ARINC

SOFTWARE DATA LOADER USING ETHERNET INTERFACE

ARINC REPORT 615A-3

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Report 615A-1	November 14, 2000	January 12, 2001
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Report 615A-3	October 11, 2006	June 30, 2007

A description of the changes introduced by each supplement is included on Goldenrod paper at the end of this document.

FOREWORD

Aeronautical Radio, Inc., the AEEC, and ARINC Standards

Aeronautical Radio, Inc. (ARINC) was incorporated in 1929 by four fledgling airlines in the United States as a privately-owned company dedicated to serving the communications needs of the air transport industry. Today, the major U.S. airlines remain the Company's principal shareholders. Other shareholders include a number of non-U.S. airlines and other aircraft operators.

ARINC sponsors aviation industry committees and participates in related industry activities that benefit aviation at large by providing technical leadership and guidance and frequency management. These activities directly support airline goals: promote safety, efficiency, regularity, and cost-effectiveness in aircraft operations.

The Airlines Electronic Engineering Committee (AEEC) is an international body of airline technical professionals that leads the development of technical standards for airborne electronic equipment-including avionics and in-flight entertainment equipment-used in commercial, military, and business aviation. The AEEC establishes consensus-based, voluntary form, fit, function, and interface standards that are published by ARINC and are known as ARINC Standards. The use of ARINC Standards results in substantial benefits to airlines by allowing avionics interchangeability and commonality and reducing avionics cost by promoting competition.

There are three classes of ARINC Standards:

a) ARINC Characteristics – Define the form, fit, function, and interfaces of avionics and other airline electronic equipment. ARINC Characteristics indicate to prospective manufacturers of airline electronic equipment the considered and coordinated opinion of the airline technical community concerning the requisites of new equipment including standardized physical and electrical characteristics to foster interchangeability and competition.

b) ARINC Specifications – Are principally used to define either the physical packaging or mounting of avionics equipment, data communication standards, or a high-level computer language.

c) ARINC Reports – Provide guidelines or general information found by the airlines to be good practices, often related to avionics maintenance and support.

The release of an ARINC Standard does not obligate any airline or ARINC to purchase equipment so described, nor does it establish or indicate recognition or the existence of an operational requirement for such equipment, nor does it constitute endorsement of any manufacturer's product designed or built to meet the ARINC Standard.

In order to facilitate the continuous product improvement of this ARINC Standard, two items are included in the back of this volume:

An Errata Report solicits any corrections to the text or diagrams in this ARINC Standard.

An ARINC IA Project Initiation/Modification (APIM) form solicits any recommendations for addition of substantive material to this volume which would be the subject of a new Supplement.

ATTACHMENTS

APPENDICES

1.1 Purpose of this Report

This document provides general and specific design guidance for the development of software data loading equipment for all types of aircraft. The primary purpose of data load is to upload loadable software parts to airborne computers. A secondary function of data load is downloading data from airborne computers. Software data load functionality generally falls into the following categories:

- Portable Data Loader (PDL) for loading equipment on the ground or carried onto aircraft to perform onboard loading.
- Airborne Data Loader (ADL) for installation on aircraft to perform onboard loading.
- Data Load Function (DLF) is software that performs the data loading.

This document defines data loaders designed to load avionics equipment over a high-speed interface using an Ethernet network protocol. This document defines media interfaces and protocol requirements specific to all data load functions, whether portable or airborne. This document also describes the desired capabilities of data loading equipment and the standards necessary to ensure interchangeability of equipment and mass storage media.

COMMENTARY

Earlier 615A reports defined a rigid description of an Airborne Data Loader (ADL) and a Portable Data Loader (PDL) as hardware/software implementations. The term "Data Loading Function" or DLF is defined in this report to generally define a data loading function implemented as a software module which may execute in hardware installed onboard the aircraft or on portable computer equipment carried onto the aircraft by maintenance personnel or used in the shop.

This edition of the report recognizes that portable data loaders are increasingly based on COTS ruggedized PC hardware that hosts a software-based data loading application. General requirements for a PDL are provided which can be applied to COTS or purpose-built PDLs.

Form and fit interchangeability is specified and expected for the ADL, but not specified for the PDL where maximum flexibility of hardware implementation is desired.

COMMENTARY

Avionics equipment that is loadable over the ARINC 429 data bus will continue to be load**ed by data loaders defined by ARINC Report 615. ARINC Report 615A is also being used to load avionics over other avionics buses using elements of the Ethernet protocol (e.g., ARINC 615A over AFDX; ARINC 615A over CAN Bus).**

COMMENTARY

Equipment manufacturers should note that this document aims to encourage them to optimize the characteristics of the data loader; ease of use, cost, maintenance, performance, weight and size. They are at liberty to accomplish this objective by means of design techniques they consider to be the most appropriate as their customers are interested primarily in the end result rather than the means employed to achieve it.

1.2 Document Conventions

ARINC documents are voluntary standards intended to ensure interoperability of equipment independent of the manufacturer or the airframe installation. Some data loader functions defined in this document must be implemented in order to meet a minimum level of compatibility between loaders (and other tools) designed to this standard, loadable software designed to this standard, and software transport media designed to this standard.

In this document, “should” is used to define a capability that must be implemented for the unit to meet the minimum level of compatibility intended by this standard and “does/is/will” are used to express a statement of fact based on other requirements. “May” is used to express an optional capability. In cases where these capabilities are implemented, it should be implemented in a specific manner defined in this standard. Otherwise an incompatibility may exist with the aircraft or other interfacing equipment.

1.3 Function of the Equipment

The data loaders should be able to retrieve a software part from various sources such as mass memory or removable media.

Transfers between the data loader and the target hardware should occur via an Ethernet data bus defined in **ARINC Specification 664 Part 2:** *Ethernet Physical and Data Link Layer Specification* and **ARINC Specification 664 Part 3:** *Internet Based Protocols and Services*.

The transfer of data from the data loader to the airborne computer is referred to as “uploading.” The transfer of data from the airborne computer to the data loader is referred to as “downloading.” Both upload and download capability is desired for the data loader.

