU Mark 2 should be able to display this information in a maintenance friendly format, and may optionally be able to print or downlink the data. In order to do this, the CMU Mark 2 should:

a. process the Bit Oriented BITE fault codes (Label 350) information received from the HFDR/HFDU for equipment status information. This information includes basic equipment health (HW)

b. process information in the Label 270 word from the HFDL that may be useful for maintenance and troubleshooting purposes

c. be able to request and process pages of data as defined in ARINC Characteristic 753, Section 10.5.2.2, using command/control response messages

COMMENTARY

ARINC Characteristic 753 has also made provisions to use Command/Control messages to exchange Owner's Requirements tables. However, at present there are no Owner's Preference elements defined for HF Data Link.

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.2.4 Gatelink Interface

COMMENTARY

The operation of the Gatelink has yet to be defined although the increasing need for such a link to accommodate the extremely high volume of digital data to and from the aircraft is recognized.

Gatelink data communications should be conducted via an interface with a Gatelink Unit. The Gatelink Unit is described in ARINC Specification 632, "Gate-Aircraft Terminal Environment Link (Gatelink)."

The Link layer interface should be an ARINC 429 data bus operating at high speed.

5.2.5 Transponder

c-1 There is currently no subnetwork defined over Mode S. Until such a subnetwork is defined, the Mode S bus to TCAS may be connected to the CMU input port reserved for a Mode S transponder, in order to provide a source for ICAO 24-bit aircraft address. The Mode S outputs ICAO 24-bit aircraft address on Labels 275 and 276, per ARINC Specification 429, Part 2. If the separate Transponder Data Link is later connected to these CMU input ports to support a new subnetwork, the Data Link bus may also be a source for ICAO 24-bit aircraft address. If so, the transponder is expected to output ICAO 24-bit aircraft address on Labels 214 and 216 as per Attachment 6 Tables 6-10 and 6-11 and ARINC Specification 429, Part 1. c-1

The CMU Mark 2 should, therefore, recognize ICAO 24-bit aircraft address from the transponder on either Labels 275, 276 or Labels 214, 216. Note that similar formats are used for the 2 Label pairs.

5.2.6 ARINC 761 STU Interface

Satellite data communications can be conducted via interfaces with one or more ARINC 761 Satellite Terminal Units (STU). The CMU Mark 2 should be capable of interfacing with four ARINC 761 STUs. Each ARINC 761 STU should be considered a separate and independent air/ground sub network by the CMU. The CMU should be able to transmit and receive simultaneously via each ARINC 761 STU installed.

c-1

The ARINC 761 STU Label 270 word (defined in ARINC Characteristic 761) includes an equipment type field which identifies the type of air/ground link provided by that STU. The CMU uses the equipment type field to identify which physical CMU ARINC 429 ports lead to which air/ground links (i.e. aircraft wiring can vary and the CMU detects this and adapts). The CMU detects which air/ground links are available, manages its queues and configures its router accordingly.

The connections defined in Section 5.3.2.4 are used when the CMU Mark 2 interfaces with STUs via a low speed ARINC 429 bus. The connections defined in Sections 5.3.2.6 and 5.3.2.7 are used when the CMU Mark 2 interfaces with STUs using high speed ARINC 429 buses.

On the same aircraft some ARINC 761 STUs may be connected to the CMU Mark 2 via the low speed ARINC 429 bus and some ARINC 761 STUs may be connected to the CMU Mark 2 via the high speed ARINC 429 buses.

5.2.6.1 SATCOM Data 2

The Data 2 CMU-STU protocol is defined in ARINC Specification 618. Data 2 is an ACARS packet based sub-network developed to facilitate integration into the existing ACARS VHF network. The complete CMU-STU interface for Data 2 is defined in ARINC Specification 618 either explicitly or by reference. ARINC Specification 618 also contains the packet formats exchanged between the CMU Mark 2 and its peer on the ground. c-1

5.2.6.2 SATCOM Data 3

TBD (Future bit-oriented interface, i.e. ATN, ISO 8208, etc.)

5.2.6.3 STU as an End System

TBD

5.3 Onboard System - Interface and Protocols

5.3.1 Digital ARINC 429 Physical Interface

COMMENTARY

The physical layer provides the functions necessary to activate, maintain, and release the physical link which carries the bit stream of the communication.

The electrical interface, voltage, timing, output impedance, etc., is to be as described in ARINC Specification 429-15.

Both high and low speed buses should be supported on specified ports.

5.3.2 Digital ARINC 429 Device Interface

The CMU Mark 2 should be capable of providing at least 12 ARINC 429 outputs. Five of the outputs should be low speed. Four of the outputs should be capable of high speed.

5.3.2.1 General Data Bus #1

General Data Bus Group #1 provides one low speed output and four low speed inputs. These data bus interfaces are intended for general onboard avionics subsystems. The following table lists the pins assigned in Group #1. The preferred installation configuration is shown in the SOURCE column.

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.3.2.1 General Data Bus #1 (cont'd)

Bus	Source	Spec	Pins
Output #1	CMU Mark 2	758	MP-15E,F
Input #1A	MCDU #1	739	MP-14A,B
Input #1B	Printer	740/744	MP-12J,K
Input #1C	CFDIU/OMS	604/624	MP-13G,H
Input #1D	FMC #1	702/A	MP-15J,K

5.3.2.2 General Data Bus #2

General Data Bus Group #2 provides one low speed output and four low speed inputs. These data bus interfaces are intended for general onboard avionics subsystems. The following table lists the pins assigned in Group #2. The preferred installation configuration is shown in the SOURCE column.

Bus	Source	Spec	Pins
Output #2	CMU Mark 2	758	MP-12E,F
Input #2A	MCDU #2	739	MP-12C,D
Input #2B	MCDU #3	739	MP-12G,H
Input #2C	FMC #2	702/A	MP-11C,D
Input #2D	ACMS	717	MP-11E,F

5.3.2.3 Comm Data Bus #3

General Data Bus Group #3 provides one low speed output and four low speed inputs. These data bus interfaces are intended for connection to two cabin terminals. Two of the inputs are provided for expansion. These inputs are not limited to cabin terminals. The following table lists the pins assigned in Group #3. The preferred installation configuration is shown in the SOURCE column.

Bus	Source	Spec	Pins
Output #3	CMU Mark 2	758	MP-15G,H
Input #3A	Cabin Term #1	N/A	MP-14C,D
Input #3B	Cabin Term #2	N/A	MP-14J,K
Input #3C	Spare	--	MP-13J,K
Input #3D	Spare	--	MP-07J,K

5.3.2.4 Comm Data Bus #4

Comm Data Bus Group #4 provides one low speed output and four low speed inputs. These data bus interfaces are intended for connection to air-ground data link subsystems. The following table lists the pins assigned in Group #4. The preferred installation configuration is shown in the SOURCE column.

Bus	Source	Spec	Pins
Output #4	CMU Mark 2	758	TP-07G,H
Input #4A	SDU/STU1 #1	741/761	TP-02C,D
Input #4B	HFDR #2 & SDU/STU #2	753/741/761	TP-02E,F
Input #4C	HFDR/STU #1	753/761	TP-10C,D
Input #4D	CVR	757	MP-10G,H

c-1

5.3.2.5 General Data Bus #5

General Data Bus Group #5 provides one programmable low/high speed output, one high speed input (5A) and three programmable low/high speed inputs. These data bus interfaces are intended for connection to air-ground data link subsystems. The following table lists the pins assigned in Group #5. The preferred installation configuration is shown in the SOURCE column. Three spare inputs are provided.

Bus	Source	Spec	Pins
Output #5	CMU Mark 2	758	TP-06F,G
Input #5A	ADL	615	TP-05D,E
Input #5B	Spare	--	TP-14H,J
Input #5C	Spare	--	MP-05E,F
Input #5D	Spare	--	MP-06A,B

5.3.2.6 Comm Data Bus #6

Comm Data Bus Group #6 provides one high speed output and four high speed inputs. These data bus interfaces are intended for connection to air-ground data link subsystems. The following table lists the pins assigned in Group #6. The preferred installation configuration is shown in the SOURCE column.

Bus	Source	Spec	Pins
Output #6	CMU Mark 2	758	MP-12A,B
Input #6A	XPDR #1	718	MP-08C,D
Input #6B	VDR #1	750	TP-05A,B
Input #6C	VDR #2	750	TP-10A,B
Input #6D	SDU/STU #1	741/761	TP-06H,J

c-1

5.3.2.7 Comm Data Bus #7

Comm Data Bus Group #7 provides one high speed output and four high speed inputs. These data bus interfaces are intended for connection to air-ground data link subsystems. The following table lists the pins assigned in Group #7. The preferred installation configuration is shown in the SOURCE column.

5.0 INTERFACES AND PROTOCOLS (cont'd)

Bus	Source	Spec	Pins
Output #7	CMU Mark 2	758	TP-13H,J
Input #7A	VDR #3	750	MP-07C,D
Input #7B	XPDR #2	718	MP-10A,B
Input #7C	SDU/STU #2	741/761	TP-12D,E
Input #7D	Gatelink	--	MP-08J,K

c-1

5.3.2.8 General Data Bus #8

General Data Bus Group #8 provides one high speed output and four high speed inputs. These data buses are intended for connection to end systems such as ELS. The following table lists the pins assigned in Group #8. The preferred installation configuration is shown in the SOURCE column. Two inputs are provided as spares.

Bus	Source	Spec	Pins
Output #8	CMU Mark 2	758	MP-10J,K
Input #8A	ELS	--	MP-10C,D
Input #8B	Cabin	746	MP-08G,H
Input #8C	Spare	--	TP-14A,B
Input #8D	Spare	--	TP-14C,D

5.3.2.9 Flight System Data Bus #9

Flight System Data Bus Group #9 provides one high speed output and three high speed inputs. These data buses are intended for connection to advanced flight management systems. The following table lists the pins assigned in Group #9. The preferred installation configuration is shown in the SOURCE column. One input is provided as a spare.

Bus	Source	Spec	Pins
Output #9	CMU Mark 2	758	TP-10G,H
Input #9A	DCDU #1	--	MP-08A,B
Input #9B	FMC #1	702/A	TP-10E,F
Input #9C	Spare	--	MP-05A,B

5.3.2.10 Flight System Data Bus #10

Flight System Data Bus Group #10 provides one high speed output and three high speed inputs. These data buses are intended for connection to advanced flight management systems. The following table lists the pins assigned in Group #10. The preferred installation configuration is shown in the SOURCE column. One input is provided as a spare.

Bus	Source	Spec	Pins
Output #10	CMU Mark 2	758	MP-11A,B
Input #10A	DCDU #2	--	TP-06B,C
Input #10B	FMC #2	702/A	MP-04C,D
Input #10C	Spare	--	MP-08E,F

5.3.3 Broadcast ARINC 429 Interface

ARINC Specification 429, "Mark 33 Digital Information Transfer System (DITS)," is the controlling document for many data word formats, refresh rates, resolutions, etc. Material contained in this document related to these topics is included for reference purposes only. In the event of conflict between this document and ARINC Specification 429, the latter should be assumed to be correct.

The CMU Mark 2 should accept incoming ARINC 429 content (broadcast) data words as described in applicable related ARINC documentation.

ARINC Specification 429 provides for certain data words which are used for bus maintenance and to maintain the integrity of the avionics systems. These data words are exchanged using the content-specific labels listed in ARINC Specification 429. The CMU Mark 2 should support transmission of necessary housekeeping data and be capable of accepting requests for content data words. Content data words are transmitted periodically and usually referred to as broadcast words.

The CMU Mark 2 should broadcast ARINC 429 content data words at the rates (high/low speed) specified on general purpose output buses as needed. The contents of these data words are described in the following subsections. The content data words identified in the following subsections should be sent at the one Hz minimum rate specified in ARINC Specification 429.

COMMENTARY

ARINC Specification 429 calls for a repetition interval between 0.5 and 1.0 seconds for the broadcast of data content words. The nominal is set to the upper bound of this range.

5.3.3.1 Digital Data Bus Inputs

The Digital Data Bus Inputs #1 through #6 are assigned to pins (MP-14E,F), (MP-14G,H), (TP-1F,G), (TP-4J,K), (TP-4E,F), and (TP-4G,H), respectively. These are general purpose ARINC 429 inputs that may be used by the CMU Mark 2 to acquire aircraft related parameters transmitted in a periodic (broadcast) format from various sources.

Typically, these may be used to input sensors for OOOI events. The data sources and formats may be different in various installations. These labels and formats are

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.3.3.1 Digital Data Bus Inputs (cont'd)

generally derived from specific aircraft Interface Control Drawings (ICDs).

Sources peculiar to Boeing aircraft include the EFIS/EICAS Interface Unit (EIU) and the Engine Indication Crew Alert System (EICAS). Sources peculiar to Airbus Industries include the System Data Acquisition Concentrator (SDAC) and the Flight Warning Computer (FWC).

The Digital Data Buses may run high or low speed depending upon aircraft installation.

Digital Data Bus Input #7 is assigned to pins (MP-6E,F) and is expected to be connected to a source of GPS data.

Digital Data Bus Input #8 is assigned to pins (TP-8G,H) and is expected to be connected to ARINC 702A FMC #1 broadcast data output.

Digital Data Bus Input #9 is assigned to pins (MP-6J,K) and is expected to be connected to ARINC 702A FMC #2 broadcast data output.

5.3.3.2 DFS/UTC Output Data Bus

Assignments have been made for a DFS/UTC Data Bus Output on TP-07A and TP-07B as a low speed output. This combined output can provide both VHF tuning frequency data and a real time clock output source. The UTC Clock data words include Labels 125, 150, and 260. The DFS data word Labels are 030 and 047. See Attachment 6, Broadcast Word Definitions.

When the installation includes an ARINC 716 VHF transceiver, the CMU Mark 2 outputs the operational channels for the VHF transceiver to use on this bus. See Section 5.2.1.1.7, DFS ARINC 429 Tuning Interface.

c-1 Only the active CMU transmits UTC and DFS data words. The standby CMU does not transmit UTC and DFS data words.

5.3.3.3 Subsystem Identifier Word Definition (172)

The CMU Mark 2 should report its system identification using data words having the Label 172. The format and content of data word Label 172 is defined in Attachment 6, Broadcast Word Definitions. The active CMU and standby CMU both transmit Label 172 data words.

5.3.3.4 LRU Identification Word Definition (377)

The CMU Mark 2 should report unit identification using data words having the Label 377. The format and content of the data word is defined in Attachment 6, Broadcast Word Definitions. The active CMU and standby CMU both transmit Label 377 data words.

5.3.3.5 ICAO 24-bit Aircraft Address Word Definition

c-1 The CMU Mark 2 should transmit the ICAO 24-bit aircraft address of the aircraft in which it is installed using ARINC 429 Label 214 and 216 data words on all general output buses. The ICAO 24-bit aircraft address is as stored in the CMU Configuration Database. The format and content of Label 214 and 216 data words are defined in Attachment 6, Tables 6-10 and 6-11, and ARINC Specification 429. The ICAO 24-bit aircraft address may be utilized by various connected LRU's, including SDU's, HFDL, VDR, and FMCs for addressing purposes. It is very important that all aircraft systems have access to a valid ICAO 24-bit aircraft address for correct operation. c-1

The CMU Mark 2 sets Bits 9-10 of Label 214 and 216 data words according to the installation position of the CMU (left or right). All spare bits are set to zero. The active CMU and standby CMU both transmit Label 214 and 216 data words.

c-1

The CMU Mark 2 may receive the ICAO 24-bit aircraft address via an APM. The CMU Mark 2 may receive the ICAO 24-bit aircraft address via the Mode-S transponder's TCAS output bus using ARINC 429 words containing Labels 275 and 276 on the high speed ARINC 429 port assigned as the Mode-S Input. The non-address bits are utilized to report status (bits 9-13 of Label 275 and bits 9-12 and 21-29 of Label 276) and are ignored by the CMU. If the CMU is connected to a "data link" capable Mode-S, then it should receive the ICAO 24-bit aircraft address using Labels 214 and 216. This externally sourced ICAO data may be utilized to validate the CMU Configuration Database. c-1 c-1

For a Mode-S acquired ICAO 24-bit aircraft address to be declared valid for use by the CMU, the following applies:

a. The bus on which the ICAO 24-bit aircraft address is transmitted is active (as defined in Attachment 6)

b. The data can not be zero (note it may be set to zero during power up with NCD SSM)

c. SSM can not be Functional Test (note that Mode-S sets Labels 275 and 276 to NCD while in standby mode, typically while on ground, so SSM is typically NCD when the CMU acquires the data)

d. Both Labels are present.

5.3.3.6 Status Output Word #1 (270)

The CMU Mark 2 should report status on two separate ARINC 429 words, identified by Labels 270 and 276. These words convey air/ground data link status, maintenance related information, and also provide crew alerts for use on external display systems. c-1

The Label 270/276 words should be output on all CMU General Output buses once per second at all times during normal operation. In dual CMU Mark 2 installations, the active CMU and standby CMU both transmit the Label 270 and 276 words. The standby unit should set all of the bits consistent with the active CMU Mark 2 data (as monitored via the cross talk bus), except the following, which are internally generated by each respective CMU: c-1

5.0 INTERFACES AND PROTOCOLS (cont'd)

Bits	Label	Meaning
9-10	270/276	SDI
16	270	CMU fail
20	270	Active/Standby
22-25	276	HF Status (HFDL Installed and HFDL Fail)
30-31		SSM

The general format of CMU Status Word #1 (Label 270) and CMU Status Word #2 (Label 276) are defined in Attachment 6, Tables 6-8 and 6-9. The CMU Mark 2 should determine and report Data Link Media Status on the sub-networks. The CMU Mark 2 should set the bits in its Label 270/276 words at all times during normal operation for each individual media that is defined, whether it is actually installed or not on the aircraft. This information is then provided in bits 17-19, and 24 of Label 270 and bit 19 of Label 276 by the CMU Mark 2. This information is needed by the End Systems, such as FMC's, as not all Data Link Services are available at times (such as VHF data link). The Data Link media Status is also necessary for the internal router to make routing decisions based on the user policy table. That is, the router should not attempt transmissions on links that do not exist. This information may also be needed by any Data Link Applications End System hosted by the CMU Mark 2.

COMMENTARY

The messages, as defined, provide media availability information, not the type of service, such as ACARS or ATN. The ATN is expected to utilize Join/Leave Messages for each subnetwork. The definitions and protocols of the Join/Leave are not yet mature. Additional Status output words may be added in future Supplements to address this as needed.

Bits 11-16, 21-23 of Label 270 and bits 11-18 of Label 276 are intended for the generation of aural/visual alerts to the flight crew on events related to Data Link. These bits provide general link availability status and are for general alerting, such as after receipt of an uplink message to the crew. The actual message text displayed, the existence of a message, and priorities (when multiple messages are set) are dependent on the aircraft model and configuration of the external display system.

COMMENTARY

It may be more desirable to have the actual message text supplied by the CMU Mark 2 to the external display system, as the message contents could be derived from the uplink. An example could be annunciation of receipt of "ATIS BRAVO" as opposed to just annunciating the text "MESSAGE". This capability may be considered in future Supplements to ARINC Characteristic 758.

Bit 12 (Link Availability) of Label 270, is the logical OR of all the links. It is intended for crew annunciation and applications should instead monitor the individual link status bits. The CMU Mark 2 NO COMM discrete output (see Section 5.4.6.2) also provides this information and should always represent the logical OR of the Links.

COMMENTARY

Some aircraft restrict the setting of the bits in Label 270 because of the design of the display device. In this case, other bits in the Label 270 word may sometimes inhibit the setting of the Link Availability bit. As such, Link Availability may not represent the true data link status.

Other Label 270/276 crew alert discretes are set by the CMU Mark 2 when the event occurs, such as by receipt of an uplink message or a change in the printer status. The CMU Mark 2 should not annunciate inappropriate alerts during certain phases of flight, such as during takeoff and landings.

Bit 16 (CMU Fail), bit 20 (Active/Standby), and bits 30-31 (SSM) of Label 270 provide external systems with the overall health and state of the CMU Mark 2. External subsystems should use bit 20 in dual CMU installations to determine which CMU Mark 2 to exchange information with.

5.3.3.7 Status Output Word #2 (276)

The CMU Mark 2 transmits an ARINC 429 word with Label 276 which contains bits that indicate message status data and bits that indicate the status of the HF Data Link system. The logic for bits 20 through 27 is defined in Section 5.2.3 and its subsections.

The active CMU and standby CMU both transmit Label 276 data words. The standby unit should set all of the bits according to the active CMU data, except bits 22-25 (HFDR #1 installed, HFDR #2 installed, HFDR #1 fail, and HFDR #2 fail) which are independently calculated by the standby CMU.

5.3.3.8 Status Output Word #3 (271)

COMMENTARY

This section is reserved for an additional Data Link Status word which is expected to be added by a future supplement to allow reporting of both ACARS and ATN subnetwork status.

5.3.3.9 Maintenance Words (350,351)

The CMU Mark 2 transmits ARINC 429 words with Labels 350 and 351 which contain bits that indicate LRU status data based on the activity of the ARINC 429 receiver for each LRU. Reference Attachment 6, Broadcast Word Definitions. The active CMU and standby CMU both transmit Label 350 and 351 data

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.3.3.9 Maintenance Words (350,351) (cont'd)

words. Each CMU independently determines the values of the LRU status bits.

5.3.4 ARINC 429 System Address Label (SAL)

For all "dialog" based ARINC 429 protocols, such as ARINC 739, ARINC 740, and ARINC 429 File Transfer, the CMU Mark 2 should recognize a System Address Label (SAL) value of 304.

5.3.5 ARINC 429 BOP Protocol

The ARINC 429 Bit Oriented Protocol (BOP) Link layer is used for transferring information from one LRU to another. ARINC Specification 429 defines several versions of the BOP.

The CMU Mark 2 supports BOP Version 1 and optionally supports Version 3 (connectionless) depending on the CMU Mark 2 architecture.

Version 1 provides flow control, error detection, and error recovery. Version 1 provides a highly reliable link layer.

Version 3 is streamlined for higher throughput and lower propagation delays. Version 3 assumes that error detection, error recovery, and flow control occur at a higher level, when needed.

COMMENTARY

> Bit-oriented protocol was first introduced into ARINC Specification 429 by Supplement 12 and has been expanded to include newer versions and clarified in subsequent supplements.

5.3.6 ARINC 646 ELAN Interfaces

The CMU Mark 2 should provide ports compatible with ARINC Specification 646, "Ethernet Local Area Network (ELAN)" for high speed LAN transfers based on Ethernet protocols.

COMMENTARY

c-1

> ARINC Specification 646 is not needed for a Level 0 or Level 1 CMU Mark 2 except for simulator and 615A Data Loader support. Future supplements are expected to define the ARINC Specification 646 interfaces which are part of the Level 2 aircraft interface definition.

5.3.7 ARINC 619 ACARS Interfaces

ARINC Specification 619 is used to access external ACARS End Systems (Message source/sinks). ARINC Specification 619 provides interfaces to ACMS, CMC, FMCs, and Cabin Systems that are directly compatible with the ACARS Air/Ground Sub-network. SDUs may also be ACARS End Systems for purposes of maintenance data and owner table exchange.

The CMU Mark 2 should use ACARS Label/Sublabel combinations to route messages to and from these LRUs. ARINC Specification 619 uses ARINC 429 as a physical interface and a variety of ARINC 429 link layer protocols depending upon aircraft configuration and the LRU.

The CMU Mark 2 should support BOP and character ARINC 429 protocols with the ACARS End Systems as needed.

The CMU Mark 2 should be capable of DUAL FMC master/slave determination as specified in ARINC Specification 619.

5.3.8 ARINC 656 Flight Management Interface

For a Level B CMU as end system architecture, (see Attachment 2), the ARINC Specification 656 Interface is used to send and receive data between the Data Management application in the CMU Mark 2 and the Flight Management System. See ARINC Specification 656 and ARINC Characteristic 702A, "Advanced Flight Management Computer System". This interface should be provided by high speed ARINC 429 using the BOP Link Layer Services.

5.3.9 Optional MIL-STD-1553B Interface

The CMU Mark 2 may be installed in a military configuration that could require support for MIL-STD-1553B buses. In this configuration six pins on the rear connector can be used to provide dual MIL-STD-1553B buses. The MIL-STD-1553B terminals are anticipated to be installed in a military only configuration of the CMU Mark 2.

The MIL-STD-1553B Data Bus is expected to be used to pass information with the onboard Flight Management Computer. It may also be used to provide access to remote annunciators and CDUs. ARINC Characteristic 739 MCDUs are not anticipated in this configuration. ARINC Specification 656 could potentially be used, but the MIL-STD-1553B implementation is beyond the scope of this document.

In terms of MIL-STD-1553B, the CMU Mark 2 acts as a remote terminal (RT) on the bus. It is assumed that a Configuration Data Base and APM is also needed with this configuration. The APM should include MIL-STD-1553B configuration information such as MIL-STD-1553B remote terminal address and subaddress.

