A350
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSE - T1+T2 - RR Trent XWB
Integrated Modular Avionics and Avionics Data communication Network

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INTEGRATED MODULAR AVIONICS AND AVIONICS DATA COMMUNICATION NETWORK

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V2414251 - V00T0MM0

INTEGRATED MODULAR AVIONICS (IMA) DESCRIPTION (2/3)

General Architecture

Conventional avionics are based on the Line Replaceable Units (LRUs) with the same general functions (input acquisition, process and input computing, generation of output), also called resources. These are used to operate their own avionics applications.
The general function of the Integrated Modular Avionics (IMA) is:
- To organize shared resources
- To supply a centralized computing and data communication capability.
Some system applications hosted in the same computer (module) can use them.
The advantages are:
- Weight saving (less wiring and boxes)
- Cost reduction.
The IMA contains these modules:
- Core Processing Input/Output Modules (CPIOMs)
- Common Remote Data Concentrators (CRDCs).
CPIOMs:
The CPIOM is a computer that can do multiple applications at the same time.
Each CPIOM hosts independent applications/functions for A/C systems in the same computing and memory resource. It also supplies an Input/Output (I/O) interface service to other equipment (conversion of non-Avionics Full Duplex Switched Ethernet (AFDX) signals (ARINC, CAN, analog, discrete) into AFDX signals).
CRDCs:
The CRDCs collect, convert and exchange data between the AFDX network and the equipment without AFDX capability (most of them are installed out of the avionics compartment, in remote areas), i.e. sensors, switches, potentiometers, cockpit panels, etc. communicating through ARINC, CAN, analog or discrete means.
The CRDCs host no avionics application.
Dialog through AFDX, CAN, ARINC, discrete and analog:
The CPIOMs and the CRDCs dialog through the AFDX network. They use a protocol equivalent to Ethernet communication technology, which is adapted to the aviation constraints (integrity of data, redundancy and reliability).

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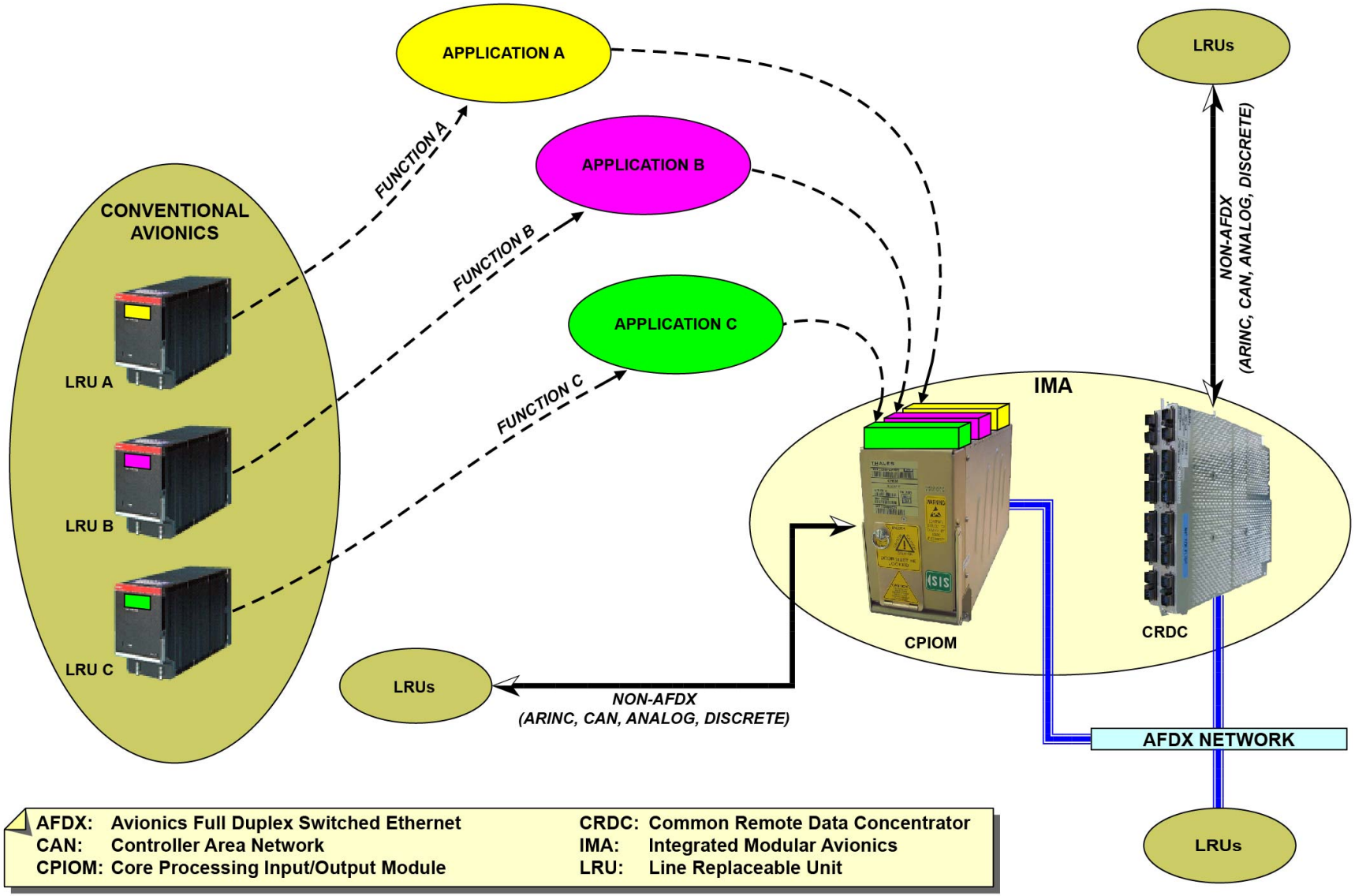

GENERAL ARCHITECTURE

INTEGRATED MODULAR AVIONICS (IMA) DESCRIPTION (2/3)

CPIOM Types

There are two types of CPIOMs:
- Type H (12 units)
- Type J (9 units + 1 optional).

They are different in the definition of their physical interfaces (I/Os): for example, CPIOMs J can generate audio signals (e.g. FWS application function), but CPIOMs H can supply a wider variety of signals.
All CPIOMs are installed in the main avionics compartment.
- CPIOM groups (clusters)

There are:
- Three groups (also named clusters) of CPIOMs type H (H3, H4 and H6)
- Four groups of CPIOMs type J (J1, J2, J5 and J7).
- CPIOM identification

Each CPIOM is identified by one letter and two digits (e.g. H31):
- The letter gives the CPIOM type: H or J.
- The first digit gives the CPIOM group to which it belongs: from 1 to 7.
- The second digit gives the CPIOM number in this group: from 1 to 4.

CPIOM interchangeability:
- The CPIOM-H and CPIOM-J are not interchangeable because they do not have the same hardware.
- The CPIOMs of the same type and of the same group can be swapped with no other requirement than A/C systems applications uploading.
- The CPIOMs of the same type but of different group can be swapped if their core software is uploaded and if the A/C system applications are uploaded.