Airline operators desire a data loader that is capable of supporting the new generation of avionics equipment that requires high-speed loading due to the increased size of operational programs and data being loaded. The data loader should support new generation avionics equipment that is foreseeable over the operational life of the airplane. Some airline operators may install both new generation and legacy generation equipment requiring loading by ARINC 615A and ARINC 615 (via the ARINC 429 protocol). The ARINC 615A definition should not preclude the combination of both data loading types in one data loader device.

COMMENTARY

The airline user community set the desired operational capability for data loading. The following specifications should be viewed as minimum capabilities. Airlines welcome additional improvements if they are cost-effective.

The goal is to load any target hardware within 15 minutes. This is made relatively easy by the high speed nature of Ethernet, but care should be taken when ARINC 615A is transported over other networks (example: CAN Bus or AFDX). When other networks are involved, network bandwidth can slow the data loading transaction.

Use of hard-wired selection switches for selection of devices to be loaded is undesirable. The network nature of Ethernet and the addressing features of ARINC 615A should be used to support target identification.

Operator interaction should be limited to the installation of the physical media (if used), selection of the target hardware, selection of software part(s), and verification that the load operation is complete. Other desired characteristics of the human interface are described in Appendix A.

1.3.1 Interrelationship of ARINC Standards Relating to Data Loading

Data loading is performed in the context of the following ARINC Standards:

ARINC Report 664: *Aircraft Data Network*

ARINC 665: *Loadable Software Standard*

ARINC 666: *Electronic Distribution of Software*

ARINC 667: *Guidance for the Management of Field Loadable Software (FLS)*

An overview of the relationships among these documents can be found in ARINC 667 Figure 1-1 Field Loadable Software Process Overview.

1.4 Unit Description

In this document all references to the “data loader” should be interpreted as meaning the PDL, ADL, or DLF.

1.4.1 PDL Description

The PDL should be a portable unit housing all of the components, electronic circuitry, controls, etc., incident to the functioning of the system within an easily transportable instrument case. All control and status indications should be available on the front panel of the PDL. This unit is intended for use on all avionics equipment with loadable software.

The PDL is expected to perform the data loading functions defined in this document. However, some airline operators may desire a more elaborate portable device that is capable of performing additional functions such as retrieval of maintenance data from ARINC 604 BITE systems or ARINC 624 Onboard Maintenance Systems. Also, since the PDL is not an aircraft part and may be based on COTS products, relaxed environmental requirements are applied to this unit.

COMMENTARY

The PDL should be a portable device housing all of the components, electronic circuitry, controls, etc., required to support data loading in an easily transportable package. All control and status indications **should be available via dedicated enunciators or a user-friendly graphical interface. The PDL should support data loading of all avionics equipment with embedded software loadable via the 615A protocol.**

Some airline operators may desire to use the PDL to perform additional maintenance functions. This functionality may be readily supported by the PC and COTS nature of next generation PDLs. Additional functionality can be added by additional software applications. The specific nature of this extra functionality is out of scope of this document.

1.4.2 ADL Description

The ADL should be consistent with on-board equipment features including standard aircraft instrument panel mounting features, cable connection, easy access, environmental performance, and provide for straight forward operation. The design should provide adequate protection of the medium from contaminating environments.

1.4.3 Data Load Function (DLF) Description

An ARINC 615A-compliant data loading utility can be used for ARINC 615A data loading. The data loading software-based utility may be hosted on a PC architecture device such as an Electronic Flight Bag (EFB) or other portable computing device, an on-board portable device, or an avionics device. Such a combination of hardware and software provides the functionality of ARINC Report 615A data loading.

A Data Load Function supporting 615A data load and executing in an onboard computing device is typically a proprietary design specified and controlled by the airframe manufacturer. A typical architecture is a terminal function (a terminal dedicated to general aircraft/cockpit activities or specific to aircraft maintenance) and a 615A data load application and software part repository hosted on a server.

Retrofit DLF functionality may be supplied as well. As an example, DLF functionality may be provided by an ARINC Report 615A-compliant data loading utility hosted on a PC architecture device such as an Electronic Flight Bag (EFB) or a retrofit airborne server. Such a combination of hardware and software provides the functionality of an ADL or a PDL, as appropriate.

1.5 Interchangeability

1.5.1 Media Interchangeability

Interchangeability of the formatted medium is desired regardless of the manufacturing sources of the data loader or the media.

1.5.2 Unit Interchangeability

Interchangeability of data loader equipment is desired regardless of the manufacturing source.

1.6 Interoperability

Avionics equipment intending to comply with this standard should be designed to meet the electrical and functional interface characteristics of this standard.

Interoperability between ARINC 615A and ARINC 615 data loaders is desirable. On airplanes where there is a mix of ARINC 615A and ARINC 615 loadable avionics equipment, the load port should support either data loader or a combined ARINC 615A/615 data loader.

The standards contained herein may be applied to other equipment capable of data loading, though not specifically dedicated to the data loading function. When the ADL function is incorporated into other systems located on the airplane it is recommended that those systems should contain the digital interfaces and protocols specified in this document and support the standardized media types, if applicable.

Software parts loaded via this standard should be compliant with **ARINC Report 665:** *Loadable Software Standards*.

1.7 Reliability of Portable Devices

The anticipated use of the data loader demands attention to the need for reliability in all phases of design, production, installation, and operation of the equipment.

COMMENTARY

The designer may be surprised to find no elaborate requirements for reliability. The airlines are in a most fortunate position in this regard because they have found the pressures of the “marketplace” exert a truly meaningful influence upon the design and production quality control necessary to achieve high equipment reliability.

1.8 Maintainability

ADL and purpose built PDL designs: equipment design should be modular in concept and should be designed and assembled to facilitate shop repair.

COTS-based equipment: should be maintainable at a modular level and repairable within COTS repair channels.

1.9 Regulatory Approval

A PDL is considered ground support equipment and is not an aircraft part. An ADL is an aircraft part and should meet all applicable regulations.

1.10 Related Documents

Refer to Appendix B for a complete listing of the documents that apply to ARINC Report 615A.

2.1 Introduction

This section sets forth the physical criteria, input and output interfaces, and power supply characteristics desired for the Portable Data Loader (PDL) and Airborne Data Loader (ADL).