The primary data link applications to be supported are related to ATS, but limited "AOC" like applications may be desired as well, such as OOOI, maintenance information, and weather.

Interfaces to the sub-networks (VHF, SATCOM, etc.) are expected to be as defined elsewhere in this Characteristic, including the ARINC 429 data buses.

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.3.10 Cockpit Voice Recorder Interface

If the CMU Mark 2 is operating above CMU Level B, then an ARINC 429 interface to the Cockpit Voice Recorder (CVR) should be provided.

COMMENTARY

> At this time, a single ARINC 429 port is reserved for this interface, should it be required. This interface is expected to be used for recording ATS data link messages.

5.3.11 User Defined Interfaces

Blocks of pins are reserved for additional interfaces that may be provided by the CMU Mark 2. These pins could be used to support other interfaces (older printers, OAT, etc.) that may be desired by some users. These pins could also be used for additional ARINC 429 ports or other data buses. Where electrical definitions can be standardized, the user defined pins have been identified with their electrical characteristics. Inclusion of any of these capabilities is at a manufacturer's option.

5.3.12 Spare Interface

Blocks of pins are reserved for spare interfaces that may be provided by the CMU Mark 2. All spare inputs and outputs are for future ARINC Characteristic 758 assignment activities and are not intended for user defined signaling. Where electrical definitions can be standardized, the spare pins have been identified with their electrical characteristics. Inclusion of any of these capabilities is at a manufacturer's option.

5.3.13 OOOI Discretes

Nine standard ARINC discrete inputs have been reserved by the CMU Mark 2 for input of Out-Off-On-In (OOOI) airplane status. One discrete is reserved for Air/Ground status (TP-15J) and the remainder (TP-15A through TP-15H) are for connection to other sensors, such as doors and parking brakes. A Return Signal is also provided at TP-15K.

The Configuration Data Base is used to define the signal polarity for each discrete in a given installation. On newer aircraft these discretes are transmitted on a digital bus. The CMU Mark 2 is responsible for any filtering or debounce of the discretes as needed. Inclusion of any of these capabilities is at a manufacturer's option.

5.3.14 APM Interface

The Airplane Personality Module (APM) interface is defined in ARINC Report 607.

The APM interface allows the CMU Mark 2 to read and write data to an APM if installed. The APM consists of an externally mounted serial Electrically Erasable Programmable Read Only Memory (EEPROM) device. The APM may be used to store the information for the CMU Mark 2 Configuration Database. The CMU Mark 2 should read the APM data on a regular basis, such as once per flight or upon power up. The CMU Mark 2 should validate the data as described in Section 4.12.3. See Section 4.12, Configuration Database.

APM data is updated (written) by first loading the data into CMU NVM. Upon update completion, the CMU Mark 2 copies the data to the APM, then proceeds with database validation.

The CMU Mark 2 provides the interfaces and header format as needed for the APM as specified in ARINC Report 607. Each APM contains a standard header file used for basic identification. An example memory map for the CMU Mark 2 APM definition is provided in Attachment 5.

The CMU Rear connector pins are assigned (TP-1A, TP-1B, TP-1C, TP-1D, TP-1E, TP-1H, TP-1J, TP-1K, TP-2A and TP-2B) for the APM interface.

The integrity of the APM data should be protected by a CRC.

COMMENTARY

> Consideration should be given to mirroring the data in the APM (two copies) for improved integrity and transient protection.

The APM may be powered only when reading/writing to increase APM reliability. When no valid APM data is received from the APM, the CMU Mark 2 should indicate an inoperative APM state.

5.3.15 ATN End Systems Interfaces

c-1

The CMU Mark 2 should be capable of interface to onboard ATN End Systems which host ATN applications.

The CMU Mark 2 may also be an ATN End System. See Section 3.1.1.

5.3.15.1 ATN - ES/IS Protocol

When interfacing to external onboard ATN End Systems, the CMU Mark 2 provides the role of an ATN router. The CMU Mark 2 routes standard network layer packets via network level addressing to those end systems over the ATN-compatible physical, link and network layers. All upper layer (including Transport) protocols which support the ATN application hosted in an external onboard ATN End System, are also resident in that end system, since these protocols operate as the end-to-end peer of the ground-based ATN End System. The ICAO ATN SARPs defines the Internetworking requirements. c-1

5.3.15.2 CMU as ATN End System

The CMU Mark 2 may be an ATN-compatible End System and interface with other ATN-compatible End Systems (ES). The upper layer (including Transport) protocols which support the CMU-hosted ATN application are also hosted in the CMU Mark 2, since these protocols operate as the end-to-end peer of the ground-based ATN End System.

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.3.16 Dual System Interface

The CMU Mark 2 Dual Interface consists of two serial buses, discrete I/O, and two program pin selects. The active/standby condition of the CMU can be controlled from a CMU MCDU screen and transferred over the cross talk bus or an optional switch connected to the discrete I/O. See Section 4.15 and Attachment 1-8.

5.3.16.1 Cross Talk Bus

Pin assignments have been made for the CMU Mark 2 Cross Talk Input (TP-2G,H) and Output (TP-12B,C) Data Buses.

The CMU Mark 2 cross talk bus should provide information necessary to maintain a robust dual CMU Mark 2 installation. The information exchanged and the medium used are determined by each equipment manufacturer.

The CMUs exchange status, data, and control information over the cross talk bus. The active CMU indicates its active status to the standby CMU over the cross talk bus, and the standby CMU likewise indicates its status. When the active CMU changes its status to standby, then the other CMU detects this change in status (as indicated by data on the cross talk bus) and becomes active.

COMMENTARY

> No provision is made for interchangeability of vendor units with regard to DUAL Interfaces and their design.

5.3.16.2 Active/Standby Discrete Input

A discrete input (TP-6D) should be provided to place the CMU Mark 2 in the standby mode. This discrete input is used to command the CMU Mark 2 to assume the standby mode. A "Standard Open" indicates that the CMU Mark 2 is permitted to assume the active state. Some installations may use other means to control the active/standby state and not switch this input. In this case the "Standard Open" indicates that the CMU Mark 2 determines its active/standby state from other inputs (cross talk bus, MCDU screen, etc.). In all cases a "Standard Ground" causes the CMU to switch to the standby mode of operation. "Standard Open" and "Standard Ground" are defined in Section 2.9, ARINC Standard Interface.

5.3.16.3 Active/Standby Discrete Output

The CMU Mark 2 Active/STANDBY Discrete output (TP-2J) is provided to report the status of CMU Mark 2 operation (Active/STANDBY). A "Standard Ground" indicates that the CMU Mark 2 is active and operating normally. In the event of a failure or if the CMU Mark 2 is commanded to the standby mode, the output should be a "Standard Open." The CMU hardware should be designed to ensure that the Active/STANDBY Discrete output is open when the primary power is removed. "Standard Open" and "Standard Ground" are defined in Section 2.9, ARINC Standard Interfaces.

5.3.16.4 Dual - SDI Program Pins

Two Source/Destination Identifier (SDI) Program pins (TP-14E,F) are provided to identify the physical location (left, right) of the CMU Mark 2. "Standard Program Pin Ground" and "Standard Program Pin Open" are used for these two inputs. See Section 2.9, ARINC Standard Interfaces. The SDI Program Pins are used to designate the CMU Mark 2 location per the following tables.

Pin Number	Identifier Program Pin	ARINC 429 Reference
TP-14E	SDI 1	SDI Bit 9
TP-14F	SDI 2	SDI Bit 10

SDI 2	SDI 1	Description
0	0	Single
0	1	Left
1	0	Right
1	1	Not used

5.3.16.5 Program Pin Common

Wiring between the SDI program pins and Program Pin Common (TP-11D) is used to determine the "1" state shown in the table above. An open state indicates the "0" state.

5.3.17 ARINC 615 Data Loader Interface

The CMU Mark 2 interfaces with an ARINC 615 data loader via the ARINC 429 connections defined in Section 5.3.2.5 and a discrete input, Pin TP-6E. ARINC Report 615, "Airborne Computer High Speed Data Loader," defines the ARINC 429 protocol used to interface with a software data loader.

The CMU Mark 2 should provide a discrete input (TP-6E) to monitor the status of a selector switch, located in aircraft wiring, which indicates that the ARINC 429 input and output data buses are connected to the data loader. The "ground" state indicates that the data buses are connected and the data loading function is enabled. An "open" state indicates no connection. Reference ARINC Reports 615 and 615A.

5.4 Flight Deck Systems - Interfaces and Protocols

The CMU Mark 2 should be able to adapt to a wide variety of flight deck systems. These systems include MCDUs, printers, aural alerting, and visual alerting devices.

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.4.1 ARINC 739 MCDU Interfaces

The Multipurpose Control and Display Unit (MCDU) described in ARINC Characteristic 739 is the primary flight crew interface for CMU Level A-B, and perhaps C Applications.

ARINC 429 ports are assigned to send and receive information to and from at least three independent MCDUs utilizing the ARINC Characteristic 739 protocol.

If the CMU Mark 2 provides crew interfacing for ATS applications, then the CMU Mark 2 is expected to provide concurrent MCDU operations and the capability for access to the ATS messages with a minimum of key strokes. Reference ARINC Characteristic 739, "Multi-Purpose Control and Display Unit.

COMMENTARY

> ARINC Characteristic 739 does not provide dynamic, user friendly access to applications hosted on various LRUs. ARINC Characteristic 739A is being developed to address this short coming. The CMU is expected to support ARINC Characteristic 739A in the future.

5.4.2 DCDU Data Link Display Interface

The CMU Mark 2 should be capable of supporting up to two Dedicated Control and Display Units (DCDUs) in addition to or in place of the MCDUs for CMU Level D (and perhaps C) Operations. Two High speed ARINC 429 ports are reserved for this purpose. These DCDUs are assumed to be mounted in the Primary Field of View, suitable for supporting all ATS Data Link Services.

COMMENTARY

> The DCDUs should be capable of message display and input, such as ROGER, WILCO, and REJECT.

5.4.3 Optional CDU Interface

A CMU Mark 2 may utilize an optional control and display unit. User defined pins are reserved for this interface.

COMMENTARY

> This characteristic does not describe the optional CDU Interface. Each equipment manufacturer has developed a unique interface to the subject unit, where needed.

5.4.4 ARINC 740/744 Printer Interface

The CMU Mark 2 sends data to the printer and receives status information from the printer. A second printer may be used in some installations for redundancy or to support a Cabin Installation. Reference ARINC Characteristic 740, "Multiple-Input Cockpit Printer." and ARINC Characteristic 744, "Full-Format Printer".

5.4.5 ARINC 744A Printer Interface

The CMU Mark 2 may provide the capability to interface with a high speed ARINC 744A Printer, such as for transfer of weather graphics on the ports assigned for Ethernet communications. Reference ARINC Characteristic 744A "Full Format Printer With Ethernet."

5.4.6 Crew Alerting Interfaces

Alerting systems vary widely from aircraft to aircraft. On newer aircraft external systems typically provide management of most alerts (aural and primary field of view visual alerts). Any new alerting capabilities in the CMU Mark 2 will likely require some modification to these systems.

On older aircraft, the CMU Mark 2 will likely do all management of its alerts. The CMU Mark 2 should ensure that inappropriate alerts are not generated in designated phases of flight, such as take off and landing. In order to accomplish this, access to radio altitude and airspeed may be needed.

COMMENTARY

> To provide more system flexibility, it is desirable to develop a digital interface to the display systems that allow transfer of message content to the display systems. This could also apply to retrofit aircraft where EFIS is added. ARINC Specification 656 protocol could be a candidate mechanism.

5.4.6.1 Digital Output Alerts

The CMU Mark 2 should provide digital alert signals using Label 270 and 276 as necessary on its general output buses. This data word has bits assigned for use in support of an alerting system to the flight crew. In this method, bits are converted to pre-defined messages and remotely managed priorities within the alerting systems.

The number of messages that may be enabled at one time depends on the specific alerting system. The CMU Mark 2 should be able to accommodate different flight deck philosophies. That is, in some cases, these messages should be prioritized by the CMU Mark 2, or they may be prioritized by the display system itself. The data associated with Crew Alerting is defined in Section 5.3.3.6.

5.4.6.2 "No Communications" Alert Discrete

An optional "NO COMM" discrete may be supported by the CMU Mark 2. The CMU Mark 2 sets the NO COMM discrete output according to the logic defined in Section 5.3.3.6.

The NO COMM Alert discrete should take the form of a "ground" on connector pin MP-9K when a NO COMM condition exists. Under data link service available conditions, the output should be an "open."

5.0 INTERFACES AND PROTOCOLS (cont'd)

5.4.6.2 "No Communications" Alert Discrete (cont'd)

The switching device in the CMU should be capable of holding off 30 Vdc in the "open" state. In the "ground" state, the potential across it should not exceed 2 Vdc, and it should be capable of sinking 200 mA of current.

COMMENTARY

> The current holding capabilities and voltage boundaries of this discrete output are an exception to the Standard Ground and Standard Open. The more stringent criteria are due to the potential for the CMU to be installed on aircraft in which the output is used to sink lamp current directly rather than to control a lamp driver.

Termination of the NO COMM Alert state may be initiated by crew action.

5.4.6.3 Failure Warning Discrete

In the event that a system malfunction is detected (see Section 6.1), it should be annunciated by a dc ground at the Fault Annunciation Discrete Output connector pin MP-9J. An open indicates the absence of a system malfunction. This discrete may be routed to destinations in the aircraft external to the CMU Mark 2, such as the processing unit of a central warning system. The dc ground switching device in the CMU Mark 2 should be capable of holding off 36 Vdc in the open state. In the ground state, the potential across it should not exceed 2 Vdc and it should be capable of sinking 200 milliamperes of current.

COMMENTARY

> The current handling capabilities and voltage boundaries of this discrete output are an exception to the Standard Ground and Standard Open. The most stringent criteria are due to the potential for the CMU to be installed on aircraft in which the output is used to sink lamp current directly, rather than to control a lamp driver.

5.4.6.4 Open/Short Alert Contacts (Relays)

An AOC or ATS application may need a CMU Mark 2 to interface with a system which uses a continuity (open/short) sensing technique for generation of alerts, such as an aural alert.

Two sets of relay contacts for this purpose should be provided. Each set may be used independently. Typically, these contacts are used to illuminate a "Call" light (MP-9F,G) or to ring a chime (TP-9G,H). Each of these relay contacts when closed should support one amp of current to flow from a 28 Vdc source to an external device. The direction of current flow should be from TP-9G to TP-9H and MP-09F to MP-09G, respectively. In addition, both sets of contacts should be able to provide continuous closure, momentary closure, or a cyclic closure for a specified time or until a reset event occurs.

Trigger events are typically receipt of specific uplink messages, but could also be triggered by logic within the CMU Mark 2. Reset events may be automatic, crew input, or external Alert Reset Input discrete.

5.4.6.5 Alert Reset Discrete Input

Pin MP-9C is for the Alert Reset Discrete. A momentary "ground" of 50 millisecond duration should command the reset condition of crew alerts, including the relay contacts. Other than the momentary nature of the discrete input, this discrete input should be consistent with the Standard Open and Standard Ground Discrete described in Section 2.9, ARINC Standard Interfaces.

5.5 ARINC 610A Simulator Interface

The CMU should support the ARINC 610A simulator interfaces defined in the following sub-sections.

5.5.1 Installed in Simulator Discrete Input

A discrete input (MP-2C) should be provided to place the CMU Mark 2 in the simulator mode. This discrete input, in conjunction with the ARINC 429 interface, is used to command the CMU Mark 2 to assume the simulator mode. In all cases a "Standard Open" indicates that the CMU Mark 2 should assume the standard operation (i.e. installed in aircraft). A "Standard Ground" causes the CMU to switch to the simulator mode of operation when there are also ARINC 429 broadcast words on the simulator bus (see Section 5.5.2). "Standard Open" and "Standard Ground" are defined in Section 2.9, ARINC Standard Interface. c-1

5.5.2 Simulator ARINC 429 Interface

The CMU uses both broadcast and file transfer facilities to exchange data over the ARINC 429 interface.

5.5.2.1 Simulator ARINC 429 Physical Layer

The Simulator ARINC 429 Data Bus Group provides one high speed output and one high speed input. These data bus interfaces are intended for use with an ARINC 610A simulator only. The following table lists the pins assigned to the Simulator ARINC 429 Data Bus Group.

Bus	Source	Spec	Pins
Output	CMU Mark 2	758	MP-15C,D
Input	Simulator	610A	MP-10E,F

5.5.2.2 Simulator ARINC 429 Link Layer

The CMU and simulator use version 1 of ARINC Specification 429 Williamsburg protocol for file transfer. ARINC Report 610A, Section 5.7, defines the options and data formats for the file transfer protocol.

5.5.3 Simulator ARINC 646 (Ethernet) Interface

Ethernet interface #1 has been allocated for CMU-simulator communication.

5.5.3.1 Simulator ARINC 646 Physical Layer

The CMU provides one ARINC 646 output and one ARINC 646 input for interfacing with the simulator. The following table lists the pins assigned to the Simulator ARINC 646 interface:

Bus	Source	Spec	CMU Pins
Output	CMU Mark 2	758	MP-11J,K
Input	Simulator	610A	MP-11G,H

5.5.3.2 Simulator ARINC 646 Link Layer

TBD.

6.0 MAINTENANCE AND TEST

6.1 Built-in Test Provisions

6.1.1 General Discussion

The utmost attention should be paid to the need for integrity and availability in all phases of system design, production, and installation.

BITE should closely relate to bench testing. Error modes encountered on the aircraft should be reproducible in the shop. Error messages should be closely related to and assist in bench testing, allowing the error to be duplicated. System faults should be classified based on their effect on the system as debilitating or non-debilitating.

Fault reports should enable the operator to isolate the cause of a fault and provide adequate information for repair of the system.

Where possible, optional functions present in the CMU Mark 2 that are not activated by the operator should be excluded from all testing. Testing components or functions not used by the operator serve only to provide additional nuisance faults.

The self-contained fault detection should incorporate non-volatile memory and logic to identify true hardware faults based on historical trends.

The system should also incorporate built-in debugging tools, annunciators, test buttons, and/or memory readout, to facilitate engineering troubleshooting. These tools should be categorized for line maintenance or engineering use, as appropriate.

COMMENTARY

> It is important to remember that all aspects of the testing program (BITE, ramp, and shop testing) contribute to the reliable and profitable operation of a system by the end users. The ability of the program to identify faults and facilitate their repair has a profound affect on maintainability and overall reliability. Attention to a close relationship between aircraft faults and shop testing should help in reducing the number of unscheduled removals.

6.1.2 Self-Contained Fault Detection and Reporting

The CMU Mark 2 should provide BITE capability in accordance with ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment". The CMU should be capable of reporting the results of the BITE when installed on an aircraft which does not contain an Onboard Maintenance System (OMS).

COMMENTARY

> BITE status can be reported in many different ways. For example, BITE status may only be reported via a pass/fail annunciator on the front panel of the CMU Mark 2. Alternatively or in addition, the CMU Mark 2 may contain an extensive set of BITE screens which can be displayed on a CDU/MCDU.

6.1.3 Centralized Fault Reporting Interface (ARINC 604/624)

The CMU Mark 2 unit should contain Built-In Test Equipment (BITE) capability in accordance with ARINC Report 624, "Onboard Maintenance System," and ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment".

6.1.3.1 Bit-Oriented Fault Reporting

The CMU Mark 2 should contain fault reporting capability in accordance with ARINC Report 624. Maintenance data should be reported using Labels 350 and 351 at a one Hz minimum update rate during all modes of CMU Mark 2 operation. The format and content of these words are described in Section 5.3.3.7.

6.1.3.2 Character Oriented Fault Reporting

The CMU Mark 2 should, as an option to the user, provide fault reporting capability in accordance with the character oriented fault reporting protocol contained in ARINC Report 604, "Guidance for Design and Use of Built-In Test Equipment".

COMMENTARY

> New equipment designs should be produced in accordance with ARINC Report 624. The optional use of ARINC Report 604 is to provide for retrofit installations where an OMS is not present and the equipment needs to interact with an ARINC 604 Centralized Fault Display System (CFDS).

6.1.4 Ramp Return To Service Testing

When a CMU Mark 2 is installed on an air transport aircraft, some form of end-to-end testing should be available to:

a. Provide an operational verification of the system function prior to return to service

b. Reduce unnecessary removals of the CMU Mark 2 when the fault was actually in another part of the system

As an end-to-end test, the procedure needs to verify integrity of the LRU, as well as interface with other systems and applicable antenna connections. The CMU Mark 2 should support return to service testing in a line maintenance environment. The CMU Mark 2 ramp test should also have provisions for in hangar testing.

The return to service test results should indicate the probable cause of failure in order to minimize needless replacement of healthy equipment.

COMMENTARY

> Emphasis on end-to-end system testing should lead to an increase in the Mean Time Between Unscheduled Removals, especially for removals not related to LRU faults.

6.0 MAINTENANCE AND TEST (cont'd)

6.1.5 Software Configuration Management

It is expected that all software modules and applicable data bases should be aircraft loadable. The CMU Mark 2 should display the part numbers of all software modules and applicable data bases. The CMU Mark 2 should transmit the part numbers when it is installed on an aircraft which contains an OMS that uses this data.

6.2 Provisions For Automatic Test Equipment

6.2.1 General

To enable automatic test equipment (ATE) to be used in bench maintenance, internal circuit functions not available at the unit service connector, and considered by the equipment manufacturer necessary for automatic test purposes, may be brought to pins on an auxiliary connector of a type selected by the equipment manufacturer. This connector should be fitted with an adequate number of contacts to support the ATE functions. The connector should be provided with a protective cover suitable to protect these contacts from damage, contamination, etc., while the unit is installed in the aircraft. The manufacturer should observe ARINC Specification 600 standards for unit projections, etc., when choosing the location for this auxiliary connector.

6.2.2 ATE Testing

Where possible, optional functions present in the CMU Mark 2 that are not activated by the operators should be excluded from all testing. Testing components or functions not used by the operator serves only to provide additional nuisance faults.

A program which loads test software should validate the software load via a checksum, or other method to determine that the load is valid.

In all cases, when loading software or data bases, the procedure should provide a method for recovering from faults. Similarly, when running automatic tests, the procedure should provide a method to abort testing when an obvious fault exists without major disruption to the CMU Mark 2 or the ATE. The CMU Mark 2 and its ATE should support these abilities.

Complete information for test implementation, complying with ARINC Report 625, "Industry Guide for Test Program Set (TPS) Quality Management" should be provided to an airline on request.

The CMU Mark 2 should be ATE testable and should have a test specification written in ATLAS in accordance with ARINC Specification 626, "Standard ATLAS Subset for Modular Test". ATLAS is preferred for avionics unit testing and variations from the ATLAS vocabulary are not accepted. The test specification should be developed using the guidelines specified in ARINC Report 625 and ARINC Report 627, "Programmer's Guide for SMART Systems Using ARINC 626 ATLAS". The ATLAS test specification should be shop verified on an ARINC Specification 608A, "Design Guidance for Avionics Test Equipment, Part 1 - System Definition" compliant test set.

6.3 Dataloading

The CMU Mark 2 should accept data and program updates from a data loader encoded in accordance with ARINC Specification 615.

The CMU Mark 2 should be software loadable via a front panel connector or the rear ARINC 600 connector, see Section 5.3.17.

It is expected that all software modules and applicable data bases should be aircraft loadable. For Dual LRU installations, all modules should also be cross loadable.

COMMENTARY

> Since mixed cases of cross loadable and non-cross loadable software modules present many problems, operators prefer that all or none of the software modules be cross loadable.

In all cases, when loading software or data bases, the procedure should provide a method for recovering from faults. The CMU Mark 2 should be able to abort a software or database loading process without a major disruption of the system (disruption resulting in removal of the CMU Mark 2 from the aircraft).

The CMU Mark 2 should be able to perform a "host" role for indirect loading of the APM module of airplane configuration data.

6.4 Systems Management Tools

To be added by a future supplement.

6.5 Test Environments

6.5.1 Laboratory Environment

The CMU Mark 2 should be capable of supporting data link service and data link applications testing in the laboratory environment. The laboratory environment includes vendor development stations, Data Link Service Provider Laboratories, and Airline/ATS facilities for applications interoperability testing.

Data Link service testing should permit exercising of all Data Link Sub-networks and protocols independent of the Data Link Applications. Potentially this could be used by Data Link Service Providers as part of the network qualification process.

Data Link Applications Testing should permit testing of applications message formats, logic, and crew interfaces independent of the Data Link Services.

6.5.2 Shop Test Environment

The shop test environment is assumed to be primarily for hardware testing and software loading only of the CMU Mark 2.

COMMENTARY

Correlation of flight crew equipment write-ups in the shop in software intensive LRUs and Data Link equipment is an increasingly difficult task.

6.5.2 Shop Test Environment (cont'd)

COMMENTARY (cont'd)

> This can be compounded by shop test stations capable of hardware performance testing and software loading. The shop test environment may also need to encompass some aircraft and/or laboratory simulation capabilities to deal with No Fault Found (NFF) conditions.

