Plan for Software Aspects of Certification (PSAC) for the Data Link Communications Application DLCA-6500

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1 Scope

1.1 Purpose

The objective of this document is to fulfill the requirements 66 in DO-178B [61], section 11.1, Plan for Software Aspects of Certification.

In accordance with the DO-178B guidelines, this document includes:

- System Overview
- Software Overview
- Certification Considerations
- Software Life Cycle
- Software Life Cycle Data
- Schedule
- Additional considerations

1.2 Additional Considerations Applicability

This document applies to the planned software development activities associated with creating the Data Link Communications Application (DLCA-6500) software product, which will be hosted on the Common Computing Module (CCM) and the Adaptive Flight Display AFD-37X0. Throughout this document when there are differences between the CCM and the AFD-37X0, the differences will be noted. DLCA-6500 will be developed and verified in accordance with the objectives for DO-178B Level C software. See Section 5.2 Software Criticality Level for more information.

1.3 Deliverables

In accordance with DO-178B [61] guidelines, section 11.0, data will be produced during the software life cycle to plan, direct, explain, define, record, or provide evidence of activities. This data enables the software life cycle processes, system or equipment certification, and post-certification modification of the software product. See DO-178B Matrix for the correlation between DO-178B guidelines and sections of this document addressing those guidelines.

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2 References

The documents listed in this section are referenced in one or more places throughout this document. This section provides the precise title, publisher, control numbers (if any), and date of publication (if necessary for control) of each referenced document. For easy identification, each point of reference includes a bracketed number (defined in this section) that corresponds to the document being referenced. References with an X in the part number have either not been released or not had a part number assigned. Any RCPN that ends in (XXX), implies the latest document number or revision. The Software Configuration Index (SCI) [55] will identify the exact a revision letter.

2.1 Rockwell Collins (RC) Internal Documents

2.1.1 Policies and Procedures

[1] Rockwell Collins Technical Consistent Process Version 3.2, RCPN 832-8716-009

[2] Design Quality Assurance Plan for Hardware, Software and System Development, RCPN 946-5892-100

[3] Software Configuration Management Plan, RCPN 832-2963-001

[4] Risk Assessment and Oversight for Offshoring or Activities involving Civil Certification, HRC-ENG-P-016

[5] Pro Line Fusion® Input Output Common Format Interface Definition Document (IOCF IDD) Process BRS-ENG-P-006

2.1.2 Project-Specific Documents

[6] Software Development Plan (SDP) for the Commercial Systems (CS) Data Link Projects, RCPN 829-6997-600

[7] Coding Standards for C++ Language, RCPN 832-0536-005

[8] Application Footprint Document for the Data Link Communications Application (DLCA 6500) 945-8964-(XXX)

[9] High Level Software Requirements Specification (SRS) for the Pro Line Fusion DLCA-6500 Data Link Communications Application, RCPN 945-9216-(XXX)

[10] Software Requirements Specification (SRS) for the Data Link Communications Application (DLCA) Future Air Navigation System (FANS-1/A), RCPN 945-0516-(XXX)

[11] Software Requirement Specification (SRS) for Common System Services Data Link Communication Application (DLCA), RCPN 945-0592-(XXX)

[12] Software Requirements Specification (SRS) for Aeronautical Telecommunication Network Context Management (CM) And Controller Pilot Data Link Communication (CPDLC), RCPN 945-0591-(XXX)

[13] Software Requirement Specification (SRS) for DLCA-6500 Human Machine Interface (HMI), RCPN 945-0517-(XXX)

[14] Input/Output Common Format (IOCF) Interface Definition Document for Datalink Communications, RCPN 945-1474-(XXX)

[15] Software Design Document (SDD) for the DLCA-6500 Data Link Software Component Design, RCPN 945-7650-(XXX)

[16] Computer Program Configuration Item for the Data Link Communication Application (DLCA-6500) with A661 for Human Machine Interface (HMI) RCPN 096-6363-(XXX)

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[17] Computer Program Configuration Item (CPCI) for the Data Link Communication Application (DLCA-6500) Core Software Library, RCPN 096-2550-(XXX)

[18] Computer Program Configuration (CPCI) for the Data Link Communication Application (DLCA-6500) Message Library, RCPN 096-6864-(XXX)

[19] Computer Program Configuration Item (CPCI) for the Data Link Communication Application (DLCA-6500) XML I/O Configuration File, RCPN 096-5697-(XXX)

[20] Computer Program Configuration Item (CPCI) for XML ATN Default Addresses, RCPN 096-5698-(XXX)

[21] Computer Program Configuration Item (CPCI) for the DLCA-6500 XML General Configuration File, RCPN 096-9861-(XXX)

[22] Software Verification Procedures and Results (SVPR) for the DLCA-6500, RCPN 945-0520-(XXX)

[23] Software Accomplishment Summary for the DLCA-6500, RCPN 945-0519-(XXX)

[24] Top Level Drawing for DATA LINK COMMUNICATIONS APPLICATION, DLCA-6500, RCPN 810-0315-(XXX)

[25] Data Link Products Peer Review Checklists, RCPN 963-9782-100

[26] Peer Review Method Using PREP for the Commercial Systems Data Link Organization, RCPN 945-9104-(XXX)

[27] CoRE Platform Software Accomplishment Summary, RCPN 815-0524-(XXX)

[28] LynxOS-178 Software Accomplishment Summary, AAN-1161-02-(XXX)

[29] Software Accomplishment Summary (SAS) for the Protocol Manager Application (PMA-6000), RCPN 963-6390-(XXX)

[30] Software Accomplishment Summary (SAS) for the AFDX-ASL, RCPN 815-9675-(XXX)

[31] Plan for Software Aspect of Certification for the Pro Line Fusion ARINC-661 Graphics Server and ARINC 661 Application Programming Interface, RCPN 963-9111-008

[32] Computer Program Configuration Item (CPCI) for the Support Files for the DLCA-6500, RCPN 096-9885-(XXX)

[33] Computer Program Configuration Item (CPCI) for the A661 Definition Files for the DLCA-6500, RCPN 096-9377-(XXX)

[34] Persistent Storage Design Description, RCPN 815-0020-(XXX)

[35] CoRE Common Input Output – CIO- SW Design Description, RCPN 815-0119-(XXX)

[36] Reliable User Datagram Protocol – RUDP Communication Library Design Description, RCPN 815-0686-(XXX)

[37] Reliable User Datagram Protocol – RUDP Connection Library Design Description, RCPN 815-0712-(XXX)

[38] Health Monitor SW Design Description, RCPN 815-0594-(XXX)

[39] Software Design Description (SDD) for PMA-6000, RCPN 815-9996-(XXX)

[40] AFDX Local Area Network – LAN – Design, RCPN 815-0533-(XXX)

[41] ARINC 661 Application Programming Interface (API) Software Design Document, RCPN 964-2609-(XXX)

[42] Software Accomplishment Summary for the Fusion ARINC 661 Application Programming Interface (A661 API), RCPN 964-9718-(XXX)

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[43] Software Developers User's Guide for the Data Link Communication Application (DLCA) ARINC 661 Projects, RCPN 946-5683-(XXX)

[44] Software Verification User's Guide for the Data Link Communication Application (DLCA) ARINC 661 Projects, RCPN 945-9320-(XXX)

[45] CoRE Common I/O SW User’s Guide, RCPN 815-0080-(XXX)

[46] Software Accomplishment Summary for AFD-37X0 Platform Software, RCPN 945-6685-(XXX)

[47] Software Accomplishment Summary (SAS) for the Pro Line Fusion User Interface Data Items for Data Link Communications Application (DLCA), RCPN 946-0M08-(XXX)

[48] Software Deliverable for the Data Link Communications Application, RCPN 811-5733-(XXX)

[49] Computer Program Configuration Item for the Archive of DOORS Project for DLCA-6500, RCPN 096-2548-(XXX)

[50] Computer Program Configuration Item (CPCI) for the Data Link Communication Application (DLCA-6500) Message Library Tester 096-9882-(XXX)

[51] Computer Program Configuration Item (CPCI) for the Data Link Communications Application (DLCA-6500) VAPS (Virtual Application Protocol Software) Model, RCPN 096-9378-(XXX)

[52] Computer Program Configuration Item (CPCI) for the Data Link Communication Application (DLCA-6500) Electronic Nameplate, RCPN 096-2552-(XXX)

[53] Software Deliverable for the Data Link Communications Application Message Library, RCPN 072-0951-(XXX)

[54] Computer Program Configuration Item (CPCI) for the Data Link Communication Application (DLCA-6500) Software Verification Procedures and Results (SVPR), RCPN 096-2551-(XXX)

[55] Software Configuration Index (SCI) for the Data Link Communications Application (DLCA-6500), RCPN 946-1T23-(XXX)

[56] Computer Program Configuration Item (CPCI) for the Data Link Communication Application (DLCA-6500) Processor Configuration Table (PCT), 096-0FP7-(XXX)

[57] Computer Program Configuration Item (CPCI) for the Data Link Communication Application (DLCA-6500) Media Set, RCPN 096-09L2-(XXX)

[58] Software Deliverable for the Data Link Communication Application (DLCA-6500) Media Set, RCPN 072-2266-(XXX)

[59] DOORS Documentation Method for the Commercial Systems Data Link Organization, 945-9527-001

[60] Software Accomplishment Summary for the Reliable User Datagram Protocol (RUDP) Libraries, RCPN 946-0MH2-(XXX)

2.1.3 Project-Specific Certification Documents

Documents referenced in section 2.1.2

2.2 External Documents

2.2.1 General Certification Documents

[61] Software Considerations in Airborne Systems and Equipment Certification, RTCA/DO-178B, December 1992.

[62] RTCA DO-258A Interoperability Requirements for ATS Applications Using ARINC 622 Data Communications (FANS 1/A Interop Standard), April 7, 2005

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[63] RTCA DO-306 Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard), October 11, 2007

[64] RTCA DO-306 Change 1 Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard), March 17, 2011

[65] FAA Order 8110.49A Software Approval Guidelines, March 29, 2018

[66] ARINC 622-4 ATS Data Link Applications Over ACARS Air-Ground Network, Oct 12, 2001

[67] EUROCONTROL SPECIFICATION on Data Link Services, EUROCONTROL SPECIFICATION, EUROCONTROL-SPEC-0116 Edition 2.1, January 28, 2009

[68] INTEROPERABILITY REQUIREMENTS STANDARD FOR AERONAUTICAL TELECOMMUNICATION NETWORK BASELINE 1 (ATN B1 INTEROP STANDARD), EUROCAE ED-110B/RTCA DO-280B, December 2007

[69] SAFETY AND PERFORMANCE REQUIREMENTS STANDARD FOR AIR TRAFFIC DATA LINK SERVICES IN CONTINENTAL AIRSPACE (CONTINENTAL SPR STANDARD), EUROCAE ED-120 with Changes 1 and 2, October 2007

[70] MANUAL OF TECHNICAL PROVISIONS FOR THE AERONAUTICAL TELECOMMUNICATION NETWORK (ATN), Doc ICAO 9705AN/956, SECOND EDITION – 1999, plus PDR's identified in EUROCONTROL-SPEC-0116

[71] Certification Authorities Software Team (CAST) Position Paper CAST-8, Use of the C++ Programming Language, January, 2002

[72] Guidelines for Design Approval of Aircraft Data Link Communications Systems Supporting Air Traffic Services (ATS), AC 20-140A

[73] RTCA DO-305A Future Air Navigation System 1/A – Aeronautical Telecommunication Network Interoperability Standard (Fans 1/A – ATN B1 Interop Standard), March 21, 2012

[74] ICAO Doc 4444, Procedures for Air Navigation Services, Air Traffic Management, 15th Edition, November 22, 2007

[75] ICAO Doc 10037 Global Operational Data Link Document (GOLD) Manual, 1st Edition, 2017

[76] Advisory Circular (AC) 20-115D, Airborne Software Development Assurance Using EUROCAE ED-12( ) and RTCA DO-178( ), 2017, July 12

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3 Systems Overview

The objective of this section is to provide a system overview of the DLCA-6500, which meets the System Overview objective of the Plan for Software Aspects of Certification found in DO-178B [61], section 11.1.a. Descriptions are provided in terms of the architecture and the allocation of hardware and software, as it relates to DLCA-6500.

3.1 System Functional Description

Figure 3-1 CCM High Level Architecture (See figures below) provides a high level context diagram for the DLCA-6500, which illustrates the major interfaces and data flows to/from the DLCA-6500. The functional components of the DLCA-6500 and the other components are discussed in the subsequent sections.

The DLCA-6500 provides the Link 2000+ implementation of Aeronautical Telecommunication Network (ATN) applications and FANS 1/A+ applications. These applications define the Data Link methods and messages that are exchanged between the aircraft and the ground services in support of Air Traffic Services (ATS) and Air Traffic Control (ATC). The application supports seamless transfer of bilingual aircraft transiting from FANS to ATN and ATN to FANS per DO-305A [73], Section 4 interoperability requirements.

The applications that make up FANS-1/A+ are:

1. ATS Facilities Notification (AFN),
2. Automatic Dependent Surveillance - Contract (ADS-C), and
3. Controller Pilot Data Link Communication (CPDLC)

The AFN, ADS-C, and CPDLC applications are defined by RTCA DO-258 Rev A [62], which is the interoperability requirement standard for FANS-1/A+ systems. The FANS-1/A+ applications uses an ARINC 622 [66] data communications interface. ARINC 622 provides a definition to convert bit-oriented messages to character-oriented messages that can be transmitted over the ACARS character oriented network. The reverse procedure is performed for receiving messages. This is also known as the ACARS Convergence Function (ACF).

The Link 2000+ ATN applications are:

1. Context Management (CM), and
2. Controller Pilot Data Link Communication (CPDLC)

The Link-2000 ATN applications are defined by RTCA DO-280B/EUROCAE ED-110B [68], and ICAO 9705[70] plus the PDRs as defined by EUROCONTROL-SPEC-0116[67].

Notable ATN differences from FANS 1/A+ includes:

- Full bit-oriented protocol stack
- Only able to transmit messages over VHF Data Link Mode 2 (VDLM2)
- Currently ATN is used only over European domestic airspace, while FANS is used in globally in remote and Oceanic environments.
- Only a subset of the ATN CPDLC messages as defined in the EUROCONTROL-SPEC-0116 [67] is supported. FANS supports the full CPDLC message set as defined in RTCA DO-258 Rev A [62].

A portion of the ATN CPDLC and FANS 1/A+ functionality provides the opportunity to harmonize the related functionality. The DLCA-6500, and the associated subsystems, will provide a harmonized interface to both applications. The CPDLC message display text was harmonized using guidance from ICAO Doc 4444 [74] and ICAO Doc 10037 GOLD Manual [75].