Manufacturers should note that, although this report does not preclude the use of different interface and interwiring features, the practical problem of redesigning to accommodate some special system could very well make the use of that other design prohibitively expensive for the customer. They should recognize, therefore, the practical advantages of developing equipment in accordance with the standards set forth in this document.

COMMENTARY

DO-160 characteristics provided below may not be sufficient for all aircraft. Equipment manufacturers should consult the aircraft manufacturer's specifications for interoperability as they may be more stringent than specified below.

2.2 Form Factor and Connectors

2.2.1 Physical Size

2.2.1.1 PDL Physical Size

The PDL should be designed to be a portable flight line piece of test equipment. Although no restrictions have been made on the actual size of the PDL, the users desire that this unit be as small as possible. Shock absorbing bumpers or rails could be an attractive feature to users concerned about durability. All accessory components such as cables and media could be carried as an integral part of the PDL completely contained within the packaging unit.

2.2.1.2 ADL Physical Size

The ADL should be designed for commercial aircraft instrument panel mounting height and width dimensions found in MS25212. Panel height should not exceed 4.5 inches maximum including power supply. Any vibration/shock isolation features needed to meet this application should be contained within the enclosure and not require any special alignment for installation. ADL length should be limited to 7.0 inches maximum from rail mounting surface of front panel to the rear of the chassis excluding connector protrusion.

COMMENTARY

Although MS25212 limits instrument depth to 6.5 inches, the ADL may exceed this value to a limit of 7.0 inches. Though undesirable, the manufacturers believe that this depth is necessary to house the disk drive. If you can make it shorter, by all means do it.

2.2.2 Data Loader Weight

2.2.2.1 PDL Weight

The packaged weight of the PDL should not exceed 17.6 pounds (8 kg). The weight should be distributed as evenly as possible so as to provide for convenient transportation by one person using only one hand.

2.2.2.2 ADL Weight

The packaged weight of the ADL should not exceed 6.6 pounds (3 kg).

2.2.3 Controls and Indicators

2.2.3.1 PDL Controls and Indicators

The PDL operator's interface should be via a graphical interface or by a control panel. The control features should be designed for ease of use and should contain all controls necessary to control system functions and all indicators necessary to determine system and functional status.

2.2.3.2 ADL Annunciator Lights

The ADL should contain a method of displaying the status of the current operation. Any indicators should not distract the flight deck crew during flight.

COMMENTARY

There are conflicting views as to whether or not operational status indicators should appear on the panel of the ADL. Some indicated that with the MCDU interface, ADL status indicators are redundant and could be distracting to operators. For applications where the MCDU interface is not implemented, however, status indicators were felt to be necessary for operator usage. The solution to this problem recommended herein is to mount the status indicators behind a movable panel (e.g., the disk drive access door) so that they will be visible only with the door open.

2.2.4 Connector

2.2.4.1 PDL Interface Cable

The PDL interface cable connector that mates to the aircraft is an MS27473T-18A-53P or equivalent. The placement of signals on this connector should be backward compatible with ARINC Report 615 to allow manufacturers to supply a combined ARINC 615A/615 data loader in one physical package if desired. Refer to Attachment 1 for connector pinout definition.

The connector on the PDL-end of the cable is not defined in this specification.

2.2.4.2 ADL Connector

The ADL interface connector should be an MS27508E-18A-53P mounted on the rear panel of the unit. Refer to Attachment 1 for connector pinout definition. The placement of signals on this connector should be backward compatible with ARINC Report 615 to allow manufacturers to supply a combined ARINC 615A/615 data loader in one physical package if desired.

2.2.5 Data Bus Interface

The interface to the data loader is an Ethernet interface.

COMMENTARY

Data loader and Target HW devices are expected to support 10BaseT connections. If a data loader or device supports higher speed connections (e.g., 100BaseT), then it must be able to automatically fallback to a lower speed when connected to a slower device.

2.3 Power Circuitry

2.3.1 Primary Power Input

The data loader should be able to operate from a variety of power sources and/or autonomously via battery power. The data loader should operate with no degradation in its specified performance through a power interruption of 20 millisecond duration.

ADL Power

The ADL should be able to operate normally in the range of 104 to 122 Vac (RMS), 380 to 420 Hz. The data loader should not be damaged by a power input in the range of 0 to 97 Vac (RMS) for a period of up to ten seconds. Additional guidance on power input is provided in ARINC Report 609: *Design Guidance for Aircraft Electrical Power Systems*.

PDL Power

The PDL input power is not specified.

2.3.2 Power Control Circuitry

The data loader should include automatic control features which prevent inadvertent upset of previously recorded data in the event of normal aircraft power cycling or power interrupts. The PDL should have a guarded power switch designed to prevent inadvertent power removal from the unit during the data transfer operation. The ADL should not require a separate power switch.

2.3.3 Internal Circuit Protection

COMMENTARY

DO-160 characteristics provided below may not be sufficient for all aircraft. Equipment manufacturers should consult the aircraft manufacturer's specifications for interoperability as they may be more stringent than specified below.

2.3.3.1 PDL Internal Circuit Protection

The PDL should contain over-current protection for the electronic circuits. The current rating of each circuit protection device should be clearly identified. If a fuse is employed in the design, spare fuses should be provided in an easily accessible storage location in the PDL.

2.3.3.2 ADL Internal Circuit Protection

The ADL should include internal circuit protection features which do not require the use of fuses. The ADL should sustain operation without damage or disturbance to previously recorded data when operated from a RTCA DO-160, Section 16, Category A power source, including voltage spikes per Section 17, Category A. The power supply should include overvoltage, undervoltage, and overload protection.

2.4 Environmental Conditions

The design of the data loader should be suitable for airline operation while meeting specified performance during and/or after exposure to the minimum environmental conditions listed in Attachment 5. Although the ADL can be expected to operate in a Category X environment per RTCA DO-160, Sections 10, 11, 12, and 14, measures should be taken to limit the potential for contaminant entry through the media access opening.