6.5.3 Flight Test Environment

The CMU Mark 2 should provide the ability to log Data Link traffic (uplinks, downlinks) and performance information to an on-board printer, internal storage or external mass storage devices for use in flight test and certification support.

6.5.4 Operational Environment

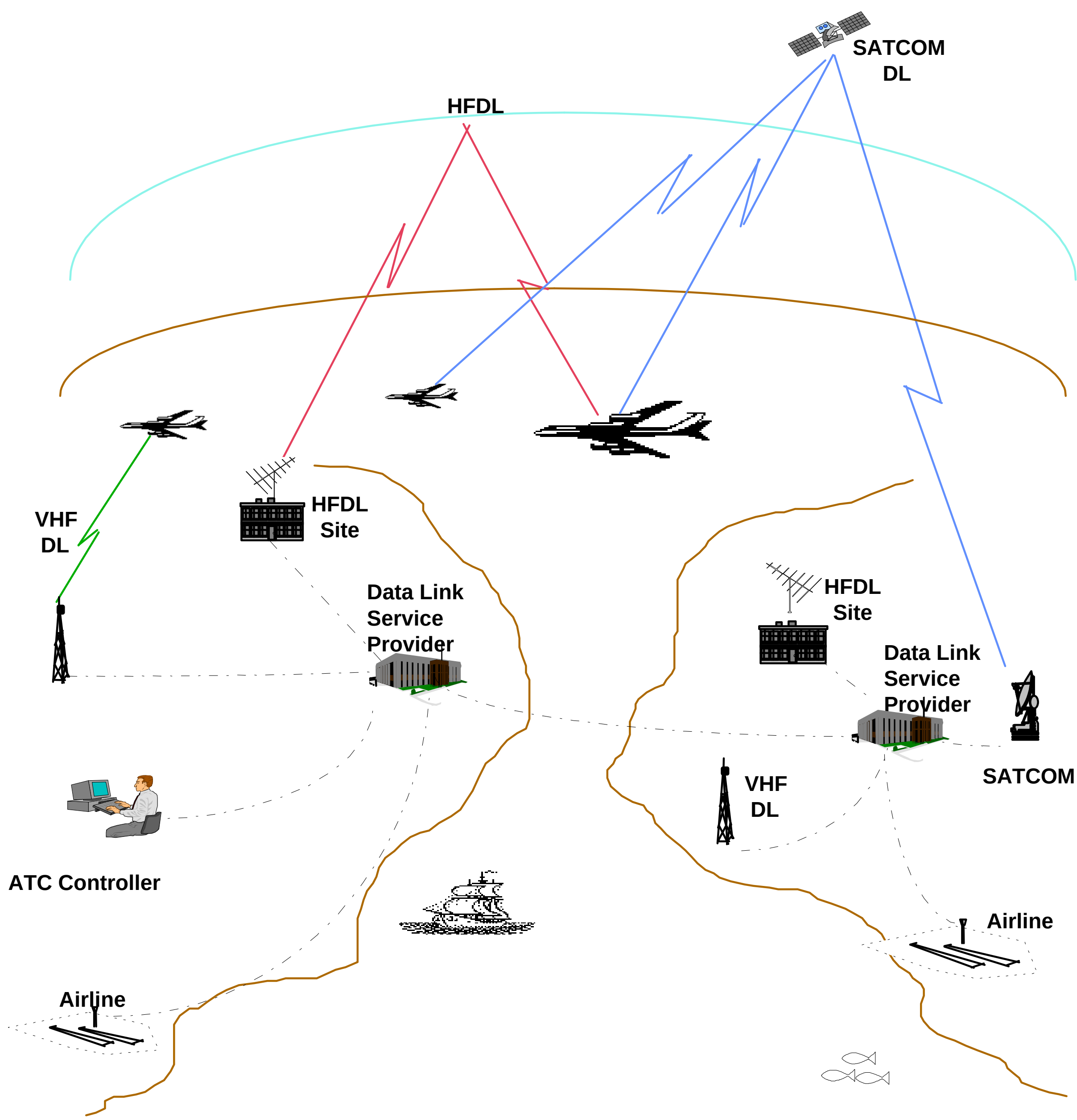
The CMU Mark 2 may provide the ability to log data link traffic (uplinks, downlinks) and performance information to an on-board printer, internal storage or external mass storage devices while in the operational environment, provided no adverse flight deck effects occur as a result of this mode of operation.

Ideally, internal storage would be utilized (with perhaps reduce data collected) and would primarily be for troubleshooting purposes.

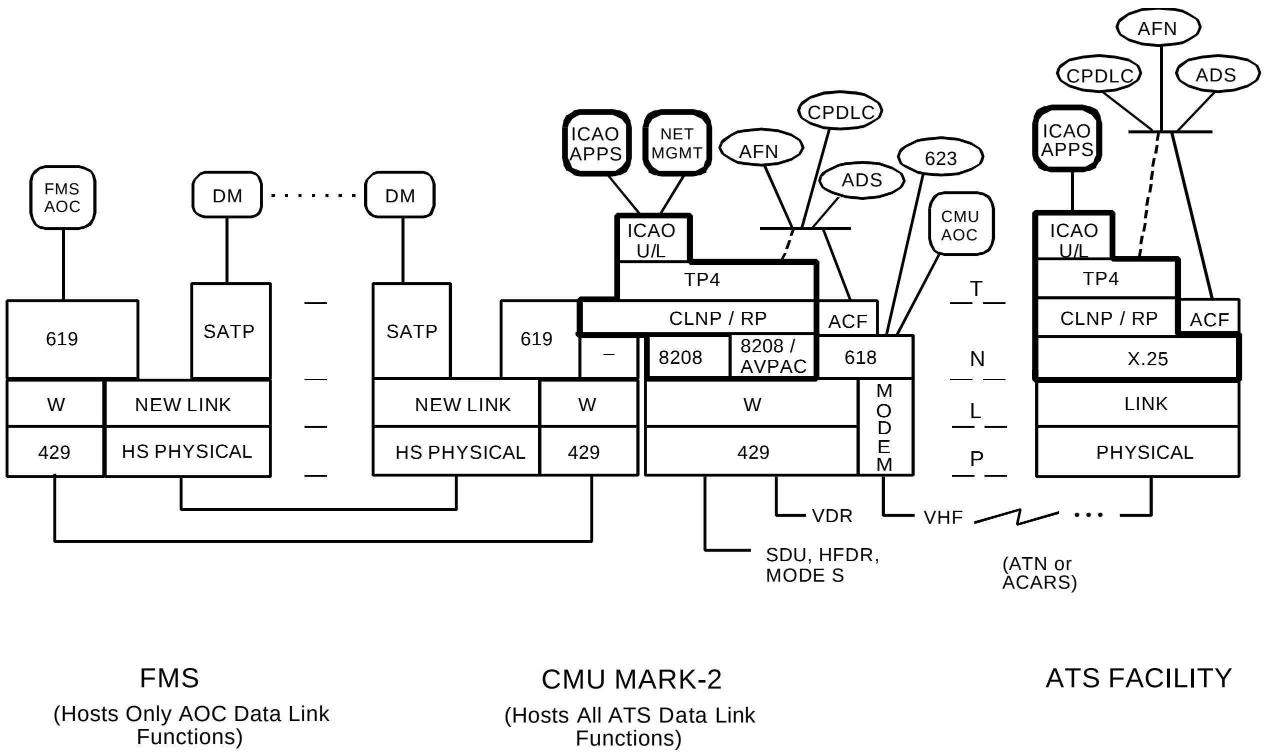
Data Link Service Providers have also expressed some interest in avionics providing network performance monitoring and reporting in the operational environment.

ATTACHMENT 1-1
DATA LINK INFRASTRUCTURE

Data Link Infrastructure



ATTACHMENT 1-2
CMU AS END SYSTEM ARCHITECTURE



DM	-	656 Data Manager application (handles parameter transfers)
SATP	-	656 Simple Application Transfer Protocol
NEW LINK	-	429 Connectionless Protocol or IEEE 802.3
HS PHYSICAL	-	HS429 or 10-BaseT (Ethernet)
W	-	429 Willamsburg Protocol
ICAO Apps	-	ICAO CPDLC, ADS, and CM applications
ICAO U/L	-	ICAO (Fast Byte) upper layers

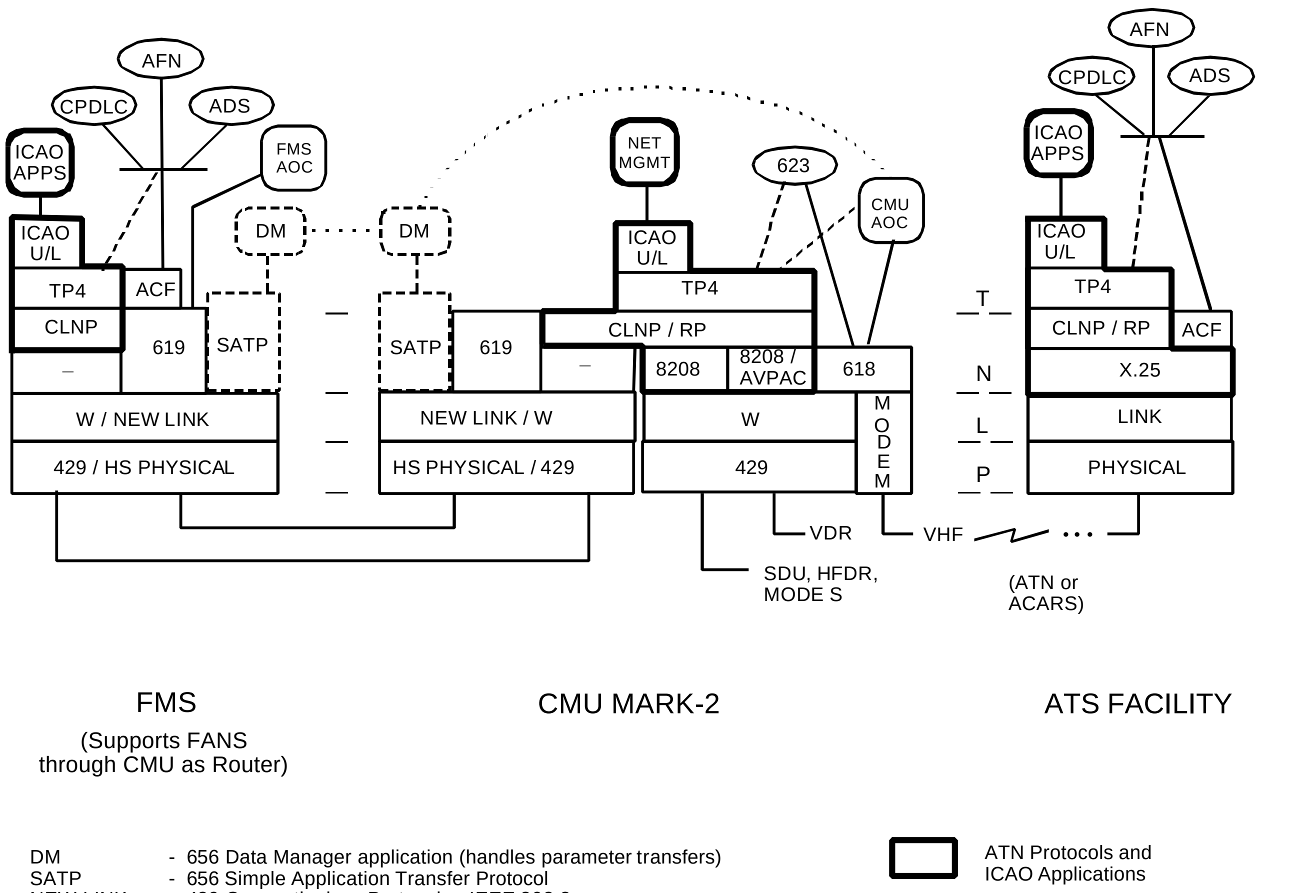
ATN Protocols and ICAO Applications

Optional paths

Note: DM and SATP needed for this architecture.if FMS data required for CMU hosted applications.

Comments and acronyms definition in accordance with final report, “Analysis of ATN Architectures for ATS Data Link” prepared by the Data Link Architectures ad hoc working group circulated under AEEC Letter 94-268/DLK-688

ATTACHMENT 1-3
CMU AS ROUTER ARCHITECTURE

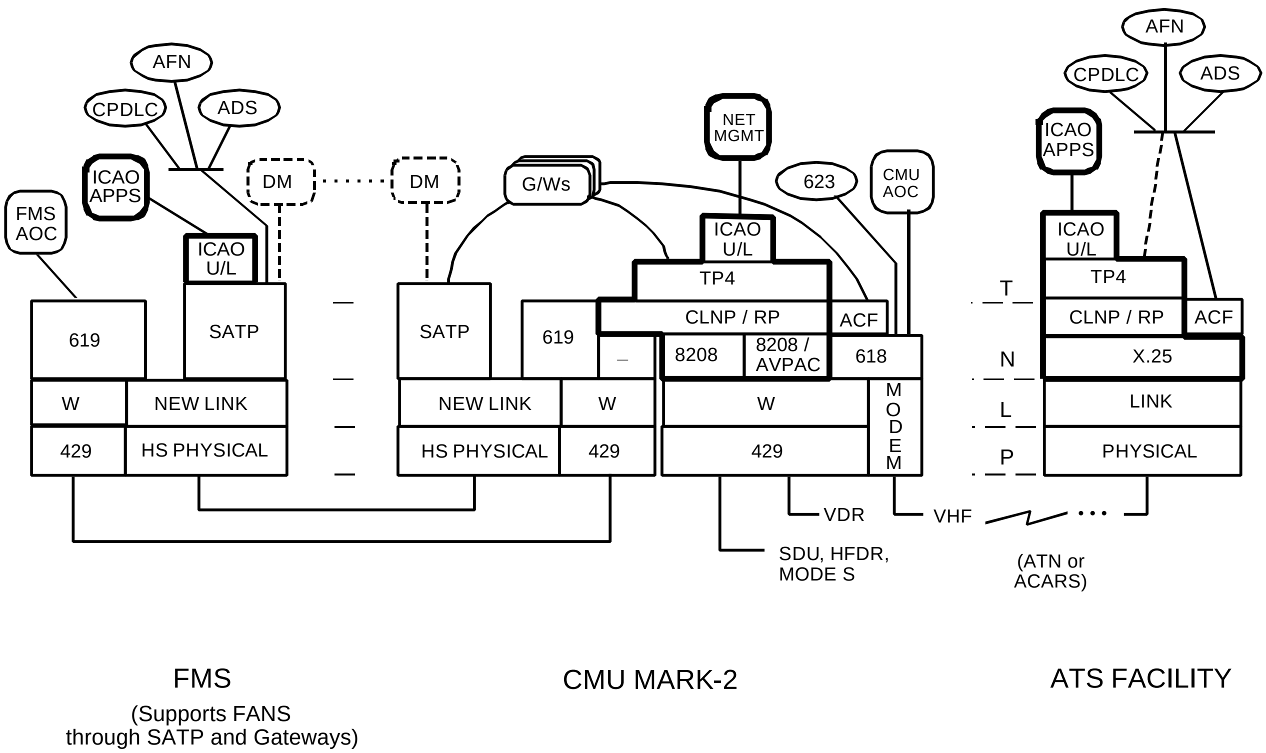


DM	-	656 Data Manager application (handles parameter transfers)
SATP	-	656 Simple Application Transfer Protocol
NEW LINK	-	429 Connectionless Protocol or IEEE 802.3
HS PHYSICAL	-	HS429 or 10-BaseT (Ethernet)
W	-	429 Willamsburg Protocol
ICAO Apps	-	ICAO CPDLC, ADS, and CM applications
ICAO U/L	-	ICAO (Fast Byte) upper layers

Note: DM and SATP are optional for this architecture.

Comments and acronyms definition in accordance with final report, "Analysis of ATN Architectures for ATS Data Link" prepared by the Data Link Architectures ad hoc working group circulated under AEEC Letter 94-268/DLK-688

ATTACHMENT 1-4
CMU AS REMOTE STACK (GATEWAY) ARCHITECTURE



DM - 656 Data Manager application (handles parameter transfers)
SATP - 656 Simple Application Transfer Protocol
NEW LINK - 429 Connectionless Protocol or IEEE 802.3
HS PHYSICAL - HS429 or 10-BaseT (Ethernet)
W - 429 Willamsburg Protocol
ICAO Apps - ICAO CPDLC, ADS, and CM applications
ICAO U/L - ICAO (Fast Byte) upper layers

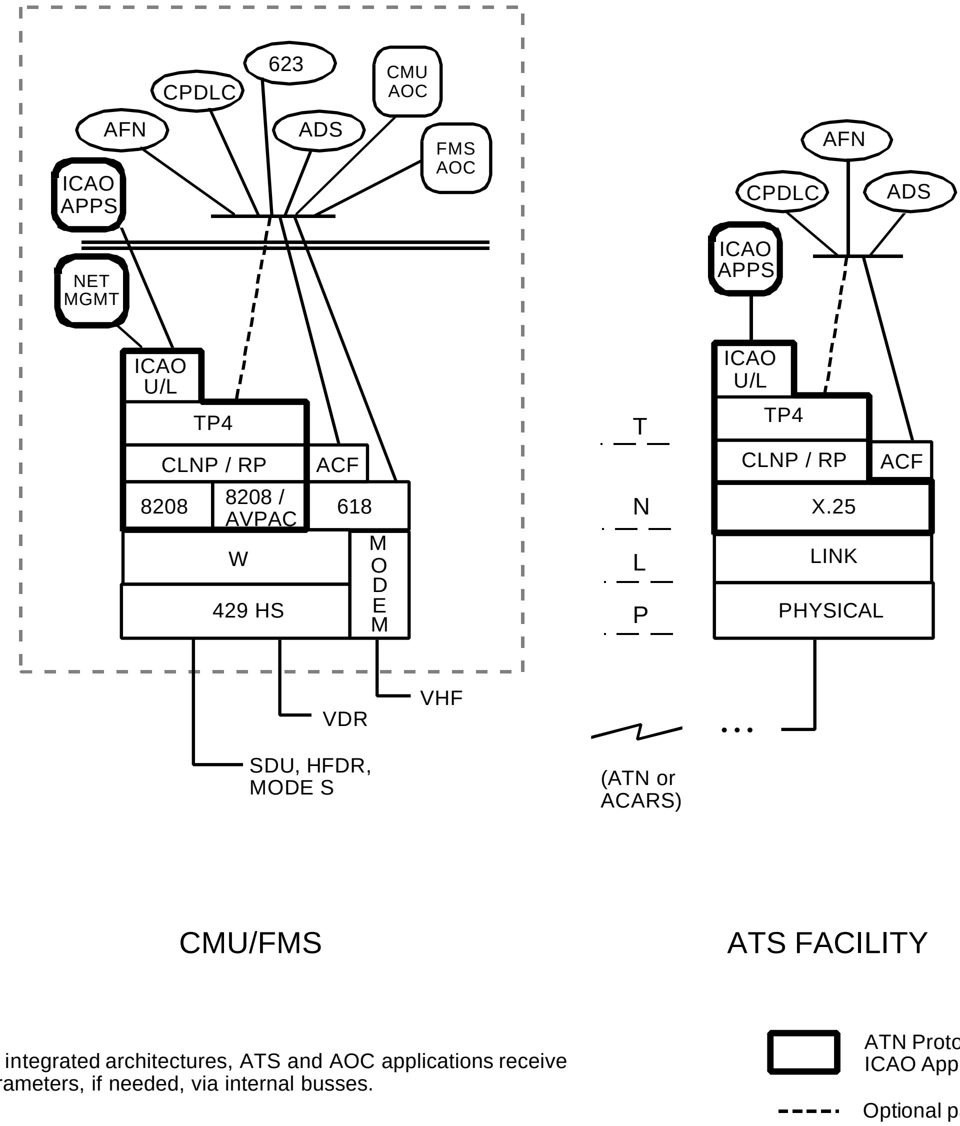
ATN Protocols and ICAO Applications

Optional paths, functions

Note: DM is optional, but SATP is needed for this architecture.

Comments and acronyms definition in accordance with final report, “Analysis of ATN Architectures for ATS Data Link” prepared by the Data Link Architectures ad hoc working group circulated under AEEC Letter 94-268/DLK-688

ATTACHMENT 1-5
CMU/FMS AS INTEGRATED ARCHITECTURE

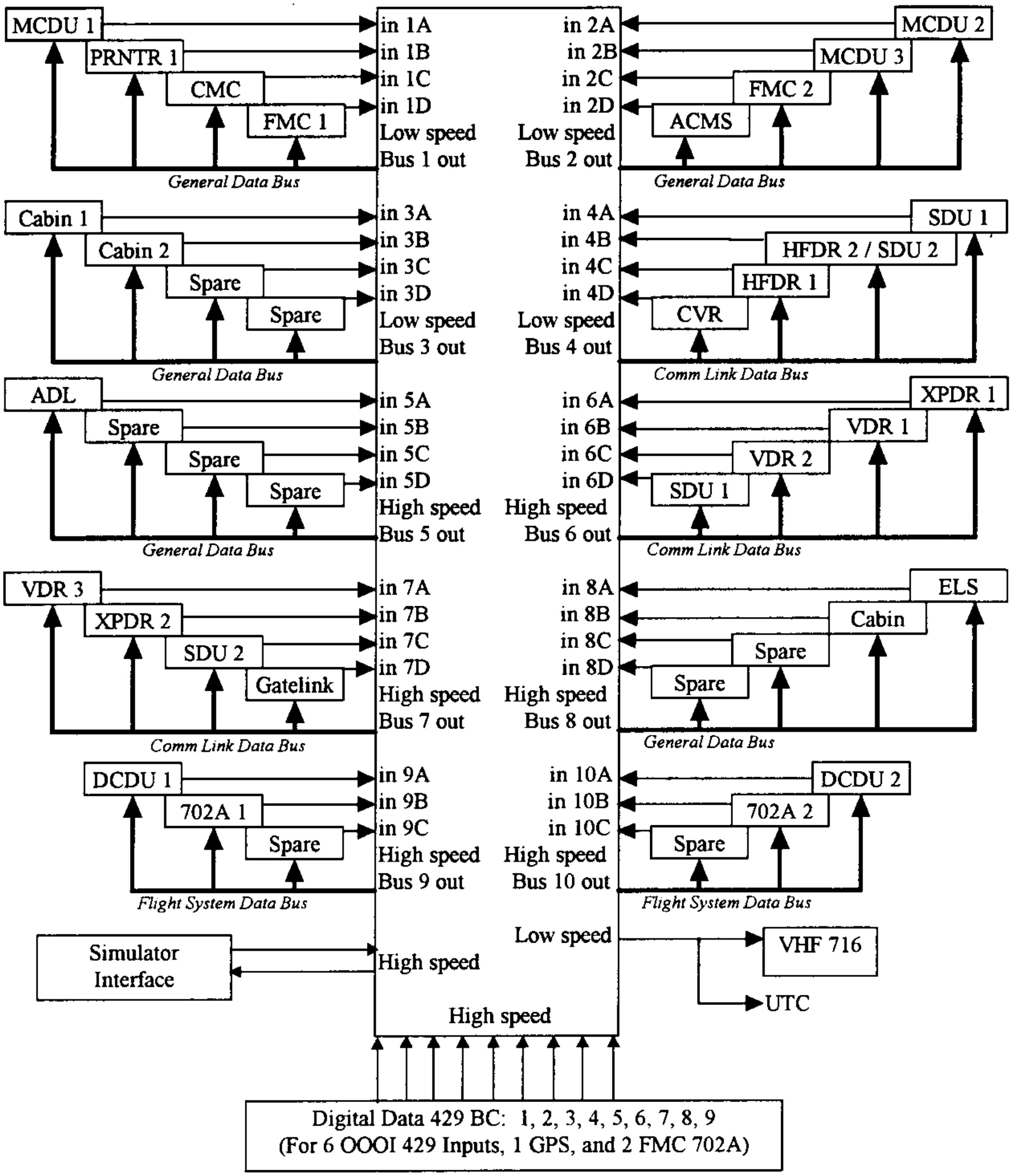


Note: In integrated architectures, ATS and AOC applications receive data parameters, if needed, via internal busses.