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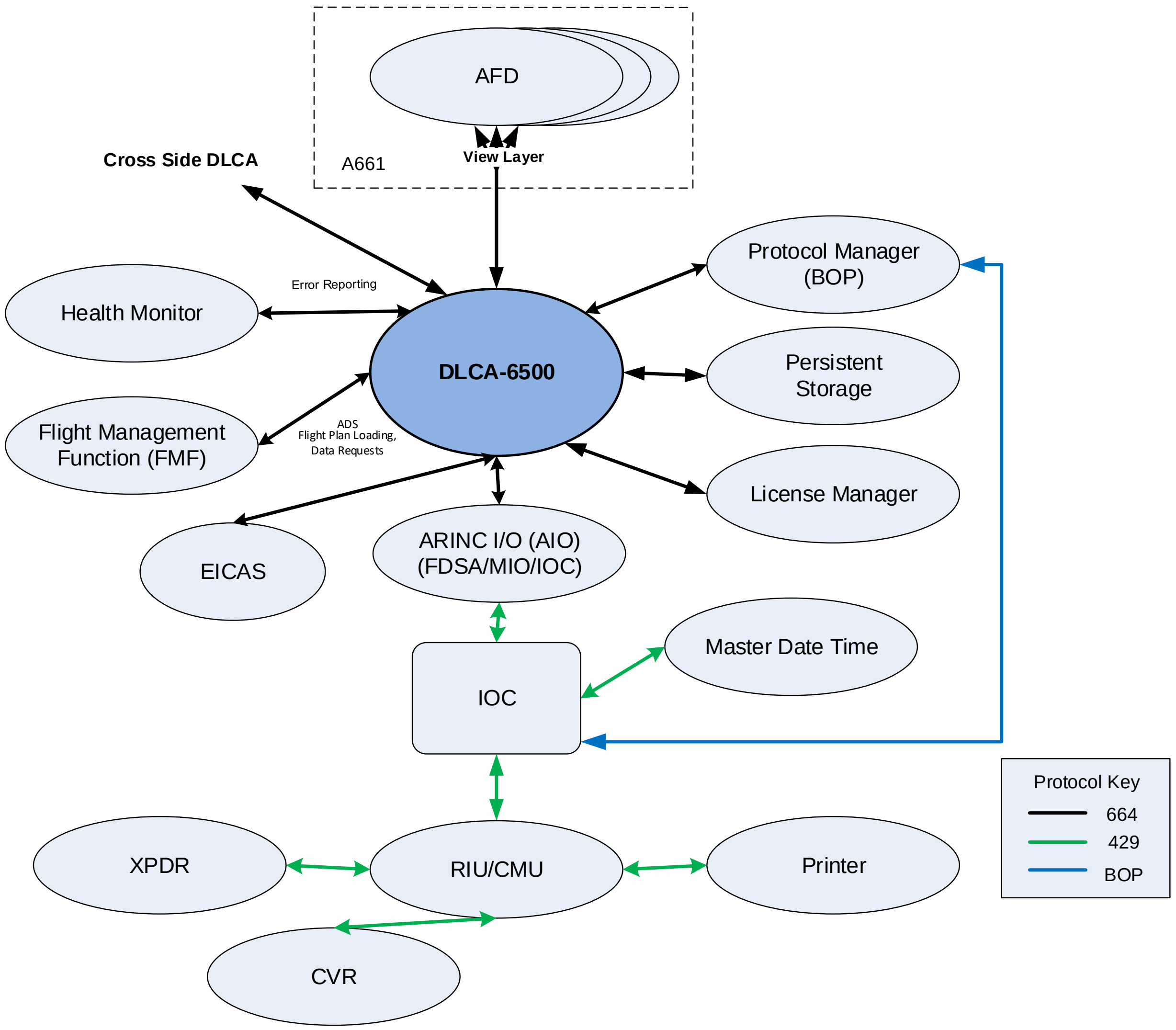
3.1.1 CCM System Functional Description

Figure 3-1 CCM High Level Architecture



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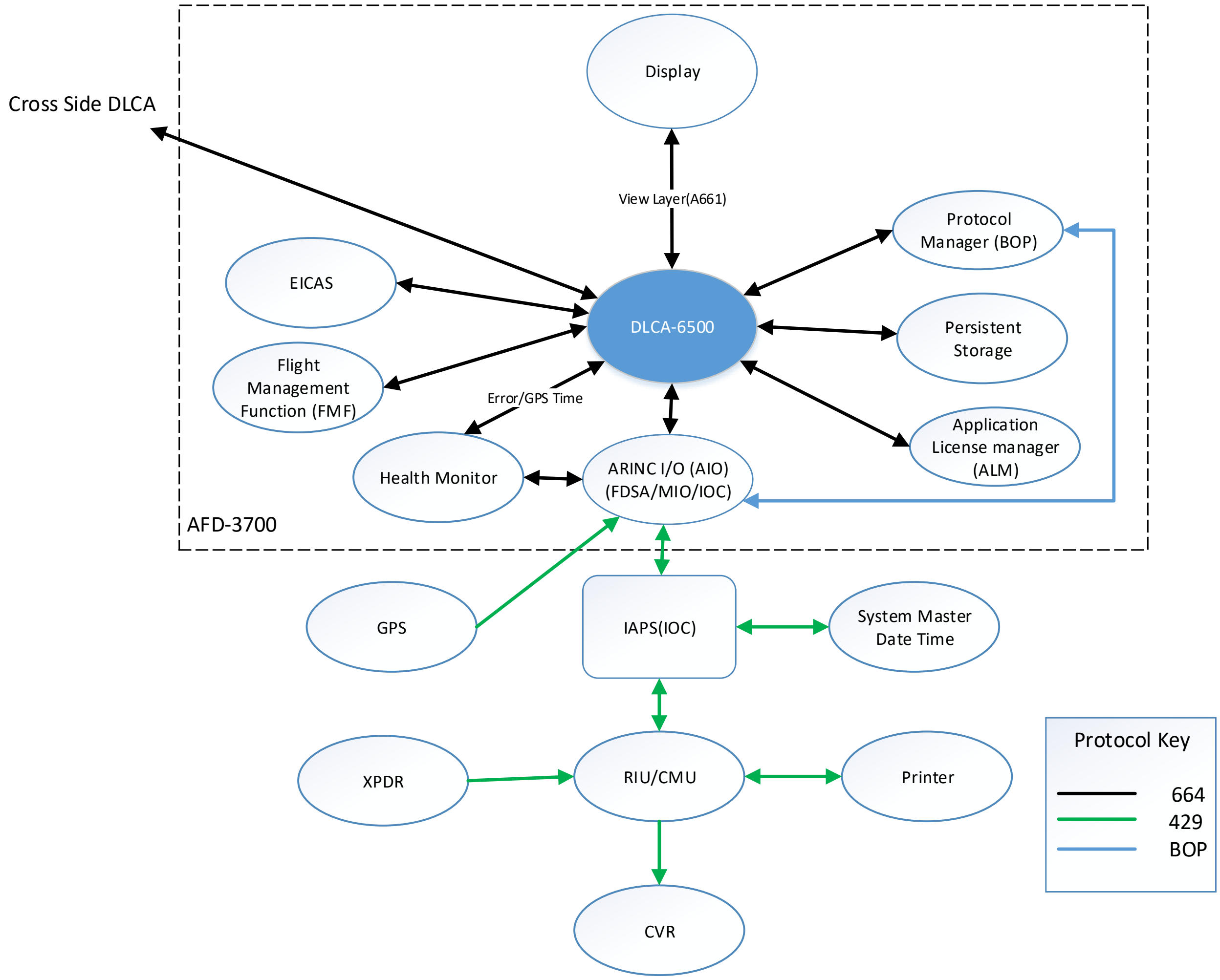
3.1.2 AFD-37X0 System Functional Description

Figure 3-2 - AFD-3X70 High Level Architecture



3.2 System Safety Considerations

The goal of this project is to develop and verify the DLCA-6500 application executes with the Platform Software (See Table 9-1 -Hardware Dependent Components for appropriate citation). The development and verification process must ensure that this application provides sufficient integrity, reliability, and/or redundancy to assure that all requirements associated with avoidance of operational hazards are complied with when integrated with existing and new avionics on the target airplane.

The system safety and partitioning concepts, such as resource management, fault tolerance, and scheduling algorithms, are provided by the underlying platform software in the Integrated Modular Architecture (IMA) environment (see sections 4.4.1.4.3 and 4.4.3 below)

3.3 System Architecture

This subsection describes, from a systems perspective, what is known about the hardware architecture at the time of the preparation of this PSAC with emphasis on system safety.

The system is based on a modular and integrated architecture that combines multiple concentrated processing centers with localized point-to-point communications and a high-speed communications network between processing centers to minimize the installation requirements on the aircraft.

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The DLCA-6500 software can execute on multiple hardware platforms. This PSAC describes the two supported types of hardware:

1) The Common Computing Module (CCM)
2) The AFD-37X0

3.3.1 CCM System Architecture

The DLCA-6500 software executes on a Common Computing Module (CCM) that provides the basic computing resource, operating environment, and communication network. The CCM utilizes the LynxOS-178 operating system that allows “hard” real time partitioning to ensure that no application can “starve” any other application of resources (i.e. time or memory resources).

Details of the Hardware Architecture can be found in the CoRE Platform Software Accomplishment Summary (SAS) [27].

3.3.2 AFD-37X0 System Architecture

The DLCA-6500 software executes on a FUSION Adaptive Flight Display (AFD-37x0) that provides the basic computing resource, operating environment, and communication network. The AFD-37x0 utilizes the LynxOS-178 operating system that allows “hard” real time partitioning to ensure that no application can “starve” any other application of resources (i.e. time or memory resources).

The DLCA-6500 application software interfaces with ARINC 661 Graphics Server (AGS) via binary definition files (BDFs) submitted under the User Interface Data Items SAS. These BDFs establish the graphical components used by the DLCA-6500 and their interfaces, allowing the software to modify the graphics at run-time. The BDFs and other configuration files submitted under the User Interface Data Items SAS [47] are loaded into the AGS at initialization and provide the AGS with the input required for generation of graphics services on the display.

Details of the Hardware Architecture can be found in the AFD-37x0 Platform Software Accomplishment Summary (SAS) [46].

3.3.3 System Allocations for the DLCA-6500

The DLCA-6500 code will be developed using the C++ programming language for a PowerPC target processor running on LynxOS-178 operating system [28].

The minimum timing and memory requirements allocated to DLCA-6500 are identified in Table 3-1. The actual system allocation might be different per program setting. These values are the minimum values needed for DLCA to operate. These requirements will be validated throughout the development cycle and listed in the Footprint measurements taken at the completion of the project.

DLCA does not have direct access to persistent memory (FLASH or NVM) since it operates on an Integrated Modular Architecture (IMA). The system allocates NAND (FLASH) file system resources to store the executable, configuration (XML) files and the VAPS (BDF/TDF) files. The platform provides an abstraction layer to NVM and the system allocates resources for DLCA.

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Table 3-1 Minimum Memory and Timing Requirements

Type	DLCA-6500 CCM Minimum Allocation	DLCA-6500 AFD-37X0 Minimum Allocation
System RAM	20MB	20MB
Minor / Major Frame Time	5 ms / 50 ms	8 ms / 50ms
% Allocated of the Processor	10%	16%

3.3.4 Hardware Architecture

Details of the Hardware Architecture can be found in the Platform Software Accomplishment Summary (SAS) (Appendix E Hardware Dependent Components).

3.3.5 Software Architecture

The DLCA-6500 software architecture is explained in section 4.4 Software Architecture. This section provides a graphical high level overview of the system along with a detailed description of each component.

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4 Software Overview

The following subsections provide a brief overview of the software components included in this equipment. The descriptions include the identification of the software component, with emphasis on how safety considerations have been addressed, and a brief description of the approach taken for each consideration. Where the use of previously approved software impacts safety considerations, a description of the scope of reuse is provided, including references to the source of the previously developed software. The descriptions also address the use of new technologies, significant architectural features, and safety techniques such as fail safes, fault tolerance, redundancy, and partitioning.

The DLCA-6500 Application (see figures below) is built using the HMI, Core Library, Message Library and Support files. In addition, the DLCA-6500 Application relies on a set of external libraries that are described in section 4.4.3 External Libraries. The external libraries are covered by their own SAS which is identified in section 4.4.3 for each external library.

XML files used to provide startup and configuration information for the DLCA-6500 Application, the XML files are described in section 4.4.1.4XML Files and are covered by this SAS.

The Top Level (T/L) 810-0315-(XXX) and Software Configuration Index (SCI) for the Data Link Communications Application (DLCA-6500) [55] will serve as a software configuration index for DLCA-6500.

The following terms are used in the subsection below and are defined here:

Computer Software Component (CSC) – Collection of more than 1 source file.

Computer Software Unit (CSU) – A single source file.

Executable – A CPCI that is compiled, linked, and executes on the target CPU.

Library – CPCI to be used later during the creation of the DLCA-6500 Application.

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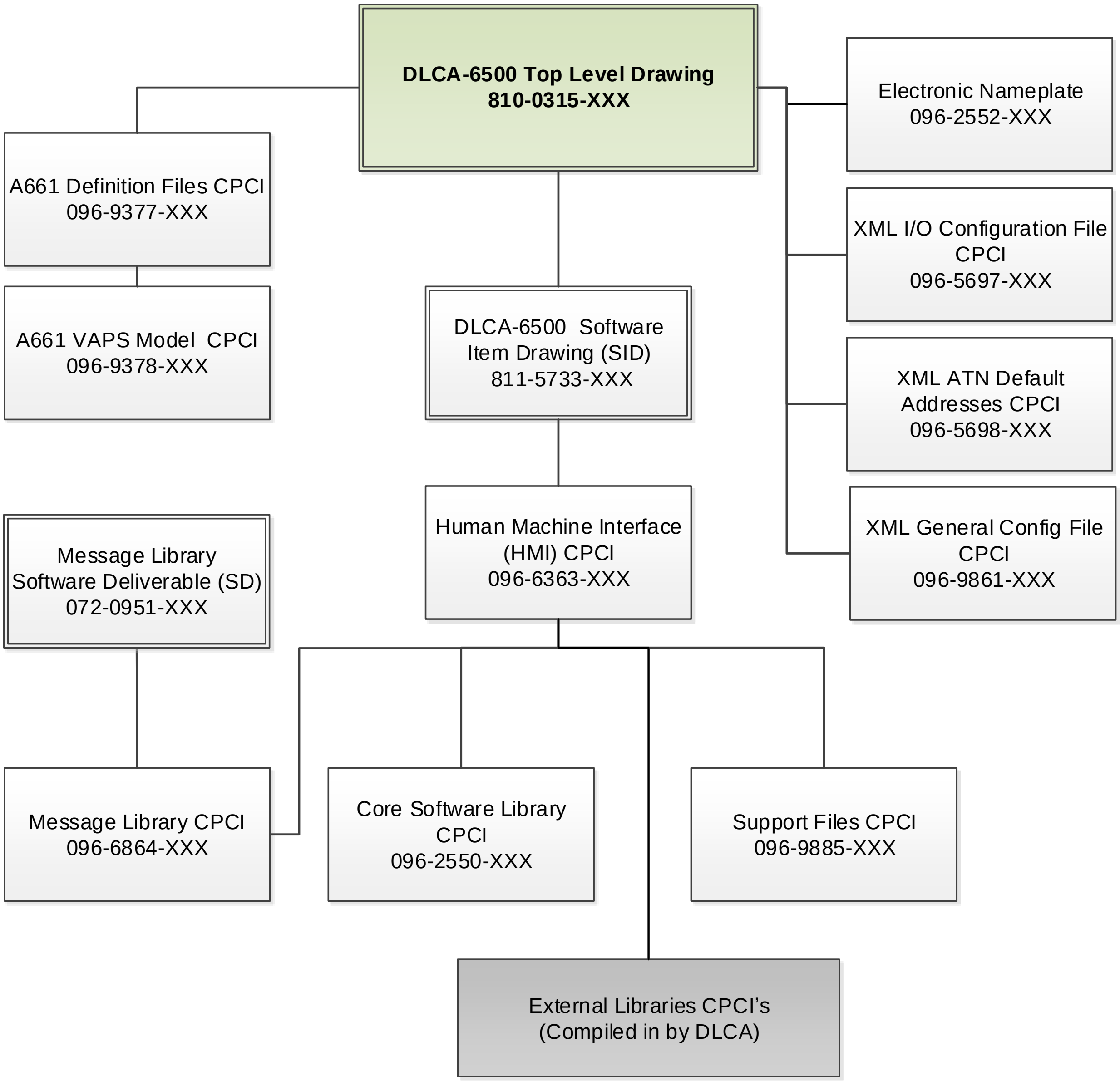
4.1 CCM Hardware