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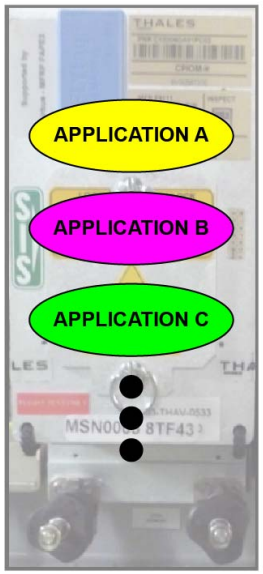
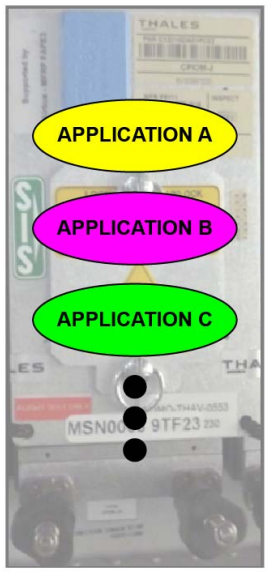


CPIOM-H3x
(H31 TO H34)

CPIOM-H4x
(H41 TO H44)

CPIOM-H6x
(H61 TO H64)

CPIOM-H



CPIOM-J1x
(J11 TO J12)

CPIOM-J2x
(J21 TO J24)

CPIOM-J5x
(J51 & OPTIONAL J52)

CPIOM-J7x
(J71 & J72)

CPIOM-J

CPIOM-H31

- NUMBER IN A DEFINED GROUP
- CPIOM GROUP
- CPIOM TYPE (H OR J)

- TWO TYPES OF CPIOM: H & J.
- CPIOM-H AND CPIOM-J ARE NOT INTERCHANGEABLE (DIFFERENT HARDWARE).
- CPIOMs FROM THE SAME TYPE & GROUP >>> SWAP POSSIBLE >>> NO CORE S/W LOADING NECESSARY.
- CPIOMs OF THE SAME TYPE BUT DIFFERENT GROUP >>> SWAP POSSIBLE >>> CORE S/W LOADING NECESSARY.
- FOR MOST CPIOM INSTALLATION TASKS, THE UPLOADING OF AVIONICS APPLICATIONS IS ALSO NECESSARY.

S/W: Software

CPIOM TYPES

INTEGRATED MODULAR AVIONICS (IMA) DESCRIPTION (2/3)

CPIOM Internal Architecture

A CPIOM has the following architecture:
- Hardware
- One computation part, which hosts the Central Processing Unit (CPU) and I/O resources for AFDX network interface.
- One I/O part, which receives, processes and manages the non-AFDX I/Os.

Note that the two parts (electronic cards) are interconnected.
- Not field-loadable software
- The resident software, which is a part of the computation function.
- CPIOM module software-field loadable

Each CPIOM has some field loadable software:
- One configuration table, which defines allocation of memory, CPU and I/Os resources to the applications.
- One configuration table for resource BITE, which is applicable to the BITE messages sent to the CMS. The resource BITE perimeter is limited to failure or damage that occurs within the CPIOM.
- One core software (BITE included), which is an operating system used by the applications to get access to the CPIOM resources (CPU, memory, I/Os) and to monitor the hardware.
- System field-loadable software (A/C system applications/database)

The CPIOMs also host A/C system functions that:
- Contain one or some A/C system applications
- Can include one or more related databases.

Two A/C system applications hosted in the same CPIOM, which want to communicate with each other, must do it through the AFDX network.
The CPIOM field loadable-software must be loaded onto the CPIOM in a specific sequence (see maintenance procedure).
The CPIOM can be tested from the OMS if all software are uploaded before in accordance with maintenance procedures.

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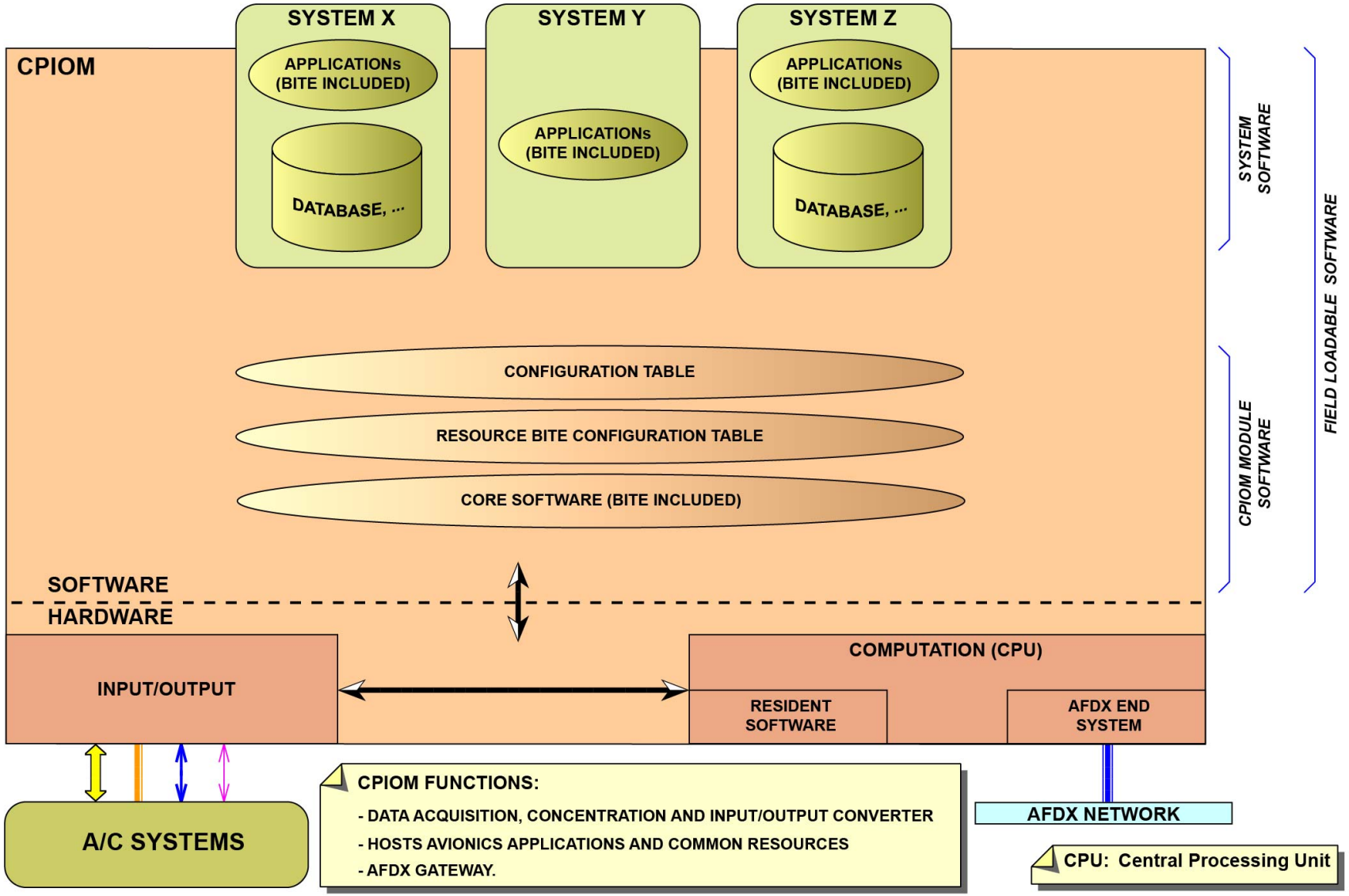

CPIOM INTERNAL ARCHITECTURE

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INTEGRATED MODULAR AVIONICS (IMA) DESCRIPTION (2/3)

CRDC Types

The CRDCs (29 units) are divided into two types:
- CRDC-A (15 units)
- CRDC-B (14 units).