COMMENTARY

The document used for the environmental test of airborne equipment is **RTCA Document DO-160:** *Environmental Conditions and Test Procedures for Airborne Equipment*. Although the PDL is not airborne equipment and RTCA DO-160 is not directly applicable, the PDL will be operating in an environment very similar to that incurred by airborne equipment. Therefore, many of the test procedures in RTCA DO-160 for the data loader can be used exactly as provided. Other RTCA DO-160 test procedures are useful as guidance material for determining the test procedures needed to validate PDL operation in environmental conditions differing from those of the airborne unit.

2.4.1 Temperature

The data loader should be able to withstand a non-operating temperature range of -55^{o}C to +85^{o}C. The medium is expected to withstand non-operating temperatures within the range of -30^{o}C to +70^{o}C.

2.4.1.1 PDL Temperature

The PDL should be designed to operate in the temperature range of -15°C to +55°C.

COMMENTARY

Use of an internal fan for air circulation or a heater for warming is discouraged for the PDL. If used, manufacturers are urged to use fans that generate a minimal amount of noise.

2.4.1.2 ADL Temperature

The ADL should be designed to operate over the temperature range of RTCA DO-160, Category A1 equipment (-15°C to +55°C, +70°C short term) without the need for internal heaters or cooling air. Medium tracking compatibility which includes writing and reading at opposite temperature extremes without excessive data loss or upset of previously recorded data should be provided by the drive design.

2.4.2 Pressure

Both the ADL and PDL should be designed to operate at any pressure altitude ranging from -1000 feet to 15,000 feet. Further, the ADL should operate at up to 40,000 feet for as much as 15 minutes.

COMMENTARY

Operation at altitude of the PDL is not expected.

Although 40,000 feet is specified here, the marketplace will be expecting performance up to “the typical ceiling of the aircraft.”

2.4.3 Rain

The PDL should exhibit no physical deterioration due to exposure to a moderate rain with the cover properly installed. The PDL should operate with no degradation in its specified performance immediately after removal from the rain exposure.

2.4.4 Solvent Resistance

It is recommended that the PDL control panel and interface cable should be resistant to the following fluids which may come in contact with the equipment during normal airline service:

1. Engine oil per MIL-L-7808, MIL-L-23699, and P&WA Specification 521B, Type I and Type 2.
2. Hydraulic test fluid.
3. Jet engine fuel.
4. Windshield rain repellent.
5. De-icing fluid.

2.4.5 Vibration

The ADL should function without error, damage to medium, or upset of previously recorded data while operating in either write or read modes during vibration requirements of RTCA DO-160, Section 8, Category K, fixed wing aircraft. The unit should meet these requirements when instrument panel, console, or equipment rack (non-isolated) mounted in any of the normal mounting planes.

2.4.6 Shock/Handling

2.4.6.1 PDL Shock/Handling

It is recommended that the PDL should be capable of withstanding a drop of 30 inches in which the point(s) of impact can be corners or any surface of the PDL case. The PDL should not sustain any damage that would preclude meeting the operation and environmental conditions of this Report.

COMMENTARY

The importance of building an abuse resistant unit cannot be overly stressed. Ruggedized COTS equipment is recommended.

2.4.6.2 ADL Shock/Handling

The ADL should function without unrecoverable error, damage to medium, or upset of previously recorded data while operating in either write or read modes during a shock impact to any of the major axis as described in RTCA DO-160, Section 7 (6 Gs, 11 msec). The ADL should withstand normal bench handling shock without damage. The ADL should remain attached to its mounting when subjected to the crash safety requirements of RTCA DO-160, Section 7.

2.4.7 Electromagnetic Compatibility.

2.4.7.1 PDL Electromagnetic Compatibility

It is recommended that the PDL should be designed to operate in the presence of strong electromagnetic fields. The supplier should use design and fabrication techniques which will minimize the effect of such fields on the normal operation of the unit.

2.4.7.2 ADL Electromagnetic Compatibility

The ADL power supply should support operation as Category A equipment per RTCA DO-160, Sections 18, 19, 20, and 21. Under no circumstances should electro-magnetic interference result in permanent damage or upset of previously recorded data.

2.4.8 Dust

The ADL should exhibit no physical deterioration and should operate with no degradation to its specified performance during and following exposure to a dirty atmosphere. Any access opening should be fitted with a cover door and

gasket to minimize the opportunity for dust and other contaminants to enter the mechanism.

2.4.9 Explosive Atmosphere

The ADL should be designed to minimize the potential for ignition of explosive gases. RTCA DO-160, Section 9, Environment III, Category X applies.

2.4.10 Fungus Resistance

The ADL design should minimize the use of fungus nutrient materials. RTCA DO-160, Section 13, Category X environment applies.

2.5 Grounding

The data loader interface connector shell should be electrically bonded to chassis ground. The ADL panel mounting features should include bonding surfaces which maintain chassis ground continuity between the ADL chassis and the aircraft mating surfaces.

3.0 UNIT DESIGN

3.1 Introduction

This section provides data loader design guidance that enhances the usability of the data loader in real life operating conditions and environments. Key design goals are:

1. To make the controls easily operable in all environmental conditions, such as temperature extremes, lighting extremes, and operator weather protection clothing.
2. To make the data loading operation intuitive and unambiguous by providing task and context appropriate feedback in the form of messages or indicators, and providing continuous feedback about the progress of the load.
3. To provide data loader fault reporting in an easily understandable form with the intent of aiding the operator in isolating the source of a data loading problem.
4. To minimize shop maintenance time.

3.2 Controls

As a minimum, the data loader should provide controls to perform the following functions:

1. Mode Selection
2. Source Medium Selection
3. Load Selection
4. Load Destination Selection
5. Accept/Continue
6. Cancel/Abort
7. Target Hardware Identification

3.3 Indicators/Displays

The data loader should have a display as part of the integral control interface. The display should be easily readable in both direct sunlight and low ambient light conditions. Indicators may also be included. A display/indicator test should be performed automatically during the data loader self-test procedure.The display/indicators on the ADL should be hidden from view during flight. The display/indicators should provide the capabilities described in the following sections.

As a minimum, the display should be capable of displaying 15 alphanumeric upper case characters, plus the hyphen (-). All letters and numbers must be distinguishable from each other (e.g., “2” versus “Z” or “0” versus “Q”).

Indicators/displays with a limited life span (e.g., incandescent lamps) should be easily replaceable without disassembly of the unit.