Figure 4-1 CCM Hardware - DLCA-6500 Software Configuration Part Numbers



DLCA-6500 Top Level Drawing
810-0315-XXX
A661 Definition Files CPCI
096-9377-XXX
A661 VAPS Model CPCI
096-9378-XXX
DLCA-6500 Software Item Drawing (SID)
811-5733-XXX
Electronic Nameplate
096-2552-XXX
XML I/O Configuration File CPCI
096-5697-XXX
XML ATN Default Addresses CPCI
096-5698-XXX
XML General Config File CPCI
096-9861-XXX
Human Machine Interface (HMI) CPCI
096-6363-XXX
Message Library Software Deliverable (SD)
072-0951-XXX
Message Library CPCI
096-6864-XXX
Core Software Library CPCI
096-2550-XXX
Support Files CPCI
096-9885-XXX
External Libraries CPCI’s
(Compiled in by DLCA)

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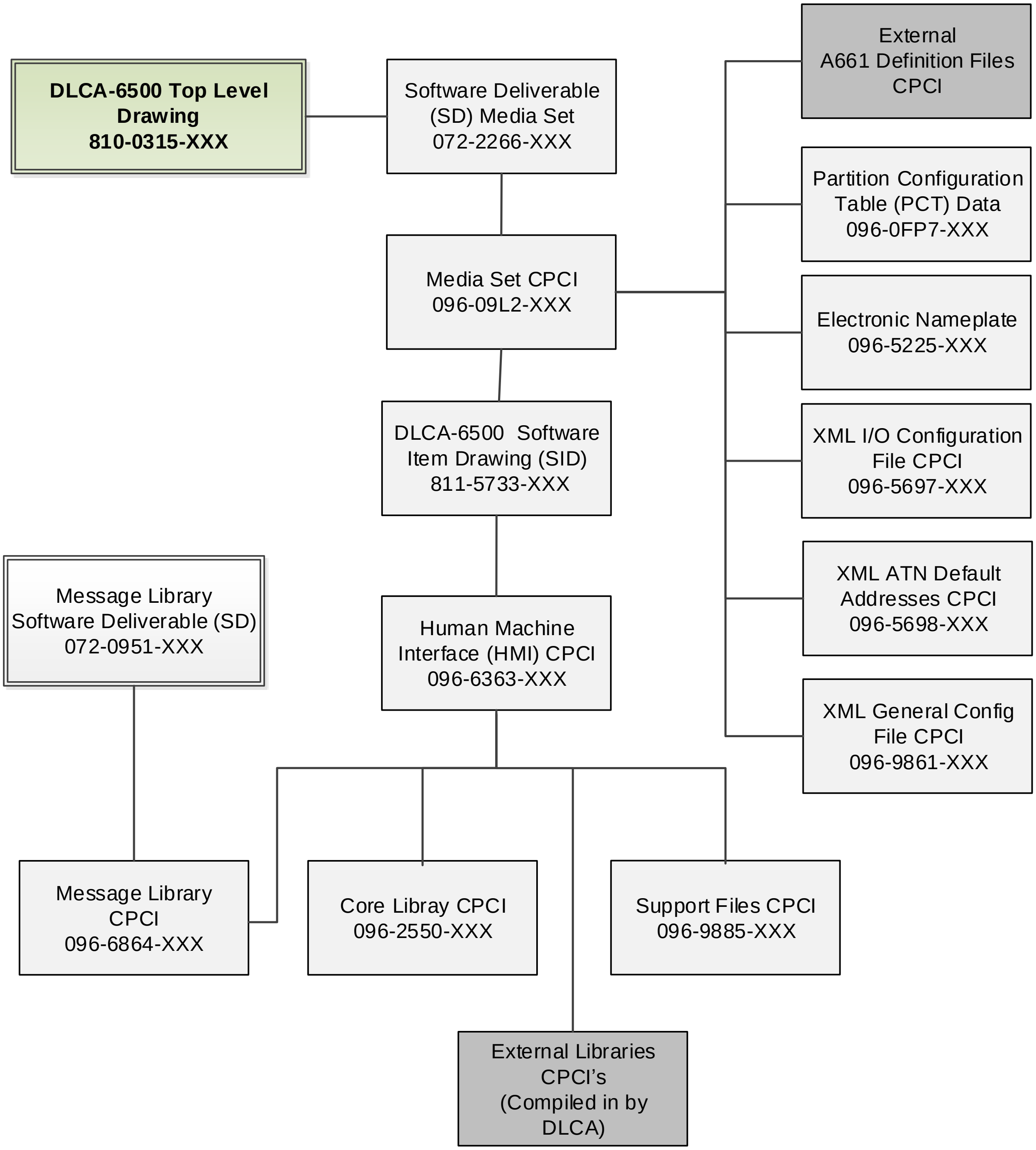
4.2 AFD-37X0 Hardware

Figure 4-2 AFD-37X0 Hardware - DLCA-6500 Software Configuration Part Numbers


DLCA-6500 Top Level Drawing 810-0315-XXX
Software Deliverable (SD) Media Set 072-2266-XXX
Media Set CPCI 096-09L2-XXX
DLCA-6500 Software Item Drawing (SID) 811-5733-XXX
Human Machine Interface (HMI) CPCI 096-6363-XXX
External A661 Definition Files CPCI
Partition Configuration Table (PCT) Data 096-0FP7-XXX
Electronic Nameplate 096-5225-XXX
XML I/O Configuration File CPCI 096-5697-XXX
XML ATN Default Addresses CPCI 096-5698-XXX
XML General Config File CPCI 096-9861-XXX
Message Library Software Deliverable (SD) 072-0951-XXX
Message Library CPCI 096-6864-XXX
Core Libray CPCI 096-2550-XXX
Support Files CPCI 096-9885-XXX
External Libraries CPCI’s (Compiled in by DLCA)

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4.3 Data Link Communications Application (DLCA-6500) Functions

The DLCA-6500 Application CPCI is responsible for providing the functions in Figure 4-3 below. The details of DLCA Software components HMI, Message Library and Core Library are included in section 3.3.5 Software Architecture.

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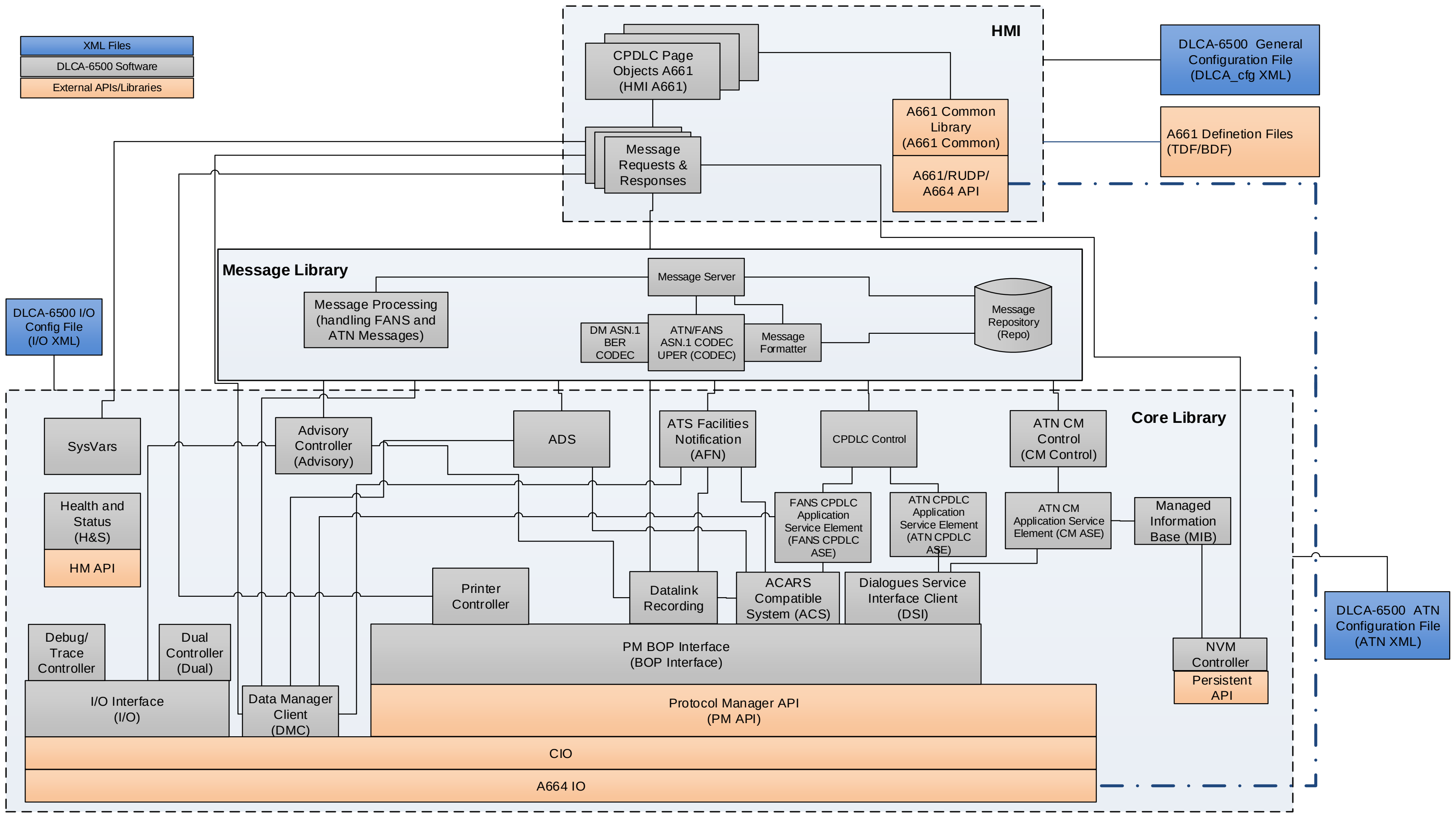
Figure 4-3 Detailed Software Architecture


XML Files
DLCA-6500 Software
External APIs/Libraries
HMI
CPDLC Page Objects A661 (HMI A661)
Message Requests & Responses
A661 Common Library (A661 Common)
A661/RUDP/ A664 API
DLCA-6500 General Configuration File (DLCA_cfg XML)
A661 Definetion Files (TDF/BDF)
Message Library
Message Server
Message Processing (handling FANS and ATN Messages)
DM ASN.1 BER CODEC
ATN/FANS ASN.1 CODEC UPER (CODEC)
Message Formatter
Message Repository (Repo)
DLCA-6500 I/O Config File (I/O XML)
Core Library
SysVars
Advisory Controller (Advisory)
ADS
ATS Facilities Notification (AFN)
CPDLC Control
ATN CM Control (CM Control)
Health and Status (H&S)
HM API
FANS CPDLC Application Service Element (FANS CPDLC ASE)
ATN CPDLC Application Service Element (ATN CPDLC ASE)
ATN CM Application Service Element (CM ASE)
Managed Information Base (MIB)
Printer Controller
Datalink Recording
ACARS Compatible System (ACS)
Dialogues Service Interface Client (DSI)
DLCA-6500 ATN Configuration File (ATN XML)
Debug/ Trace Controller
Dual Controller (Dual)
PM BOP Interface (BOP Interface)
NVM Controller
Persistent API
I/O Interface (I/O)
Data Manager Client (DMC)
Protocol Manager API (PM API)
CIO
A664 IO

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4.4 Software Architecture

4.4.1 Application Specific Layer

The DLCA-6500 application specific software layer is made up of software covered by this PSAC and also includes libraries not covered by this PSAC.

The application specific software layer provides the following set of specific functions to support the capabilities described in section 3.1 System Functional Description. The following subsections address the software in Figure 4-3 covered by this PSAC. Section 4.4.3 gives a description of the external libraries used by DLCA-6500 that are not covered by this PSAC.

4.4.1.1 HMI

The Human Machine Interface (HMI) is a collection CSC’s which provide support for page presentation and interface to the DLCA-6500. The following subsection describes in more detail the CSC’s that make up the HMI.

4.4.1.1.1 CPDLC Page Objects A661 (HMI A661)

The Controller Pilot Data Link Communication (CPDLC) Page Objects CSC is made up of CSU’s that define and manage the logical views (pages) for an ARINC 661 based HMI for crew interaction with DLCA-6500. These logical views are arranged to form a hierarchical menu structure of pages that allow the crew to:

- Initiate ATS Facilities Notification (AFN) or Context Management (CM) Logon contact with ground Air Traffic Services Units (ATSU).
- Categorically select and compose CPDLC downlink messages.
- View and respond to CPDLC uplink messages.
- Display message log of CPDLC uplink and downlink messages.
- Display Automatic Dependent Surveillance (ADS) connection and contract status.
- Display DLCA-6500 system health and status.
- Terminate CPDLC connection.

4.4.1.1.2 Message Requests and Responses

The Message Requests and Responses CSC is made up of CSU’s that provide the mechanism through which the HMI can generate downlink requests and obtain information about the operating environment. Message requests interact with the core message logic to generate downlink message. If several displays happen to be viewing and/or manipulating a particular type of request message, each of those displays will be communicating with one host for that message type. In this way, all the displays will be synchronized to the current contents of the message data as contained within that common host.

4.4.1.2 Core Library

4.4.1.2.1 Automatic Dependent Surveillance Contract (ADS)

The Automatic Dependent Surveillance (ADS) CSC is responsible for implementing the airborne ADS application as defined in DO-258A.[62] This CSC manages up to four connections with ground ATSU centers and provides air/ground contract management for the various types of ground-initiated ADS contracts (immediate, periodic, and event triggered). This CSC utilizes the Data Manager (DM) Client to establish local contracts with the on-board FMS to retrieve the required data elements at the required time to provide downlink responses for each air/ground contract. There is a 1:1 relationship between an air/ground contract and a local DM contract with the FMS. The ADS CSC has ultimate responsibility for providing air/ground contract responses within the required timeframe, and will do so using default data as described in DO-258A if the FMS and/or DM system becomes unresponsive/unavailable.

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4.4.1.2.2 Data Manager Client (DMC)

The Data Manager Client CSC is responsible for establishing a link with one or more Flight Management System (FMS) Data Manager Servers to exchange data element transfers required by the CPDLC and ADS applications to support a fully integrated Data Link solution with the FMS. Data element exchanges are managed using contracts between the DM client and DM server. Contracts are used to manage the following message types:

- Input Message – Data to be loaded into the FMS
- Request Message – Data requested from the FMS
- Output Message – Response message to a request
- Status Message – Facilitates connection and contract state management

Only the DM client initiates a contract, and both the DM client and DM server maintain contract handlers (state machines) until the contract is fulfilled. The DM client will monitor connection status with the active FMS DM server and will re-establish the connections as necessary.

4.4.1.2.3 Dialogue Service Interface Client (DSI)

The Dialogue Service Interface (DSI) Client CSC is used to establish a communication channel via Bit Oriented Protocol (BOP) from DLCA-6500 to the DSI Provider to access the ATN stack. The DSI Provider and ATN stack are hosted on either the Radio Interface Unit (RIU) or the Communications Management Unit (CMU). The Protocol Manager API manages the communication channel between the DSI Provider (RIU/CMU) and the DSI Client (DLCA-6500).