The CRDCs are fully interchangeable without software upload if they belong to the same type. The CRDC-A and CRDC-B have different physical interfaces.
The CRDCs are installed in pressurized areas along the A/C.

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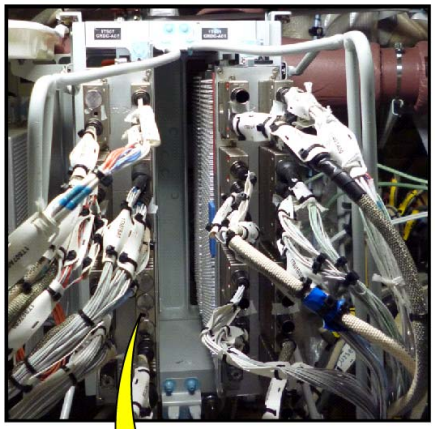
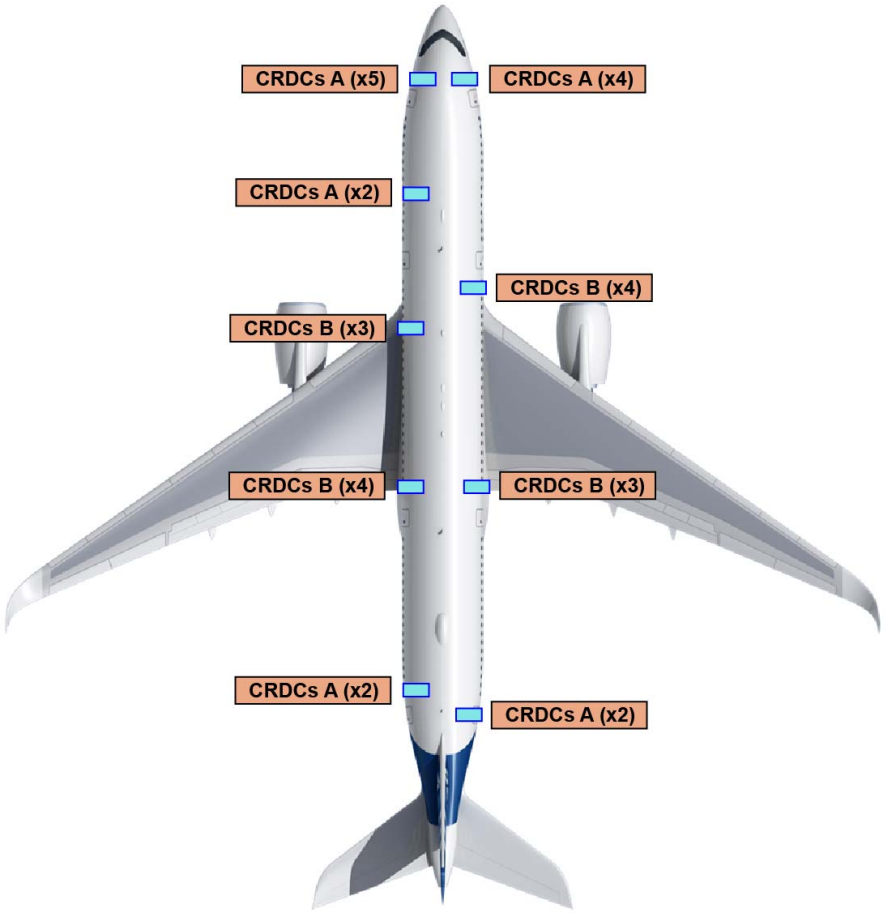


CRDC



2 TYPES OF CRDC: A (x15) & B (x14)

CRDC THAT BELONGS TO THE SAME TYPE CAN BE SWAPPED WITHOUT SOFTWARE UPLOAD.

CRDC TYPES

INTEGRATED MODULAR AVIONICS (IMA) DESCRIPTION (2/3)

CRDC Internal Architecture

The CRDC is a standardized modular avionics-unit. It is a part of the IMA architecture.
Each CRDC has these functions:
- Data acquisition and concentration
The CRDC is used for remote concentration of analog and discrete I/O data. It also sends and receives data from/to computer processing resources of A/C systems.
- Combinatory logic (boolean logic, basic mathematical operations, etc.)
CRDCs also do simple calculations to operate some systems autonomously.
- Gateway function
The CRDC is an AFDX gateway from/to CAN, ARINC 429, discrete and analog signals. It is used for communication between the systems with AFDX capability and the systems with no AFDX capability. The CRDCs do not host avionics applications.
A CRDC has hardware and software:
- Hardware
- Data conversion and I/O processing block, in charge of data acquisition, concentration and transfer.
- A computation part that includes the boolean logic and a gateway to the AFDX network (AFDX end system).
- Software
Each CRDC has field loadable software:
- One configuration table, which defines allocation of the resources to the user systems.
- One configuration table for resource BITEs , which defines allocation of the BITE messages that can be sent to the CMS.
- One core software (resource BITEs included), which does the I/O conversion and routing, monitors the internal hardware and the faults reporting to the CMS.

The resource BITE perimeter is limited to a failure or damage that occurs on a physical component of the CRDC. This includes electronic failures, false contacts, etc. It is configured by the resource BITE configuration table.
The CRDC field loadable software must be loaded in the CRDC in a specific sequence (see Aircraft Maintenance Manual (AMM)).
The CRDC can be tested from the OMS if all the software is previously uploaded in accordance with AMM procedures.