COMMENTARY

Since the portable data loader is expected to operate in a wide range of temperatures, manufacturers are urged to select appropriate indicators/displays for the unit. The indicators/displays should operate over the entire operating temperature range specified.

The ADL indicators should be out of sight during flight operation to avoid distracting the crew. The indicators should, however, be easily accessible. It is acceptable to place indicators behind the media access door. At all times, the operator should be able to determine the following:

1. Loader is on and operating (activity and/or progress indication).
2. Loader mode of operation (upload, download, configuration verification, etc.).
3. In the event of a failure (Loader, Target, Media, etc.), it should be apparent that the failure exists. The appropriate actions to resolve the failure should be annunciated.
4. Pending operator action (e.g., select target, insert next disk, etc.).
5. Status of current operation (e.g., Ready, Complete, In Progress).

3.4 Legends and Instructions

All function selectors and indications on the data loader control panel should be clearly and unambiguously annotated. The size of the lettering and the display (if provided) of the PDL should be such that an operator with normal vision can read the information from a distance of 24 inches. The size of the lettering and the display (if provided) of the ADL should be such that an operator with normal vision can read the information from a distance of 18 inches.

COMMENTARY

The actual procedures for operation of the data loader may vary from user to user. It is expected that users will have their own set of instructions. However, the manufacturers are urged to provide as much help as possible to an operator without a manual at hand. It is expected that a basic set of instructions mounted on the equipment will be provided. The detail of these instructions should be of sufficient detail to preclude incorrect or hazardous use of the equipment.

3.5 Self-Load Capability

The data loader should be loadable from its local drives or by network means. As an option, it may be loadable from the Ethernet interface. Its software configuration should be displayed in the same manner as other ARINC 615A-compatible units. This includes conformance to **ARINC Report 665:** *Loadable Software Standards.*

3.5.1 Equipment Data Base

The data loader may be able to load an airplane-specific data base of loadable target hardware and a fleet-specific list of equipment names and their logical addresses.

3.5.2 Operational Software

The data loader may include the capability to update its own operational program.

3.6 Testing

It is recommended that the data loader should be capable of two modes of internal testing:

1. Self-test exercised automatically at the time of data loader power-up.
2. Maintenance diagnostic test.

3.6.1 Autonomous Self-Test

The data loader should have the capability to exercise a self-test. The self-test sequence should validate the ability of the unit to perform its intended function. The self-test should be executed at the time of power-up and whenever so directed by receipt of a self-test command.

As a minimum the self-test should involve an indicator test, an instruction set exercise for the processor used, a RAM memory check, and a check on PROM-based program content. If the unit uses programmable input/output (I/O), then a test should be run to validate the I/O.

3.6.2 Maintenance Diagnostic Test

A maintenance test media capable of a thorough test of the data loader should be provided by the supplier. When the maintenance test media is installed, the data loader should run a specialized test of the unit.

The maintenance diagnostic tests should, as a minimum, distinguish between failures of the media drive, media controller, interface electronics, and media. The data loader should include signal wrap-around capability at the Ethernet interface to allow as nearly a complete validation as is feasible with a minimum of additional test equipment. The test coverage should be 90% or better.

The method used to annunciate maintenance test failures is not defined herein and may be implemented at the manufacturer’s discretion.

COMMENTARY

The maintenance media is intended for detailed troubleshooting in the shop. Alternatively, it may be used for engineering analysis on board the aircraft. The internal self-test of the data loader is expected to be adequate for all routine line maintenance functions.

4.1 Removable Media

In addition to network loading capabilities, support for COTS removable media types may be provided:

- **PC Card, PCMCIA, CardBus**
- **USB memory stick**
- **Optical Disc - Compact Disc (CD) or Digital Versatile Disc (DVD) with a diameter of either 12 or 8 centimeters (cm)**

Supported, but not recommend for 615A applications:

- **3.5 inch floppy Disk (not recommended for new hardware designs, supported for legacy applications only)**

Use of other portable media types:

- **Other COTS removable media types may be used to support the transport of software parts to the data loader, but care should be exercised to choose removable media that will have reasonable hardware support level and a long commercial life in the market place.**

COMMENTARY

To support anticipated software part load sizes (up to 650 M-byte), the CD is the recommend removable media type for software part transport. It is inexpensive, widely supported with hardware and highly portable.

COMMENTARY

Loading directly from rotational media is not recommended if software parts can be stored in memory on the data loader and loaded directly from memory storage.

Sequential loading from multiple disks or from a mix of different media types is not supported by the data loader.

COMMENTARY

The avionics industry is moving to electronically distributed software (EDS). EDS allows software to be directly loaded to the data loader by network interface with software parts transferred and stored in onboard memory. It is acceptable for a data loader to receive parts by a fully electronic means for on-board storage in data loader memory storage. It is recommended that facilities for removable media be supported for field transfer of software parts, but this is not mandatory.

Use of a 3.5 inch floppy Disk for software part storage is not recommended and is supported for legacy applications only.

Use of the floppy Disk media for concurrent disk loads is not supported.

Swapping removable media is not supported.

The media should be compliant with ARINC Report 665.

4.1.1 3.5 Inch Floppy Disk (for Legacy Use Only)

The storage medium will be a 3.5 inch double-sided high-density (HD) magnetic diskette with 1.44 Megabytes of storage capacity. Interchangeability of the formatted medium is desired regardless of the manufacturing sources of the data loader or the diskettes.

4.1.1.1 Drive Mechanism

The drive mechanism and media loading features should operate reliably when mounted normally in any of the three primary axes, and exposed to typical commercial aircraft environments.

This disk drive mechanism should accept a 3.5 inch double-sided, high-density (HD) magnetic disk cartridge. The mechanism should be able to read and write to the formatted medium.