4.4.1.2.4 Managed Information Base (MIB)

The Managed Information Base (MIB) CSC stores and retrieves application information including addresses, facility designator, application type and version, and aircraft address. The MIB provides an interface that is used by other components which need access to this information.

4.4.1.2.5 ATN CPDLC Application Service Element (CPDLC ASE)

The Aeronautical Telecommunications Network CPDLC ASE manages states that correspond to establishing an ATN CPDLC connection, accepting CPDLC messages, and closing the CPDLC dialogue.

The states relating to CPDLC connection can only be reached when the ground server sends an uplink requesting a connection to be established. Once the connection is established, the ATN CPDLC ASE will accept CPDLC messages. DLCA-6500 will not be able to send or receive CPDLC messages until this state is reached. The ASE will accept CPDLC messages from the ground server that established the connection until the dialogue is closed. When the CPDLC dialogue is closed, through an end indication or an abort, the DLCA-6500 will no longer accept messages from this ground server until a connection is established with it.

When indications (e.g. end, start, dialogue) are received from the DSI, the ATN CPDLC ASE is responsible for moving these messages along to the CPDLC Control to allow confirmation of these indications. CPDLC Control will send responses and messages to the ASE, and in turn the ASE will move the state as needed as well as send the messages and responses to the DSI client so that these can be sent down to the ground server.

4.4.1.2.6 FANS CPDLC Application Service Element (CPDLC ASE)

The Future Air Navigation System CPDLC ASE manages states that correspond to establishing an FANS CPDLC connection, accepting CPDLC messages, and closing the CPDLC dialogue.

The states relating to CPDLC connection can only be reached when the ground server sends an uplink requesting a connection to be established. Once the connection is established, the FANS CPDLC ASE will accept CPDLC messages. DLCA-6500 will not be able to send or receive CPDLC messages until this state is reached. The FANS CPDLC ASE will accept CPDLC messages from the ground server that established the connection until the dialogue is closed. When the CPDLC dialogue is closed, through an end indication or an abort, the DLCA-6500 will no longer accept messages from this ground server until a connection is established with it.

When indications (e.g. end, start, dialogue) are received from the ACS, the FANS CPDLC ASE is responsible for moving these messages along to the CPDLC Control to allow confirmation of these indications. CPDLC Control will send responses and messages to the FANS CPDLC ASE, and in turn the FANS CPDLC ASE will move the state as needed as well as send the messages and responses to the ACS so that these can be sent down to the ground server.

4.4.1.2.7 ATN CM Control (CM Control)

The ATN CM Control is responsible for processing all CM messages that are received from the ATN CM ASE. The ATN CM Control provides automatic responses including processing incoming connections and providing information via the ASE which ultimately will be received by the ground peer, such as the ATC capability of the aircraft. Control includes the capability to manage building and sending Logon Requests, or Aborts. Control also maintains the current ATN logon status.

4.4.1.2.8 ATN CM Application Service Element (CM ASE)

The Aeronautical Telecommunications Network Context Management ASE accepts three types of uplink messages: Contact, Update and Logon responses. Contact and Update messages can be received by DLCA-6500 when DLCA-6500 is not currently logged on. The messages are used to update the Message Identification Number (MIN) by adding to or updating what is currently present. Logon response messages are received in reply to logon requests sent from DLCA-6500.

DLCA-6500 is responsible for sending logon requests to the ground server in order to begin communication. An ATN CPDLC connection cannot be established until DLCA-6500 is Logged On (i.e. a manually initiated CM Logon has successfully completed). DLCA-6500 will open a CM dialogue when it sends the logon request down and will close the dialogue, unless the ground server requests otherwise, once there is a response. If the dialogue remained open, DLCA-6500 will not close the dialogue until a termination is received from either DLCA-6500 or the ground server.

4.4.1.2.9 CPDLC Control

The CPDLC Control processes messages received from FANS CPDLC ASE or ATN CPDLC ASE, and when messages are requested to be sent by the HMI. CPDLC Control detects if errors are present within uplink messages received from the ground peer including verifying the included integrity check value. This ensures the message was received from the correct ground peer, was intended for this aircraft, and was not corrupted. CPDLC Control is responsible for generating automated downlink responses such as start or end is accepted or rejected, and CPDLC system messages such as logical acknowledgement, error, current data authority, not current data authority, etc.

CPDLC Control contains and uses message dialogue objects in order for messages that require a response, from either the DLCA-6500 or the ground peer to be monitored. If a CPDLC message does not require a response, the message dialogue will close once it is processed. Messages that do require a response will not close the message dialogue until a CPDLC message response is sent or received for the initial message, or the time allowed for a response to be sent or received expires.

In the interface between the CPDLC HMI and CPDLC Control, the CPDLC Control keeps track of information that deals with the ATC center. The CPDLC Control facilitates the communication between the ground peer and the aircraft; giving information to the HMI to display or transferring messages via the ASE to the ground peer. It provides information the CPDLC HMI requests in respect to connection maintenance such as the current data authority (CDA) and next data authority (NDA).

4.4.1.2.10 Advisory Controller (Advisory)

The Advisory Controller is responsible for setting/clearing bits in the output word(s) that are broadcast to the Engine Indicating Crew Alert System (EICAS) for aural and visual alerting. The controller is also responsible for building and maintaining a list of inactive and active advisories. It then will use this list to inform when and what advisory should be displayed or cleared.

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4.4.1.2.11 ACARS Compatible System (ACS)

The ACARS Compatible System (ACS) implements the ARINC 622 [66] ACARS Convergence Function (ACF), which takes binary encoded downlink messages and converts them into character-oriented format for transport over the ACARS character-oriented network. Likewise, for uplink messages, it converts from character-oriented format to native binary encoded format.

4.4.1.2.12 ATS Facilities Notification (AFN)

The AFN CSU is responsible for establishing the initial logon connection with the ground. It is also responsible for handling autonomous ATS facility transfers from one center to the next (CDA to NDA).

4.4.1.2.13 Health and Status (H&S)

Health and Status provides reporting of application faults to the system Health Monitor. This may include detecting a failure of the peer DLCA-6500 application (in a dual installation) or detecting a loss of I/O with an external peripheral or application.

4.4.1.2.14 Dual Controller (Dual)

The Dual Controller is responsible for determining the active/standby mode for each peer DLCA-6500 in a dual installation. This determination is made on initial startup to ensure that one peer is active and the other is standby, based on a defined set of rules. Additionally, the Dual Controller monitors for switching conditions during runtime, such that the standby DLCA-6500 will become active (and vice versa) when conditions warrant a mode change.

4.4.1.2.15 PM BOP Interface (BOP Interface)

The PM BOP Interface provides a method to send and receive BOP messages via PM. The BOP interface also manages the flow control of uplink/downlink messages, CVR data, and printer messages and provides methods to maintain the link and disconnect when necessary.

4.4.1.2.16 I/O Interface

The I/O Interface uses the CIO library, or set of APIs, to communicate with other subsystems using AFDX. As depicted in Figure 4-3, this interface is used by DLCA-6500 Health and Status and Dual Controller software modules. The interface abstracts the communication functionality. DLCA-6500 Data transfers include Cross talk data and status, trace data, chime alerts, and status words.

4.4.1.2.17 SysVars

SysVars is the manager and central repository for DLCA-6500 application system data.

4.4.1.2.18 Debug/Trace Controller

Debug/Trace Controller manages whether print statements are enable/disabled.

4.4.1.2.19 Printer Controller

Printer Controller manages the format and delivery of a message to the printer, the messages are those in a closed state. Printer Controller also manages whether the print prompt is displayed or not.

4.4.1.2.20 NVM Controller

The NVM Controller manages the DLCA-6500 application data that needs to be stored persistently. The NVM controller uses the API provided by the external Persistent Storage API library.

4.4.1.2.21 Datalink Recording

Provides a single point for formatting and delivering messages for Datalink Recording. Provides methods for sending ASCII copies of uplink/downlink messages to the CVR. Provides methods for sending messages detailing the status of the DLCA, state of CPDLC, and state of advisories to the CVR.

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4.4.1.3 Message Library

4.4.1.3.1 Message Server

The Message Server provides the interface to encode, decode, and build a formatted textual message for display on the AFD.

4.4.1.3.2 Message Processing

The Message Processing invokes the encoder/decoder and message formatter. It also checks if the message can be encoded/decoded using the codec(s).

4.4.1.3.3 DM ASN.1 Codec

The Data Manager (DM) Abstract Syntax Notation One (ASN.1) Codec is used to encode and decode all messages that are transferred between the Flight Management System's Data Link Data Manager (DLDM) software and DLCA. The codec provides a uniform means to exchange data in a uniform manner that can be interpreted by different systems.

4.4.1.3.4 ATN/FANS ASN.1 Codec UPER (Codec)

The FANS/ATN Abstract Syntax Notation One (ASN.1) Codec Packed Encoding Rules, unaligned variant (UPER) is used to decode and encode all FANS and ATN CPDLC uplink/downlink messages, FANS ADS messages, and CM/AFN messages. This codec complies with the ASN.1 syntax defined in DO-258A and ED-110B. The codec provides a uniform means to exchange data in a uniform manner that can be interpreted by different systems.

4.4.1.3.5 Message Formatter

The message formatter is used to build a textual string to print or display using the raw data received from an uplink or downlink.

4.4.1.3.6 Message Repository

The Message Repository is the storage location for all uplink and downlink messages. This contains the message header information as well as the message attributes. It allows you to delete and add new messages.

4.4.1.4 XML Files

The DLCA-6500 relies on XML files for customization of program specific options and for I/O configuration information. The XML files the DLCA-6500 application uses are covered by this PSAC. Each XML file is a unique CPCI. Each XML file is used during verification testing of the DLCA-6500. This verification testing validates the XML file is properly configured for the program.

4.4.1.4.1 XML I/O Configuration File

The XML I/O Configuration File [19] is an XML text file that describes the external interfaces and data flows for the DLCA-6500 application. It contains the Well Known Names (WKN), Well Known Services (WKS) and the NDO IDs as defined in DLCA-6500's IOCF document [14] for this platform.

This component is configuration controlled as its own entity in order to facilitate common reusable software on different platforms; however it is not intended to be individually loadable in the field. The content of this file will be verified together with the DLCA-6500 application and then released/fielded as a bundled load.

4.4.1.4.2 XML ATN Configuration File

The XML ATN Configuration File [20] contains the default list of ATN facilities and their respective CM addresses that are going to be pre-loaded in the DLCA-6500 application software. The ATN addresses contained in this file represents the stations the pilot can logon to in ATN service type. In addition to the ATN Addresses, other ATN configuration data will be stored in this file. This data includes information such as ATN Timers.

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4.4.1.4.3 XML DLCA General Configuration File

The XML DLCA General Configuration File[21] is an XML file that contains parameters used to configure DLCA-6500 human machine interface and to determine if this is a CCM or AFD-37X0 environment. This file is to provide a method to modify configurable items within the HMI without requiring a change to the source code.

The XML General Configuration File [21] is an XML text file that provides the ARINC 661 Graphical Server (AGS) connection required for the DLCA-6500 application. It contains the Well Known Names (WKN), Well Known Services (WKS) that are used to communicate with AGS as defined in DLCA-6500's IOCF document [14] for the platform that the DLCA is hosted. It also includes configuration settings required for the Configurable Inbox.

This component is configuration controlled as its own entity in order to facilitate common reusable software on different plaforms; however it is not intended to be individually loadable in the field. The content of this file will be verified together with the DLCA-6500 application and then released/fielded as a bundled load.

4.4.1.5 A661 Definition Files

The definition file will be used to inform the AGS of the widget data necessary to allocate the memory resources for graphics, as well as to establish a means for the DLCA-6500 to describe and update the user interface details. The definition file will be a binary file auto generated based on the DLCA-6500 Virtual Avionics Prototyping System (VAPS) widget layout.

The Binary Definition File is read by the AFDA-6500 Display Application as part of the process to create the AFD Configuration Table (AFDT) files. Refer to the PSAC for the Flight Display System Application for further detail regarding BDF loading, and validation checks.

The A661 Definition file also contains a Text Data File (TDF). This file is a human readable file of the BDF.

For CCM platform, the VAPS A661 Definition file is created and developed by the DLCA team and covered under the DLCA SAS[23]. For AFD-37X0 platform, the VAPS A661 Definition file is external to DLCA and covered under the User Interface Items SAS [47].

4.4.2 Platform Specific Layer

The platform specific layer provides software components that allow the DLCA-6500 application to be hosted on the CCM-5110 platform or the AFD-37X0 platform. Some of these software components are listed below for the CCM-5110 platform:

- Boot.
- Kernel Download Image (KDI)
    - LynxOS-178
    - Hardware Support
    - System Applications
    - Static Device Drivers
- User File System (USEFS)
- Platform Software Libraries.
    - LynxOS-178 Standard Libraries and Includes
    - Persistent Storage
    - Common I/O (CIO)
    - Reliable User Datagram Protocol (RUDP) Communication

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  - Reliable User Datagram Protocol (RUDP) Connection
- Device drivers – NAND, CRC, and IOC Mezzanine.

The collection of these device drivers and libraries are utilized by DLCA-6500, but are not part of the DLCA-6500 high-level design and are not covered by this PSAC.

4.4.3 External Libraries

In order to communicate with other applications within the IMA system, the DLCA-6500 application will statically link in external libraries that contain client APIs. These APIs establish a common path for multiple applications to communicate with the services provided by the serving application.

All client APIs/libraries linked into the DLCA-6500 software application are required to be separately maintained and verified by the applications providing the service. The development of these client APIs and their related documentation and verification is completely independent of the DLCA-6500, and is outside the scope of this PSAC. All of the client APIs that are linked into the DLCA-6500 application code will go through independent verification to DO-178B level C standards or higher.

4.4.3.1 Platform Libraries

4.4.3.1.1 LynxOS-178 Standard Libraries and Includes

The LynxOS-178 Standard Libraries & Includes API provides a set of functions used for accessing the operating system. This allows the DLCA-6500 to communicate with the hardware without having to understand the lower level hardware/software protocols. This library is covered by the Platform SAS (See Table 9-1 -Hardware Dependent Components for appropriate citation).

4.4.3.1.2 Persistent Storage Library

The Persistent Storage API will provide the DLCA-6500 an interface to store its operational data persistently in Non Volatile Memory (NVM). The data includes CM ground facilities and their ATN address, and ATN settings such as timers, and strapping data.

This library is covered by the Platform SAS (See Table 9-1 -Hardware Dependent Components for appropriate citation). See the Persistent Storage Design Description [34], section 5.1.1 for API definitions.

4.4.3.1.3 Common I/O (CIO) Library

The Common I/O library provides an API for an application to transfer information over the Avionics System LAN (ASL) to other applications.

This library is covered by the Platform SAS (See Table 9-1 -Hardware Dependent Components for appropriate citation). See the CIO Design Description [35], section 3.3.5 for API definitions.

4.4.3.1.4 Reliable User Datagram Protocol (RUDP)

4.4.3.1.4.1 RUDP Communication Library

The RUDP Communication library provides the API to send and receive data over the ASL.

This library is covered by the SAS the Reliable User Datagram Protocol (RUDP) Libraries [60]. See the RUDP Communication Library Design Description [36], section 3.3.1 for API definitions.

4.4.3.1.4.2 RUDP Connection Library

The RUDP Connection library is used on the remote application’s side. The RUDP Connection library uses a connection based API to interface with the remote application software.

This library is covered by the SAS the Reliable User Datagram Protocol (RUDP) Libraries [60]. See the RUDP Connection Library Design Description [37], section 3.3.1 for API definitions.