W	- 429 Willamsburg Protocol
ICAO Apps	- ICAO CPDLC, ADS, and CM applications
ICAO U/L	- ICAO (Fast Byte) upper layers

Comments and acronyms definition in accordance with final report, "Analysis of ATN Architectures for ATS Data Link" prepared by the Data Link Architectures ad hoc working group circulated under AEEC Letter 94-268/DLK-688

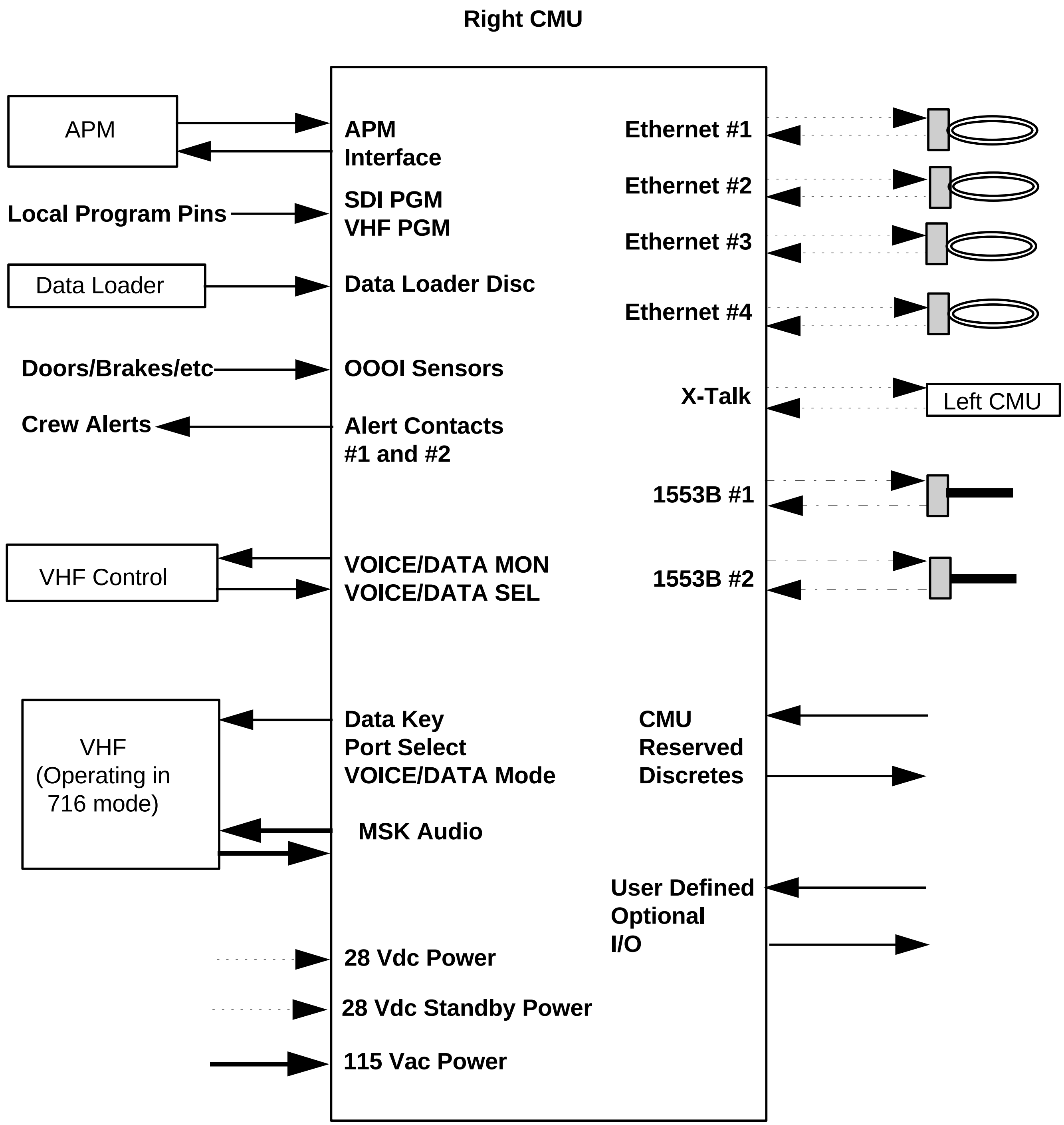
ATTACHMENT 1-6
ARINC 429 BUSES



12 transmitters 48 receivers

Note: 1=Left, 2=Right, 3= Center System

ATTACHMENT 1-7
NON ARINC 429 INTERFACES



ATTACHMENT 1-8
DUAL INSTALLATIONS

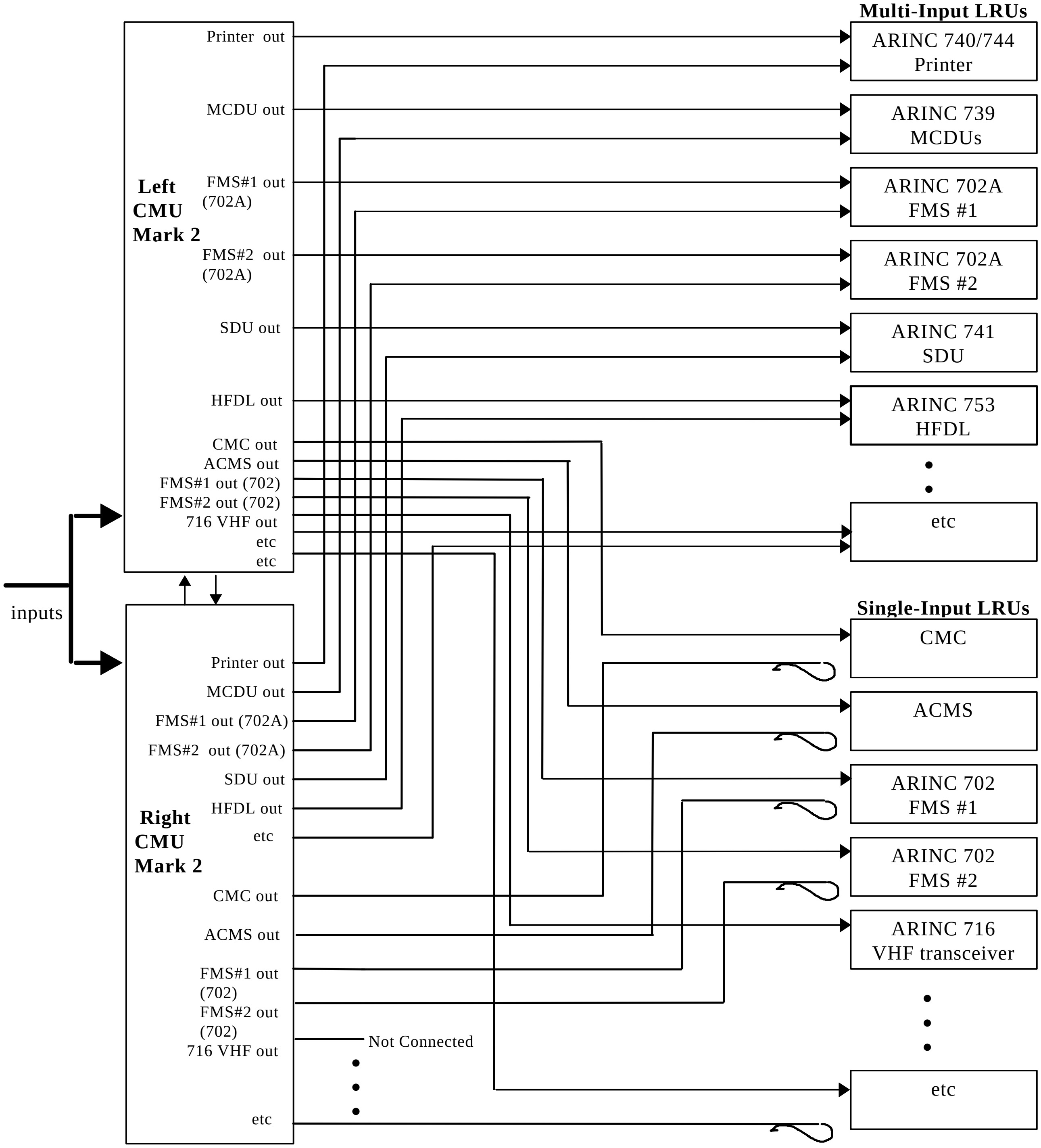


Figure 1-8a Example of Dual CMU ARINC Specification 429 Connections to Other LRUs.

Note: 1) CMU Mark 2 outputs to devices which support two inputs are wired directly from both CMUs to the device. Devices and discretes, which accept only a single input could be upgraded to accommodate two ARINC Specification 429 LS inputs, or, are switched through the use of an external switching unit.

2) Single Lines shown above may represent multiple busses, such as for the ARINC 702A FMS.

ATTACHMENT 1-8 (cont'd)
DUAL INSTALLATIONS

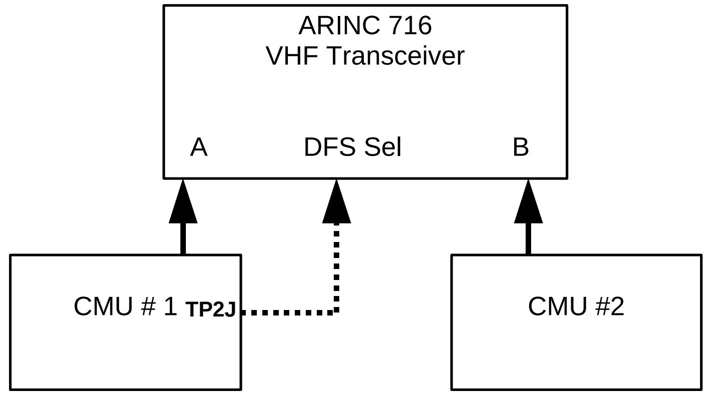


Figure 1-8b EXAMPLE of how dual CMUs could be wired to one ARINC 716 VHF Transceiver when the CMUs provide VHF voice frequency tuning in addition to the VHF data frequency tuning.

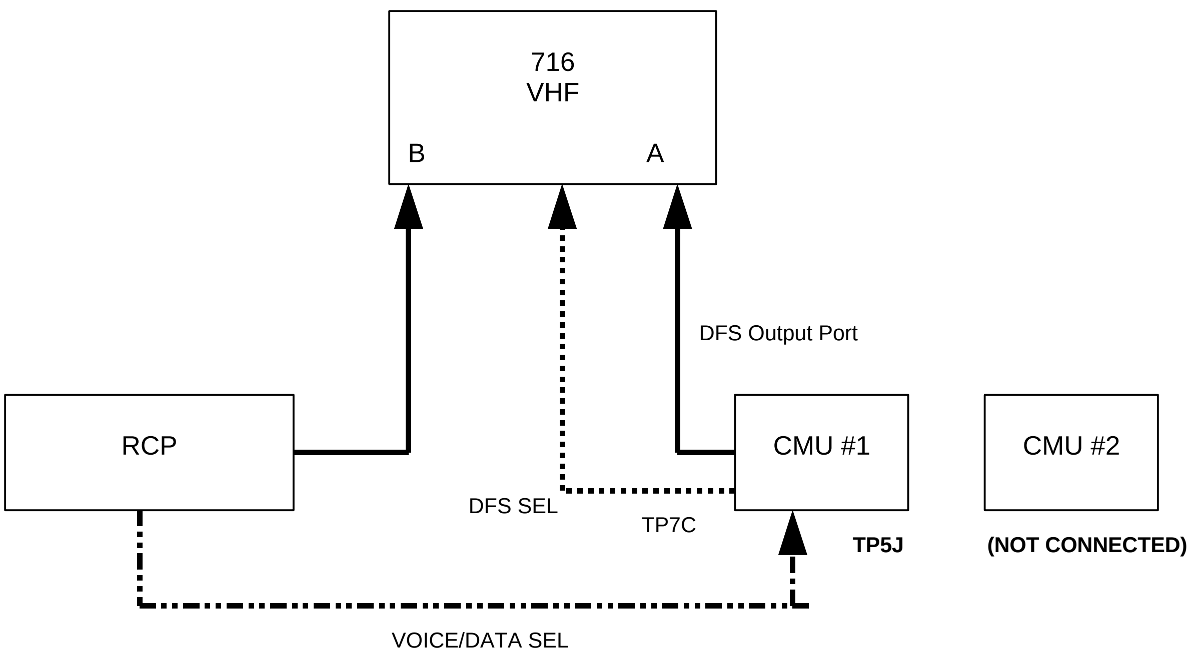
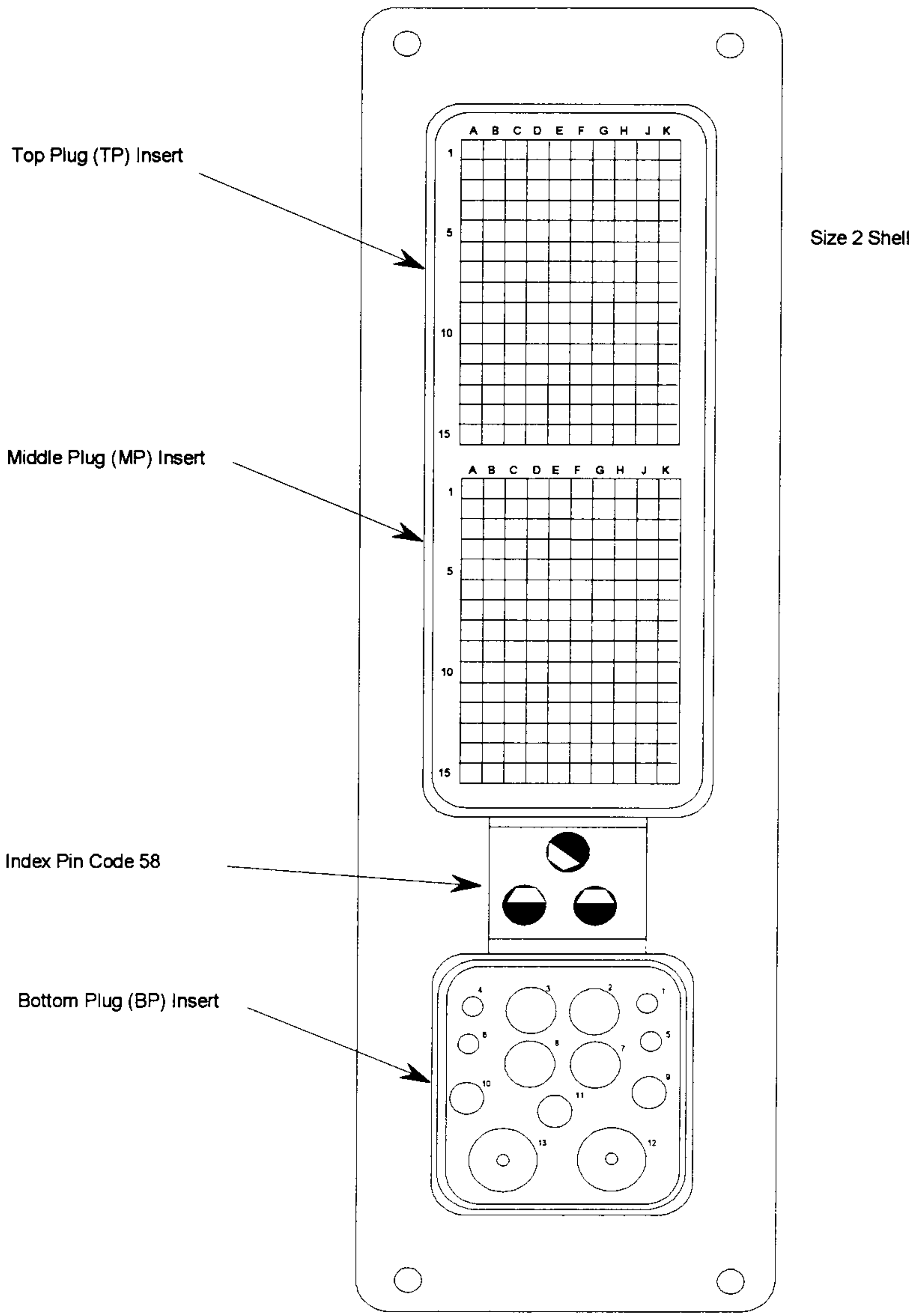


Figure 1-8c EXAMPLE of how dual CMUs could be wired to one ARINC 716 VHF Transceiver when the RCPs provide VHF voice frequency tuning and CMU provides the VHF data frequency tuning.

ATTACHMENT 2-1
REAR CONNECTOR INSERT DIAGRAM



Rear View LRU Connector

ATTACHMENT 2-2
STANDARD INTERWIRING

SIGNAL NAME		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES	
APM Power		TP01A	dc Power	607 APM		
APM Power return		TP01B	dc Ground	607 APM		
APM Enable #1		TP01C	APM	607 APM		
APM Enable #2		TP01D	APM	607 APM		
APM Serial Clock Out		TP01E	APM	607 APM		
Digital Data Bus #3 In	A	TP01F	ARINC 429 H/L In	OOOI Source		
Digital Data Bus #3 In	B	TP01G	ARINC 429 H/L In	OOOI Source		
APM Serial Data Out		TP01H	APM	607 APM		
APM Serial Data In		TP01J	APM	607 APM		
APM Write Protect # 1 Out		TP01K	APM	607 APM		
RSVD - APM Write Protect #2 Out		TP02A	APM	607 APM		
RSVD Spare		TP02B	APM	607 APM		
Comm Link Data Bus #4A In	A	TP02C	ARINC 429 L In	741 SDU #1 761 STU #1		c-1
Comm Link Data Bus #4A In	B	TP02D	ARINC 429 L In	741 SDU #1 761 STU #1		c-1
Comm Link Data Bus #4B In	A	TP02E	ARINC 429 L In	753 HFDR #2, 741 SDU #2 761 STU #2		c-1
Comm Link Data Bus #4B In	B	TP02F	ARINC 429 L In	753 HFDR #2, 741 SDU #2 761 STU #2		c-1
User Defined - CMU Crosstalk Data Bus In	A	TP02G	User Defined	758 CMU		
User Defined - CMU Crosstalk Data Bus In	B	TP02H	User Defined	758 CMU		
Dual Active/Standby		TP02J	Discrete Out	758 CMU		
RSVD (Printer Shield Common)		TP02K	dc Ground	dedicated Printer	Optional	c-1
RSVD (Printer Data Bus Serial Data Out)	A	TP03A	ARINC 597	dedicated Printer	Optional	c-1
. (Printer Data Bus Serial Data Out)	B	TP03B	ARINC 597	dedicated Printer	Optional	c-1
for (Printer Paper Low In)		TP03C	Discrete In	dedicated Printer	Optional	c-1
. (Printer Ready/Busy In)		TP03D	Discrete In	dedicated Printer	Optional	c-1
. (Printer Status A In)		TP03E	Discrete In	dedicated Printer	Optional	c-1
(Printer Status B In)		TP03F	Discrete In	dedicated Printer	Optional	c-1
. (Printer Status C In)		TP03G	Discrete In	dedicated Printer	Optional	c-1
(Printer Common)		TP03H	dc Ground	dedicated Printer	Optional	c-1
ARINC (UTC Clock Serial Data Out)	A	TP03J	ARINC 419		Optional	c-1
724 (UTC Clock Serial Data Out)	B	TP03K	ARINC 419		Optional	
RSVD for ATE		TP04A	User Defined			
RSVD for ATE		TP04B	User Defined			
RSVD for ATE		TP04C	User Defined			
RSVD for ATE		TP04D	User Defined			
Digital Data Bus #5 In	A	TP04E	ARINC 429 H/L In	OOOI Source		
Digital Data Bus #5 In	B	TP04F	ARINC 429 H/L In	OOOI Source		
Digital Data Bus #6 In	A	TP04G	ARINC 429 H/L In	OOOI Source		
Digital Data Bus #6 In	B	TP04H	ARINC 429 H/L In	OOOI Source		
Digital Data Bus #4 In	A	TP04J	ARINC 429 H/L In	OOOI Source		
Digital Data Bus #4 In	B	TP04K	ARINC 429 H/L In	OOOI Source		

ATTACHMENT 2-2 (cont'd)
STANDARD INTERWIRING

	SIGNAL		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
	Comm Link Data Bus #6B In	A	TP05A	ARINC 429 H In	750 VDR #1	
	Comm Link Data Bus #6B In	B	TP05B	ARINC 429 H In	750 VDR #1	
	Spare		TP05C			
	General Data Bus #5A In	A	TP05D	ARINC 429 H In	615 Data Loader	
	General Data Bus #5A In	B	TP05E	ARINC 429 H In	615 Data Loader	
	Spare		TP05F			
	Spare		TP05G			
	VHF Data Key Line		TP05H	Discrete Out	750 VDR	
	VHF Voice/Data Remote Select		TP05J	Discrete In	750 VDR	
	VHF Voice/Data Remote Annunciation		TP05K	Discrete Out	750 VDR	
	Spare		TP06A			
	Flight Sys Data Bus #10A In (RSVD)	A	TP06B	ARINC 429 H In	DCDU #2	
	Flight Sys Data Bus #10A In (RSVD)	B	TP06C	ARINC 429 H In	DCDU #2	
	Dual Inhibit		TP06D	Discrete In	758 CMU	
	Data Loader		TP06E	Discrete In	615 Data Loader	
	General Data Bus #5 Out	A	TP06F	ARINC 429 H/L Out		
	General Data Bus #5 Out	B	TP06G	ARINC 429 H/L Out		
c-1	Comm Link Data Bus #6D In	A	TP06H	ARINC 429 H In	741 SDU #1 761 STU #1	
c-1	Comm Link Data Bus #6D In	B	TP06J	ARINC 429 H In	741 SDU #1 761 STU #1	
	Spare		TP06K			
c-1	Digital Data Bus #1 Out (DFS/UTC)	A	TP07A	ARINC 429 L Out	716 VHF Transceiver	
c-1	Digital Data Bus #1 Out (DFS/UTC)	B	TP07B	ARINC 429 L Out	716 VHF Transceiver	
c-1	VHF DFS Port Select		TP07C	Discrete Out	716 VHF Transceiver	
	Spare		TP07D			
c-1	VHF Voice/Data Mode Monitor		TP07E	Discrete In	716 VHF Transceiver	
c-1	VHF Voice/Data Mode Annunciation		TP07F	Discrete Out	716 VHF Transceiver	
c-1	Comm Link Data Bus #4 Out	A	TP07G	ARINC 429 L Out	716 VHF Transceiver	
c-1	Comm Link Data Bus #4 Out	B	TP07H	ARINC 429 L Out	716 VHF Transceiver	
	Spare		TP07J			
c-1	VHF Data Key Line Return Common		TP07K	dc Ground	716 VHF Transceiver	
	RSVD for ARINC 646 Ethernet #3 In	A	TP08A	Ethernet In		
	RSVD for ARINC 646 Ethernet #3 In	B	TP08B	Ethernet In		
	RSVD for ARINC 646 Ethernet #3 Out	A	TP08C	Ethernet Out		
	RSVD for ARINC 646 Ethernet #3 Out	B	TP08D	Ethernet Out		
	User Defined		TP08E	User Defined		
	User Defined		TP08F	User Defined		
	Digital Data Bus #8 In (RSVD)	A	TP08G	ARINC 429 H In	702/A FMC #1	
	Digital Data Bus #8 In (RSVD)	B	TP08H	ARINC 429 H In	702/A FMC #1	
	Spare		TP08J			
	Spare		TP08K			

ATTACHMENT 2-2 (cont'd)
STANDARD INTERWIRING

SIGNAL		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES	
VHF MSK Audio Out	Hi	TP09A	Analog Out	716 VHF		
VHF MSK Audio Out	Lo	TP09B	Analog Out	716 VHF		
VHF MSK Audio In	Hi	TP09C	Analog In	716 VHF		
VHF MSK Audio In	Lo	TP09D	Analog In	716 VHF		
Spare		TP09E				
Spare		TP09F				
Aural/Visual Alert Contacts #1		TP09G	Relay	EFIS, EICAS, etc.		
Aural/Visual Alert Contacts #1		TP09H	Relay	EFIS, EICAS, etc.		
RSVD for ARINC 724 (RTS)		TP09J	Discrete In	724 MU-OAT	Optional	
RSVD for ARINC 724 (CTS)		TP09K	Discrete Out	724 MU-OAT	Optional	
Comm Link Data Bus #6C In	A	TP10A	ARINC 429 H In	750 VDR #2		
Comm Link Data Bus #6C In	B	TP10B	ARINC 429 H In	750 VDR #2		
Comm Link Data Bus #4C In	A	TP10C	ARINC 429 L In	753 HFDR #1		
Comm Link Data Bus #4C In	B	TP10D	ARINC 429 L In	753 HFDR #1		
Flight System Data Bus #9B In (RSVD)	A	TP10E	ARINC 429 H In	702/A FMC #1		
Flight System Data Bus #9B In (RSVD)	B	TP10F	ARINC 429 H In	702/A FMC #1		
Flight System Data Bus #9 Out	A	TP10G	ARINC 429 H Out			
Flight System Data Bus #9 Out	B	TP10H	ARINC 429 H Out			
RSVD for MIL STD 1553 #1	Hi	TP10J	MIL STD 1553		Optional	
RSVD for MIL STD 1553 #1	Lo	TP10K	MIL STD 1553		Optional	
RSVD for ARINC 724 (Data Term Ready)		TP11A	Discrete In	724 MU-OAT	Optional	
Spare		TP11B			Optional	
VHF Voice Channel Control Program Pin		TP11C	Local Program		Optional	
Program Pin Common		TP11D	dc Ground		Optional	
RSVD for ARINC 724 (Data Bus In)	A	TP11E	Serial Data	724 MU-OAT	Optional	
RSVD for ARINC 724 (Data Bus In)	B	TP11F	Serial Data	724 MU-OAT	Optional	
RSVD for ARINC 724 (Data Bus Out)	A	TP11G	Serial Data	724 MU-OAT	Optional	
RSVD for ARINC 724 (Data Bus Out)	B	TP11H	Serial Data	724 MU-OAT	Optional	
RSVD for ARINC 724 (OAT Shield)		TP11J	dc Ground	724 MU-OAT	Optional	
RSVD for MIL STD 1553 #1 Common		TP11K	MIL STD 1553		Optional	
Spare		TP12A				
User Defined - CMU Crosstalk Data Bus Out	A	TP12B	User Defined			
User Defined - CMU Crosstalk Data Bus Out	B	TP12C	User Defined			
Comm Link Data Bus #7C In	A	TP12D	ARINC 429 H In	741 SDU #2		
				761 STU #2		c-1
Comm Link Data Bus #7C In	B	TP12E	ARINC 429 H In	741 SDU #2		
				761 STU #2		c-1
RSVD Discrete Out #2		TP12F	Discrete Out			
RSVD Discrete Out #1		TP12G	Discrete Out			
RSVD Discrete Out #3		TP12H	Discrete Out			
RSVD Discrete Out #4		TP12J	Discrete Out			
RSVD Discrete Out Common		TP12K	dc Ground			