4.1.1.2 Physical Format

The data on the magnetic double-sided disk should be modified frequency modulation (MFM) encoded on 80 track/cylinder locations providing an unformatted storage capacity of 2 million bytes. The medium includes the standard features associated with the 3.5 inch hard-shell diskette including form factor, write protect, access shutter, chucking hub, etc. The MFM encoding, track preamble/postamble, gaps, sector ID field and data field, erasure direction, etc., should be in accordance with the ANSI standard format for high density (2 megabyte) 3.5 inch floppy disk media. Physical diskette recorded format characteristics are listed below for reference. They include the following:

Number of Cylinders	80
Number of Tracks	160
Number of Surfaces	2
Recording Density	17434 BPI (Side 1, TK 79)
Recording Method	MFM
Recording Range	22.428 mm to 41.961 mm (Side 0) 21.666 mm to 40.970 mm (Side 1)
Track Pitch	0.1875 mm TK-TK

4.1.1.3 Logical Format

The logical format for the 3.5 inch floppy disk is defined in **ARINC Report 665**.

4.1.2 PC Card Device (for Legacy Use Only)

The storage medium will be a PC Card Standard. The size of this card may be type 1, type 2 or type 3 (as defined in the PC Card definition). Technology of this card is not specified herein. (Flash memory, rotational hard disk and other technologies are acceptable.) Card technology and size are dependent on the market. The PC Card should be compatible with the PC Card Slot Standard. PC Card memory extension is not supported by this standard. The use of the PC Card for uploads is not supported by this standard.

COMMENTARY

The airlines do not want PC Cards to be used for uploads to avionics equipment. However, for non-commercial operations, the operator could perform functions which are not defined in this report. This might include erasure and “zeroizing” media, and other functions viewed to be desirable.

4.1.2.1 PC Card Interface

The AT Attachment (ATA), a storage interface standard developed by the National Committee on Information Technology Standards (NCITS) and accredited by the American National Standards Institute (ANSI), is utilized as the disk drive interface on most personal and mobile computers. Hardware drives and software drivers required for this interface should ensure compatibility with the PC Card ATA specification. The PC Card interface should accept type 1, 2, and 3 PC Cards.

To insure PC Card compatibility, the information in the Touples of the CIS (Cartridge Information Section) should be used to build a common table of access characteristics. Care should be taken in determining the power of the cartridge: some use 3.3 volts power, others use 5 volts power. Power information of the cartridge should be given by its hardware wiring and/or by a specific Touple from CIS.

4.1.2.2 Logical Format

The logical format for the PC Card device should be formatted in accordance with **ARINC Report 665**.

4.1.3 USB Memory Device

The storage medium will meet the USB 1.0 or 2.0 Standard. Technology of this card is not specified herein. Solid-state memory technology and storage size are dependent on the market. The USB memory stick should comply with the USB standard.

COMMENTARY

The airlines look for the most economic solutions for transfer of parts to the data loader for uploads to avionics equipment.

4.1.4 Optical Medium (CD and DVD)

The storage media should be a re-writable 12 cm Digital Versatile Disc (DVD-RAM), read-only Digital Versatile Disc (DVD-ROM) or Compact Disc (CD-ROM); and re-writable 8 cm DVD-RAM, DVD-ROM, or CD-ROM disc. Interchangeability of the storage media is essential, regardless of the manufacturing sources of the data loader or the disc.

4.1.4.1 12 cm Optical Disc

The 12 cm optical disc may be recorded in the methods described below. The data loader space requirements permit access for only a single disk drive. The disc may be inverted to access additional media. The various methods of recording and their corresponding capacities are as follows.

Recommend Optical Media for Most Applications:

1. Single side, single substrate Compact Disc physical format provides data density of 650 Megabytes (MB).
2. Single side, single substrate in DVD physical format provides data density of 4.7 Gigabyte (GB).

Alternatives:

1. Double substrate, double side in DVD physical format provides data density of 9.4 GB.
2. Single substrate, double layer with space between layers in DVD physical format provides data density of 8.5 GB.
3. Double substrate, quadruple layer with space between each layer in DVD physical format provides data density of 17.0 GB.

COMMENTARY

DVD/optical disc technology will likely evolve during the life of this Report revision (see front cover for date). New technology optical disc options may be considered, but should be evaluated carefully to assure long commercial life and adequate support of COTS hardware. It is recommended that the lowest acceptable size DVD storage format be used to support the largest population of field equipment.

4.1.4.2 8 cm Optical Disc

The 8 cm re-writable DVD-RAM, DVD-ROM or CD-ROM optical disc provides storage capacities of 1.4 GB, 1.4 GB, or 180 MB per side, respectively.

4.1.4.3 Drive Mechanism

The drive mechanism should be the 12 cm DVD type. The drive should provide read capability and may not provide write capability. A write capability is optional if downloading is supported and data transfer is made with physical media. The drive mechanism and media loading features should operate reliability when mounted in any of three primary axes. It is recommended that the optical drive be used only for

data transfer to or from internal storage, as using removable rotational media loading during ground operations is not recommended.

The drive mechanism should have adequate vibration resilience to operate when exposed to the typical ground handling environments of commercial aircraft when blocked or taxiing.

The disk drive mechanism should accept both 12 and 8 cm optical disc. The mechanism should be able to read only and support any DVD-RAM, DVD-R, DVD-ROM, CD-R/RW, and CD-ROM formatted medium.

4.1.4.3.1 Physical Format

Phillips – Sony Yellow Book defines the physical format for Compact Discs used for recording computer data.

Phillips – Sony Orange Book defines the physical format for Recordable Compact Discs.

ECMA – 267, Sections 4 and 5 define the DVD optical disc physical format

4.1.4.3.2 Logical Format

Removable media should be formatted in accordance with **ARINC Report 665**.

5.1 Introduction

This section defines the necessary Software Load Protocol functions for the Data Loader and on the device being loaded (hereafter called the Target Hardware). The correct implementation of the protocol will guarantee to an equipment supplier that the device will be able to be loaded by any Data Loader that respects the Standard.

This protocol takes into account some specifics of the loading process and of the Target Hardware. In general it expects the loading process to follow the scenarios defined in Attachment 2. The protocol also expects the Target Hardware to have the following attributes:

- A means to ensure that the software presented by the Data Loader has been loaded correctly before responding that the load is complete.
- A TFTP service that can handle the data loading protocol.
- The ability to enter a “data loading mode” if necessary, when the data loader requests a transfer.
- The ability to report part numbers of the loaded software.