4.4.3.1.5 Error Logging and Watchdog Library

The Error Logging and Watchdog library provides the APIs for the Health Monitor error logging, error status, and software watchdog functionality.

This library is covered by the Platform SAS (See Table 9-1 -Hardware Dependent Components for appropriate citation). See the Health Monitor SW Design Description [38], section 4.1 for API definitions.

4.4.3.1.6 Protocol Manager Client library

The Protocol Manager Client library is used to interact with the Protocol Manager server which provides Bit-Oriented protocol interfaces. The Protocol Manager Client (PM) API software provides the applications access to standard ARINC protocol functions, such as ARINC 429 Williamsburg file transfer services. The DLCA-6500 Application uses the API provided by the library to access the ARINC 429 Williamsburg file transfer services to exchange messages with RIU/CMU.

This library is covered by the Protocol Manager SAS [29]. See the SDD for PMA-6000 [39], section 4.1 for API definitions.

4.4.3.1.7 Avionics Full Duplex Avionics System LAN (AFDX-ASL)

The software modules covered by the AFDX-ASL support the Avionics System LAN (ASL) network.

4.4.3.1.7.1 AFDX_ASL WinSock2 API

Provides a WinSock2 based sockets API to provide applications an interface to the AFDX-ASL device driver.

The WinSock2 API is covered by the Avionics System LAN (ASL) SAS [30]. See AFDX – LAN Design [40], section 4.2 for API definitions.

4.4.3.1.7.2 AFDX-ASL ARINC 653 User API

Provides an ARINC 653 Inter-Partition API to provide applications an interface to the AFDX-ASL device driver.

The ARINC 653 User API is covered by the Avionics System LAN (ASL) SAS [30]. See AFDX – LAN Design [40], section 4.2 for API definitions.

4.4.3.1.8 A661 API and A661 Common Library

The ARINC 661 API is responsible for connecting and managing ARINC 661 communications to and from multiple AGS's. The ARINC 661 common library functions include:

- Sending keep alive / heart beat messages to AGSs.
- Synchronizing DLCA-6500 widget states and data with the CDS's.
- Handling layer, widget, and exception events from AGS's and Window Manger.
- Re-establishing and re-synchronizing broken connections from AGS's.

The ARINC 661 common library provides the API interface for the application to communicate with ARINC 661 Graphics server using ARINC 661 protocol. This library is used to exchange messages between DLCA application and the AGS for the DLCA-6500 A661 HMI pages. Using A661 library application updates the information that is display and presented to the user by AGS.

The ARINC 661 API is covered by the ARINC 661 PSAC [31] and the ARINC 661 SAS[42]. See ARINC 661 SDD [41], for API definitions.

4.5 Overview of Applied New Technology

There is no applied new technology used to develop the DLCA-6500 application.

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4.6 Software Fault Management Techniques

The DLCA-6500 software application will handle and report internal software errors (i.e. loss of data, cycle slip, etc.) as well as errors in establishing or maintaining connections with other applications. The platform software provides an API for the DLCA-6500 software application to communicate it's health status with the platform Health Monitor function. Along with the error, the DLCA-6500 software also reports the severity of the error as determined by the application.

The following list of fault detection mechanisms will be performed by the DLCA-6500:

1. Monitor for errors such as being unable to connect to its interfaces, cycle slips, out of memory, and initialization failures. It will log all errors and outputs them to the Health Monitor application.

2. Validate all XMLs [19] [20] [21]. This includes file integrity, range checking, and data-type checks. File integrity is determined by parsing through an XML file to verify the XML file contains all the required data and that the format of the data is correct. In the event that an XML file fails parsing, the DLCA-6500 application will shut down.

3. Perform a CRC check on all uplink messages received from the RIU/CMU to ensure the data was not corrupted while passing through the DAL D portions of the RIU/CMU. If the CRC check does not pass it will discard the message. Each CRC attached to an uplink message is covered by industry specification in which both the producer of the message and consumer of the message must conform to.

4. Transmit/receive all CPDLC and ADS data to/from the Flight Management Function (FMF) via ASN.1 encoding. Any data from the FMF that does not pass the ASN.1 decoding process will be discarded.

5. Range check all data entry received from HMI devices prior to accepting it. The range check will be based on the field where the data is entered to confirm it meets the requirements for that given field.

Refer to the Platform Software SAS Software (See Table 9-1 -Hardware Dependent Components for appropriate citation) for the applicable System Layer Documentation for additional information. This allows DLCA-6500 to interact with application of various DAL levels. Refer to the Platform Software SAS for information on software partitioning, cache, pipelining, and MMU covered by the RTOS.

4.7 Software Partitioning

There is no partitioning within the DLCA-6500. DLCA-6500 is a single threaded application.

The time and space partitioning is provided by the LynxOS-178B operating system.

In the IMA environment, software partitioning is provided by the underlying platform software based on the LynxOS-178 operating system, which manages the control and communication between applications of various DAL levels.

This allows DLCA-6500 to interact with application of various DAL levels.

Refer to the Platform Software SAS (See Table 9-1 -Hardware Dependent Components for appropriate citation) for information on software partitioning, cache, pipelining, and MMU covered by the RTOS.

4.8 Software Timing and Scheduling Strategies

At a system level, the DLCA-6500 is scheduled to run in its time slice based on an algorithm implemented by CPR (Common Process Resource), DLCA-6500 is a single threaded application. The DLCA-6500 software application does not manage shared resources. Resource management algorithms are implemented by the CPR. Refer to Platform Software SAS (See Table 9-1 -Hardware Dependent Components for appropriate citation)or the applicable system layer documentation for additional information on scheduling and the means of communication between the software components, and the impact on timing to schedule all the software components.

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5 Certification Considerations

This section describes the certification basis, proposed means of compliance, and the software criticality level of each function implemented in the scope of this PSAC. It also provides the justification for the software criticality level assignment based on a safety assessment of the software and its use within the airborne system, including a description of the potential software failure conditions.

5.1 Certification Basis and Proposed Means of Compliance

The certification basis for the DLCA-6500 software is DO-178B [61]. The proposed means of compliance are methods, activities, and the software life cycle data defined in this document and the associated Software Development Plan [6]. The SDP will be written in compliance with objectives defined in DO-178B [61] and the Rockwell Collins Technical Consistent Process (RC-TCP) [1] to demonstrate that the objectives defined in DO-178B [61] have been met.

The DLCA-6500 itself is not a TSO function, nor is it part of another functional TSO. The DLCA-6500 will be certified as part of the Type Certification for the target aircraft. The proposed means of compliance will be documented verification results demonstrating interoperability and compliance to applicable industry standards. AC 20-140A [72] provides interoperability, safety, and performance criteria and identifies requirements specified in industry standards that may be used as a means of compliance. For certifications through European Aviation Safety Administration (EASA) an Acceptable Means of Compliance (AMC) document is not yet available. As such, EASA currently provides a Certification Review Item (CRI) document that is unique to a specific certification. The CRI provides interoperability, safety, and performance criteria, again including references to requirements in industry standards. See section 3.1 System Functional Description for information on FANS and ATN industry standards.

5.2 Software Criticality Level

The DO-178B DAL for the DLCA-6500 software will be developed and certified to DO-178B Level C. The rationale for Level C is based on the assessment of the operational hazards for FANS and ATN use.

FANS operational hazards are defined in RTCA DO-306 Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard), October 11, 2007[63] and augmented by RTCA DO-306 Change 1 Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard), March 17, 2011[64].

ATN operational hazards are defined in SAFETY AND PERFORMANCE REQUIREMENTS STANDARD FOR AIR TRAFFIC DATA LINK SERVICES IN CONTINENTAL AIRSPACE (CONTINENTAL SPR STANDARD), EUROCAE ED-120 with Changes 1 and 2, October 2007 [69]

The highest FANS and ATN failure condition is classified as Major, which DO-178B [61], section 2.2.2 correlates with Level C.

Table 5-1 DLCA-6500 Criticality Data below summarizes the Major hazards from the noted FANS and ATN industry standards.

Table 5-1 DLCA-6500 Criticality Data

Ref#[1]	Hazard Description	Classification
FANS Operational Hazards		
H-CRD-7 H-IER-7 H-PR-7	Undetected late or expired message	Major

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Ref#[1]	Hazard Description	Classification
H-CRD-8 H-IER-8 H-PR-8	Undetected misdirection of a message	Major
H-CRD-9 H-IER-9 H-PR-9	Undetected corruption of a message	Major
H-CRD-10 H-IER-10 H-PR-10	Undetected spurious/inadvertent message delivery	Major
ATN Operational Hazards		
H-ACL-3	Undetected early delivery of a message used for separation	3 (Major)
H-ACL-6	Undetected late or expired message used for separation	3 (Major)
H-ACL-9	Undetected misdirection of a message used for separation	3 (Major)
H-ACL-12	Undetected corruption of a message used for separation	3 (Major)
H-ACL-15	Undetected out of sequence CPDLC messages used for separation	3 (Major)

[1] Hazard reference identifiers are based on the associated Data Link services, where…

ACL = ATC Clearance
CRD = Clearance Request and Delivery service
IER = Information Exchange and Reporting service
PR = Position Reporting service

5.3 Outsourced Supplier Management

The DLCA-6500 team will include offshore and outsourced partners. An Offshoring/Outsourcing Risk Assessment (OORA) has been completed for the DLCA-6500 effort, in accordance with the Risk Assessment and Oversight for Outsourcing or Offshoring Activities involving Civil Certification, HRC-ENG-P-016 [4]. The total score of the assessment (20/Low Risk) and rationale for each category in the Offshoring/Outsourcing Risk Level can be found in OORA.

The DLCA-6500 team will use the Rockwell Collins India Design Center (Hyderabad, India) as an offshore partner. Off-shore partners' responsibilities included requirements definition, software development and verification.

The DLCA-6500 team will also use onsite contractors from HCL Technologies, an Indian engineering firm. The onsite HCL contractors were utilized for development and verification.

The Rockwell Collins USA team has primary responsibility for meeting all the objectives of the software planning, requirements definition, software development, verification, and developmental configuration management processes.

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5.3.1 Engineering Oversight

Cedar Rapids Engineering Leads will provide oversight to ensure offsite development and verification engineers comply with Data Link's processes currently in place.

All activities performed; regardless of what partner is conducting them; will be performed using the same tools, plans and processes used by the Rockwell Collins USA team.

The plan is 30% of artifacts modified or newly generated by our offshore partners will be reviewed by an experienced member of the development team and 5% by the Rockwell Collins USA DAC for Quality. The tools and access to version control repositories that are necessary to accomplish these tasks will be made available to our off-shore partners and domestic partners. Some restrictions on network usage for the off-shore partners will be enforced by Rockwell Collins USA team to fully comply with export control regulations.

To maintain synchronization, weekly and monthly status reports and teleconferences will be scheduled between the Rockwell Collins USA and off-shore partners team members. The final responsibility is with Rockwell Collins USA team to make sure that the artifact complies with the procedures that are required for DO-178B certification.

5.3.2 Tasks and Responsibilities

All systems engineering for DLCA-6500 will be performed by system engineers located in the United States of America (USA).

Software requirements, design, and development are planned to be done in the USA by RC personnel, contractors located within the USA and India, and the India Design Center. All work done will be performed per the SDP [6] and will be reviewed per the Peer Review process [26].

DLCA-6500 plans to utilize Rockwell Collins India Design Center (hereafter referred to as RC IDC), to perform all verification activities. IDC will be used to develop Acceptance Test Procedures (ATPs), verify those ATPs provide full coverage of the DLCA-6500 software requirements, run requirements-based test procedures to produce the data used for structural coverage analysis, run test procedures for a "dry-run-for-score", and participate in a formal "run-for-score" at Rockwell Collins facilities.

As needed HCL Technologies (HCLT), an Indian engineering firm will be utilized for development and verification. All HCLT personnel used are planned to be located onsite at the RCI facilities in the USA. This would be done to help train and manage the RC IDC staff. HCLT personnel are experienced DLCA verification engineers.

The processes utilized by DLCA in previous verification efforts with off-shore verification will be repeated for this project. A verification lead will be assigned that is located in the USA. This person will be responsible for coordination with our off-shore partners. A verification lead at each of our off-shore partners will also be assigned to this project which will coordinate activities at the off-shore facilities and ensure enforcement of the DLCA processes.

All dry run and formal Run For Score (RFS) testing on the target system will be performed in the USA at Rockwell Collins facilities by RC IDC. Structural Coverage Analysis (SCA) testing is obtained from requirements based test procedures and is planned to occur at the off-shore and at USA Rockwell Collins facilities. SCA will be executed at off shore facilities because it is planned to be executed on the host environment and not on the target system. RC IDC will have the full host solution at their facilities. The target solution will only exist at Rockwell facilities in the USA.

As needed to augment staff, domestic partners will be used. All staff utilized by domestic partners will reside in the U.S. No offshoring/outsourcing outside the U.S. by the domestic partners is planned.

All TCR and safety activities will be done by personnel located in the USA. This effort will not be done through offshoring.

5.3.3 Problem Reporting and Resolution

Problem Reporting and Resolution includes a series of steps during the design and development process. A build will be created per the schedule and the state of the development. The build will undergo subsystem testing to ensure that the delivered Change Requests (CR) are implemented correctly and function properly

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on the system rig. A Change Request will be generated for any issues found in any DLCA-6500 artifact (i.e. documents, code, etc.). This Change Request (CR) will go through the Change Control Board (CCB), and the necessary actions will be taken.

When a build is delivered to the Verification Team, a similar process will be followed. Upon any bug or deviation from the requirement, a Change Request will be generated. The CR(s) will go through CCB to determine the actions to be taken on the Change Request.

Note: The term Change Request (CR) is used generically to describe a change driver created in the product's problem tracking database.

5.3.4 Configuration Management

This section is covered in detail in section 6.1.4 Software Configuration Management

5.3.5 Quality Assurance

Members of Rockwell Collins USA team travelled to India to train the RC IDC/HCL engineers assigned to the DLCA-6500 project. The training covered an overview of DO-178B and a wide range of topics concerning the software development and verification environment, processes, tools, standards, management, etc. The training sessions and training materials included relevant portions of the applicable Software Development Plan [6].

Rockwell Collins USA leadership will assess the needs for additional trainings based upon progress and performance quality. Based upon the assessment, Rockwell Collins USA leadership may choose to dispatch Rockwell Collins USA team members to India for additional training or to provide training through Rockwell Collins USA approved media.

Rockwell Collins USA leadership and coordination between the RC IDC/HCL team and Rockwell Collins USA team, including the DAC for Quality and development team, will assure that the RC IDC/HCL will perform to Rockwell Collins USA processes and standards.

The RC IDC will also have DAC Representative on site that will assure that the team performs to Rockwell Collins USA processes and standards outlined in Software Development Plan [6].

5.4 Stage of Involvement (SOI) Reviews

SOI activity will be performed throughout the initial project development and verification processes. Following initial equipment approval, subsequent SOI activities will be focused on changed areas only. For example, SOI 1 will only be repeated for follow-on projects if the planning documents previously reviewed are changed. Likewise, SOI 2 and SOI 3 will only examine the changed areas of the design and previous SOI 2 and SOI 3 reviews will remain valid.

FAA Order 8110.49A, Chapter 2 “Software Review Processes” [65] provides objectives of the software review process and guidance on the certification authority involvement.

FAA Order 8110.49A, Appendix A [65] provides a Level of Involvement worksheet. Provided in Appendix F of this document are the completed self-assessment worksheets for DLCA. The Total Score Result (TSR) was 142. Based on the TSR score result of 142 and DLCA at DAL C Software level, the level of certification authority involvement in the DLCA software is determined at LOW level of required involvement.