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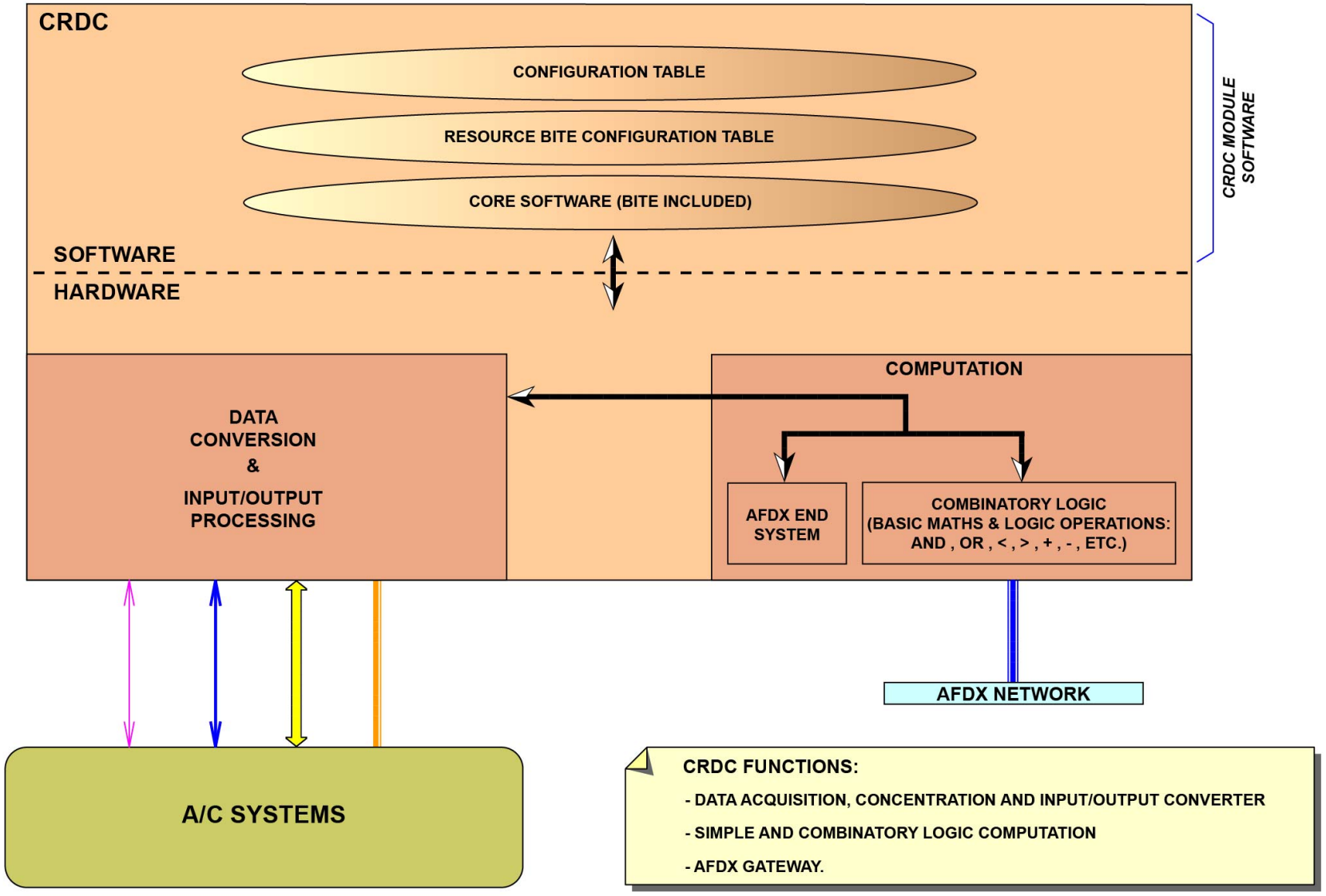

CRDC INTERNAL ARCHITECTURE

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INTEGRATED MODULAR AVIONICS (IMA) DESCRIPTION (2/3)

CRDC Normal Operation

In normal operation, the two types of CRDCs collect, convert and exchange the A/C system data between the AFDX network and the ATA XX equipments that do not have the AFDX capability.
For redundancy purpose, most of these signals are processed in parallel by two different CRDCs.
Some less critical signals are processed by one CRDC only (no redundancy).
The equipment is connected to a pre-defined set of CRDCs. The combinations of CRDCs change from one user to the other. There is no fixed pair of CRDCs and there is no CRDC related to a specific back-up CRDC.

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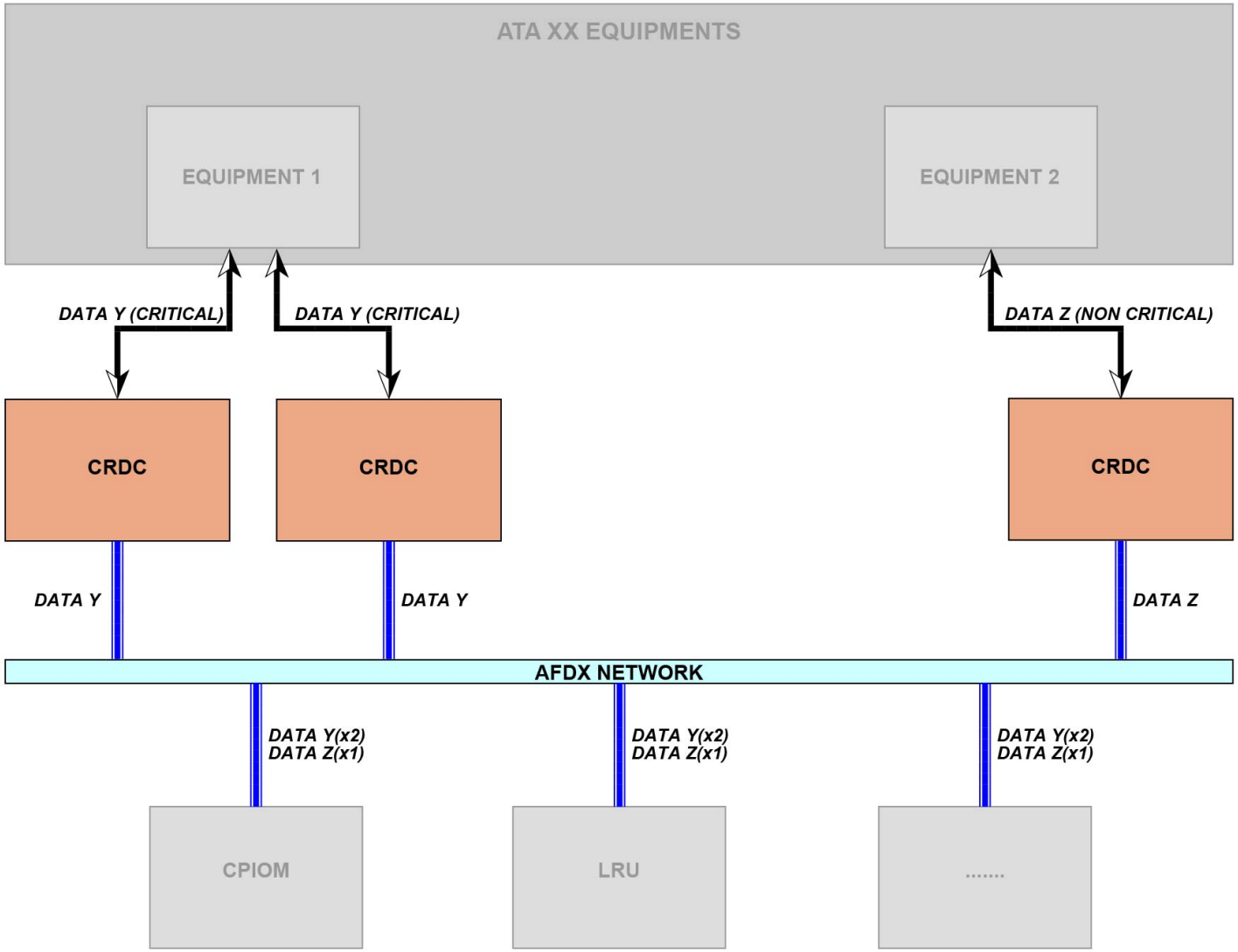

CRDC NORMAL OPERATION

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INTEGRATED MODULAR AVIONICS (IMA) DESCRIPTION (2/3)

Alarm Management Principles

Several avionics applications are hosted in the same IMA component. Thus, an IMA component failure can be a common cause for several system failures. This can cause the triggering of multiple ECAM messages.
There is no ECAM message dedicated to each IMA component failure. A second line in the ECAM message indicates that the root cause is an IMA common resource failure.