The basic philosophy of the load protocol is that the operator is responsible for determining which loads are presented to the Target Hardware, the Target Hardware is responsible for determining which files are required to satisfy the load request, and the Data Loader simply acts as a file server. The Data Loader and the Target Hardware exchange all data through TFTP (Trivial File Transfer Protocol). This includes both loadable data and protocol overhead data.

The loadable data is contained in files of the load, while the communications protocol data is contained in special files called protocol files. Only the protocol files are described in this section. Protocol file names should be composed of all upper case alphanumeric characters. Software Loads are defined in and should be compliant with ARINC Report 665.

Unless otherwise specified, all port numbers are presented in decimal notation.

5.2 Scope

The Load Protocol specification defines a means to:

1. Upload ARINC 665 software parts to Target Hardware.
2. Download data from Target Hardware.
3. Get configuration information from Target Hardware.
4. Interrupt at any time any of the three previous operations (interruption requested by the operator or by the Target Hardware).
5. Obtain subscriber information (such as MAC address, IP address, and Target Hardware identifier.)

To this end this specification:

1. Defines the protocols for uploading, downloading and information operations, and interruption services.
2. Describes the messages exchanged between the Data Loader Protocol and the end user interface.

3. Defines the protocol files exchanged between the Data Loader and the Target Hardware.
4. Defines the Find Identification of Network Devices (FIND), which should be used to determine which Target Hardware is present on the network and to obtain minimal information to establish communications (see Attachment 3).

5.3 ARINC 615A Data Loading Architecture

5.3.1 General Description

Figure 5-1 shows the functional architecture of data loading under ARINC 615A protocol.

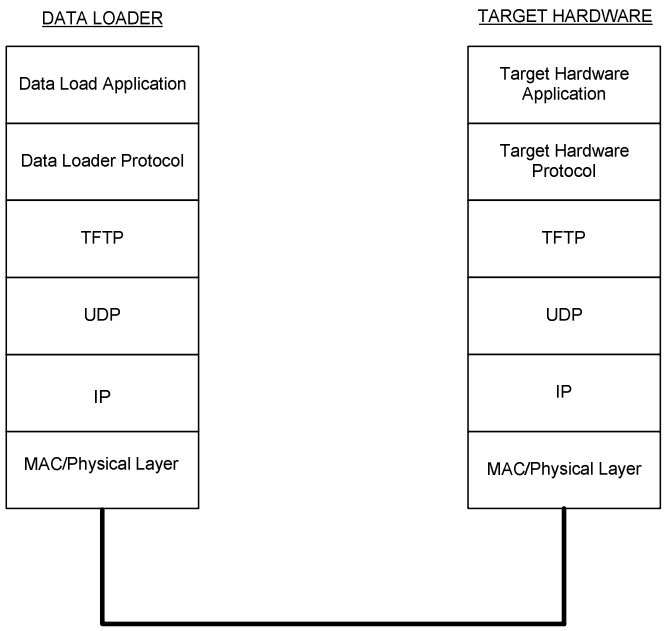


Figure 5-1 – Data Loading Functional Architecture

The architecture comprises the following layers:

1. **Application Layer. The Data Load Application (DLA) is located on the Data Loader and the Target Hardware Application (THA) is situated on the Target Hardware. These two applications are defined by the manufacturer of the data loader and the manufacturer of the embedded loader of the Target Hardware. These applications are not defined in this specification, but will use the messages provided by the lower layers. The DLA contains the user interface on the Data Loader.**
2. **Load Protocol Layer. This layer provides system load messages to the application layer. The Load Protocol Layer consists of the Data Loader Protocol (DLP) on the Data Loader side and the Target Hardware Protocol (THP) on the Target Hardware side. The aim of the Load Protocol sections is to define these protocols. The major function is to sequence and synchronize the TFTP machines.**
3. **TFTP (Trivial File Transfer Protocol). This layer offers all the mechanisms to transfer files. This protocol is defined in IAB (Internet Architecture Board) document RFC 1350.**

4. **UDP (User Datagram Protocol). This layer offers a non-connected datagram transfer mechanism. It is defined in IAB document RFC 768**
5. **IP (Internet Protocol). This layer provides the routing mechanisms to the UDP layer. It is defined in IAB document "RFC 791." The IP version considered in this standard is Version 4.**
6. **MAC/Physical Layer. The Internet Protocol Layer uses the Media Access Control (MAC) Services provided by this layer to access the Ethernet physical medium.**

COMMENTARY

All data exchanged by the Data Loader and the Target Hardware use the TFTP protocol. Exchanged data (Loadable Software, status or management information, results, etc.) reside in files sent using the TFTP protocol.

COMMENTARY

The system integrator may be faced with an interoperability issue when a Data Loader, which is designed to be connected on an Ethernet network wants to communicate with a Target Hardware designed to be connected on an ARINC 664 network. See Appendix E for data loading over an ARINC 664 network.

COMMENTARY

ARINC Report 615A does not define, in any way, MAC addresses or IP addresses.

5.3.2 TFTP Protocol

All the exchanges, **except FIND**, between the Data Loader and the Target Hardware are based on file transfers. Therefore, several types of files are defined as follows:

- Protocol files that are generated during a load process.
- Files of the Loadable Software Part as defined in ARINC Report 665.

The TFTP protocol is described in documents named RFC (Request for Comments) which are under the responsibility of the IAB (Internet Architecture Board). The references of this RFC are given below.

This section gives the option used by TFTP and the error messages concerning the transfer, this makes it possible to optimize the transfer of the file and the interoperability between any Data Loader and targets.

There is no maximum file size **imposed by TFTP**.