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6 Software Life Cycle

The objective of this section is to provide a summary of the software life cycle to be used for the DLCA-6500 software development, which meets the Software Life Cycle objective of the Plan for Software Aspects of Certification found in DO-178B [61], section 11.1.d.

As a product line application the DLCA-6500 is planned for reuse across multiple aircraft platforms. Future versions will be developed by adding new requirements, and/or modifying, and/or removing existing requirements from the previous baseline version. For each planned deliverable version, an iterative software process model will be followed, where a series of labeled builds will be developed, such that each successive build is closer to satisfying the final requirements for the planned deliverable version. Each of these intermediate builds will include activities from various life cycle processes. Not all life cycle processes will be performed for each intermediate build. However, all life cycle processes will be performed prior to certification application and/or the final production build for a given deliverable version. Regression analysis may be used if necessary to provide assurance that all appropriate life cycle activities have been performed.

The specific details of the software life cycle for DLCA-6500 may be found in the Data Link Products Software Development Plan (SDP) [6].

6.1 Description of the Software Life Cycle Processes

The entire software life cycle for the DLCA-6500 software will conform to the process documented in DO-178B [61] as well as the Rockwell Collins Technical Consistent Process [1]. The specific processes followed on this project are documented in more detail in the SDP [6].

There will be multiple internal/intermediate builds that will be part of the iterative development process. These intermediate builds will be used to support internal development and verification.

The software development will be performed using both host and target platforms. The host platform will be a Windows PC that utilizes a host compiler to generate host builds and a cross compiler to generate builds for the target hardware. The host environment also includes a simulation tool that enables the host build to run in the host environment.

6.1.1 Planning

The software development plan and the supporting integral activities for the DLCA-6500 are defined in this PSAC, the Software Development Plan [6], the SCM plan [3], and the Design Quality Assurance Plan for Hardware, Software and System Development [2]. The transition criteria, inter-relationships, and sequencing among these processes are defined in the SDPs [6] (see section 5.1).

Project plans are developed to meet the following objectives:

- Provide process activity definitions.
- Define transition criteria, inter-relationships and sequencing among processes.
- Define the software life cycle.
- Define software development standards.

Reviews of the project plans are completed per the SDP [6]. Any significant changes to the software plans will result in the updating of one or more of the software planning documents discussed in this section. DAC Representative will review these changes to ensure they are coordinated. If the PSAC is revised it will be resubmitted for approval by the certification authorities.

6.1.2 Software Development Processes

The Software Development Plan [6] define the software development processes to:

- Analyze system/subsystem requirements to define software requirements.
- Analyze software requirements to define the software architecture and low-level requirements.
- Design and code the software to implement the software architecture and low-level requirements.

- Verify the outputs of the software requirements process, design process, and coding process by having peer reviews.
- Integrate the software on the host platform and target hardware.

The processes will produce development artifacts that are accurate and consistent, verifiable, traceable to the system requirements, and compatible with the target computer.

Process Deviations/Additions contains a list of known deviations/additions to some of the detailed process steps in the SDP [6] for which this project intends to follow. It is expected that a future version of the SDP will incorporate these changes. The Software Accomplishment Summary will document any changes to this approach.

6.1.2.1 Software Development Environment

The Software Development Plan [6] provides a detailed description of the software development environment and the planned tools to be used for each of the life cycle processes. The Software Developers User's Guide [43] provides a description on using the tools called out at each life cycle process.

Reference the SDP [6] Section 4.3 for a complete listing of the planned software development tools for PPC-based targets (DLCA-6500 is targeted for the PPC) and the planned software verification tools for IMA products (DLCA-6500 is an IMA product).

The following tools will **not** be used for DLCA-6500:

- LDRA coverage analyses tool
- Data Link Tester

DO-178B [61] Section 12.2 Tool Qualification provides guidance for when a development or verification tool is required to be qualified.

"Qualification of a tool is needed when processes of this document are eliminated, reduced or automated by the use of a software tool without its output being verified…"

Tools used for this development that meet the above criteria:

- VISTA is a multi-process simulation environment suitable for use in the development and testing of avionics software.
- VectorCAST is a tool used for Structural Coverage Analysis.
- Vision Framework is a tool used for testing of avionics HMI.

6.1.2.2 Software Requirements Process

The development of software high-level requirements (HLRs) will be performed in accordance with the process defined in the Software Development Plan [6] section 6.1.

The DLCA-6500 software high level requirements will be captured in the High Level Software Requirements Specification (SRS) for the Pro Line Fusion DLCA-6500 Data Link Communications Application [9].

Note that the DLCA-6500 product is largely driven by detailed industry interoperability specifications, where these specifications target specific aircraft software applications (e.g. CPDLC) and contain detailed requirements that are already decomposed to govern specific application behavior. In these cases the industry specifications, while likely having the detail required to be treated as high-level (or even low-level) software requirements, are not considered requirements but instead are used to justify certain derived requirements. Tracing may exist between DLCA requirements and industry requirements, but this tracing is in place only to show compliance to industry specifications.

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6.1.2.3 Software Design Process

The development of the software architecture, detailed design, and low-level requirements (LLRs) will be performed in accordance with the process defined in the Software Development Plan [6] section 6.2. Unified Modeling Language (UML) will be used as applicable to aid in documenting the design. UML will not be used for anything other than documentation purposes.

The software architecture and detailed design will be documented in the Software Design Document for DLCA [15] and will include descriptions of the high-level software architecture, Input/Output interfaces, data flow and control, and pertinent design decisions with associated rationale.

The software low-level requirements will be captured in the project Software Requirements Specifications [10][11][12][13].

The IOCF [5] will also be captured as part of the design process.

The SDD [15] contains a thorough description, design data, of the class definitions. This can be found in the header files for the classes. All low level requirements will trace to entries in this document. An accompanying SDD [15], in a Microsoft word document, covers the following topics:

- Software Product Design Decisions; and
- Software Architecture and High-Level Design; and
- Software Detailed Design.

The SDD [15] describes each software unit that satisfies both the high and low-level software requirements.

6.1.2.4 Software Coding Process

The development of the software source code will be performed in accordance with the process defined in the Software Development Plan [6] section 6.3. The DLCA-6500 software will be implemented using the C++ programming language.

The software source code will be formally released in the DLCA-6500 CPCIs [16],[17], and [18].

6.1.2.5 Software Integration Process

The software integration will be performed in accordance with the process defined in the Software Development Plan [6] section 6.4.

The DLCA-6500 Executable Object Code [48] will be formally released to the Software Control Library (SCL).

6.1.3 Software Verification Processes

This section provides a brief summary of the software verification processes used to verify the results of the software development processes. The Software Verification User's Guide [44] provides additional information on the verification environment.

6.1.3.1 Verification of Software High-Level Requirements

The software high-level requirements will be verified to meet the required objectives of DO-178B using the Peer Review method as described in the Software Development Plan [6] section 7.4.1.

6.1.3.2 Verification of Software Architecture

The software architecture will be verified to meet the required objectives of DO-178B using the Peer Review method as described in the Software Development Plan [6] section 7.4.2.

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6.1.3.3 Verification of Software Low-Level Requirements

The software low-level requirements will be verified to meet the required objectives of DO-178B using the Peer Review method as described in the Software Development Plan [6] section 7.4.2.

6.1.3.4 Verification of Software Source Code

The software source code will be verified to meet the required objectives of DO-178B using the Peer Review method as described in the Software Development Plan [6] section 7.4.3.

6.1.3.5 Verification of Software Integration

The software integration process will be verified to meet the required objectives of DO-178B using the Test method as described in the Software Development Plan [6] section 7.4.4.

6.1.3.6 Development of Software Test Cases

The development of software test cases will be performed in accordance with the process defined in the Software Development Plan [6] section 7.4.5.

6.1.3.7 Verification of Software Test Cases

The software verification test cases will be verified to meet the required objectives of DO-178B [61] using the Peer Review method and the Requirements Based Test Coverage Analysis method as described in the Software Development Plan [6], section 7.4.6.

6.1.3.8 Development of Software Test Procedures

The development of software test procedures will be performed in accordance with the process defined in the Software Development Plan [6] section 7.4.7.

6.1.3.9 Verification of Software Test Procedures

The software verification test procedures will be verified to meet the required objectives of DO-178B using the Peer Review method as described in the Software Development Plan [6] section 7.4.8.

6.1.3.10 Software Verification Testing

Control coupling analysis will be performed in conjunction with SCA, where statements that were not covered will be analyzed to ensure that no adverse effects on the logical control of execution would occur if the statements were to execute. Likewise, data coupling analysis will be performed in conjunction with SCA, where statements that were not covered will be analyzed to ensure that no adverse effects on shared data would occur if the statements were to execute.

The software verification testing (requirements based testing) will be performed in accordance with the process defined in the Software Development Plan [6] section 7.4.9.

6.1.3.11 Verification of Test Results

The software verification test results will be verified to meet the required objectives of DO-178B [61] using the Peer Review method and the Structural Coverage Analysis method as described in the Software Development Plan [6] section 7.4.10.

6.1.4 Software Configuration Management

The Software Configuration Management process is described in detail in the Software Development Plan [6], section 8.

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6.1.5 Software Quality Assurance

The Software Quality Assurance Plan is described in the Software Development Plan [6], section 9 and in the Design Quality Assurance Plan for Hardware, Software and System Development [2].

6.2 Organizational Responsibilities

Section 4.1 of the Software Development Plan [6] provides a detailed description of the organization in terms of roles and responsibilities.

6.3 Certification Liaison

This PSAC will be submitted to the applicable Program Office for transmittal to the OEM for approval.

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7 Software Life Cycle Data

The objective of this section is to provide a summary of the software life cycle data to be produced and controlled during the Product Line DLCA-6500 software development, which meets the Software Life Cycle Data objectives of the Plan for Software Aspects of Certification found in DO-178B [61], section 11.1.e.

Table 7-1 DLCA-6500 Life Cycle Data Items (below) identifies the software life cycle data items that will be generated as part of the DLCA-6500 development. All software life cycle data items will be kept under configuration control at Rockwell Collins. The numbers in the DO-178B column are the numbers of the equivalent software life cycle data items as outlined in section RTCA DO-178B [61].

The “Submit” columns lists items that will be submitted as part of this certification package or available for review at a Rockwell Collins facility.

- S – Submitted as a part of the certification package
- A – Available for review at a Rockwell Collins Facility

Table 7-1 DLCA-6500 Life Cycle Data Items

DO-178B Life Cycle Data	Rockwell Collins Equivalent	CCM Submit	AFD-37X0 Submit
11.1 Plan for Software Aspects of Certification	Plan for Software Aspects of Certification for the Data Link Communications Application (DLCA-6500) (this document)	S	S
11.2 Software Development Plan	Software Development Plan for the Commercial Systems Data Link Products [6]	A	A
11.3 Software Verification Plan	Software Development Plan for the Commercial Systems Data Link Products [6]	A	A
11.4 Software Configuration Management Plan	Software Configuration Management Plan [3]	A	A
11.5 Software Quality Assurance Plan	Design Quality Assurance Plan for Hardware, Software and System Development [2]	A	A
11.6 Software Requirements Standards 11.7 Software Design Standards 11.8 Software Code Standards	Software Development Plan for the Commercial Systems Data Link Products [6] C++ Coding Standards [7]	A A	A A
11.9 Software Requirements Data	High Level SRS for the Pro Line Fusion DLCA-6500 Data Link Communications Application [9] CPCI for DOORs Archive [49]	A A	A A

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DO-178B Life Cycle Data	Rockwell Collins Equivalent	CCM Submit	AFD-37X0 Submit
11.10 Design Description	SRS for the Data Link Communications Application (DLCA) Future Air Navigation System (FANS-1/A) [10]	A	A
	SRS for Common DLCA System Services[11]	A	A
	SRS for Aeronautical Telecommunication Network Context Management (CM) And Controller Pilot Data Link Communication (CPDLC) [12]	A	A
	Software Requirement Specification (SRS) for HMI [13]	A	A
	Software Design Document (SDD) for the DLCA-6500 Data Link Software Component Design [15]	A	A
	CPCI for DOORs Archive [49]	A	A
11.11 Source Code	CPCI for the Human Machine Interface (HMI) DLCA-6500[16]	A	A
	CPCI for the DLCA-6500 Core Software Library [17]	A	A
	CPCI for the DLCA-6500 Message Library [18]	A	A
	CPCI for the DLCA-6500 XML I/O Configuration File [19]	A	A
	CPCI for the DLCA-6500 XML ATN Default Addresses [20]	A	A
	CPCI for the DLCA-6500 XML General Config [21]	A	A
	CPCI for the Support Files [32]	A	A
	CPCI for PCT Data [56]	N/A	A
	CPCI for the DLCA-6500 Media Set [57]		A
	CPCI for the DLCA-6500 Electronic Nameplate [52]		A
	CPCI for the A661 VAPS Model [51]	A	N/A
	CPCI for the A661 Definition Files [33]	A	
11.12 Executable Object Code	Software Deliverable for the DLCA-6500 Message Library [53]	A	A
	Software Deliverable for the DLCA-6500 [48]	A	A
	Software Deliverable for DLCA-6500 Media Set [58]	N/A	A

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DO-178B Life Cycle Data	Rockwell Collins Equivalent	CCM Submit	AFD-37X0 Submit
11.13 Software Verification Cases and Procedures	SVPR for the DLCA-6500 [22] CPCI for the DLCA-6500 SVPR [54]	S S	S S
11.14 Software Verification Results	Software Verification Procedures and Results (SVPR) for the DLCA-6500 [22] CPCI for the DLCA-6500 SVPR [54]	S S	S S
11.15 Software Life Cycle Environment Configuration Index a. Identify the software life cycle environment hardware and its operating system software. b. Identify the software development tools c. Identify the test environment used to verify the software product d. Identify qualified tools and their associated tool qualification data.	Plan for Software Aspects of Certification for the Data Link Communications Application (DLCA-6500) (this document). Covers RTCA DO-178B [61] objectives 11.15.a, 11.15.b, 11.15.c, 11.15.d. Software Development Plan [6]. Covers RTCA DO-178B [61] objectives 11.15.b, 11.15.c. Software Verification Procedures and Results for the DLCA-6500 [22]. Covers RTCA DO-178B [61] objectives 11.15.c. CPCI's for the DLCA-6500 [16], [17], [18], [19], [20], [21] [32], [33]. Covers RTCA DO-178B [61] objectives 11.15.a, 11.15.b.	A A S A	A A S A
11.16 Software Configuration Index	Software Configuration Index (SCI) for the Data Link Communications Application (DLCA-6500) [55] Top Level Drawing [24]	S A	S A
11.17 Problem Reports	Problem Reports[1]	A	A
11.18 Software Configuration Management Records	SCM Records[2]	A	A
11.19 Software Quality Assurance Records	SQA Records[3]	A	A
11.20 Software Accomplishment Summary	DLCA Software Accomplishment Summary for the DLCA-6500 [23] DLCA-6500 Footprint Document [8]	S S	S N/A

[1] Change Request (CR) records will be archived in a change tracking tool database.

[2] Software Configuration Management (SCM) records will be archived in the Enterprise Product Data Management database.

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[3] Software Quality Assurance (SQA) records will be archived in an audit tool database.

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8 Additional Considerations

The objective of this section is to document additional considerations which may affect the certification process as it relates to the development of the DLCA-6500 artifacts. The following sections address the suggested additional considerations as described in the Plan for Software Aspects of Certification found in DO-178B [61] section 11.1.g.