IMA module that causes only one ECAM message

The amber message "DUE TO IMA MODULE FAULT" is added to the ECAM message when there is a primary failure because of an IMA component. For example, the dual total loss of the CPIOMs H31 and H32 that host the FQMS applications causes the triggering of this message.

IMA module that causes several ECAM messages

To consolidate the indication about the root cause, when it is necessary, an IMA amber alarm "IMA MODULE FAULT" is shown on top of the ECAM messages.
If there is more than one fault because of the IMA component failures (for example ENGINE #1, VENT and CAB PRESS systems), the FWS will trigger a generic IMA message on top of the ECAM message list.

Dispatch principles

If there is a component failure (CPIOM, CRDC), the FWS generates a dispatch message in the dispatch function (upper center Display Unit (DU)).
The different dispatch messages can come into view in relation to the parameters that follow:
- Single or multiple IMA module failures (when one or some modules are impacted)
- ATA XX alarms, triggered or not by IMA module failures.

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CPIOM OR CRDC FAILURES THAT CAUSE ONLY ONE ECAM MESSAGE

IMPACTED ATA XX SYSTEM ECAM WARNING

FUEL TOTAL NETWORK LOSS
DUE TO IMA MODULE FAULT

WARNING DISPLAY

A SECOND LINE INDICATES THAT THE ROOT CAUSE IS AN IMA MODULE FAILURE.

DISPATCH PAGE

IMA
> IMA CPIOM H41

IMA COMPONENT SINGLE FAILURE THAT DOES NOT TRIGGER ATA XX ALARMS

IMA MODULE FAULT
CAB PRESS INHIBITED BY DOORS
DOOR MULTIPLE POS DET FAULT
> IMA CRDC A09

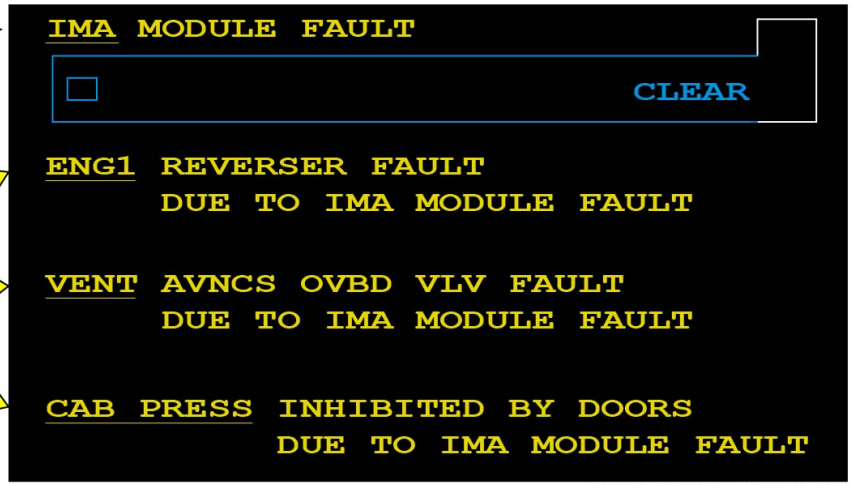
IMA COMPONENT SINGLE FAILURE THAT TRIGGERS ATA XX ALARM(S)

ALARM MANAGEMENT PRINCIPLES - IMA MODULE THAT CAUSES ONLY ONE ECAM MESSAGE ... DISPATCH PRINCIPLES

CPIOM OR CRDC FAILURES THAT CAUSE SEVERAL ECAM MESSAGES

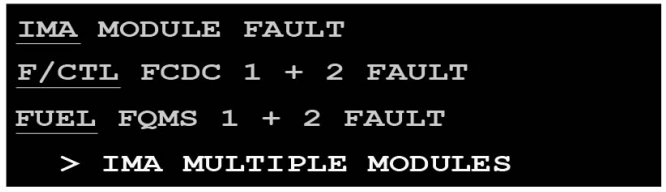
GENERAL IMA ALERT

IMPACTED ATA XX SYSTEMS ECAM WARNINGS
+
IMA MODULE FAILURE ROOT CAUSE INDICATION



WARNING DISPLAY

DISPATCH PAGE



IMA COMPONENTS MULTIPLE FAILURES THAT TRIGGERS ATA XX ALARMS

ALARM MANAGEMENT PRINCIPLES - IMA MODULE THAT CAUSES ONLY ONE ECAM MESSAGE ... DISPATCH PRINCIPLES

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AVIONICS FULL DUPLEX SWITCHED ETHERNET (AFDX) NETWORK DESCRIPTION (2/3)

General

AFDX network overview

The Avionics Full Duplex Switched Ethernet (AFDX) network contains 14 switches, 7 for each network, and related AFDX cables.
These switches interconnect the A/C system components that follow:
- 22 Core Processing Input/Output Modules (CPIOMs), including one optional
- 55 Line Replaceable Units (LRUs) with AFDX interface
- 29 Common Remote Data Concentrator (CRDC).

Note that there are two types of CPIOMs:
- CPIOM H (12)
- CPIOM J (10), including one optional (CPIOM J52 (ACR2)).

Pairs of superposed switches show the full network redundancy.