ATTACHMENT 2-2 (cont'd)
STANDARD INTERWIRING

SIGNAL		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
RSVD for ARINC 724 (Uplink BCS Indicator)		TP13A	Discrete Out	724 MU-OAT	Optional
RSVD for ARINC 724 (Uplink ACK Indicator)		TP13B	Discrete Out	724 MU-OAT	Optional
RSVD for ARINC 724 (Uplink NAK Indicator)		TP13C	Discrete Out	724 MU-OAT	Optional
RSVD for ARINC 724 (Output Bus)	A	TP13D	User Defined	724 ACARS CU	Optional
RSVD for ARINC 724 (Output Bus)	B	TP13E	User Defined	724 ACARS CU	Optional
RSVD for ARINC 724 (Input Bus)	A	TP13F	User Defined	724 ACARS CU	Optional
RSVD for ARINC 724 (Input Bus)	B	TP13G	User Defined	724 ACARS CU	Optional
Comm Link Data Bus #7 Out	A	TP13H	ARINC 429 H Out		
Comm Link Data Bus #7 Out	B	TP13J	ARINC 429 H Out		
Spare		TP13K			
General Data Bus #8C In (Spare)	A	TP14A	ARINC 429 H In		
General Data Bus #8C In (Spare)	B	TP14B	ARINC 429 H In		
General Data Bus #8D In (Spare)	A	TP14C	ARINC 429 H In		
General Data Bus #8D In (Spare)	B	TP14D	ARINC 429 H In		
SDI Program Pin #1		TP14E	Local Program		
SDI Program Pin #2		TP14F	Local Program		
Spare		TP14G			
General Data Bus #5B In (Spare)	A	TP14H	ARINC 429 H/L In		
General Data Bus #5B In (Spare)	B	TP14J	ARINC 429 H/L In		
RSVD - Discrete In		TP14K	Discrete In		
RSVD for ARINC 724/B		TP15A	Discrete In	OOOI Sensor In #1	Optional
RSVD for ARINC 724/B		TP15B	Discrete In	OOOI Sensor In #2	Optional
RSVD for ARINC 724/B		TP15C	Discrete In	OOOI Sensor In #3	Optional
RSVD for ARINC 724/B		TP15D	Discrete In	OOOI Sensor In #4	Optional
RSVD for ARINC 724/B		TP15E	Discrete In	OOOI Sensor In #5	Optional
RSVD for ARINC 724/B		TP15F	Discrete In	OOOI Sensor In #6	Optional
RSVD for ARINC 724/B		TP15G	Discrete In	OOOI Sensor In #7	Optional
RSVD for ARINC 724/B		TP15H	Discrete In	OOOI Sensor In #8	Optional
RSVD for ARINC 724/B		TP15J	Discrete In	OOOI Sn In On/Off	Optional
RSVD for ARINC 724/B		TP15K	dc Ground	OOOI Sensor Rtn	Optional

ATTACHMENT 2-2 (cont'd)
STANDARD INTERWIRING

SIGNAL		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Spare		MP01A			
Spare		MP01B			
Spare		MP01C			
Spare		MP01D			
Spare		MP01E			
Spare		MP01F			
Spare		MP01G			
Spare		MP01H			
Spare		MP01J			
RSVD Discrete In Common		MP01K	dc Ground		
RSVD Discrete In #1		MP02A	Discrete In		
RSVD Discrete In #2		MP02B	Discrete In		
8.33 kHz Tuning		MP02C	Discrete In	716 VHF Transceiver	c-1
Installed In Simulator		MP02D	Discrete In	Simulator	
RSVD Discrete In #5		MP02E	Discrete In		
RSVD Discrete In #6		MP02F	Discrete In		
RSVD Discrete In #7		MP02G	Discrete In		
RSVD Discrete In #8		MP02H	Discrete In		
Spare		MP02J			
Spare		MP02K			
RSVD for ARINC 646 Ethernet #2 In	A	MP03A	Ethernet In		
RSVD for ARINC 646 Ethernet #2 In	B	MP03B	Ethernet In		
RSVD for ARINC 646 Ethernet #2 Out	A	MP03C	Ethernet Out		
RSVD for ARINC 646 Ethernet #2 Out	B	MP03D	Ethernet Out		
User Defined		MP03E			
User Defined		MP03F			
RSVD for ARINC 646 Ethernet #4 In	A	MP03G	Ethernet In		
RSVD for ARINC 646 Ethernet #4 In	B	MP03H	Ethernet In		
RSVD for ARINC 646 Ethernet #4 Out	A	MP03J	Ethernet Out		
RSVD for ARINC 646 Ethernet #4 Out	B	MP03K	Ethernet Out		
Spare		MP04A			
Spare		MP04B			
Flight Sys Data Bus #10B In (RSVD)	A	MP04C	ARINC 429 H In	702/A FMC #2	
Flight Sys Data Bus #10B In (RSVD)	B	MP04D	ARINC 429 H In	702/A FMC #2	
Spare		MP04E			
Spare		MP04F			
Spare		MP04G			
Spare		MP04H			
Spare		MP04J			
Spare		MP04K			

ATTACHMENT 2-2 (cont'd)
STANDARD INTERWIRING

SIGNAL		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Flight Sys Data Bus #9C In (Spare)	A	MP05A	ARINC 429 H In		
Flight Sys Data Bus #9C In (Spare)	B	MP05B	ARINC 429 H In		
Spare		MP05C			
Spare		MP05D			
General Data Bus #5C In (Spare)	A	MP05E	ARINC 429 H/L In		
General Data Bus #5C In (Spare)	B	MP05F	ARINC 429 H/L In		
Spare		MP05G			
Spare		MP05H			
Spare		MP05J			
Spare		MP05K			
General Data Bus #5D In (Spare)	A	MP06A	ARINC 429 H/L In		
General Data Bus #5D In (Spare)	B	MP06B	ARINC 429 H/L In		
Spare		MP06C			
Spare		MP06D			
Digital Data Bus #7 In (RSVD)	A	MP06E	ARINC 429 H/L In	743/A GPS	
Digital Data Bus #7 In (RSVD)	B	MP06F	ARINC 429 H/L In	743/A GPS	
Spare		MP06G			
Spare		MP06H			
Digital Data Bus #9 In (RSVD)	A	MP06J	ARINC 429 H/L In	702/A FMC #2	
Digital Data Bus #9 In (RSVD)	B	MP06K	ARINC 429 H/L In	702/A FMC #2	
Spare		MP07A			
Spare		MP07B			
Comm Link Data Bus #7A In	A	MP07C	ARINC 429 H In	750 VDR #3	
Comm Link Data Bus #7A In	B	MP07D	ARINC 429 H In	750 VDR #3	
ARINC 724B Discrete Common		MP07E	dc Signal Ground		
RSVD for MIL STD 1553 #2	Hi	MP07F	MIL STD 1553		Optional
RSVD for MIL STD 1553 #2	Lo	MP07G	MIL STD 1553		Optional
RSVD for MIL STD 1553 #2 Common		MP07H	dc Signal Ground		Optional
General Data Bus #3D In (Spare)	A	MP07J	ARINC 429 L In		
General Data Bus #3D In (Spare)	B	MP07K	ARINC 429 L In		
Flight Sys Data Bus #9A In (RSVD)	A	MP08A	ARINC 429 H In	DCDU #1	
Flight Sys Data Bus #9A In (RSVD)	B	MP08B	ARINC 429 H In	DCDU #1	
Comm Link Data Bus #6A In	A	MP08C	ARINC 429 H In	718A XPDR #1	
Comm Link Data Bus #6A In	B	MP08D	ARINC 429 H In	718A XPDR #1	
Flight Sys Data Bus #10C In (Spare)	A	MP08E	ARINC 429 H In		
Flight Sys Data Bus #10C In (Spare)	B	MP08F	ARINC 429 H In		
General Data Bus #8B In (RSVD)	A	MP08G	ARINC 429 H In	746 Cabin System	
General Data Bus #8B In (RSVD)	B	MP08H	ARINC 429 H In	746 Cabin System	
Comm Link Data Bus #7D In	A	MP08J	ARINC 429 H In	751 Gatelink	
Comm Link Data Bus #7D In	B	MP08K	ARINC 429 H In	751 Gatelink	

ATTACHMENT 2-2 (cont'd)
STANDARD INTERWIRING

SIGNAL		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Spare		MP09A			
Spare		MP09B			
Aural/Visual Alert Reset		MP09C	Discrete In	EFIS, EICAS, etc.	
VHF Voice Mode Isolation		MP09D	Program Logic	Aircraft wiring	Optional
Spare		MP09E			
Aural/Visual Alert Contacts #2		MP09F	Relay	EFIS, EICAS, etc.	
Aural/Visual Alert Contacts #2		MP09G	Relay	EFIS, EICAS, etc.	
Spare		MP09H			
Fault Annunciation		MP09J	Discrete Out		
RSVD for ARINC 724 (NO COMM)		MP09K	Discrete Out	EFIS, EICAS, etc.	Optional
Comm Link Data Bus #7B In	A	MP10A	ARINC 429 H In	718A XPDR #2	
Comm Link Data Bus #7B In	B	MP10B	ARINC 429 H In	718A XPDR #2	
General Data Bus #8A In	A	MP10C	ARINC 429 H In	ELS	
General Data Bus #8A In	B	MP10D	ARINC 429 H In	ELS	
Simulator Data Bus In	A	MP10E	ARINC 429 H In	610A Simulator	
Simulator Data Bus In	B	MP10F	ARINC 429 H In	610A Simulator	
Comm Link Data Bus #4D In	A	MP10G	ARINC 429 L In	757 CVR	
Comm Link Data Bus #4D In	B	MP10H	ARINC 429 L In	757 CVR	
General Data Bus #8 Out	A	MP10J	ARINC 429 H Out		
General Data Bus #8 Out	B	MP10K	ARINC 429 H Out		
Flight Sys Data Bus #10 Out	A	MP11A	ARINC 429 H Out		
Flight Sys Data Bus #10 Out	B	MP11B	ARINC 429 H Out		
General Data Bus #2C In	A	MP11C	ARINC 429 L In	702/A FMC #2	
General Data Bus #2C In	B	MP11D	ARINC 429 L In	702/A FMC #2	
General Data Bus #2D In	A	MP11E	ARINC 429 L In	717 ACMS	
General Data Bus #2D In	B	MP11F	ARINC 429 L In	717 ACMS	
Ethernet #1 In (Simulator)	A	MP11G	646 Ethernet In	Simulator/615A Data Loader	c-1
Ethernet #1 In (Simulator)	B	MP11H	646 Ethernet In	Simulator/615A Data Loader	c-1
Ethernet #1 Out (Simulator)	A	MP11J	646 Ethernet Out	Simulator/615A Data Loader	c-1
Ethernet #1 Out (Simulator)	B	MP11K	646 Ethernet Out	Simulator/615A Data Loader	c-1
Comm Link Data Bus #6 Out	A	MP12A	ARINC 429 H Out		
Comm Link Data Bus #6 Out	B	MP12B	ARINC 429 H Out		
General Data Bus #2A In	A	MP12C	ARINC 429 L In	739 MCDU #2	
General Data Bus #2A In	B	MP12D	ARINC 429 L In	739 MCDU #2	
General Data Bus #2 Out	A	MP12E	ARINC 429 L Out		
General Data Bus #2 Out	B	MP12F	ARINC 429 L Out		
General Data Bus #2B In	A	MP12G	ARINC 429 L In	739 MCDU #3	
General Data Bus #2B In	B	MP12H	ARINC 429 L In	739 MCDU #3	
General Data Bus #1B In	A	MP12J	ARINC 429 L In	740/744A Printer	
General Data Bus #1B In	B	MP12K	ARINC 429 L In	740/744A Printer	

ATTACHMENT 2-2 (cont'd)
STANDARD INTERWIRING

SIGNAL		PIN	SIGNAL TYPE	SOURCE/SINK	NOTES
Spare		MP13A			
Spare		MP13B			
Spare		MP13C			
Spare		MP13D			
Spare		MP13E			
Spare		MP13F			
General Data Bus #1C In	A	MP13G	ARINC 429 L In	604 CFDIU (CMC)	
General Data Bus #1C In	B	MP13H	ARINC 429 L In	or 624 OMS	
General Data Bus #3C In (Spare)	A	MP13J	ARINC 429 L In		
General Data Bus #3C In (Spare)	B	MP13K	ARINC 429 L In		
General Data Bus #1A In	A	MP14A	ARINC 429 L In	739 MCDU #1	
General Data Bus #1A In	B	MP14B	ARINC 429 L In	739 MCDU #1	
General Data Bus #3A In	A	MP14C	ARINC 429 L In	Cabin Terminal #1	
General Data Bus #3A In	B	MP14D	ARINC 429 L In	Cabin Terminal #1	
Digital Data Bus #1 In	A	MP14E	ARINC 429 L In	OOOI Source	
Digital Data Bus #1 In	B	MP14F	ARINC 429 L In	OOOI Source	
Digital Data Bus #2 In	A	MP14G	ARINC 429 L In	OOOI Source	
Digital Data Bus #2 In	B	MP14H	ARINC 429 L In	OOOI Source	
General Data Bus #3B In	A	MP14J	ARINC 429 L In	Cabin Terminal #2	
General Data Bus #3B In	B	MP14K	ARINC 429 L In	Cabin Terminal #2	
RSVD for ARINC 724 (Data Bus In)	A	MP15A	Serial Data	573 AIDS	Optional
RSVD for ARINC 724 (Data Bus In)	B	MP15B	Serial Data	573 AIDS	Optional
Simulator Data Bus Out	A	MP15C	ARINC 429 H Out	610A Simulator	
Simulator Data Bus Out	B	MP15D	ARINC 429 H Out	610A Simulator	
General Data Bus #1 Out	A	MP15E	ARINC 429 L Out		
General Data Bus #1 Out	B	MP15F	ARINC 429 L Out		
General Data Bus #3 Out	A	MP15G	ARINC 429 L Out		
General Data Bus #3 Out	B	MP15H	ARINC 429 L Out		
General Data Bus #1D In	A	MP15J	ARINC 429 L In	702/A FMC #1	
General Data Bus #1D In	B	MP15K	ARINC 429 L In	702/A FMC #1	
Primary Power 115 Vac Hot (400 Hz)		BP01	ac Power	Aircraft Power	Gen Av
RSVD - 28 Vdc Primary Power Hot		BP02	dc Power	Aircraft Power	Gen Av
RSVD - 28 Vdc Primary Power Return		BP03	dc Power Ground	Aircraft Power	
Spare		BP04			
Spare		BP05			
Spare		BP06			
Primary Power 115 Vac Cold (400 Hz)		BP07	ac Power	Aircraft Power	
Chassis Ground		BP08	dc Signal Ground	Aircraft Power	
Spare		BP09			
Standby Power 28 Vdc Positive In		BP10	dc Power	Aircraft Power	
Standby Power 28 Vdc Return		BP11	dc Power Ground	Aircraft Power	
Spare		BP12			
Spare		BP13			

ATTACHMENT 2-2A
NOTES APPLICABLE TO STANDARD INTERWIRING

The following should be considered on all installations:

1) Wire Size

The size (gauge) of wire selected for aircraft installations should be considered carefully. Factors to be considered include current handling capacity, attenuation, insulation, weight, and flexibility. Over the years, the airlines have reported a number of sad experiences with aircraft where small (less than #22 guage) wire was used. Although the airlines are, of course, interested in the weight saving its use affords, they will quickly point out that these savings are rapidly nullified by maintenance costs if frequent breakage ocurs.

2) Twisted Shielded Wire

Digital data bus shields should be grounded to the aircraft structure at both ends of the cable run. Further, digital data bus shields should be grounded to the aircraft structure on both sides of each production break.

3) General Guidance

Additional installation guidance is provided in Section 2.0 of this document

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ATTACHMENT 2-3
REAR CONNECTOR INSERT LAYOUT

Table 1 - Top Plug (TP) Insert

	A	B	C	D	E	F	G	H	J	K
1	----APM---- Power	Power Return	Enable #1	Enable #2	Clock Out	OOOI #3 In A	B	----APM---- Data Out	Data In	Write Prot #1 Out
2	----RSVD APM---- Write Prot #2 Out	Spare	SDU/STU #1 CL Data Bus #4A In A	B	HFDR #2/SDU #2/STU #2 CL Data Bus #4B In A	B	CMU Crosstalk In A	B	ACT/STY Out	OPT-724 Printer Common
3	----RSVD Optional ARINC 724 Printer---- Data Bus Out A	B	Disc In	Disc In	Disc In	Disc In	Disc In	Common	Optional 419 UTC Out A	B
4	----RSVD User Defined ATE----				OOOI #5 In A	B	OOOI #6 In A	B	OOOI #4 In A	B
5	VDR #1 CL Data Bus #6B A	B	Spare	Data Loader #5A In A	B	----Spare----		VHF Data Key Line Disc Out	VHF V/D Remote Disc In	VHF V/D Remote Disc Out
c-1 6	Spare	RSVD DCDU #2 FS Data Bus #10A A	B	Dual Inhibit Disc In	Data Loader Disc In	Gen Data Bus #5 Out A	B	SDU #1/STU #1 CL Data Bus #6D in A	B	Spare
7	DFS/UTC Dig Data Bus #1 Out A	B	DFS Port Select Disc Out	Spare	V/D Mode Monitor Disc In	V/D Mode Annun Disc Out	CL Data Bus #4 Out A	B	Spare	VHF Data Key Line Rtn Common
8	RSVD Ethernet #3 In A	B	RSVD Ethernet #3 Out A	B	User Defined		RSVD 702 FMC #1 Dig Data Bus #8 In A	B	----Spare----	
9	VHF MSK Audio Out Hi	Lo	VHF MSK Audio In Hi	Lo	----Spare----		A/V Alert Contacts #1 Relay	Relay	RSVD Optional OAT Disc In	Disc Out
10	VDR #2 CL Data Bus #6C In A	B	HFDR #1 CL Data Bus #4C In A	B	RSVD 702A FMC #1 FS Data Bus #9B In A	B	FS Data Bus #9 Out A	B	RSVD MIL STD 1553 #1 Hi	Lo
11	RSVD Optional OAT Disc In	Spare	OPT VHF Voice Chnl Ctrl Prgm	Program Pin Common	----RSVD Optional for ARINC 724 OAT---- Data Bus In A	B	Data Bus Out A	B	Shield	RSVD MIL STD 1553 #1 Common
c-1 12	Spare	CMU Crosstalk Data Bus Out A	B	SDU #2/STU #2 CL Data Bus #7C In A	B	RSVD #2 Disc Out	RSVD #1 Disc Out	RSVD #3 Disc Out	RSVD #4 Disc Out	RSVD Disc Out Common
13	RSVD Optional for 724 OAT Disc Out	Disc Out	Disc Out	RSVD Optional 724 CU Data Bus Out A	B	RVSD Optional 724 CU Data Bus In A	B	CL Data Bus # 7 Out A	B	Spare
14	Spare Gen Data Bus #8C In A	B	Spare Gen Data Bus #D In A	B	SDI Prgm Pin #1	SDI Prgm Pin #2		Gen Data Bus #5B In A	B	RSVD Disc In
15	----OOOI Sensor Discrete Input---- #1	#2	#3	#4	#5	#6	#7	#8	On/Off	Return

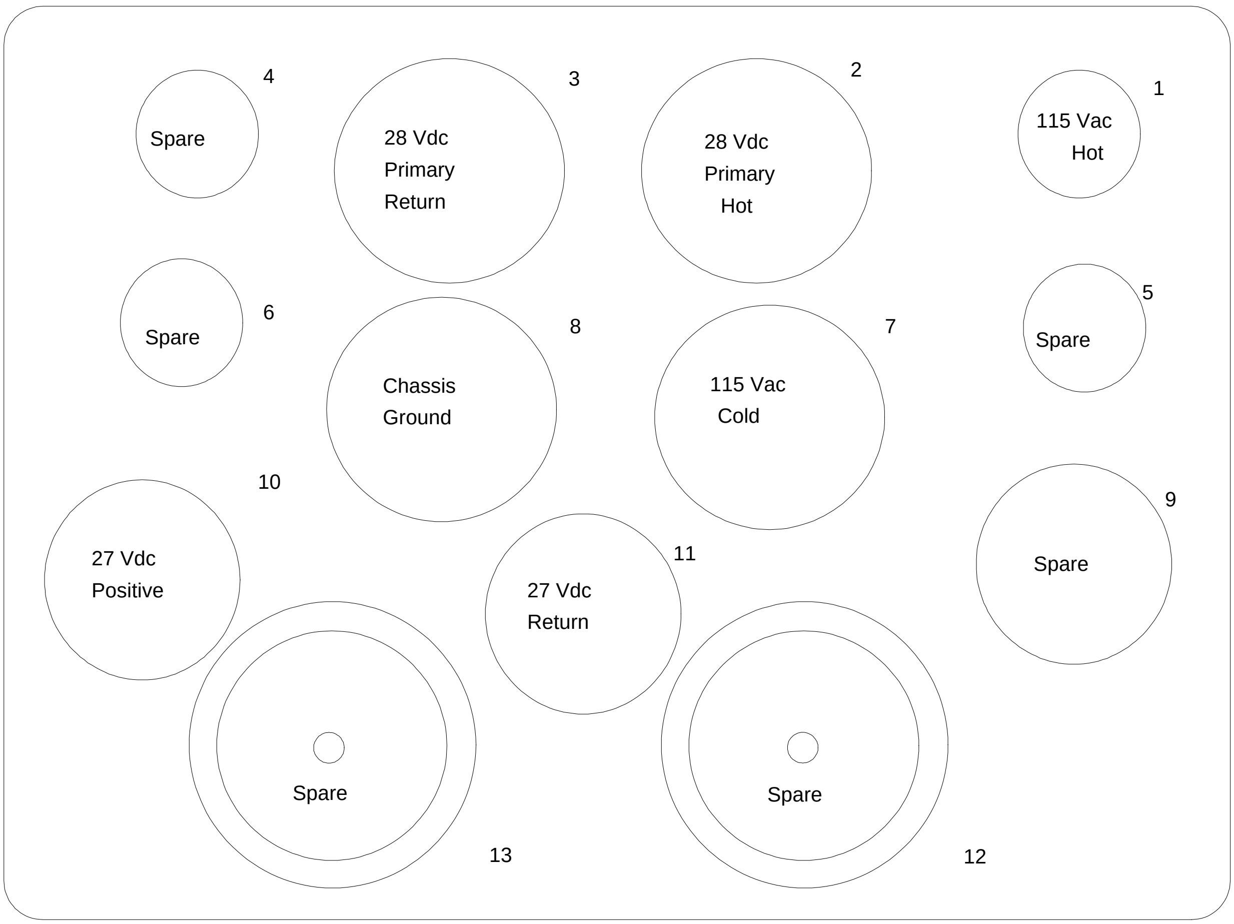
ATTACHMENT 2-3 (cont'd)
REAR CONNECTOR INSERT LAYOUT

Table 2 Middle Plug (MP) Insert

	A	B	C	D	E	F	G	H	J	K	
1	----Spare----									RSVD Disc In Common	
2	RSVD Disc #1 In	8.33 kHz Disc In	Installed in Simulator Disc In	----RSVD Discrete Input---- #4	#5	#6	#7	#8	Spare		c-1
3	RSVD Ethernet #2 In A	B	RSVD Ethernet #2 Out A	B	User Defined		RSVD Ethernet #4 In A	B	RSVD Ethernet #4 Out A	B	
4	Spare		702A FMC #2 FS Data Bus #10B In A	B	----Spare----						
5	Spare FS Data Bus #9C In A	B	Spare		Spare Gen Data Bus #5C In A	B	----Spare----				
6	Spare Gen Data Bus #5D In A	B	Spare		743A GPS Dig Data Bus #7 In A	B	Spare		702A FMC #2 Dig Data Bus #9 In A	B	
7	Spare		VDR #3 CL Data Bus #7A In A	B	724 Disc Common	RSVD MIL STD 1553 #2 Hi	Lo	Common	Spare Gen Data Bus #3D In A	B	
8	DCDU #1 FS Data Bus #9A In A	B	XPDR #1 CL Data Bus #6A In A	B	Spare FS Data Bus #10C In A	B	RSVD for Cabin Sys Gen Data Bus #8B In A	B	Gatelink CL Data Bus #7D In A	B	
9	Spare		A/V Alert Reset Disc In	OPT VHF Voice Mode Isolation Program	Spare	A/V Alert Contacts #2 Relay	Relay	Spare	Fault Annunc Disc Out	RSVD - Opt NO COMM Disc Out	
10	XPDR #2 CL Data Bus #7B In A	B	ELS Gen Data Bus #8A In A	B	RSVD 610A SIM In A	B	CVR CL Data Bus #4D In A	B	Gen Data Bus #8 Out A	B	
11	FS Data Bus #10 Out A	B	FMC #2 Gen Data Bus #2C In A	B	ACMS Gen Data Bus #2D In A	B	Simulator/615A Data Loader Ethernet #1 In A	B	Simulator/615A Data Loader Ethernet #1 Out A	B	c-1
12	CL Data Bus #6 Out A	B	MCDU #2 Gen Data Bus #2A In A	B	Gen Data Bus #2 Out A	B	MCDU #3 Gen Data Bus #2B In A	B	740/744A Printer Gen Data Bus #1B In A	B	
13	----Spare----						CMC Gen Data Bus #1C In A	B	Spare Gen Data Bus #3C In A	B	
14	MCDU #1 Gen Data Bus #1A A	B	Cabin Terminal #1 Gen Data Bus #3A In A	B	OOOI #1 Dig Data Bus #1 In A	B	OOOI #2 Dig Data Bus #1 In A	B	Cabin Terminal #2 Gen Data Bus #3B In A	B	
15	RSVD OPT 724 - 573 Serial Data In A	B	610 Simulator Out A	B	Gen Data Bus #1 Out A	B	Gen Data Bus #3 Out A	B	FMC #1 Gen data Bus #1D In A	B	

ATTACHMENT 2-3 (cont'd)
REAR CONNECTOR INSERT LAYOUT

Table 3 - Bottom Plug (BP) Insert



ATTACHMENT 3
CMIS NETWORK MANAGEMENT SERVICES

Table 3-1 Management-Notification Service

Service	Type	Definition
M-EVENT-REPORT	Confirmed/nonconfirmed	Reports an event about a managed object to a peer CMISE-service user.