8.1 Use of Previously Approved Software

According to AC 20-115D [76], paragraph 9, Previously Approved Software is software that was approved using ED-12/DO-178, ED-12A/DO-178A, or ED-12B/DO-178B. DLCA does not have any Previously Approved software that was approved using ED-12/DO-178 or ED-12A/DO-178A. The CIA will list the baseline for previously approved software that was developed to ED-12B/DO-178B.

DLCA-6500 reused life cycle artifact of the baseline (Refer to the CIA for the baseline which will be used). The baseline modifications were driven by new requirements and software enhancements, which were developed and verified in accordance with the applicable objectives for DO-178B, resulting in this version of the DLCA-6500 software. There were no changes to any of the existing DAL levels.

Certification credits will be taken for all artifacts that did not changed from the baseline version. For artifacts that changed from the baseline version, partial credit will be taken for the unmodified portions of those artifacts, whereas re-verification was performed on the changed and affected portions. The re-verification effort will include requirements and functional based testing as well as structural coverage of the changes.

The DLCA-6500 SAS [23] will identify the final set of artifacts changed.

8.2 Commercial Off The Shelf (COTS) Software

N/A – there is no Commercial off the Shelf Software (COTS) in the DLCA-6500.

8.3 Compiler Assumptions

No assumptions are made regarding the correctness of any of the compilers, assemblers, linkers, or loaders used in the development of the DLCA-6500 software.

8.4 Option Selectable Software

Option selectable software is synonymous with deactivated software, and represents functional code segments that can be enabled/disabled by an external configuration item – such as a license key or strap. For all such code segments, the software verification test procedures will test the function when enabled *and* will test that the function will not execute when disabled.

The following option selectable software exists in the DLCA-6500:

- Dual DLCA Key: Enables active/standby mode determination logic with a peer DLCA-6500.
- FANS Key: Enables the FANS applications within the DLCA-6500.
- ATN Key: Enables the ATN applications within the DLCA-6500.

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Table 8-1 DLCA Options (Licenses Keys/Strapping)

Valid Keys/Strapping	Explanation of Options
None	No DLCA active
2	Single DLCA with FANS
3	Single DLCA with ATN
2,3	Single DLCA with FANS & ATN
1,2	Dual* DLCA with FANS
1,3	Dual* DLCA with ATN
1,2,3	Dual* DLCA with FANS and ATN

Note: * indicates Active/Standby Dual Installation

The following option selectable code exists in DLCA:

- Inbox: The DLCA software can enable the Configurable Inbox, the Non-Configurable Inbox or deactivate the inbox. This is managed in the XML DLCA General Configuration File [21].
- Configurable Inbox Style: The Configurable Inbox can use a Message Log or operate without one. This is managed in the XML DLCA General Configuration File [21].
- IOC Flows: The ICAO Address and Data Link Interlock Status word can use a different number of flows on the CCM hardware versus the AFD-37X0 hardware. With the CCM hardware, the DLCA uses 4 flows and with the AFD-37X0 hardware, the DLCA uses 2 flows. This is managed in the XML I/O Configuration File [19].
- Top Level Menuing: The DLCA software can enable the drop down menu logic or tab menu logic. This is managed in the XML DLCA General Configuration File [21].

For those items that correspond to an enabled/disabled option, the requirement base software verification will test the function when enabled and will test that the function will not execute when disabled.

8.5 User Modifiable Software

N/A – there is no user-modifiable software in the DLCA-6500 product.

8.6 Field Loadable Software

The DLCA-6500 application will be field-loadable. Data load functionality will allow the software to be updated without removing hardware from the aircraft. Data load software included as a part of the Platform Software provides field loadable capability for the DLCA-6500 application. Entry into the data load software is controlled by the platform's Level A boot software, which ensures that the hardware is in the proper configuration before allowing data load to begin. When data load is complete, the hardware is rebooted. The Level A platform software then verifies the integrity of the new software load via CRC before allowing the software to run.

Refer to the Platform Software SAS (See Table 9-1 -Hardware Dependent Components for appropriate citation) for information on the data load software.

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8.7 Multiple Version Dissimilar Software

N/A – multiple-version dissimilar software will not be used in the DLCA-6500 product.

8.8 Partitioning

Refer to Section 4.7 Software Partitioning.

8.9 Product Service History

No product service history credit will be taken for the DLCA-6500 product.

8.10 Reverification Guidelines

Modified software will be re-verified using a subset of the process used for a full verification. Modified software includes, but is not limited to, software whose functionality may have changed due to compiler, assembler, linker, or loader version/option changes. The Verification Lead Engineer will manage the verification activities including identifying and correlating the changed areas with the full verification process to define a unique single-use verification subset to be used for the re-verification. The subset must include not only verification of the identified source changes but also verification of all causes and effects of the changes. For example, most source code changes are caused by a revision to a requirement and thus have an effect on the Requirements Process, Integration Process, and Testing Process. Therefore, some verification of the Requirements Process, Integration Process, and Testing Process must be included in the verification subset.

8.11 Tool Assessment and Qualification

See Table 8-2 - DLCA-6500 S/W Tools for a list of tools used in the development of the life cycle data for DLCA-6500. Qualification is required for all software tools which:

1. Can insert an error into the airborne software or fail to detect an existing error in the software within the scope of the intended use of the tool; AND
2. Will not have the output of the tool verified as specified in Section 6 of DO-178B [61]; AND
3. Eliminate, reduce or automate a process of DO-178B by the use of the tool.

Applying this assessment to the tools planned for use in the DLCA-6500 resulted in three tools requiring qualification. They are discussed in the sections below.

Table 8-2 - DLCA-6500 S/W Tools

Life Cycle	Tool Capability	Tool Used	DO-178B Qualification Required?
Support	Documentation	Google Application Suite	No
Support	Documentation	DOORS	No
Support	Documentation	Microsoft Office Word	No
Support	Documentation	Microsoft Office VISIO	No
Support	Documentation	Microsoft Office PowerPoint	No

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Life Cycle	Tool Capability	Tool Used	DO-178B Qualification Required?
Support	Schedule Management	Microsoft Project	No
Support	Schedule Management	SAP	No
Support	Problem Report Tracking	JIRA	No
Support	Configuration Management	Subversion	No
Support	Peer Review Tool	Rockwell Collins PREP	No
Support	Traceability	DOORS	No
Requirements	Specification	DOORS	No
Requirements	Specification	Microsoft Word	No
Requirements	Modeling	Microsoft Office Visio	No
Design	Modeling	Microsoft Word	No
Design	Modeling	DOORS	No
Design	Design graphical layout	VAPS XT	No
Design	IDE	Eclipse	No
Coding (Intel based target)	Source Code Analyzer	Gimpel PC Lint for C/C++	No
Coding (Intel based target)	Source Code Analyzer	Dr.Memory[2]	No
Coding (Intel based target)	Source Code Analyzer	Understand[1]	No
Coding (Intel based target)	IDE	Eclipse CDT	No
Coding (PPC based target)	C/C++ Compiler	LynxOS-178 CDK GNU gcc PPC cross compiler for Windows	No
Coding (PPC based target)	Source Code Analyzer	Gimpel PC Lint for C/C++	No
Coding (PPC based target)	Source Code Analyzer	Understand[1]	No
Software Verification	Coverage Analysis	Vector Cast	Yes

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Life Cycle	Tool Capability	Tool Used	DO-178B Qualification Required?
Software Verification	Test Simulation	AGPS	No
Software Verification	Test Simulation	ATC Ground Station	No
Software Verification	Test Simulation	Airtel ATN Router	No
Software Verification	Test Simulation	Message Library Tester [50]	No
Software Verification	Test Simulation	Trace Tool	No
Software Verification	Test Simulation	Vision Framework Tool	Yes
Software Verification	Test Simulation	VISTA	Yes
Software Verification Procedures & Results	Documentation	MS Word	No
Software Verification Procedures & Results	Documentation	MS Excel	No

Note 1: Understand tool is an Aid tool to help the developer. Manual Review is performed on the Source Code to ensure Software Coding standard.

Note 2: Dr.Memory is an Aid tool to the developer to check any memory leaks. Manual Review is performed on the Source Code to ensure Software Coding standard.

8.11.1 Qualification Overview

Rockwell Collins developed tools that require verification tool qualification per DO-178B and FAA Order 8110.49A.

All tools selected for qualification will be qualified per DO-178B [61] and FAA Order 8110.49A.

8.11.1.1 VectorCAST Cover Tool Suite

VectorCAST Cover Tool Suite is developed by VectorCAST and is a software tool used to automate the collection and reporting of structural coverage results, whereby the source code is instrumented with tags that record statement coverage during functional requirements based testing. The reports are used to assist engineering in performing Structural Coverage Analysis (SCA).

VectorCAST offers a Tool Qualification Kit, and enables clients and certification authorities to audit the VectorCAST Tool Suite for use in projects. Rockwell Collins will coordinate with VectorCAST to obtain the Tool Qualification Kit, and perform the qualification testing.

8.11.1.2 VISTA

VISTA is a software tool used throughout the development and verification processes of the DLCA-6500 product. This tool facilitates code execution, debugging, and verification testing in both target hardware and host-based environments. Selected features of this tool are used to automate the gathering of verification test results. Therefore, these features of the tool will be qualified. VISTA was developed by Rockwell Collins. The qualification of this tool will be performed by the VISTA development group.

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8.11.1.3 Vision Framework

Vision Framework was developed by a tools group at Rockwell Collins. The Vision Framework automates testing activities that require visually confirming expected results on a display. Vision Framework uses a combination of screenshots along with Optical Character Recognition (OCR) and shape recognition software to provide reliable test results that can be reviewed. The qualification will be performed by the Vision Framework development group.

8.12 Dynamic Memory Allocation

The DLCA-6500 software will have its own locally managed dynamic memory allocation function. A fixed-sized heap will be allocated once from the system during initialization, and all subsequent system calls to allocate and deallocate memory (new, delete, malloc, free) will be overridden to utilize the locally managed heap. The managed heap is implemented using a “buddy heap” algorithm; such that adjacent free blocks are merged to form larger blocks to prevent fragmentation. The following implementation details are also employed to provide speed and prevent fragmentation:

- The free list is sorted by block size such that allocations are performed “best fit first” and ensuring that the largest block is always the last to be subdivided
- Merging of adjacent free blocks (buddies) occurs immediately when a block is freed for reuse. Up to three blocks may be merged in one operation
- Blocks are paragraph aligned on 16 byte boundaries
- Sizes are allocated on paragraph alignment

In the DLCA-6500 design, objects that serve as the fundamental operational components of the system are designed following the Singleton Pattern, and thus instantiated only once at program initialization. The operational software itself is not designed to dynamically change. This ensures a more deterministic execution profile. Only objects that contain data as a result of an external data-driven event are dynamically allocated. In these instances, protection from too many events/messages is handled in the same manner as if a static allocation were exceeded – the application will identify the limit and reset. The rationale is based on the concept that static limits are not intended to be exceeded “by design”, and that there is no logical advantage for continued operation in a degraded mode. This error will also be annunciated on the diagnostic output port.

Additionally, a continuous monitor function exists to record low and high water marks on the heap and is periodically annunciated on the diagnostic output port. This monitor function is examined during verification testing to empirically test against memory leaks and to verify the system returns to the same quiescent state following repeated bursts of data activity.

8.13 Programming Language Considerations

This section addresses the concerns noted in the FAA CAST position paper CAST-8 [71], regarding use of the C++ programming.

The sections below follow the same outline as in the CAST-8 [71] position paper, and provide discussion aimed at each of the stated concerns within that paper.

8.13.1 Compile-Time Issues

8.13.1.1 Dead/Deactivated Code

Deactivated code is addressed in Section 8.4.

The DLCA-6500 software will not contain any dead code. Specific areas that could potentially lead to dead code are addressed individually below:

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- Unused classes in library modules: There will be no 3rd party or other imported libraries for which only a subset of the contained classes are planned. All libraries developed for the DLCA-6500 contain explicit functionality used by other DLCA-6500 modules.
- Unused methods of a class: There will be no unused (uncalled) methods in the DLCA-6500 class designs. Where entire classes are re-used/ported from previous development, they will be tailored to remove any unused methods not required for DLCA-6500.
- Methods of a class overridden in a subclass: While this is a powerful C++ feature, its use in DLCA-6500 will be limited to contexts in which both objects of the class and subclass are instantiated, thus requiring the base class implementation. In cases where an object of the base class is not expected to be instantiated, those methods will be declared pure virtual to force the implementation in the derived class.
- Unused attributes of a class: There will be no unused (un-accessed) attributes in the DLCA-6500 class designs. Where entire classes are re-used/ported from previous development, they will be tailored to remove any unused attributes not required for DLCA-6500.

8.13.1.2 Encapsulation

Encapsulation is one of the major tenets of a good object oriented design. The DLCA-6500 software design will incorporate encapsulation techniques in the interest of producing software that is maintainable and extensible. The public interfaces defined for every class will be sufficiently documented such that the programmer understands internal side effects as well as pre- and post-conditions. Furthermore, the source code management system will allow each programmer full access to the detailed implementation of every class design in the DLCA-6500 software system to aid in class utilization.

8.13.1.3 Inheritance

Inheritance will be limited to single inheritance for concrete classes in the DLCA-6500 software design. Multiple inheritance is only allowed when inheriting from multiple interface (pure virtual) classes. By limiting inheritance to no more than one concrete class, repeated inheritance is avoided and the resulting software design is less complex and easier to maintain.

8.13.1.4 Overloading

Overloading is a powerful C++ mechanism for creating a family of related functions that only differ in type and number of arguments. The DLCA-6500 software design will utilize function overloading with the following constraints to eliminate confusion:

- Functions will not be created with the same name for different purposes, i.e. the overloaded functions will perform essentially the same service.
- Subclasses will not overload a function inherited from a superclass. Overloading inherited functions can cause confusion between what’s been overridden and overloaded and may lead to unexpected implicit type conversions.

8.13.2 Run-Time Issues

8.13.2.1 Dynamic Binding/Dispatch

Another powerful tenet of C++ and object oriented design; dynamic binding is used to support polymorphism. The DLCA-6500 software design will limit the use of dynamic binding to those capabilities provided by the C++ virtual function pointer table implementation as part of the certified LynxOS-178 C++ run-time library. No other implementation of dynamic binding will be developed in the DLCA-6500 application domain. Additionally, the use of Run-Time Type Identification (RTTI) will not be allowed in the DLCA-6500 software design.

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8.13.2.2 Polymorphism

Supported by dynamic binding discussed above, polymorphism is a fundamental asset to good object oriented design. The DLCA software design will utilize polymorphism to define consistent levels of abstraction between similar objects with different behavior. To eliminate ambiguity and tracing complexity, polymorphic classes will typically be designed using interface (pure virtual) classes at the desired level of abstraction, and implementation of those interface classes only at the last derived subclass level. Implementation of a public or protected method in a base or intermediate class will only be allowed when the method is defined as virtual in the class, and the implementation must be overridden by all derived classes.

For a derived class where the parent's class implementation is fully sufficient, the derived class's override method will only explicitly call the parent class method.

This allows structural coverage tools to clearly demonstrate the execution of inherited functions by all derived classes.

8.14 Alternative Methods of Compliance

Not Applicable for this PSAC.

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9 Certification Schedule

The objective of this section is to provide a schedule of the software development activities for the Product Line DLCA-6500 software development, which meets the Schedule objective of the Plan for Software Aspects of Certification found in DO-178B [61], section 11.1.f.

The DLCA-6500 will follow its schedule that will correspond to certification millstones. Several key milestones include SOI 1, 2, 3, 4. Schedule details are specified in the project specific CIA.