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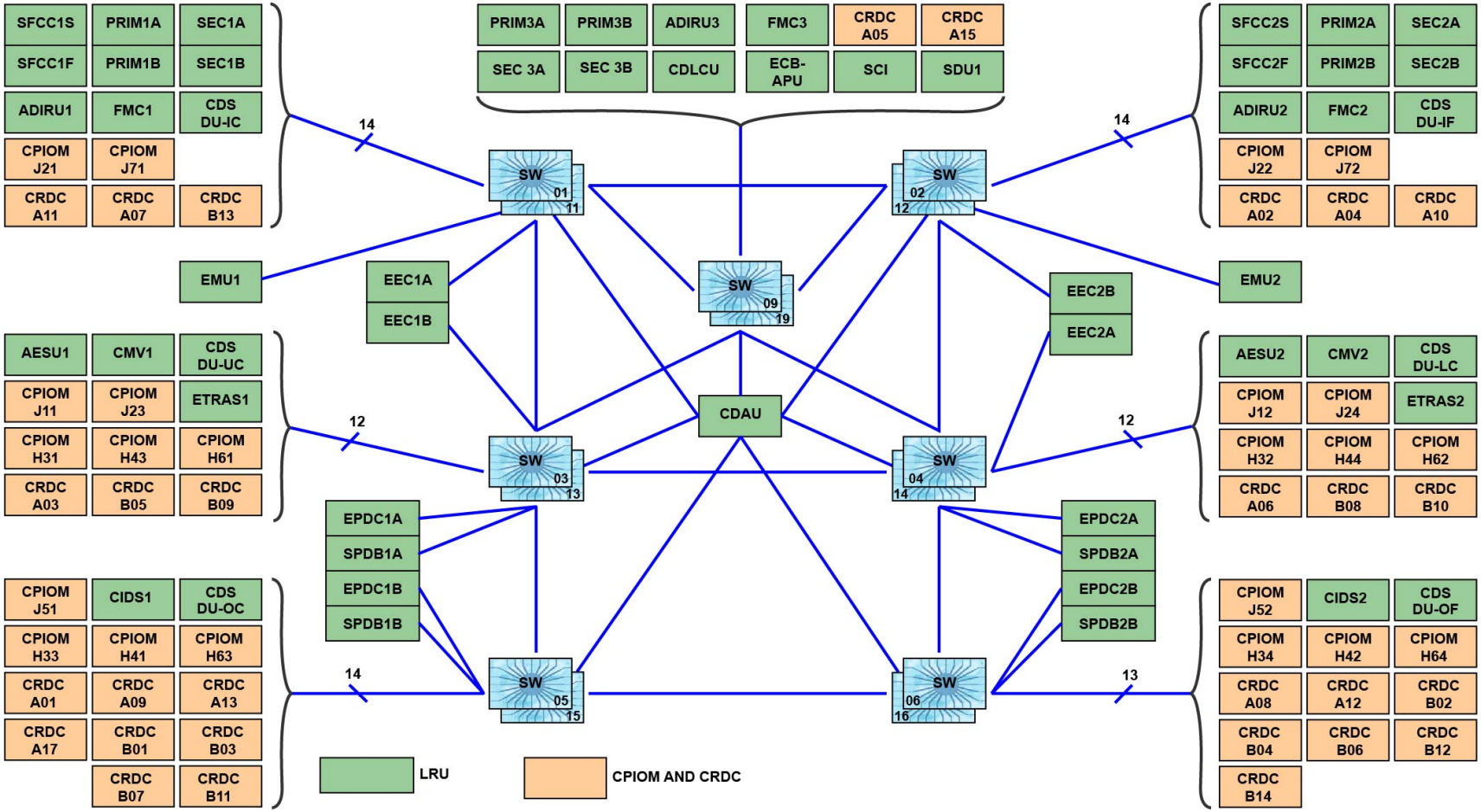

GENERAL - AFDX NETWORK OVERVIEW

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AVIONICS FULL DUPLEX SWITCHED ETHERNET (AFDX) NETWORK DESCRIPTION (2/3)

General (continued)

AFDX network description

The basic function of the AFDX network is to transmit data between network subscribers:
- Operational data
- Maintenance data
- Data loading.

The physical architecture of the AFDX network contains network subscribers, that are interconnected through AFDX links. These links include Quad cables and Quadrax contacts. These subscribers are divided in two parts:
- AFDX network switches
- IMA subscribers (CPIOMs, CRDCs and LRUs with AFDX interface).

For redundancy function, the AFDX network is divided into two identical networks:
- Network A
- Network B.

Each network contains seven interconnected switches (14 switches for the two networks). Almost all subscribers have a connection to the two networks and can transmit the same AFDX data frame through the two networks at the same time (first one received is used, second one is rejected).

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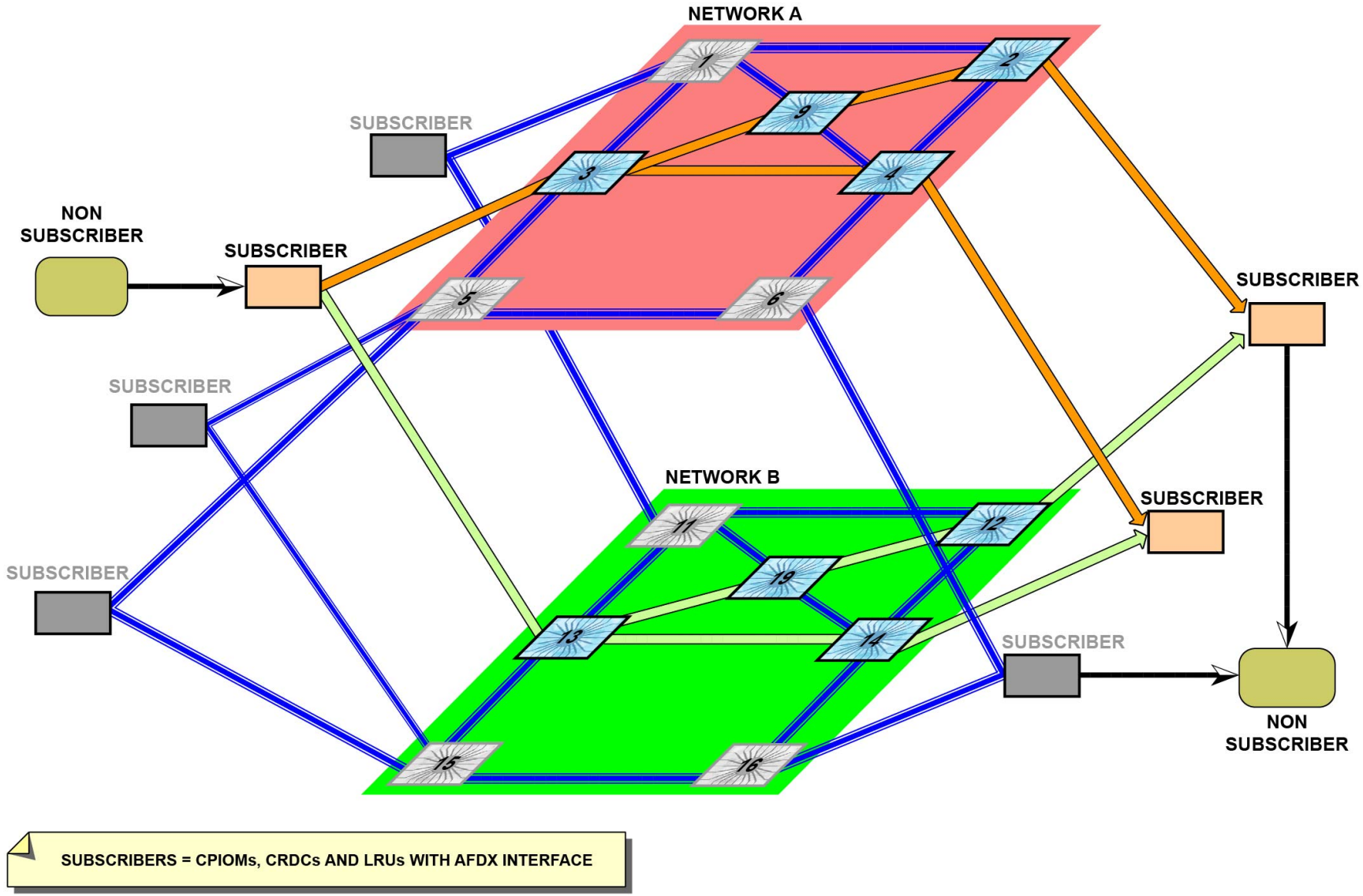

GENERAL - AFDX NETWORK DESCRIPTION

AVIONICS FULL DUPLEX SWITCHED ETHERNET (AFDX) NETWORK DESCRIPTION (2/3)

AFDX Switches - Internal Architecture

The basic function of a switch is:
- To receive incoming AFDX data (from CPIOMs, CRDCs, subscribers or other switches)
- To analyze the data
- To forward the AFDX frame onto the applicable output ports, in relation to the configuration table.