Table 3-2 Management-Operation Services

Service	Type	Definition
M-GET	Confirmed	Request the retrieval of management information from peer CMISE-service user.
M-SET	Confirmed/nonconfirmed	Requests the modification of management information by a peer CMISE-service user.
M-ACTION	Confirmed/nonconfirmed	Requests that a peer CMISE-service perform an action.
M-CREATE	Confirmed	Requests that a peer CMISE-service user create an instance of a managed object.
M-DELETE	Confirmed	Requests that a peer CMISE-service user delete an instance of a managed object.
M-CANCEL-GET	Confirmed	Requests that a peer CMISE-service user cancel a previously requested and currently outstanding invocation of the M-GET service.

ATTACHMENT 4
HF DATA RADIO CONTROL LOGIC TABLES

Table 4-1 HFDR 1 Fault Logic Reported By CMU 1:

CMU 1 Inputs					CMU 1 Output
CMU 1 Label 276, bit 22	HFDR 1 Label 270, bit 16	HFDR 1 Label 270, bit 12	HFDR 1 429 Activity	HFDR 1 Label 270 SSM bits	Label 276, bit 24
0 (not installed)	x (don't care)	x	x	x	0 (no fault)
1 (installed)	x	x	not	x	1 (fault)
1	1 (fault)	1 (fault)	active	00 (normal)	1
1	1	0 (no fault)	active	00	1
1	0 (no fault)	1	active	00	1
1	0	0	active	00	0
1	x	x	active	01 (ncd)	0
1	x	x	active	10 (test)	0
1	x	x	active	11 (failure)	1

c-1

c-1

Table 4-2 HFDR 2 Fault Logic Reported By CMU 1:

CMU 1 Inputs					CMU 1 Output
CMU 1 Label 276, bit 23	HFDR 2 Label 270, bit 16	HFDR 2 Label 270, bit 12	HFDR 2 429 Activity	HFDR 2 Label 270 SSM bits	Label 276, bit 25
0 (not installed)	x (don't care)	x	x	x	0 (no fault)
1	x	x	not	x	1
1 (installed)	1 (fault)	1 (fault)	active	00 (normal)	1 (fault)
1	1	0 (no fault)	active	00	1
1	0 (no fault)	1	active	00	1
1	0	0	active	00	0
1	x	x	active	01 (ncd)	0
1	x	x	active	10 (test)	0
1	x	x	active	11 (failure)	1

c-1

ATTACHMENT 4 (cont'd)
HF DATA RADIO CONTROL LOGIC TABLES

Table 4-3 HFDR 1 Fault Logic Reported By CMU 2:

CMU 2 Inputs					CMU 2 Output
CMU Label 276, bit 22	HFDR 1 Label 270, bit 16	HFDR 1 Label 270, bit 19	HFDR 1 429 Activity	HFDR 1 Label 270 SSM bits	Label 276, bit 24
0 (not installed)	x (don't care)	x	x	x	0 (no fault)
1 (installed)	x	x	not	x	1 (fault)
1	1 (fault)	1 (fault)	active	00 (normal)	1
1	1	0 (no fault)	active	00	1
1	0 (no fault)	1	active	00	1
1	0	0	active	00	0
1	x	x	active	01 (ncd)	0
1	x	x	active	10 (test)	0
1	x	x	active	11 (failure)	1

c-1

c-1

Table 4-4 HFDR 2 Fault Logic Reported By CMU 2:

CMU 2 Inputs					CMU 2 Output
CMU 2 Label 276, bit 23	HFDR 2 Label 270, bit 16	HFDR 2 Label 270, bit 19	HFDR 2 429 Activity	HFDR 2 Label 270 SSM bits	Label 276, bit 25
0 (not installed)	x (don't care)	x	x	x	0 (no fault)
1	x	x	not	x	1
1 (installed)	1 (fault)	1 (fault)	active	00 (normal)	1 (fault)
1	1	0 (no fault)	active	00	1
1	0 (no fault)	1	active	00	1
1	0	0	active	00	0
1	x	x	active	01 (ncd)	0
1	x	x	active	10 (test)	0
1	x	x	active	11 (failure)	1

c-1

c-1

ATTACHMENT 4 (cont'd)
HF DATA RADIO CONTROL LOGIC TABLES

Table 4-5 HFDR 1 Voice/Data logic:

c-1
c-1

CMU Inputs						CMU Output
HFDR 1 Voice/Data Status from HFDR 1 Label 270, bit 13	HFDR 1 Label 270 SSM	HFDR 1 Label 270 Activity	HFDR 1 Voice/Data Status from HFDR 2 Label 270, bit 13	HFDR 2 Label 270 SSM	HFDR 2 Label 270 Activity	Label 276, bit 20
1 (voice)	valid data	active	x (don't care)	x (don't care)	x (don't care)	1 (voice)
0 (data)	valid data	active	x	x	x	0 (data)
x	other	active	x (don't care)	x	x (don't care)	1 (voice)
x	x	not active	1	valid data	active	1
x	x	not active	0	valid data	active	0
x	x	not active	x	other	active	1
x	x	not active	x	x	not active	1

Table 4-6 HFDR 2 Voice/Data logic:

c-1
c-1

CMU Inputs						CMU Output
HFDR 2 Voice/Data Status from HFDR 1 Label 270, bit 25	HFDR 1 Label 270 SSM	HFDR 1 Label 270 Activity	HFDR 2 Voice/Data Status from HFDR 2 Label 270, bit 25	HFDR 2 Label 270 SSM	HFDR 2 Label 270 Activity	Label 276, bit 21
1 (voice)	valid data	active	x (don't care)	x (don't care)	not active	1 (voice)
0 (data)	valid data	active	x	x	not active	0 (data)
x	other	active	x	x	not active	1
x	x	x	1	valid data	active	1
x	x	x	0	valid data	active	0
x	x	x	x	other	active	1
x	x	not active	x	x	not active	1

ATTACHMENT 4 (cont'd)
HF DATA RADIO CONTROL LOGIC TABLES

The following table states the logic for HFDR Master/Slave determination in truth table format.

Table 4-7 HFDR Master/Slave Selection Table (all bits refer to Label 276 from MU)

HFDR 1 Installed bit 22	HFDR 2 Installed bit 23	HFDR 1 Fault bit 24	HFDR 2 Fault bit 25	HFDR 1 Voice bit 20	HFDR 2 Voice bit 21	HFDR 1 Master bit 26	HFDR 2 Master bit 27
not (0)	not (0)	x	x	x	x	slave (0)	slave(0)
installed (1)	not	x	x	x	x	master(1)	slave
not	installed (1)	x	x	x	x	slave	master(1)
installed	installed	fault (0)	x	voice (1)	x	slave	master
installed	installed	fault	x	data (0)	voice (1)	master	slave
installed	installed	fault	x	data	data (0)	slave	master
installed	installed	op	x	voice	voice	master	slave
installed	installed	op	x	voice	data	slave	master
installed	installed	op	x	data	voice	master	slave
installed	installed	op	op	data	data	x *	alternate state
installed	installed	op	fault	data	data	master	slave

* Consideration should be given to not altering the pre-existing master/slave state when entering the condition defined by this row.

ATTACHMENT 5
EXAMPLE OF APM MEMORY MAP

Table 5-1 Minimum Data Required In APM

Address	Category	Fields	Size/Format
	APM Config Block	APM Config Block Length Version (Vendor Defined) (end of APM Config block)	
	Identity Block	Identify Block Length ICAO 24-bit aircraft address 56 bit Official Registration Mark (Seven Character Registration Number) AVLAN MAC Address Aircraft Model/Type 2 character Airline Identifier 3 character ICAO Airline Identifier VHF Control Configuration HFDR #1 Installed HFDR #2 Installed	

c-1

ATTACHMENT 5 (cont'd)
EXAMPLE OF APM MEMORY MAP

Table 5-2 Example of APM Memory Map with Extended Data Fields

Address	Category	Fields	Size/Format	
	APM Config Block	APM Config Block Length Version (Vendor Defined) (end of APM Config block)		
	Identity Block	Identify Block Length ICAO 24-bit aircraft address 56 bit Official Registration Mark (Seven Character Registration Number) AVLAN MAC Address Aircraft Model/Type 2 character Airline Identifier 3 character ICAO Airline Identifier VHF Control Configuration HFDR #1 Installed HFDR #2 Installed		c-1 c-1 c-1
	Options Block	Options Block Length SDU 1 Installed SDU 2 Installed VHF Voice External Select Radio Management Preset Enable VHF 3 Installed VDR 3 Installed CMU Services Enabled ATN Services Enabled ATS CPDLC Enabled 740/744 Printer Installed 744A Printer Installed		
	User Block	User Block Length Airline Fleet Identifier Number (FIN)		
	Integrity Block	CRC		
	Reserved	Future Use		

ATTACHMENT 6
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-1 ARINC 429 Input Port Monitoring

The following defines criteria for determining whether an input port is active.

CMU Input Port	Activity Label	Min Update Rate
Cabin Terminal #1	172	1 Hz
Cabin Terminal #2	172	1 Hz
CFDIU	125	1 Hz
X-Talk Bus	N/A	N/A
ACMS	172	1 Hz
FMC #1	270	1 Hz
FMC #2	270	1 Hz
HFDR #1	270	1 Hz
HFDR #2	270	1 Hz
MCDU #1	172	1 Hz
MCDU #2	172	1 Hz
MCDU #3	172	1 Hz
OOOI #1	Aircraft specific	1 Hz
OOOI #2	Aircraft specific	1 Hz
Printer	350	1 Hz
SDU #1/STU #1	270	1 Hz
SDU #2/STU #2	270	1 Hz
SDU #3/STU #3	270	1 Hz
SDU #4/STU #4	270	1 Hz
OOOI #3	Aircraft Specific	1 Hz
OOOI #4	Aircraft Specific	1 Hz
OOOI #5	Aircraft Specific	1 Hz
OOOI #6	Aircraft Specific	1 Hz
VDR #1	270	1 Hz
VDR #2	270	1 Hz
VDR #3	270	1 Hz
XPDR/ICAO #1	275	1 Hz
XPDR/ICAO #2	276	1 Hz
FMC HS #1	270	1 Hz
FMC HS #2	270	1 Hz

NOTE: A bus is generally declared active when three consecutive words at the specificied rate are received. A bus is declared inactive when 3 consecutive samples fail.

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-2 ARINC Specification 429 Broadcast Output Map

Label	Name	Rate	General Output Buses 1,2	General Output Buses 3,8	DFS/UTC	Comm Output Buses 4,6,7	General Output Buses 5,9,10	
030	DFS Tuning Word	5/S			X			
172	Subsystem Identifier	1/S	X	X		X	X	
377	Equipment Identifier	1/S	X					
350	BITE Word #1 (Binary)	1/S	X					
351	BITE Word #2 (Binary)	1/S	X					
125	UTC BCD	1/S			X			
150	UTC Binary	1/S			X			
260	UTC BCD Date	1/S			X			
270	Status Output #1	1/S	X	X		X	X	
276	Status Output #2	1/S	X	X		X	X	
214	ICAO 24-bit aircraft address Word #1	1/S	X	X		X	X	
216	ICAO 24-bit aircraft address Word #2	1/S	X	X		X	X	c-1
047	DFS Autotune Word 8.33 kHz	5/S			X			

DFS = Digital Frequency Select

Table 6-3 Label 030 - DFS AUTO-TUNE Word

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		**10 MHz**			**1 MHz**				**0.1 MHz**				**0.01 MHz**				**0.001 MHz**				**SDI**		**Octal Label**		
			3			1				5				5				0						030		
0	0	0	0	1	1	0	0	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0 0 0	0 1 1	0 0

Notes:

1. This example illustrates the coding for VHF Communications frequency 131.550 MHz. The valid frequency range is 118.000 to 136.975 MHz.
2. The 100 MHz digit is defined as "1" and not transmitted.
3. Frequency Selection Increments 25 kHz
4. SDI 00 is output (all call). Some radios do not respond to all call properly and require the SDI bits be set for their installed position.

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-4 Label 047 - DFS AUTO-TUNE Word 8.33 kHz

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		**10 MHz**			**1 MHz**				**0.1 MHz**				**0.01 MHz**				**0.001 MHz**				**SDI**		**Octal Label**		
			3			1				5				5				0						047		
0	0	0	0	1	1	0	0	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0	1 1 1	0 0 1	0 0

Notes:

c-1 1. This example illustrates the coding for VHF Communications frequency 131.550 MHz. The valid frequency range and channel naming are provided in ARINC Characteristic 716 Appendix 1.
2. The 100 MHz digit is defined as "1" and not transmitted.
3. Frequency Selection Increments 8.33 kHz
4. SDI 00 is output (all call)
5. The 8.33 kHz channel pairing definition is provided in Appendix 1 of ARINC Characteristic 716.
c-1 6. Label 047 is only used for tuning voice channels.

Table 6-5 Label 125 - UTC Time (BCD) Word

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		**10 Hours**			**1 Hours**				**10 Minutes**				**1 Minutes**				**0.1 Minutes**				**SDI**		**Octal Label**		
			2			**3**				**5**				**9**				**9**						125		
	0	0	0	1	0	0	0	1	1	0	1	0	1	1	0	0	1	1	0	0	1	0	0	1 0 1	0 1 0	1 0

Notes:

1. This example illustrates the coding for UTC BCD Time (Data 23:59:.9) All Pad bits are set to binary 0.
2. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
3. SSM per ARINC Specification 429

Table 6-6 Label 150 - UTC Time (Binary) Word

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**			**Hours**					**Minutes**						**Seconds**						**Pad**	**SDI**		**Octal Label**		
				23					**59**						**59**									150		
	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	0	0	0 0 0	1 0 1	1 0

Notes:

1. This example illustrates the coding for UTC Time (binary). All Pad bits are set to binary 0.
2. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
3. SSM per ARINC Specification 429

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-7 Label 260 - UTC Date Word

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6 5 4 3 2 1
P	**SSM**		**10 days**		**1 days**				**10 month**	**1 month**				**10 years**				**1 years**				**SDI**		**Octal Label**
			2		5				1	2				8				8						260
	0	0	1	0	0	1	0	1	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0 0 0 0 1 1 0 1

Notes:

1. This example illustrates the coding for UTC BCD Date. All Pad bits are set to binary 0.
2. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
3. SSM per ARINC Specification 429

Table 6-8 Label 270 - Output Status Word #1

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6 5 4 3 2 1
P	**SSM**		**Discrete Data**																			**SDI**		**Octal Label**
																								270
																						0	0	0 0 0 1 1 1 0 1

Bit	**Description**	**Content = 1**
11	Message Waiting	Message Waiting
12	Link Availability	No Links Available
13	VHF VOICE	VHF in VOX Mode
14	VOICE Go Ahead	VOX Go-Ahead (SELCAL)
15	Reserved	
16	CMU Fail	CMU Failed
17	HF/SAT Link Status	HFDL and SATCOM Link Not Available c-1
18	VHF Link Status	VHF Link Not Available
19	Mode-S Link Status	Mode-S Link Not Available
20	Active/Standby (DUAL)	CMU in Active Mode
21	Printer Message	Printer MSG Received
22	Printer Status	Printer Failure
23	Alert	Alert (logic triggered)
24	HF Data Link Status	HF DL Available
25	Gatelink Status	Gatelink Available
26	reserved	
27	reserved	
28	reserved	
29	reserved	

Notes:

1. This example illustrates the coding for Output Status Word #1. Bits 11, 21, 22, 23 are reserved for backwords compatibility with existing alerting systems.
2. All Pad bits are set to binary 0.
3. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
4. SSM per ARINC Specification 429

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-9 Label 276 - Output Status Word #2

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		**Discrete Data**																			**SDI**		**Octal Label**		
																									276	
																						0	0	0 1 1	1 1 1	0 1

	Bit	**Description**	**Content = 1**
	11	Med Level Message	Message Waiting
	12	Low Level Message	Message Waiting
	13	Med Level ATC Message	Message Waiting
	14	Low Level ATC Message	Message Waiting
	15	Med Level Printer Message	Message Waiting
	16	Low Level Printer Message	Message Waiting
	17	Med Level ATC Print Msg	Message Waiting
	18	Low Level ATC Print Msg	Message Waiting
c-1	19	SAT Link	Not Available
	20	HF #1 Voice	Voice
	21	HF #2 Voice	Voice
	22	HFDL #1 Installed	Installed
	23	HFDL #2 Installed	Installed
	24	HFDL #1 Fault	Fault
	25	HFDL #2 Fault	Fault
	26	HFDL #1 Master	Master
	27	HFDL #2 Master	Master
	28	HFDL #1 SSM bits	Normal
c-1	29	HFDL #2 SSM bits	Normal

Notes:

1. This example illustrates the coding for Output Status Word #2. All "Med" Level Messages should trigger automatic aural alert.
2. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
3. SSM per ARINC Specification 429
   See Section 5.2.3 for bits 20 through 27

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-10 ICAO 24-Bit Aircraft Address Word #1 - Label 214

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		**A16-- A1**																					**Octal Label**		
																		MSB							**214**	
																								001	100	01

Bit	Function		Coding	Notes
1	Label		1	
2	.	2	0	
3	.		0	
4	.		0	
5	.	1	1	
6	.		1	
7	.		0	
8	Label	4	0	
9	PAD			
10	.			
11	.			
12	.			
13	PAD			
14	ICAO 24-Bit Aircraft Address (Part 1)		A1 (MSB)	
15	.		A2	
16	.		A3	
17	.		A4	
18	.		A5	
19	.		A6	
20	.		A7	
21	.		A8	
22	.		A9	
23	.		A10	
24	.		A11	
25	.		A12	
26	.		A13	
27	.		A14	
28	.		A15	
29	ICAO 24-Bit Aircraft Address (Part 1)		A16	
30	SSM			1
31	SSM			1
32	Parity		Odd	

c-1

Note 1. Sign Status Matrix (SSM) Definition per ARINC Specification 429.

BIT		MEANING
31	30	
0	0	Normal Operation
0	1	NCD
1	0	Functional Test
1	1	Failure Warning

Note 2. All PAD bits are set to binary 0.

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-11 ICAO 24-Bit Aircraft Address Word #2 - Label 216

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**											**A24-------------------------A17**													**Octal Label**	
												LSB													**216**	
																								011	100	01

	Bit	Function		Coding	Notes
	1	Label		1	
	2	.	2	0	
	3	.		0	
	4	.		0	
	5	.	1	1	
	6	.		1	
	7	.		1	
	8	Label	6	0	
	9	PAD			
	10	.			
	11	.			
	12	PAD			
c-1	13	ICAO 24-Bit Aircraft Address (Part 2)		A17	
	14	.		A18	
	15	.		A19	
	16	.		A20	
	17	.		A21	
	18	.		A22	
	19	.		A23	
	20	ICAO 24-Bit Aircraft Address (Part 2)		A24 (LSB)	
	21	PAD			
	22	.			
	23	.			
	24	.			
	25	.			
	26	.			
	27	.			
	28	.			
	29	PAD			
	30	SSM			1
	31	SSM			1
	32	Parity		Odd	

Note 1. Sign Status Matrix (SSM) Definition per ARINC Specification 429.

BIT		
31	30	MEANING
0	0	Normal Operation
0	1	NCD
1	0	Functional Test
1	1	Failure warning

Note 2. All PAD bits are set to binary 0.

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-12 Label 350 - Maintenance Word #1

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6 5 4 3 2 1
P	**SSM**		**------------Discrete Data------------**																			**SDI**		**Octal Label**
																								350
																						0	0	0 0 0 1 0 1 1 1

Bit	**Description**	**Content = 1**
11	CMU	Failure
12	OOOI #1 Input	Inactive
13	OOOI #2 Input	Inactive
14	MCDU #1 Input	Inactive
15	PRINTER Input	Inactive
16	FMC #1 Input	Inactive
17	DFDAU Input	Inactive
18	MCDU #2 Input	Inactive
19	MCDU #3 Input	Inactive
20	FMC #2 Input	Inactive
21	CFDIU Input	Inactive
22	Cabin Terminal 1 Input	Inactive
23	SDU #1/STU #1 Input	Inactive c-1
24	X-Talk Input	Inactive
25	HFDL #1 Input	Inactive
26	SDU #2/STU #2 Input	Inactive c-1
27	HFDL #2 Input	Inactive
28	Cabin Terminal #2 Input	Inactive
29	CMD Word	ACK

Notes:

1. This example illustrates the coding for Maintenance Word #1. Digital bus inputs are faulted based on activity label monitoring as defined in Attachment 6, Table 6-1.
2. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
3. SSM per ARINC Specification 429
4. SSM should be set to NCD until sampling is completed on power ups.