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Appendix A List of Acronyms

Acronym	Definition
AC	Advisory Circular
ACARS	Aircraft Communications Addressing and Reporting System
ACS	ACARS Compatible System
ADS	Automatic Dependant Surveillance
AFDX	Avionics Full-Duplex Switched Ethernet
AFN	ATS Facilities Notification
AGPS	Air Ground Protocol Stack
AGS	ARINC-661 Graphics Server
ALM	Application License Manager
AMC	Acceptable Means of Compliance
API	Application Programming Interface
ARINC	Aeronautical Radio Incorporated
ARTCC	Air-Route Traffic Control Center
ASE	Application Service Element
ASL	Avionics System LAN
ASN.1	Abstract Syntax Notation One
ATC	Air Traffic Control
ATN	Aeronautical Telecommunications Network
ATP	Acceptance Test Procedures
ATS	Air Traffic Services
ATSU	Air Traffic Services Unit
BER	Binary Encoding Rules
BOP	Bit Oriented Protocol
BMS	Binary Message Server
BRS	Business and Regional Systems
CAST	Certification Authorities Software Team
CCB	Change Control Board
CCM	Common Computing Module
CDA	Commanders Digital Assistant
CIO	Common Input/Output
CM	Context Management
CMU	Communications Management Unit
CNS	Communications, Navigation, and Surveillance
CODEC	Coder/Decoder
CORE	Computing on Redundant Elements
COTS	Commercial off the Shelf
CPCI	Computer Program Configuration Item
CPDLC	Controller Pilot Data Link Communication
CR	Change Request
CRC	Cycle Redundancy Check

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Acronym	Definition
CRI	Certification Review Item
CS	Computer Software
CSC	Computer Software Component
CSU	Computer Software Unit
DAC	Design Assurance Center
DAL	Design Assurance Level
DLCA	Data Link Communications Application
DLCS	Data Link Communications System
DM	Data Manager
DO-178B	FAA Software Development Standard
DOORS	Dynamic Object Oriented Requirements System
DSI	Dialogue Service Interface
EASA	European Aviation Safety Administration
EER	Engineering Estimate Request
EICAS	Engine Indicating Crew Alert System
EMOD	Engineering Modification
FAA	Federal Aviation Association
FANS	Future Air Navigation System
FAR	Federal Air Regulations
FDOR	Flight Deck Operational Requirements
FHA	Flight Hazards Analysis
FMF	Flight Management Function
FMS	Flight Management System
GPS	Global Positioning System
HCLT	HCL Technologies Limited
HL	High Level
HLR	High Level Requirements
HMI	Human Machine Interface
ICAO	International Civil Aviation Organization
IDC	India Design Center
IDE	Integrated Development Environment
ID	Identification
IMA	Integrated Modular Avionics
IOC	Input/Output Concentrator
IOCF	Input Output Common Format
IPC	Integrated Processing Cabinet
IPS	Integrated Platform Software
JAR	Joint Airworthiness Requirements
KDI	Kernel Downloadable Image
LAN	Local Area Network
LCVSM	Lifecycle Value Stream Manager
LLR	Low Level Requirements
LTC	Lead Technical Contact
MIB	Managed Information Base

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Acronym	Definition
MIN	Message Identification Number
MRN	Message Reference Number
NAND	Not And
NDA	Next Data Authority
NDO	Network Data Object
NVM	Non-Volatile Memory
OEM	Original Equipment Manufacturer
OOT	Object-Oriented Technology
OS	Operating System
PC	Personal Computer
PCT	Partition Configuration Table
PDR	Preliminary Design Review
PDU	Protocol Data Unit
PE	Project Engineer
PM	Protocol Manager
POSIX	Portable Operating System Interface
PSAC	Plan for Software Aspects of Certification
Systems PSAC	Program Specific Plan for System Integration Aspects of Certification
RAM	Random Access Memory
RBT	Requirements Based Test
RBTCA	Requirements Based Test Coverage Analysis
RCI	Rockwell Collins India
RCPN	Rockwell Collins Part Number
REV	Revision
RIU	Radio Interface Unit
RFS	Run For Score
RTCA	Radio Technical Commission for Aeronautics
RTTI	Run-Time Type Identification
RUDP	Reliable User Datagram Protocol
SAP	Financial Analysis Software
SARD	System Architecture Requirements Document
SARPS	Standards and Recommended Practices
SAS	Software Accomplishment Summary
SCA	Structural Coverage Analysis
SCL	Software Control Library
SCM	Software Configuration Management
SDD	Software Design Document
SDP	Software Development Plan
SIL	Service Information Letter
SOI	Stages of Involvement
SQA	Software Quality Assurance
SQAP	Software Quality Assurance Plan
SRD	Subsystem Requirements Document
SRS	Software Requirements Specification

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Acronym	Definition
SSA	System Safety Analysis
STP	Software Test procedure
SVPR	Software Verification Procedure and Results
TBD	To Be Defined
TCR	TSO Compliance Representative
TPM	Technical Project Manager
TSO	Technical Standard Order
UPER	Unaligned Packed Encoding Rules
VAPS	Virtual Applications Prototyping System
VCT	Virtual Machine Configuration Table
VDD	Version Description Document
VDLM2	VHF Digital Link Mode 2
VHF	Very High Frequency
WDI	Well Defined Interface
WKN	Well Known Names
WKS	Well Known Services
WP	Work Package
XML	eXtensible Markup Language

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Appendix B DO-178B Matrix

The following table is a correlation between RTCA DO-178B [61] guidelines and the sections in this document addressing those guidelines.

RTCA DO-178B Section and Title		PSAC Section Number and Heading	
System Overview	11.1.a	Systems Overview	3
Software Overview	11.1.b	Software Overview	4
Certification Considerations	11.1.c	Certification Considerations	5
Software Life Cycle	11.1.d	Software Life Cycle	6
Software Life Cycle Data	11.1.e	Software Life Cycle Data	7
Certification Schedule	11.1.f	Certification Schedule	9
Additional Considerations	11.1.g	Additional Considerations	8

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Appendix C OORA

#	Criteria	Score	Comments / Rationale	FAA Cross References
1	**Experience with Civil Aircraft Certification (5.1.1)**	0	India Design Center (IDC) has supported multiple certifications for DLCA.	8100.11D (8.b.1) 8150.1D (6-5.a, 6-5.b)
2	**Language Capabilities (5.1.1)**	0	IDC is able to speak and write in English	14 CFR Part 21 (21.24.c.2, 21.29.a.3)
3	**Facility Location (3.4, 5.1.1)** **Note: If the product is seeking an FAA TSO, RC U.S. must control all changes and maintain the U.S. as the State of Design and Location of Manufacture. Civil approval may also be sought from the foreign country instead of an FAA TSO.**	10	There is no bilateral agreement between the FAA and India	14 CFR Part 21 (21.43) 8100.11D (6, 8.a.3, 8.a.4, 8.a.7, 8.b.9, 8.b.10, 9) 8150.1D (2-3.a, 2-3.b)
4	**Experience with Applicable Means of Compliance (i.e. DO-178[], DO-254, DO-297, ARP4754[]) (5.1.1)**	0	IDC has worked on DAL-C or higher projects in the past. This project, DLCA-6500, is a DAL-C project	8100.11D (8.b.1, 8.b.5) 8150.1D (6-5.a, 6-5.b)
5	**Quality Assurance Support (5.1.1)**	5	IDC has a DAC Representative which will participate in peer reviews. RC-Cedar DAC Representative will monitor IDC's efforts and may participate in some reviews.	8100.11D (8.b.1, 8.b.2, 8.b.8) 8150.1D (2-3.a.1.b) 8150.1D (6-5.a, 6-5.b)
6	**Functional Domain Knowledge of Staff (5.1.1)**	5	None of the IDC (offshore) engineers are expected have 5 years or more Data Link domain experience.	8100.11D (8.a.6) 8150.1D (6-5.a, 6-5.b)

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#	Criteria	Score	Comments / Rationale	FAA Cross References
7	**Location of Design Data and Manufacturing Data (3.4, 5.1.1)**	0	SVN will be used to store data.	14 CFR Part 21 (21.140, 21.146.b, 21.146.f) 8150.1D (6-1.c.4, 6-2.d.4, 6-4, 6-7)
8	**Outside DER Involvement (5.1.1)**	0	IDC does not use offshore DERs	8100.11D (8.a.8, 8.b.8) 8150.1D (6-5.a, 6-5.b)
9	**Safety Perspective (5.1.1)**	0	No safety activities will be performed by IDC.	8100.11D (8.a.6, 8.b.1) 8150.1D (6-5.a, 6-5.b)
10	**RC Team O/O Experience (5.1.1)**	0	IDC has been previously used for verification and some development.	8100.11D (8.a.6, 8.b.1, 8.b.8) 8150.1D (6-5.a, 6-5.b)
		20		

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Appendix D Process Deviations/Additions

This appendix documents the known planned deviations and additions to the Software Development Plan [6] and related process documents. These deviations and additions represent the desired state of the development and verification processes at the time of this PSAC writing. It is expected that these changes will be formally included in subsequent released versions of the SDP and its related process documents.

D.1 Combine Design and Code artifacts in a single review

Section 7.4.3.2 in the *Software Development* [6] describes the entry conditions for performing a peer review of the software source code whereby the relevant software architecture, detailed design, and low-level requirements have been reviewed and approved.

While the relevant software architecture and low-level requirements are still required to be reviewed and approved as an entry condition, this deviation will allow the detailed design artifact(s) to be reviewed along with the software source code in a combined peer review.

D.2 Copyright Notice

The Coding standard document [7] Section 3.2.2 mentions about the need to update the Copyright information in the Code files. It states that Each year shall be stated if the code has been developed over a period of years.

The deviation is the above statement is not met for all the code files that are changed in the past few years and the code files that are going to change in the future. Work package DLSS-9155 is raised to update the coding standard document [7] to remove the requirement for a copyright notice in Software Data Files.

D.3 _Safety attribute

The Doors Documentation Method [59] section 5.4.1 mentions that the “_Safety” attribute should be set to blank for any new or modified requirement. The final value will be set by the System Safety Engineer after review.

The deviation is the above statement is not met for all the Doors SRS documents that are changed in the past and that are going to change in the future. Currently what we are following is that the engineer fills out the safety attribute and then the safety reviews it and if they disagree this suggestion then a change will be made. Safety does not fill this attribute out. Work package DLSS-9628 is raised to update the Doors Documentation Method.

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Appendix E Hardware Dependent Components

This appendix documents the different SAS's used by the applicable software components. The DLCA software is able operate on multiple hardware platforms.

Table 9-1 -Hardware Dependent Components

	Applicable SAS	
Component	**AFD-37X0**	**CCM**
Platform Software	[46]	[27]

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Appendix F Level of Involvement Self-Assessment

FAA 8110.49A, Appendix A[65] contains three worksheets that may be used to help the certification authority or designee determine an appropriate level of involvement in software projects. The worksheets are provided as examples only; may contain criteria that are not applicable to all projects; and their use, individually or in combination, is not mandatory. Worksheet 1 indicates a level of involvement based on the software level of the project. Worksheet 2 allows for additional refinement of involvement based on more specific criteria. Worksheet 3 uses the total score result from Worksheet 2 to indicate a level of involvement.

The following tables contains DLCA's self-assessment. The TSR score was 142. Based on a TSR score result of 142 and DLCA having a DAL C Software level, the recommended level of involvement is LOW per the worksheet tables provided in FAA8110.49A[65].

Worksheet 1: Level of Involvement Based on Software Level

RTCA/DO-178B/C Software Level	Level of Involvement
D	LOW
C	LOW or MEDIUM
B	MEDIUM or HIGH
A	MEDIUM or HIGH

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Worksheet 2: Level of Involvement Based on Other Relevant Project Criteria

	Criteria	Scale	MIN.		MAX.	Score
1.	**Applicant/Developer Software Certification Experience**					
1.1	Experience with civil aircraft or engine certification.	Scale: # projects:	0 0	5 3-5	10 6+	10
1.2	Experience with RTCA/DO-178B/C.	Scale: # projects:	0 0	5 2-4	10 5+	10
1.3	Experience with RTCA/DO-178 or RTCA/DO-178A.	Scale: # projects:	0 0	3 4-6	5 7+	0
1.4	Experience with other software standards (other than RTCA/DO-178 [ ]).	Scale: # projects:	0 0	2 4-6	4 7+	4
2.	**Applicant/Developer Demonstrated Software Development Capability**					
2.1	Ability to consistently produce RTCA/DO-178B/C software products.	Scale: Ability:	0 Low	5 Med	10 High	10
2.2	Cooperation, openness, and resource commitments.	Scale: Ability:	0 Low	5 Med	10 High	10
2.3	Ability to manage software development and sub-contractors.	Scale: Ability:	0 Low	5 Med	10 High	10
2.4	Capability assessments (for example, Software Engineering Institute Capability Maturity Model, ISO 9001[]).	Scale: Ability:	0 Low	2 Med	4 High	2
2.5	Development team average based on relevant software development experience.	Scale: Ability:	0 < 2 yrs	5 2-4 yrs	10 > 4 yrs	5
3.	**Applicant/Developer Software Service History**					
3.1	Incidents of software-related problems (as a % of affected products).	Scale: Incidents:	0 > 25%	5 > 10%	10 None	5
3.2	Company management's support of designees.	Scale: Quality:	0 Low	5 Med	10 High	10
3.3	Company software quality assurance organization and configuration management process.	Scale: Quality:	0 Low	5 Med	10 High	10

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	Criteria	Scale	MIN.		MAX.	Score
3.4	Company stability and commitment to safety.	Scale: Stability:	0 Low	3 Med	6 High	6
3.5	Success of past company certification efforts.	Scale: Success:	0 None	3 > 50%	6 All	6
4.	**The Current System and Software Application**					
4.1	Complexity of the system architecture, functions, and interfaces.	Scale: Complex:	0 High	5 Med	10 Low	0
4.2	Complexity and size of the software and safety features.	Scale: Complex:	0 High	5 Med	10 Low	5
4.3	Novelty of design and use of new technology.	Scale: Newness:	0 Much	5 Some	10 None	5
4.4	Software development and verification environment.	Scale: Environ:	0 None	3 Older	6 Modern	3
4.5	Use of alternative methods or additional considerations.	Scale: Standard:	0 Much	3 Little	6 None	3
5.	**Designee Capabilities**					
5.1	Experience of designee(s) with RTCA/DO-178B/C.	Scale: Projects:	0 < 5	5 5-10	10 > 10	5
5.2	Designee authority, autonomy, and independence.	Scale: Autonomy:	0 None	5 Self-starter	10 Outgoing	5
5.3	Designee cooperation, openness, and issue resolution effectiveness.	Scale: Effectiveness:	0 Non-Responsive	5 Responsive	10 Cooperative/Open	5
5.4	Relevance of assigned designees' experience.	Scale: Related:	0 None	5 Somewhat	10 Exact	5
5.5	Designees' current workload.	Scale: Workload:	0 High	5 Medium	10 Low	5
5.6	Experience of designees with other software standards (other than RTCA/DO-178[]).	Scale: Projects:	0 < 5	3 5-10	5 > 10	3

Total Score Result (TSR): 142

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Worksheet 3: Level of Involvement Combining Results of Worksheet 2 with Software Level

Total Score Result (TSR)	Software Level A	Software Level B	Software Level C	Software Level D
TSR ≤ 80	HIGH	HIGH	MEDIUM	LOW
80 < TSR ≤ 130	HIGH	MEDIUM	MEDIUM	LOW
130 < TSR	MEDIUM	MEDIUM	LOW	LOW

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