Each switch interfaces with the AFDX network through its AFDX end system.
All switches are installed in the avionics bay racks (24 identical Input/Output (I/O) AFDX ports).
Each AFDX switch accommodates the field loadable software that follows:
- One configuration table, also called network configuration file, which defines all data flow paths between transmitters and receivers over the network (Virtual Link (VL) concept).
- A core software, also called operating system.

All switches are loadable with the same configuration table and core software.
The special part of the configuration table used by each switch is related to its hardware pin programming.

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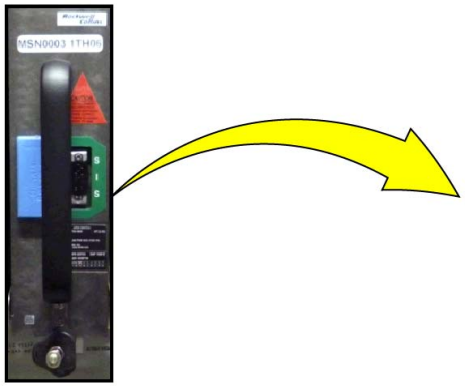
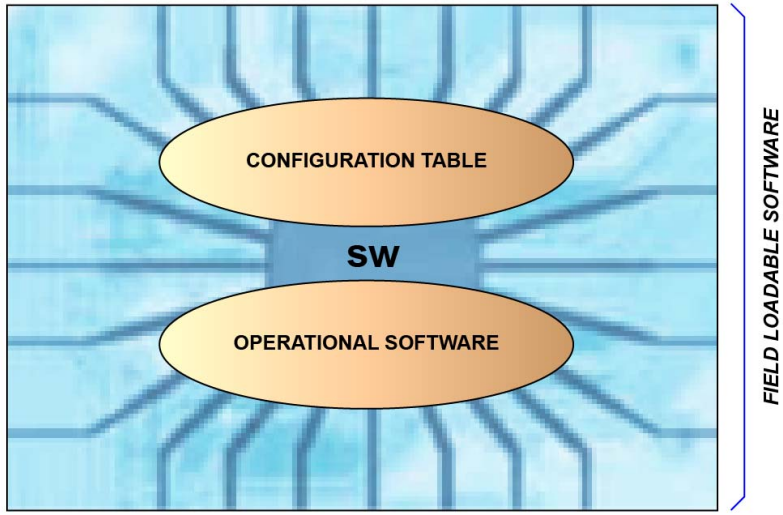
AVIONICS COMPARTMENT RACKS



AFDX

AFDX SWITCH



SWITCH BASIC FUNCTIONS:

- RECEIVE AFDX DATA
- ANALYZE DATA
- FORWARD AFDX FRAME IN RELATION TO CONFIGURATION TABLE

AFDX: Avionics Full Duplex Switched Ethernet

AFDX SWITCHES - INTERNAL ARCHITECTURE

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AVIONICS FULL DUPLEX SWITCHED ETHERNET (AFDX) NETWORK DESCRIPTION (2/3)

AFDX Network Maintenance

There is no scheduled maintenance and no inspection task necessary on the AFDX network.
The only required action applicable to the AFDX network that is necessary is the upload of the field loadable software after a removal/installation task (operational software and/or configuration table). The switch upload is done through the DLCS and uses the AFDX network itself.
Considering the AFDX network architecture and configuration (VL paths from SCI to the AFDX switches), a special software uploading sequence, given in the maintenance documentation, must be followed to make sure that the network is connected during the uploading operation.
All the AFDX switches must be uploaded with the same software Part Number (P/N) for the operational software and configuration table. The Network BITE Function (NBF) has the capability to verify that all the switches have the same software P/N.
Also, each AFDX switch makes sure that there is compatibility between the loaded operational software P/N and its hardware P/N at power-up.
On a given A/C, the AFDX switches are interchangeable (same hardware and software P/N).
A software reconfiguration can be necessary for a new switch installation (software not installed, incorrect software installed or configuration table update).

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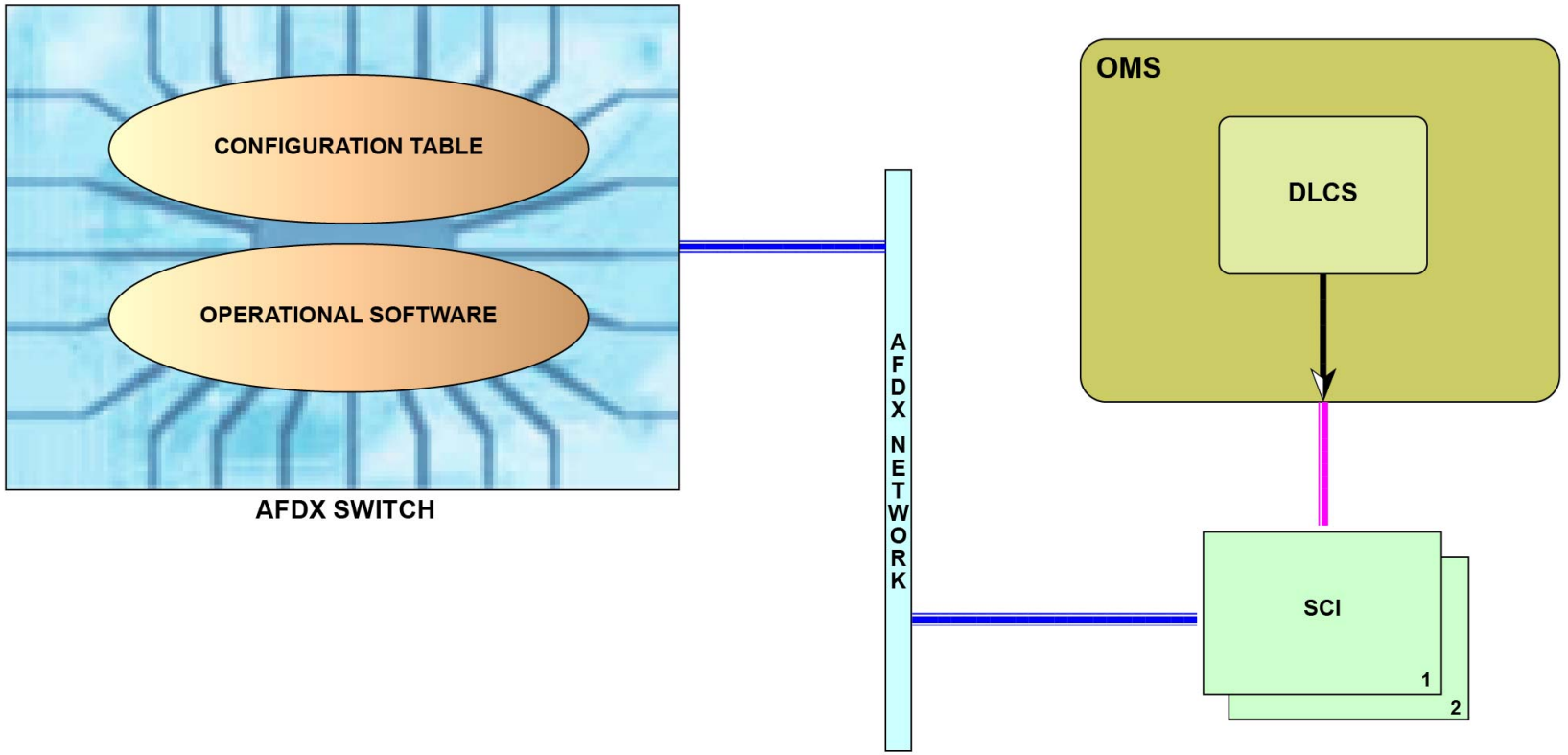