ATTACHMENT 6 (cont’d)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-13 Label 351 - Maintenance Word #2

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		--Discrete Data--																			**SDI**			**Octal Label**	
																									351	
																						0	0	100	1 0 1	1 1

Bit	**Description**	**Content = 1**
11	SDU #3/STU #3	Inactive
12	SDU #4/STU #4	Inactive
13	VDR #1 (L)	Inactive
14	VDR #2 (R)	Inactive
15	VDR #3 (C)	Inactive
16	XPDR #1	Inactive
17	XPDR #2	Inactive
18	OOOI #3	Inactive
19	OOOI #4	Inactive
20	OOOI #5	Inactive
21	OOOI #6	Inactive
22	APM	No Data
23	FMC #1 HS	Inactive
24	FMC #2 HS	Inactive
25	DCDU #1	Inactive
26	DCDU #2	Inactive
27	Digital Data Bus #7 (GPS)	Inactive
28	Digital Data Bus #8 (ARINC 702A FMC #2)	Inactive
29	Digital Data Bus #9 (ARINC 702A FMC #2)	Inactive

c-1

Notes:

1. This example illustrates Maintenance Word #2. Digital bus inputs are faulted based on activity label monitoring.
2. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
3. SSM per ARINC Specification 429.
4. SSM should be set to NCD until sampling is completed on power ups.

c-1

ATTACHMENT 6 (cont'd)
ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-14 Label 377 - Equipment Identifier Word

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		**PAD**							**Equipment ID (MSD)**				**Equipment ID**				**Equipment ID (LSD)**				**SDI**		**Octal Label**		
										0				2				4						377		
										0	0	0	0	0	0	1	0	0	1	0	0	0	0	1 1 1	1 1 1	1 1

Notes:

1. This example illustrates the coding for the Equipment Identifer Word. All Pad bits are set to binary 0.
2. SDI per Section 5.3.16.4, the values shown are for a single CMU installation
3. SSM per ARINC Specification 429

Table 6-15 Label 172 - Subsystem Identifier Word

32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8 7 6	5 4 3	2 1
P	**SSM**		**PAD**													**Subsystem SAL**								**Octal Label**		
																304								172		
																0	0	1	0	0	0	1	1	0 1 0	1 1 1	1 0

Notes:

1. This example illustrates the coding for the Subsystem Identifier Word. All Pad bits are set to binary 0.
2. SSM per ARINC Specification 429

ATTACHMENT 7
ONBOARD ROUTING LABELS/SUBLABELS

Device	Sublabel	Origin / Destination	SAL	Comments
CMU		M	304	(system generated)
CMU		C		(crew generated)
CFDIU	CF	F	303	
DFDAU	DF	D	302	
FMC 1	M1	A	300	
FMC 2	M2	B	301	
FMC	MD	A/B	300 / 301	
MCDU 1			220	
MCDU 2			221	
MCDU 3			222	
Printer		P	223	
OAT	YC			
Cabin Term 1	T1	1	374	
Cabin Term 2	T2	2	375	
Send via SAT		S	307/173	
Send via VHF		V		
Send via HF		H	340/344	
Send via VDR		V	251/252/253	
Send to Ground		G		
SDU 1	S1	Q	307	
SDU 2	S2	R	173	
SDU	SD	Q/R	307/173	

ATTACHMENT 8
ISO CHARACTER SET REFERENCE

				b_7	0	0	0	0	1	1	1	1
				b_6	0	0	1	1	0	0	1	1
b_4	b_3	b_2	b_1	b_5	0	1	0	1	0	1	0	1
0	0	0	0		00 nul	10 dle	20 SP	30 0	40 @	50 P	60 `	70 p
0	0	0	1		01 soh	11 dc1	21 !	31 1	41 A	51 Q	61 a	71 q
0	0	1	0		02 stx	12 dc2	22 "	32 2	42 B	52 R	62 b	72 r
0	0	1	1		03 etx	13 dc3	23 #	33 3	43 C	53 S	63 c	73 s
0	1	0	0		04 eot	14 dc4	24 $	34 4	44 D	54 T	64 d	74 t
0	1	0	1		05 enq	15 nak	25 %	35 5	45 E	55 U	65 e	75 u
0	1	1	0		06 ack	16 syn	26 &	36 6	46 F	56 V	66 f	76 v
0	1	1	1		07 bel	17 etb	27 '	37 7	47 G	57 W	67 g	77 w
1	0	0	0		08 bs	18 can	28 (	38 8	48 H	58 X	68 h	78 x
1	0	0	1		09 ht	19 em	29)	39 9	49 I	59 Y	69 i	79 y
1	0	1	0		0A lf	1A sub	3A *	3A :	4A J	5A Z	6A j	7A z
1	0	1	1		0B vt	1B esc	3B +	3B ;	4B K	5B [	6B k	7B {
1	1	0	0		0C ff	1C fs	2C ,	3C <	4C L	5C \	6C l	7C |
1	1	0	1		0D cr	1D gs	2D -	3D =	4D M	5D]	6D m	7D }
1	1	1	0		0E so	1E bs	2E .	3E >	4E N	5E ^	6E n	7E ~
1	1	1	1		0F si	1F us	2F /	3F ?	4F O	5F _	6F o	7F del

ATTACHMENT 9
ENVIRONMENTAL TEST CATEGORIES

DO-160C Section	Test	Level
4.0	Temperature and Altitude	A2
5.0	Temperature Variation	B
6.0	Humidity	A
7.0	Shock	YES
8.0	Vibration	B
9.0	Explosion	X
10.0	Waterproofness	X
11.0	Fluids Susceptibility	X
12.0	Sand and Dust	X
13.0	Fungus Resistance	X
14.0	Salt Spray	X
15.0	Magnetic Effect	A
16.0	Power Input	A
17.0	Voltage Spike	A
18.0	Audio Frequency Conducted Susceptibility	Z
19.0	Induced Signal Susceptibility	Z
20.0	Radio Frequency Susceptibility	U
21.0	Emission of Radio Frequency Energy	Z
22.0	Lightning Induced Transient Susceptibility	A3C3
23.0	Lightning Direct Effects	N/A
24.0	Icing	X

APPENDIX A
THE CMU MARK 2 AND ITS POSITION IN CNS/ATM

Introduction

CNS/ATM requires aircraft to have seamless Data Link Services and interoperable Applications (ground based and airborne). The concept of the CMU Mark 2 is to provide Data Link service access to the on-board Data Link Applications through various subnetworks to their peer systems on the ground. Initially, the CMU Mark 2 will be a replacement of conventional ACARS MU's (724/724B) with growth in memory, processor, and I/O for future enhancements, protocols, applications and the ATN router using peer to peer protocols.

The World Today

The CMU Mark 2 will initially perform as an ACARS Management Unit (MU). This provides the channel through which all character based and bit-oriented applications are transmitted to and from the ground. VHF (AM-MSK at 2400 bps) and SATCOM are the two ACARS subnetworks available to date. HF, however, should join them soon as it is well into its proving trials. On the ground side, ARINC, SITA, Air Canada, Avicom, Mascom and other Data Service Providers (DSP) are currently involved in conveying and processing messages and providing the link to and from the peer system (ATC, airline host, maintenance base, etc.). Because ACARS is not a peer to peer network, like ATN, the CMU Mark 2 does not act like an entry point for a communication "pipe". It does subnetwork header switching/processing in order to adapt the on-board message structure to the one used for the air-to-ground link, to determine the most appropriate subnetwork based upon multiple criteria (availability or cost, just to name a few) or to distribute the messages on-board, when needed. In communications nomenclature, it acts more like a bridge than a router. On the ground side such conversions may also take place.

APPENDIX A (cont'd)
THE CMU MARK 2 AND ITS POSITION IN CNS/ATM

The World with CNS/ATM and Utilizing ATN

This is the environment the CMU Mark 2 has been designed to transition to. Internally, the CMU Mark 2 comprises not only the ACARS functions such as ARINC Specifications 618/619 protocols and AOC End System functions such as OOOI reports and others, but also - and foremost - the ATN router. In some aircraft it may also host ATC applications.

This creates additional capability options within the CMU Mark 2 as follows:

a) ATN Router

In the ATN Router configuration the CMU Mark 2 hosts the Open System Interconnection (OSI) Router, i.e. the Layer 3 suite of protocols (connectionless IS-ES, interdomain routing) and all the Layer 2 datalink protocols (ARINC Specifications 429 & 646) required to be linked to the on-board peripherals (FMC, CMC, ACMS, and others; (Figures A1 and A2) and subnetworks like VHF Data Radio (VDR), HF and SAT. Consequently, any peripheral which uses the CMU Mark 2 as router acts as its own "communication end system" and thus has to contain the OSI communication stack required to support it's OSI application. According to "OSI theory", this would be the most elegant system design.

In short: *Peripheral = Application End System AND Communication End System.*

b) ATN End-System

If the CMU Mark 2 hosts the ATN end-system it "encapsulates" the OSI communication and interfaces to the peripherals via a specialized transport layer (Layer 4) protocol. To perform this function the CMU Mark 2 contains the "full" OSI communication stack as required for the applications which reside in the peripherals as well as some of the router protocols (since there is no external IS to ES connection no s/w has to be installed in that area). Since the application end system (on-board peer) resides within the peripheral the file has to be forwarded. Here, ARINC Specification 656 comes into play. It provides some sort of lean transport protocol which interfaces directly to the datalink layer, thus eliminating much of the burden OSI protocols would impose onto the peripheral.

In short: *Peripheral = Application End System; CMU Mark 2 = ATN Communication End System.*

c) Peer Applications and Data Manager

ATC End Systems applications for CNS/ATM were considered when growth potential was determined. If ATC applications reside within the CMU Mark 2, then data, parameters and the like need to be derived from those peripherals where they are gathered. In order to provide the service of requesting and delivering information between peripherals and the CMU Mark 2 an special application has to be installed at both ends: a Data Manager (DM). Like in option b) there must be some sort of link between those peers of the DM. Again, ARINC Specification 656 performs the transport. The impact to the peripheral has been kept minimal, the major share of the burden of the implementation of additional applications has been put onto the CMU Mark 2.

In short: *CMU Mark 2 = Application End System AND ATN Communication End System; Peripheral = Data Back-End.*

These three options have been collaboratively developed within the FMS, CMU Mark 2 and FMS/CMU Interface Subcommittees/Working Groups and are being documented primarily in ARINC Specification 656. All of the various options may potentially be found in the variety of aircraft currently in service depending upon the capabilities of the LRU's involved. Consequently, the reader has to be aware that the CMU Mark 2 Levels describe the actual capability and characteristics of the CMU Mark 2.

APPENDIX A (cont'd)
THE CMU MARK 2 AND ITS POSITION IN CNS/ATM

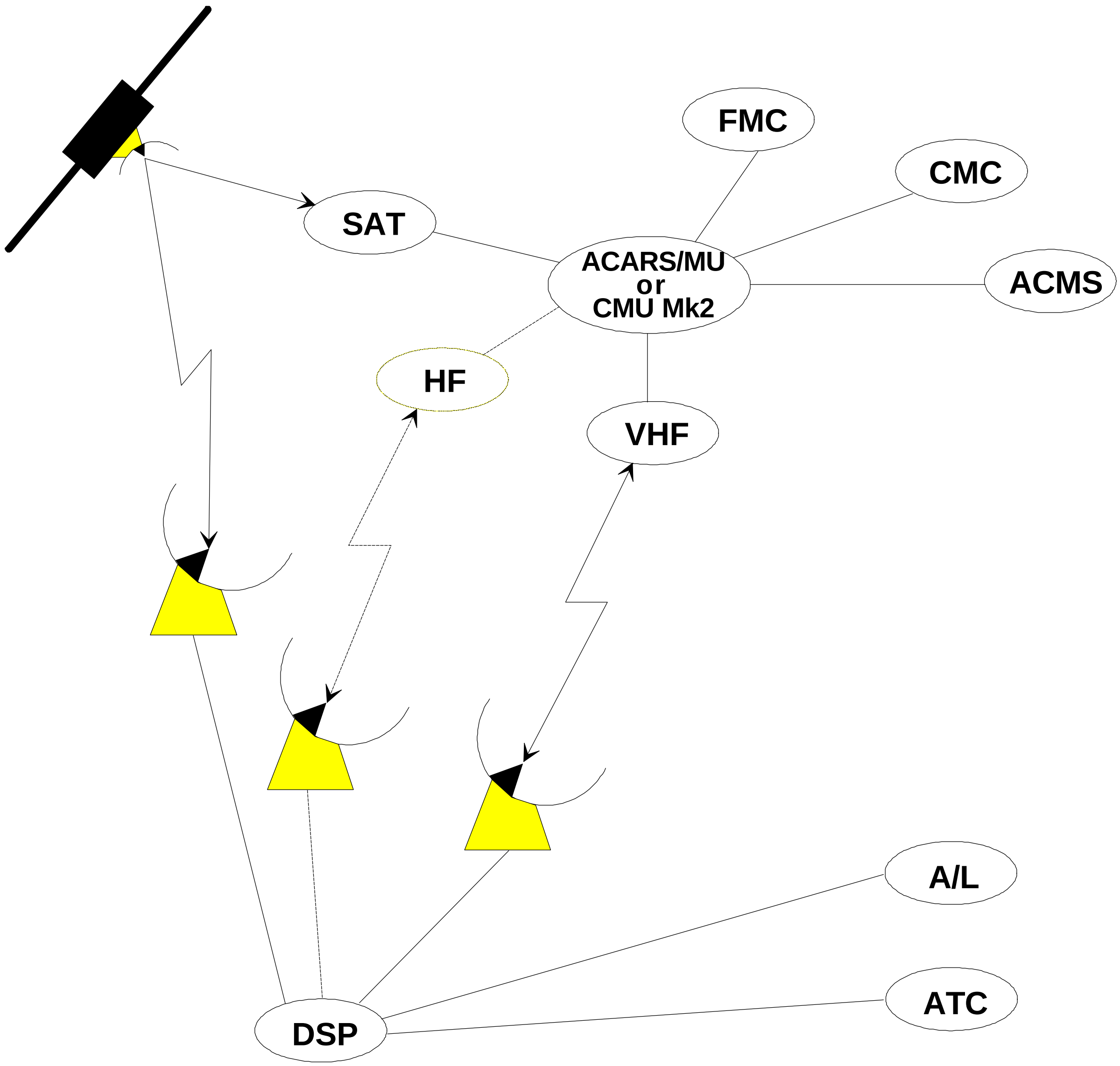


Figure A-1 The World Today

APPENDIX A (cont'd)
THE CMU MARK 2 AND ITS POSITION IN CNS/ATM

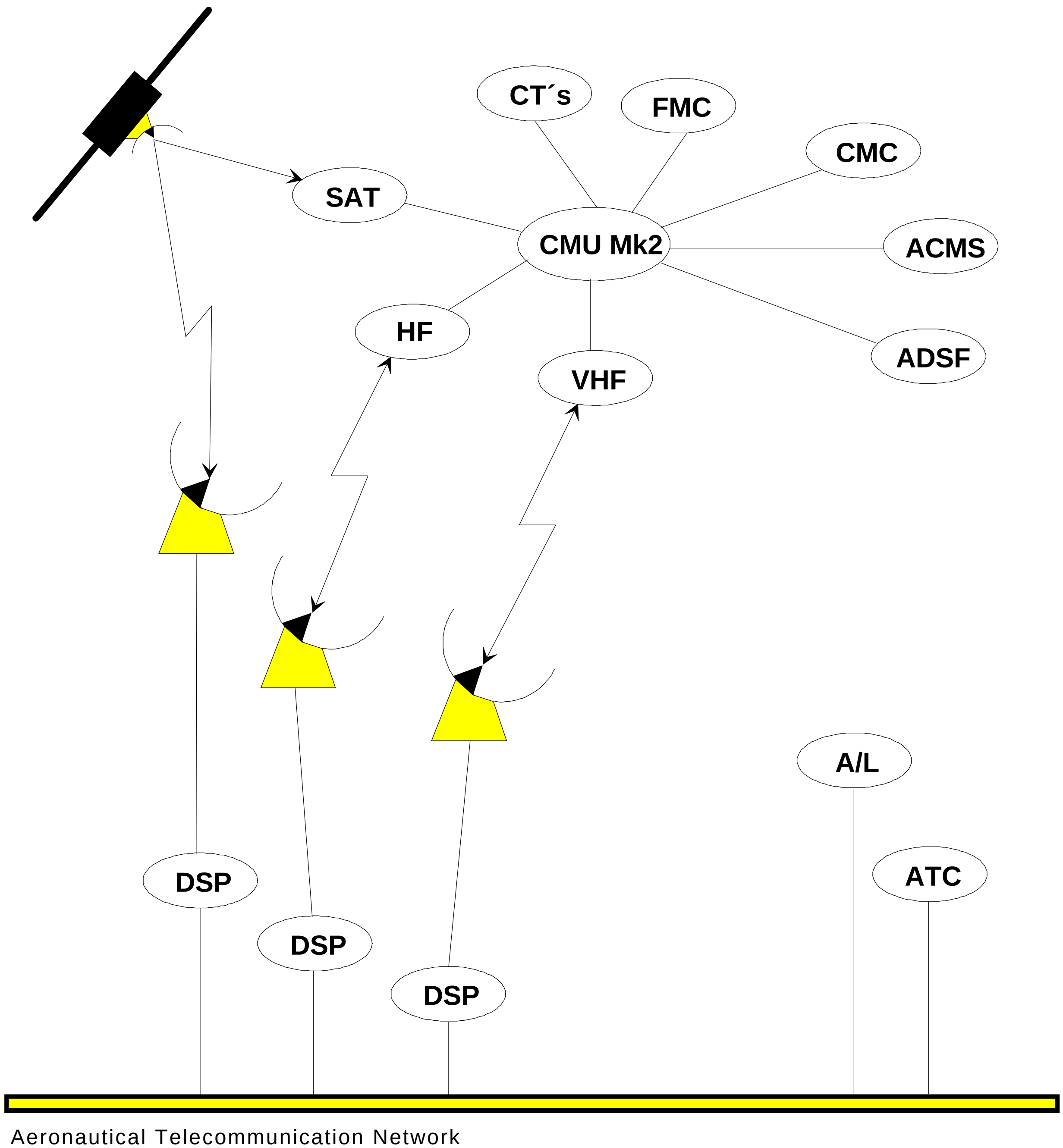
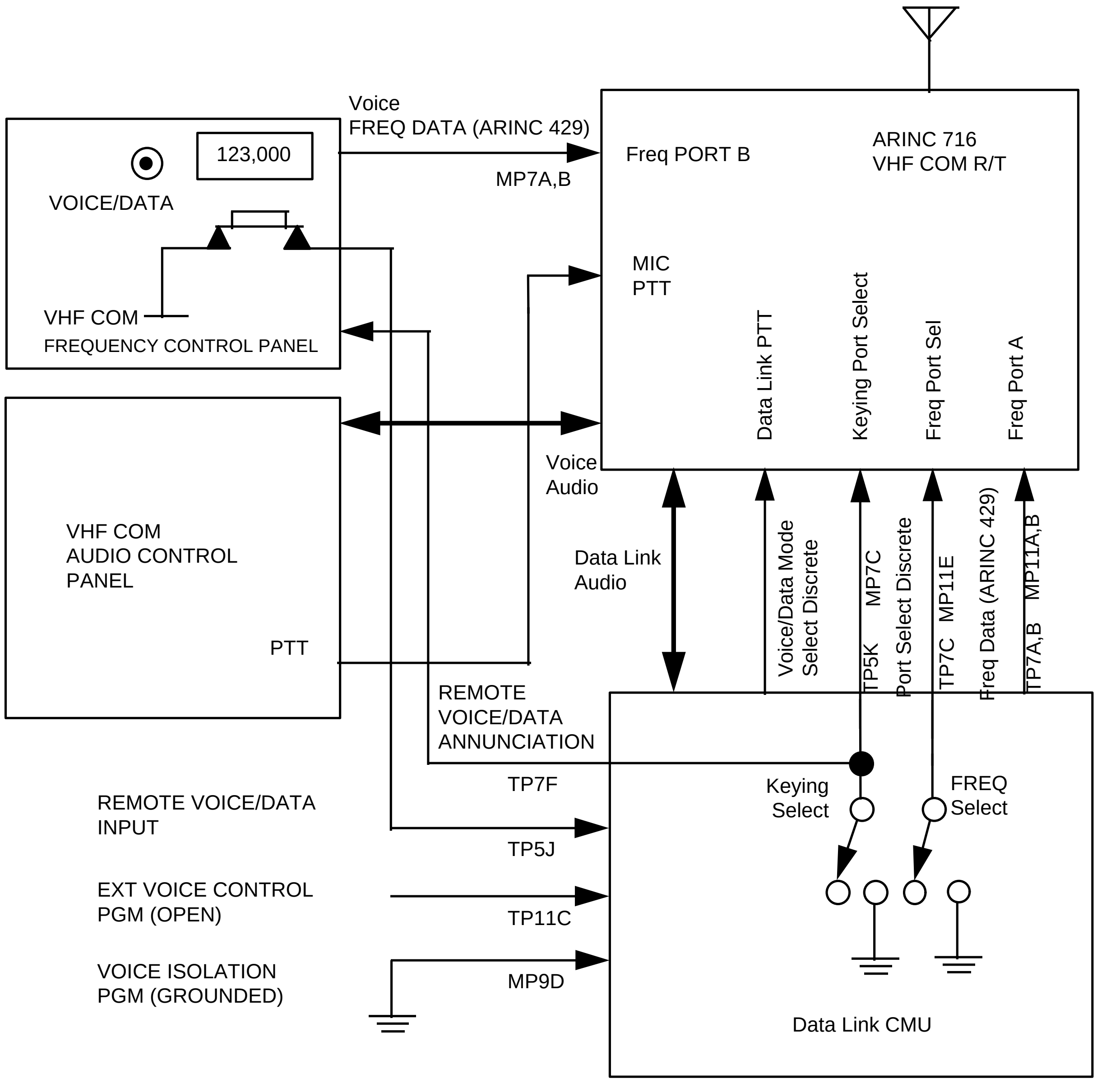


Figure A-2 The World With ATN

APPENDIX B
ARINC 716 VHF VOICE CONFIGURATION

The diagram below shows a possible configuration for shared Data/Voice use of an ARINC 716 VHF COM transceiver (or an ARINC 750 VHF COM Transciever operating in the ARINC 716 mode). The transceiver is tuned to the channel selected on the VHF COM control panel for voice communications and to the channel defined in the CMU Mark 2 for data communications. Voice operations using this transciever should typically only occur when VHF 1 or VHF 2 has failed. The arrangements indicate that the CMU Mark 2, when installed, has ultimate control over the VHF radio frequency and mode. To prevent downgrading the VHF radio certification level, it is recommended that the CMU Mark 2, protect the radio from interference due to a CMU Mark 2 malfunction. This protection should be at level of integrity equal to, or higher than, the VHF radio (improbable failure rate). It may be noted that either or both CMU Mark 2 units may be removed from the aircraft without compromising the availability of the VHF transceiver for voice communications.



APPENDIX C
REFERENCED DOCUMENTS

The latest versions of the following documents apply to the development of equipment initialized to meet ARINC Characteristic 758.

Ref 1) RTCA/DO-160 EUROCAE ED-14 "Environmental Conditions and Test Procedures for Airborne Equipment"
Ref 2) RTCA/DO-223 "MOPS for Aircraft Management (CM) Equipment"
Ref 3) RTCA/DO-219 "MOPS for ATC Controller/Pilot Data Link Communications (CPDLC)"
Ref 4) RTCA/DO-178 EUROCAE ED-12 - Software Considerations in Airborne Systems and Equipment Certification
Ref 5) RTCA/DO-212 - Automatic Dependent Surveillance (ADS)
Ref 6) RTCA Report "Required Communications Performance Standards"
Ref 7) RTCA Task Force 2 Final Report "Transition to Digital Communications"
Ref 8) RTCA Task Force 3 Final Report "Free Flight Implementation"

Ref 9) ARINC Report 413A "Guidance For Aircraft Electrical Power Utilization and Transient Protection"
Ref 10) ARINC Report 600 "Air Transport Avionics Equipment Interfaces"
Ref 11) ARINC Report 604 "Guidance for Design and Use of Built-In Test Equipment (BITE)"
Ref 12) ARINC Report 607 "Design Guidance for Avionic Equipment"
Ref 13) ARINC Report 609 "Design Guidance for Aircraft Electrical Power Systems"
Ref 14) ARINC Report 610A "Guidance for Use of Avionics Equipment and Software in Simulators"
Ref 15) ARINC Report 615 "Airborne Computer High Speed Data Loader"
Ref 15) ARINC Report 624 "Design Guidance for Onboard Maintenance System"
Ref 17) ARINC Report 625, "Industry Guide for Test Program Set (TPS) Quality Management"
Ref 18) ARINC Report 627, "Programmers Guide for SMART Systems Using ARINC 626 ATLAS"
Ref 16) ARINC Report 651 "Design Guidance for Integrated Modular Avionics"
Ref 17) ARINC Report 652 "Guidance for Avionics Software Management"
Ref 21) ARINC Report 660 "CNS/ATM Avionics, Functional Allocation and Recommended Architectures"

Ref 22) ARINC Project Paper 639, "Standards for Network Management"

Ref 23) ARINC Specification 429 "Mark 33 Digital Information Transfer System (DITS)"
Ref 24) ARINC Specification 608A, "Design Guidance for Avionics Test Equipment, Part 1 System Definition"
Ref 25) ARINC Specification 618 "Air-Ground Character-Oriented Protocol Specification"
Ref 26) ARINC Specification 619 "ACARS Protocols For Avionic End Systems"
Ref 27) ARINC Specification 620 "Data Link Ground System Standard and Interface Specification"
Ref 28) ARINC Specification 622 "ATS Data Link Applications Over ACARS Air-Ground Network"
Ref 29) ARINC Specification 623 "Character-Oriented Air Traffic Service (ATS) Applications"
Ref 30) ARINC Specification 626, "Standard ATLAS for Modular Test:
Ref 31) ARINC Specification 631 "Aviation Packet Communications Functional Description"
Ref 32) ARINC Characteristic 635 "HF Data Link Protocols"
Ref 33) ARINC Specification 636, "Onboard Local Area Network (OLAN)"
Ref 34) ARINC Specification 646 "Ethernet Local Area Network (ELAN)"
Ref 35) ARINC Specification 656 "Avionics Interface Definition for Flight Management and Communications Management Functions"

Ref 36) ARINC Characteristic 702A "Advanced Flight Management Computer System"
Ref 37) ARINC Characteristic 724B "Aircraft Communications Addressing and Reporting System (ACARS)"
Ref 38) ARINC Characteristic 739 "Multi-Purpose Control and Display Unit"
Ref 39) ARINC Characteristic 739A "Multi-Purpose Control and Display Unit"
Ref 40) ARINC Characteristic 740 "Multiple-Input Cockpit Printer"
Ref 41) ARINC Characteristic 741 "Aviation Satellite Communication System"
Ref 42) ARINC Characteristic 743A "GNSS Sensor"
Ref 43) ARINC Characteristic 744 "Full Format Printer"

APPENDIX C (cont'd)
REFERENCED DOCUMENTS

Ref 44) ARINC Characteristic 744A “Full Format Printer With Graphic Capability”
Ref 45) ARINC Characteristic 745 “Automatic Dependent Surveillance”
Ref 46) ARINC Characteristic 748 “Communications Management Unit (CMU)”
Ref 47) ARINC Characteristic 750 “VHF Data Radio (VDR)”
Ref 48) ARINC Characteristic 753 “HF Data Link System”
Ref 49) ARINC Characteristic 755 "Multi-Mode Landing System”
Ref 50) ARINC Characteristic 756 "GNSS Navigation and Landing System (GNLS)”
Ref 51) ARINC Characteristic 757 “Cockpit Voice Recorder (CVR)”
Ref 52) ARINC Characteristic 758 "Communications Management Unit (CMU) Mark 2"
Ref 53) ARINC Characteristic 760 "GNSS Navigation Unit (GNU)”

c-1 Ref 54) FAA Notice 8110.50 “Guidelines for Airworthiness Approval of Airborne Data Link Systems and Applications”
Ref 55) FAA C/SOIT Package B - Oceanic Data Link Applications
Ref 56) FAA C/SOIT Package C - Aeronautical Telecommunications Network (ATN) Services
Ref 57) FAA C/SOIT Package E - Near Term Data Link Applications

Ref 58) SAE 922003 Certification of Airborne Data Link Equipment
Ref 59) SAE ARP4791 Human Engineering Recommendations for Data Link Systems

Ref 60) ICAO Aeronautical Telecommunication Network (ATN) Standards and Recommended Practices (SARPs)
c-1 Ref 61) ICAO CNS/ATM-1 SARPs
Ref 62) ICAO VDL SARPs

Ref 63) ISO et al

APPENDIX D
ACRONYMS

A/V	Aural/Visual Alert
AAC	Aeronautical Administrative Communications
ACARS	Aircraft Communications Addressing and Reporting System
ACF	ACARS Convergence Function
ACMS	Airplane Condition Monitoring System
ACSE	Association-control-service-element
ADL	Airborne Data Loader
ADLP	Airborne Data Link Processor
ADS	Automatic Dependent Surveillance
ADS-B	Broadcast Automatic Dependent Surveillance
ADSP	ADS Panel
AEEC	Airlines Electronic Engineering Committee
AEIT	Aircraft Equipment Interoperability Test
AFMC	Advanced Flight Management Computer System
AFN	ATS Facility Notification
AIDS	Aircraft Integrated Data (Recording) System
AMSS	Aeronautical Mobile Satellite Services
ANP	Actual Navigation Performance
AOC	Aeronautical Operational Communications
APC	Aeronautical Passenger Communications
APM	Aircraft Personality Module
APPS	Applications
APU	Auxiliary Power Unit
AQP	Avionics Qualification Program
ARINC	Aeronautical Radio, Inc.
ATC	Air Traffic Control
ATE	Automatic Test Equipment
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSC	Air Traffic Services Communications
AVLAN	Avionics LAN
AVPAC	Aviation VHF Packet Communication
BITE	Built-In Test Equipment
BOP	ARINC 429 Bit Oriented Protocol (Williamsburg)
BP	Bottom Plug (ARINC 600 Connector)
CAA	Civil Aviation Administration
Cab Term	Cabin Terminal
CATT	CNS/ATM Transition Team
CCITT	International Telegraph and Telephone Consultative Committee
CDTI	Cockpit Display of Traffic Information
CDU	Control & Display Unit
CFDS	Centralized Fault Display System
CL	Connectionless Mode
CLNP	CL Network Protocol
CLNS	Connectionless Network Service
CLTP	CL Transport Protocol
CLTS	CL Transport Service
CM	Context Management
CMA	Common Mode Analysis
CMC	Central Maintenance Computer
CMIP	Common Management Information Protocol

APPENDIX D (cont'd)
ACRONYMS

CMIS	Common Management Information Service
CMISE	CMIS Element
CMU	Communication Management Unit
CNS	Communications, navigation, and surveillance
CPDLC	Controller/Pilot DL Communication
CRC	Cyclic Redundancy Check
CSMA	Carrier Sense Multiple Access
CVR	Cockpit Voice Recorder
DCDU	Dedicated Control & Display Unit
dc	direct current
DFDAU	Digital Flight Data Acquisition Unit
DFS	Digital Frequency Selection
DGNSS	Differential GNSS
DITS	Digital Information Transfer System
DL	Data Link
DM	Data Manager
DMF	Data Management Function
DMU	Data Management Unit
EDMS	Electronic Data Management System
EEPROM	Electrically Erasable Programmable Read Only Memory
EFIS	Electronic Flight Instrumentation System
EICAS	Engine Indication Crew Alert System
EIU	EFIS/EICAS Interface Unit
ELAN	Ethernet LAN
ELS	Electronic Library System
EMI	Electromagnetic Interference
ES	End System
EUROCAE	European Organization for Civil Aviation Electronics
FAA	Federal Aviation Administration
FANS	Future Air Navigation Systems
FDDI	Fiber Distributed Data Interface
FIN	Airline Fleet Identifier Number
FIR	Flight Information Region
FIS	Flight Information Service
FMC	Flight Management Computer
FMS	Flight Management System
FoM	Figure of Merit
FWC	Flight Warning Computer
GA (Gen Av)	General Aviation
GIU	Gatelink Interface Unit
GLS	GNSS-based Landing System
GLU	GNSS-based Landing Unit
GNLS	GNSS Navigator and Landing System
GNLU	GNSS Navigator and Landing Unit
GNSS	Global Navigation Satellite System
GNU	GNSS Navigator Unit
GPBOP	General Purpose Bit Oriented Protocol, ARINC 429
GPS	Global Positioning System
GPU	Ground Power Unit
GRNDS	Grounds
GW	Gate Way
HF	High Frequency
HFDL	HF Data Link
HFDR	HF Data Radio
HFDU	HF Data Unit
HS Physical	High Speed 429 or 10-Base T (Ethernet)
Hz	hertz (s^{-1})

APPENDIX D (cont'd)
ACRONYMS

I/O	Input/Output
IATA	International Air Transport Association
IC	Integrated Circuit
ICAO	International Civil Aviation Organization
ICD	Interface Control Drawing
ID	Identifier
IDRP	Interdomain Routing Protocol
IDU	Link Data Unit
INS	Inertial Navigation System
IOC	Internet Operations Center
IP	Internetwork Protocol
IRS	Inertial Reference System
IS	Intermediate System
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ISOPA	ISO Protocol Architecture
ITU	International Telecommunication Union
JAA	Joint Aviation Authorities
k	kilo (1,000)
LAAS	Local Area Augmentation System
LAN	Local area network
LME	Link Management Entity
LOC	Location Identifier
LOS	Loss Of Signal
LRU	Line Replaceable Unit
M	Mega (1,000,000)
MAC	Medium Access Control
MCDU	Multifunction Control & Display Unit
MCP	Mode Control Panel
MCU	Modular Concept Unit
MD	Management Domain
MGMT	Management
MIB	Management Information Base
MIDS	Management Information Definition Statement
MIS	Management Information Service
MMR	Multi-Mode Landing System Receiver
MO	Managed Object
MODEM	Modulator/Demodulator
MOPS	Minimum Operational Performance Standards
MP	Middle Plug (ARINC 600 Connector)
MSK	Minimum Shift Keying
MTBR	Mean Time Between Removals
MTBUR	Mean Time Between Unscheduled Removals
MU	Management Unit
N/A	Not Applicable
NDA	Non-Developmental Aircraft
NIC	New Installation Concept
NM	Network Management
NOTAM	Notice to Airmen
NVM	Non-volatile Memory
OEM	Original Equipment Manufacturer
OLAN	Onboard LAN
OMD	Onboard Maintenance Documentation
OMS	Onboard Maintenance System
OOOI	Out-Off-On-In Message (ACARS)

APPENDIX D (cont'd)
ACRONYMS

OSI	Open Systems Interconnection
PBX	Private Branch Exchange
PC	Personal Computer
PDC	Predeparture Clearance
PDL	Portable Data Loader
PDN	Public Data Network
PDU	Protocol Data Unit
PGM	Program
PICS	Protocol Implementation Conference Statement
PSDN	Packet Switched Data Network
PTT	Push-to-Talk
PVTI	Position/Velocity/Time Indicator
PWR	Power
QOS	Quality of Service
RAM	Random Access Memory
RCP	Required Communications Performance
RD	Routing Domain
RDF	Routing Domain Format
RDFD	RDF Domain [Flag]
RFI	Radio Frequency Interference
RMP	Required Monitoring Performance
RNP	Required navigation Performance
ROSE	Remote Operation Service Element
RP	Routing information Exchange Protocol
RSVD	Reserved
RTA	Required Time of Arrival
RTCA	Radio Technical Commission for Aeronautics
RVSM	Reduced Vertical Separation Minimal
SAE	Society of Automobile Engineers
SAL	System Address Label
SARPS	Standards and Recommended Practices
SATCOM	Satellite Communication System
SATP	Simple Application Transfer Protocol
SCAT	Special Category
SDAC	System Data Acquisition Concentrator
SDI	Source/Destination Identifier
SDU	Satellite Data Unit
SELCAL	Selective Call
SM	Systems Management
SMGCS	Surface Movement Guidance and Control System
SMI	Standard Message Identifier
SN	Subnetwork
STBY	Standby
TP	Top Plug (ARINC 600 Connector)
TP4	Transport Protocol Class 4
TWIP	Terminal/Enroute Weather Information for Pilots
U/L	Upper Layer (OSI Layers)
UHF	Ultra High Frequency
UTC	Universal Time Coordinate
Vac	Volt alternating current
Vdc	Volt direct current
VDL	VHF Digital Link
VDR	VHF Data Radio
VER	Version

APPENDIX D (cont'd)
ACRONYMS

VHF	Very High Frequency
W	ARINC 429 Williamsburg Protocol
WAAS	Wide Area Augmentation System
WAN	Wide Area Network
WX	Weather
XPDR	Transponder

APPENDIX E
DOCUMENT HISTORY

Status	Date	Change Description
Draft 5	Sept 6, 1996	Updated according to CMU Subcommittee meeting recommendations July 17-18, 1996 in Tiburon, California.
Draft 4	June 21, 1996	Updated according to comments provided by CMU S/C May 14-15, 1996 in Paris, France and follow-up comments in ad hoc CMU Working Group May 29-31, 1996 in Seattle, Washington.
Draft 3	April 18, 1996	Updated according Mar 12-14 New Orleans Meeting comments. Updated acronym list. Updated interconnect with segregated busses, added connector diagrams, updated architectures and descriptions, rewrite to HF Interface section, added ATN information, added 429 output word definitions, added Configuration Database (APM), added VHF Voice Drawing, add CNS/ATM White paper, updated Simulator and Test descriptions.
Draft 2	Feb 23, 1996	Updated according Jan 15-16 MLB Meeting comments. Updated overall styles for a more ARINC look and language adjustments (shalls, etc). Levels in Chapter 4 made to be "incremental". Significant update to Chapter 5 text, especially VHF and discretes. Update to Rear interconnect, including isolation of some functions.
Draft 1 / Strawman #4	Dec 20, 1995	Updated according to Nov 15-17 Atlanta Meeting comments. Chapter 4 Changes - significant rewrite and outline changes to create "CMU LEVELS". Added Data Management Function. Chapter 5 - primarily outline changes. to separate air/ground side. Updated APM Function, interface and added sample memory map. Inserted new System Architecture diagrams. Incorporated Allied Signal inputs on Pinouts. Corrected some X-references and heading errors. NO CHANGES made related to DUAL ARCHITECTURE.
Strawman #3	Oct 6, 1995	Updated Chapters 1,2, and 3 according to Sep 12-13 San Diego Meeting. Inserted Harris inputs on ATN Net MGMT. Inserted Allied Signal inputs on partitioning and CMU options. Included ARINC 600 pinouts. Misc updates to chapter 5 in some rough areas. Updated reference doc list. Created two new Word 6 styles: Action Item and Revisions for "blame management".
Strawman #2	Sep 1, 1995	Updated Chapters 1, 2, 3, and 4 according to Aug 15,16 Ad Hoc Meeting. Added new proposal material in Section 6.7 regarding ARINC 610 Simulation.

APPENDIX E (cont'd)
DOCUMENT HISTORY

Strawman #1	Aug 4, 1995	Made additional formatting changes, mostly related to section numbering method. Changed Mark II to Mark 2. Cleaned up various sections so they are at least readable. Created a different style [ref] to insert cross references.
Strawman	July 28, 1995	Initial Integration with Sextant CMU Mark 2 Strawman following initial CMU Mark 2 Working Group meeting. Considerable reorganization of document structure and development of a AEEC.DOT template for support.
Strawman	March 17, 1995	Updated after meeting review in Chicago (Allied, Collins, Aerospatiale, Delta) Moved Date with draft Revision to hold constant Created new Section 5 - GLUE - pulling things from old 4 and 5
Strawman	Feb 15, 1995	Revised Outline after Collins, Allied joint review. Raw 748 text added into more or less appropriate section, but not reviewed.
Strawman	Feb 8, 1995	Initial Strawman outline, prepared by Collins, contained outline only

SUPPLEMENT 1

TO

ARINC CHARACTERISTIC 758 ©

COMMUNICATIONS MANAGEMENT UNIT (CMU) MARK 2

Published: February 13, 1998

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: October 14, 1997

A. PURPOSE OF THIS SUPPLEMENT

This Supplement introduces the addition of the VDR Mode A interface and operation, Simulator support, and Second Generation SATCOM support. The Level B application definition was revised.

B. ORGANIZATION OF THIS SUPPLEMENT

This Supplement introduces a major rework of ARINC Characteristic 758. The normal practice of publishing a separate supplement to update the existing document has not been followed. The extensiveness of the changes introduced by Supplement 1 has resulted in the impracticality of producing a separate set of replacement pages. Supplement 1 is therefore available only as an integral part of ARINC Characteristic 758-1. The modified and added material on each page is identified by a c-1 in the margins.

C. CHANGES TO ARINC CHARACTERISTIC 758 INTRODUCED BY THIS SUPPLEMENT

This section represents a complete tabulation of the changes and additions to Characteristic 758 introduced by Supplement 1. Each change or addition is defined by the section number and the title currently employed in Characteristic 758. In each case a brief description of the change or addition is included.

1.6 Interchangeability

Editorial revision.

2.3 Power

Editorial revision.

2.8 IMA Packaging Considerations

Editorial revision.

2.9.5 Standard Discrete Input

Editorial revision.

3.1.5 Data Bus Architechture

Editorial revision.

3.2.1.1 Operational Transitional Considerations

Editorial revison.

3.3 Certification and Partitioning Considerations

Editorial revision.

4.1 Functional Description

Added Service Functional Capability Level 0.1.

4.2 Level 0 and Level 0.1 Data Link Functions

Added “and Level 0.1” to Section title. Added Level 0.1 definition and commentary.

4.2.1 ACARS “Network” Function

Updated to include Level 0.1 and ARINC 761.

4.2.2 ACARS VHF Sub-network Function

Rewrote section. Deleted 716 from Section title. Expanded definition of ACARS operation support. Deleted first commentary and second paragraph. Moved third paragraph, commentary, and fourth paragraph to Section 4.2.2.1.

4.2.2.1 ARINC 716 Support

Created new section with text from Section 4.2.2.

4.2.2.2 ARINC 750 Mode A Functions (Level 0.1)

Added new Section.

4.2.3 ACARS SATCOM Sub-network Function

Added ARINC 761 reference. Moved second paragraph and commentary to Section 4.2.3.1.

4.2.3.1 ACARS ARINC 741 SATCOM Sub-network Function

Created new Section with text from Section 4.2.3.

4.2.3.2 ACARS ARINC 761 SATCOM Sub-network Function

Added new Section.

4.2.4 ACARS HF-Sub-network Function

Editorial revision.

4.3.2 ATN Join/Leave Events

Editorial revisions.

4.3.3 ATN Internetworking Function

Editorial revision.

4.5.1 ACARS End System Function

Added ARINC 761 protocol interfaces.

4.6 Level B Application Functions

Revised third paragraph. Added commentary.

4.6.1 ACARS Convergence Function (ARINC 622)

Editorial revision..

4.6.3.1 Air Traffic Facilities Notification (ARINC 622)

Editoral revisions. Added commentary. Revised third paragraph.

4.6.3.2 CPDLC Function

Editoral revision. Revised text in third paragraph with CMU/FMC interface conditions so that the avionics may be able to obtain information from the FMC.

4.6.3.3 ADS-A Function

Editorial revision. Changed “ADS” to ADS-A” in title and text. Revised text in third paragraph to indicate that FMC interface implementations, other than ARINC 656, are possible.

4.10.2.1 Identification Data

Editorial revision.

4.12.3 Validation and Automated Correction

Editorial revisions.

4.17CMU Simulator Functions

Added new Section.

5.1.1 ACARS Air/Ground Protocols

Added third paragraph on VHF Mode A. Deleted references to ARINC Characteristic 741P2 and ARINC Specification 635 in last paragraph.

5.1.4 ATN Air/Ground Protocols

Deleted references to ARINC Specifications 637 and 638 in third paragraph.

5.1.4.2.1 Full Stack

Editorial revisions.

5.1.4.2.2 Fast Byte Stack or ICAO U/L

Deleted references to ARINC Specification 638 and the ATN manual in the second paragraph.

5.1.4.2.3 Short Stack

Deleted reference to ARINC Specification 638 in fourth paragraph. Editorial revisions.

5.1.4.3 ATN - Network/Sub-network Layer Protocol

Deleted reference to ARINC Specification 637.

5.1.4.4 ATN - Internetworking

Deleted reference to ARINC Specification 637.

5.2.1 VHF Radio Interface

Added radio configuration item b. and re-lettered remaining items. Added two paragraphs on ARINC Characteristic 750 interface.

5.2.1.1.1 ARINC 716 Modem Interface

Added text on bit 15 of the CMU status word in first paragraph. Deleted last paragraph and commentary.

5.2.1.1.5 Remote Voice/Data Mode Annunciation Ouput Discrete

Editorial revision.

5.2.1.1.7 DFS ARINC 429 Tuning Interface

Added 750 in two places in commentary. Added “and 25 kHz voice channel frequencies” to commentary.

5.2.1.1.11 8.33 kHz Tuning Discrete Input Pin

Added new Section.

5.2.1.2 ARINC 750 VHF Transceiver (Level 0.1)

Added “(Level 0.1)” to section title. Added new text on ARINC 750 VHF transceiver and air/ground protocol support.

5.2.1.2.1 Physical Interface

Changed section title and replaced text with new text.

5.2.1.2.2 Link Layer Interface

Added new section. Former Section 5.2.1.2.2 changed to Section 5.2.1.2.3.

5.2.1.2.3 ARINC 750 Status Exchange

Formerly Section 5.2.1.2.2. Added Labels 172 and 377.

5.2.1.2.4 ARINC 750 Control And Configuration

Added new Section.

5.2.1.2.4.1 VDR Configuration

Added new Section.

5.2.1.2.4.2 VDR Protocol Initialization

Added new Section.

5.2.1.2.4.2.1 VDR Mode A (ACARS Protocol)

Added new Section.

5.2.1.2.4.2.2 VDR Modes 1 and 2 (AVPAC Protocol)

Added new Section.

5.2.1.3 VHF Loadable Options

Added “ARINC 716” and reference to Section 5.2.1.1.11 in second paragraph. Deleted third paragraph. Revised fourth paragraph and added commentary.

5.2.3 HF Data Link ARINC 753 Interface

Editorial revisions.

5.2.3.1 HFDL Air/Ground Messages

Editorial revision.

5.2.3.4 HF Data Link Fault Status Determination

Changed reference in last paragraph.

5.2.3.6 HF in Voice Reporting

Editorial revisions in first paragraph and commentary.

5.2.3.7 HFDR Master/Slave Determination Logic

Changed "Altering" to "Alerting" in commentary.

5.2.3.8 HFDR/HFDU BITE Support

Editorial revision in subparagraph a.

5.2.5 Transponder

Editorial revisions. Changed "different" to "similar" in last paragraph.

5.2.6 ARINC 761 STU Interface

Added new Section.

5.2.6.1 SATCOM Data 2

Added new Section.

5.2.6.2 SATCOM Data 3

Added new Section.

5.2.6.3 STU as an End System

Added new Section.

5.3.2.4 Comm Data Bus #4

Added STU and 761 to table.

5.3.2.6 Comm Data Bus #6

Added STU and 761 to table.

5.3.2.7 Comm Data Bus #7

Added STU and 761 to table.

5.3.3.2 DFS/UTC Output Data Bus

Changed "or" to "and" in last paragraph.

5.3.3.5 ICAO 24-bit Aircraft Address Word Definition

Editorial revisions.

5.3.3.6 Status Output Word #1 (270)

Editorial revisions.

5.3.6 ARINC 646 ELAN Interfaces

Added simulator support in commentary.

5.3.15.1 ATN - ES/IS Protocol

Editorial revision.

5.5 ARINC 610A Simulator Interface

Added new Section.

5.5.1 Installed in Simulator Discrete Input

Added new Section.

5.5.2 Simulator ARINC 429 Interface

Added new Section.

5.5.2.1 Simulator ARINC 429 Physical Layer

Added new Section.

5.5.2.2 Simulator ARINC 429 Link Layer

Added new Section.

5.5.3 Simulator ARINC 646 (Ethernet) Interface

Added new Section.

5.5.3.1 Simulator ARINC 646 Physical Layer

Added new Section.

5.5.3.2 Simulator ARINC 646 Link Layer

Added new Section.

ATTACHMENT 1-8 DUAL INSTALLATIONS

Editorial revisions.

ATTACHMENT 2-2 STANDARD INTERWIRING

Added 761 source/sink, 8.33 kHz tuning for VHF transceiver, and simulator support provisions. Editorial changes made.

ATTACHMENT 2-3 REAR CONNECTOR INSERT LAYOUT

Table 1, Added STU.

Table 2, Added simulator/615A data loader support and 8.33 kHz tuning discrete.

ATTACHMENT 4 HF DATA RADIO CONTROL LOGIC TABLES

Table 4-1, Added "HFDR 1 Label 270 SSM bits" column. Added bottom three rows. Revised second and third rows.

Table 4-2, Added "HFDR 2 Label 270 SSM bits" column. Added bottom three rows.

Table 4-3**,** Added "HFDR 1 Label 270 SSM bits" column added bottom three rows. Revised second and third rows.

Table 4-4, Added "HFDR 2 Label 270 SSM bits" column. Added bottom three rows. Deleted third row. Reversed fourth and fifth rows.

Table 4-5, Added "HFDR 1 Label 270 SSM" and "HFDR 2 Label 270 SSM" columns. Added third and sixth rows.

Table 4-6, Added "HFDR 1 Label 270 SSM" and "HFDR 2 Label 270 SSM" columns. Added third and sixth rows.

Table 4-7, Editorial revisions.

ATTACHMENT 5 - EXAMPLE OF APM MEMORY MAP

Made identity blocks the same for Tables 5-1 and 5-2.

ATTACHMENT 6 ARINC SPECIFICATION 429 BROADCAST WORD DEFINITIONS

Table 6-1, Changed XPDR/ICAO #2 Activity Label from "275" to "276". Added "SDU#3/STU#3" and "SDU#4/STU#4".

Table 6-2, Editorial changes.

Table 6-4, Editorial changes and revised note 1.

Table 6-8, Changed bit 15 from "Voice Busy" to "Reserved".

Table 6-9, Changed bit 19 from "SAT Link Available" to "SAT Link Not Available". Changed bit 28 from "HFDL #1 Master" to "HFDL #1 SSM bits". Changed bit 29 from "HFDL #2 Master" to "HFDL #2 SSM bits".

Table 6-10, Revised bit ordering of ICAO 24-bit Aircraft Address Label 214 to be consistent with ARINC 429 Label 275.

Table 6-11, Revised bit ordering of ICAO 24-bit Aircraft Address Label 216 to be consistent with ARINC 429 Label 276.

Table 6-12, Editorial change. Added "STU#1" to bit 23. Added "STU#2" to bit 26.

Table 6-13, Changed bit 11 from "Cabin Terminal 2" to "SDU#3/STU#3". Changed bit 12 from "Reserved" to "SDU#4/STU#4". Editorial revisions to notes.

APPENDIX C REFERENCED DOCUMENTS

Deleted references to ARINC Specifications 637 and 638. Renumbered references. Editorial revisions.

APPENDIX D ACRONYMS

Editorial revision.