AFDX NETWORK MAINTENANCE

- SPECIFIC SW UPLOADING ORDER MUST BE STRICTLY FOLLOWED AS PER MAINTENANCE PROCEDURES.
- ON A GIVEN AIRCRAFT, AFDX SWITCHES ARE INTERCHANGEABLE (SAME HARDWARE AND SOFTWARE P/N).
- NEW SWITCH INSTALLATION MAY REQUIRE SW RECONFIGURATION (SW NOT INSTALLED, INCORRECT SW INSTALLED OR CONFIGURATION TABLE UPDATE).

AFDX NETWORK MAINTENANCE

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AVIONICS FULL DUPLEX SWITCHED ETHERNET (AFDX) NETWORK DESCRIPTION (2/3)

AFDX Network Component Failure

The AFDX network failures have no effects on the IMA components internal behavior. If there is a component failure (AFDX switch, cables), the FWS triggers:
- A Dispatch Message (DM) on the dispatch page.
- An ECAM caution/warning dedicated to the impacted ATA XX system, if applicable.
- A network related warning if the two AFDX networks (A and B) are affected.

AFDX switch:
- If there is a NO GO situation because of AFDX switches failures, a dispatch of the A/C can still be possible with a swap to agree one of the GO situation.

A configuration check and a possible uploading of the switch software are necessary for an AFDX switch removal/installation procedure. After a switch replacement, a network connection test must be done (through the NBF) to ensure network integrity.

AFDX cable:
- If there is a NO GO situation because of the AFDX cable damage, a cable repair can be possible (refer to electrical standard practices in AirN@v line documentation).

After an AFDX cable repair or after a new AFDX cable installation, a test of data transmission quality must be done with standard test equipment. This test must be followed by a connection test (NBF interactive mode).

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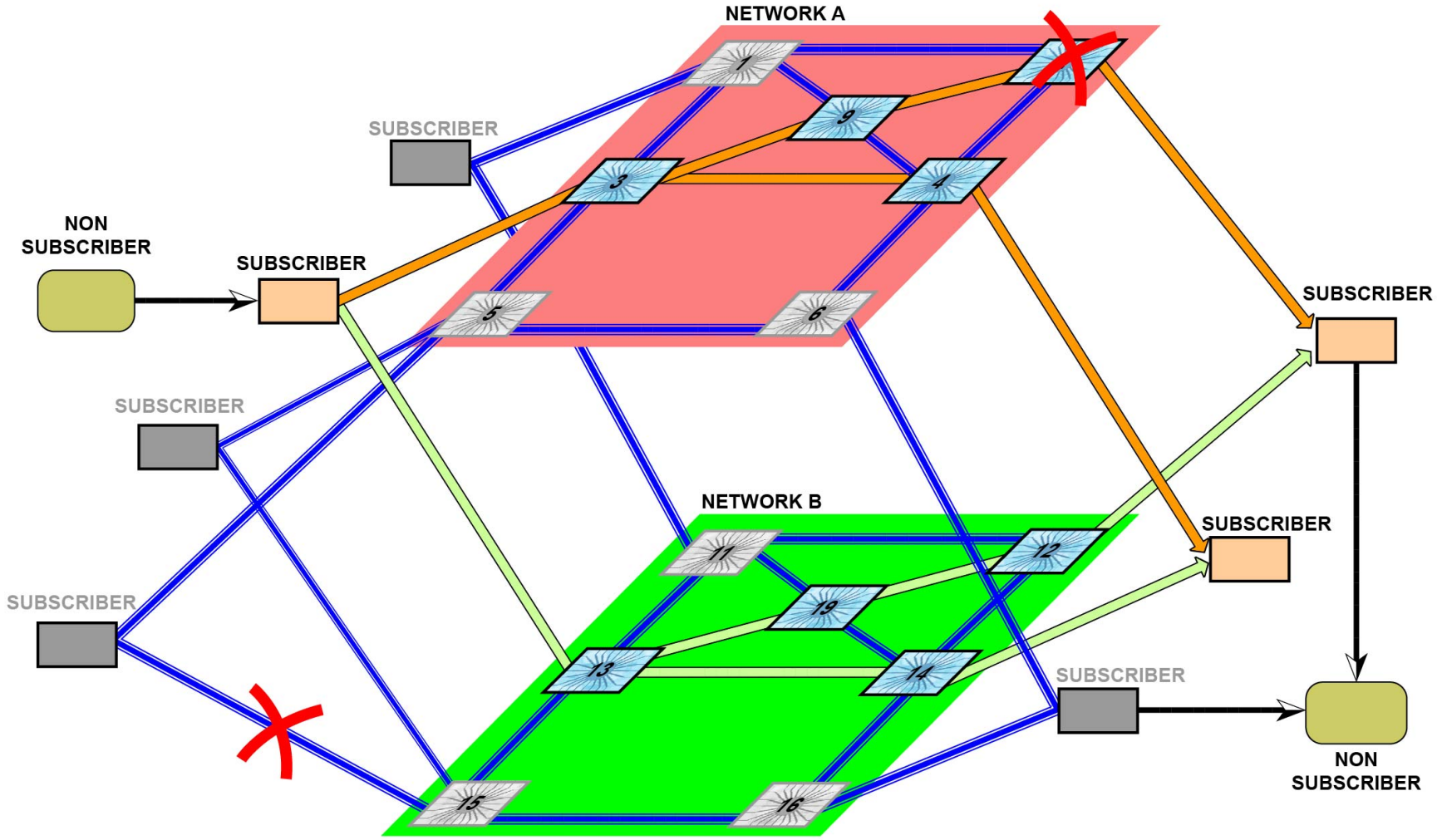

AFDX NETWORK COMPONENT FAILURE

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