5.3.2.1 TFTP Reference Documents

The applicable TFTP RFCs are:

RFC	Title	Category
1123	Requirements for internet Hosts Application and support	Standard
1350	TFTP protocol (Revision 2)	Standard
2347	TFTP option extension	Standards track, Updates 1350
2348	TFTP Blocksize Option	Standards track, Updates 1350
2349	TFTP Timeout Interval and Transfer Size Option	Standards track, Updates 1350
1785	TFTP option negotiation analysis	Informational, Updates 1350

5.3.2.2 TFTP Options

The TFTP options may be implemented to give more efficiency to the file transfer. The option mechanism provides the ability to negotiate the value of the optional field and the ability to detect that the peer computer does not support this specific option. In this case, default standard values must be used. In any case the transfer should not fail due to a non-implemented option. After the end of the last TFTP option, no more UDP or IP data should be present. For all TFTP used in the ARINC Report 615A protocol (that is, protocol files as well as data files), the only mode used is the "octet" mode (binary). **The options are defined in Section 5.3.2.3.9.**

5.3.2.3 TFTP Adaptation to Data Loading Protocol

5.3.2.3.1 TFTP Super-set

ARINC Report 615A protocol is based on standard TFTP protocol. However, the Load Protocol Layer requires extensions to the standard TFTP protocol to handle issues such as target hardware mode changes and operator interruptions. In order to maintain the original TFTP packet types, the flexibility of the error packet is exploited to implement ARINC Report 615A specific messages. TFTP error packets containing a zero for the error code value are defined by their error message text. By defining unique ARINC Report 615A messages as specific text in the error message text field they have meaning for ARINC Report 615A applications, but look like errors in a normal TFTP session. The TFTP super-set is defined in Sections 5.3.2.3.4, Definition of the Wait Message and 5.3.2.3.6, Definition of the Abort Message.

5.3.2.3.2 Dedicated Port Number

Concerning Target Hardware, Upload operation implies a specific process, such as: erase, then program, and then check physical devices as flash memory. For this reason, suppliers of Target hardware may want to separate communication between the Data-Load application and other file-transfer applications. To enable such a functional switch in a simple way, a recommended solution is to use a different well-known port number. All TFTP used in the ARINC 615A protocol should use the well-known port number 59 (decimal) registered as "Any Private File Service." This approach implies the use of specific TFTP implementation or TFTP package allowing parameterization of the well-known port number.

5.3.2.3.3 Error Message General Description

If an error occurs during the transfer of a file, an error packet is sent to indicate the type of error. This packet is identified by the op code value of 05, followed by an error code value defined as follows:

Error Code Value	Meaning
0	Not defined, see error message
1	File not found
2	Access violation
3	Disk full or allocation exceeded
4	Illegal TFTP operation
5	Unknown transfer ID (port number)
6	File already exists
7	No such user
8	TFTP option refused
“Error message” in ASCII	Gives clearly the error message with ASCII character string

The error code value should be used to describe the error. The error message field should be used with the error code value of 0. The error message field may be used with error code values other than 0.

The error code value 3 should be used by the data loader to inform the target hardware that the data loader cannot open a new TFTP process because no more resources are available

The error code value 3 should also be used by the target hardware to inform the data loader that the target hardware cannot open a new TFTP process because no more resources are available.

5.3.2.3.4 Definition of the Wait Message

For the Load Protocol to simplify the exchange between the Data Loader and the Target Hardware, a wait message is implemented via the Error Message facility. It uses the Error Code 0. Either the Data Loader or the Target Hardware can initiate a wait message. This message may be generated in response to any TFTP transfer request.

The format of the wait message is: “WAIT:x” in ASCII, where x equals the wait time in seconds.

The unit receiving the wait message should abort the current TFTP transfer and initiate a new one after the specified time.

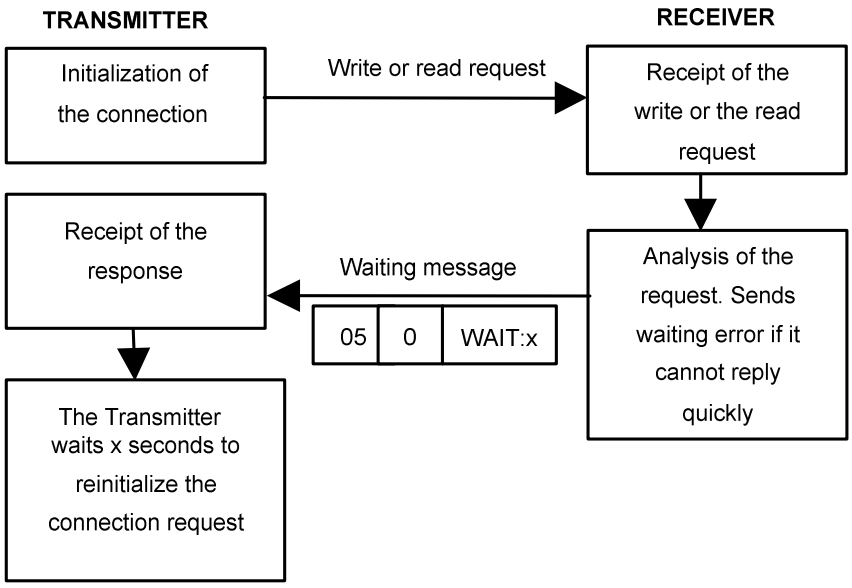
To clarify the format of this TFTP error, an example of the wait message with a wait time of 50 seconds is:

OpCode	Error Code Value	Error Message (Text)	ASCII String Termination
0x0005	0x0000	“WAIT:50”	0x00

The maximum value for the wait delay is 65,535 seconds.

5.3.2.3.5 Utilization of the Wait Message

This wait message is used only when a connection request (Read or Write) is received by a computer and when it cannot accept this connection because it is busy and/or it cannot reply to this request quickly. This is illustrated as follows:



5.3.2.3.6 Definition of the Abort Message

To abort the process in progress, the Data Loader Protocol sends an abort message in response to a TFTP request from the Target Hardware. It uses the Error Code value of 0. The format of this message is the following: “ABORT:XXXX” in ASCII. The XXXX string corresponds to the representation as four hexadecimal characters of the status code corresponding to the abort request by the Data Loader. This way, the Target Hardware is able to know the origin of the abort and memorize information if necessary, for example, to switch between operator abort or application abort. The format of this error is as follows:

OpCode	Error Code Value	Error Message (text)	ASCII String Termination
0x0005	0x0000	“ABORT:XXXX”	0x00

Note: XXXX = 4 ASCII characters representing the HEXADECIMAL value of the Load Status Code (Table 6.4.10-1).

5.3.2.3.7 Utilization of the Abort Message

This abort message is issued by the Data Loader when an abort_request is received by the Data Loader Protocol; this mechanism can be used by the Data Loader Protocol itself in case of detection of problems. This is illustrated as follows:

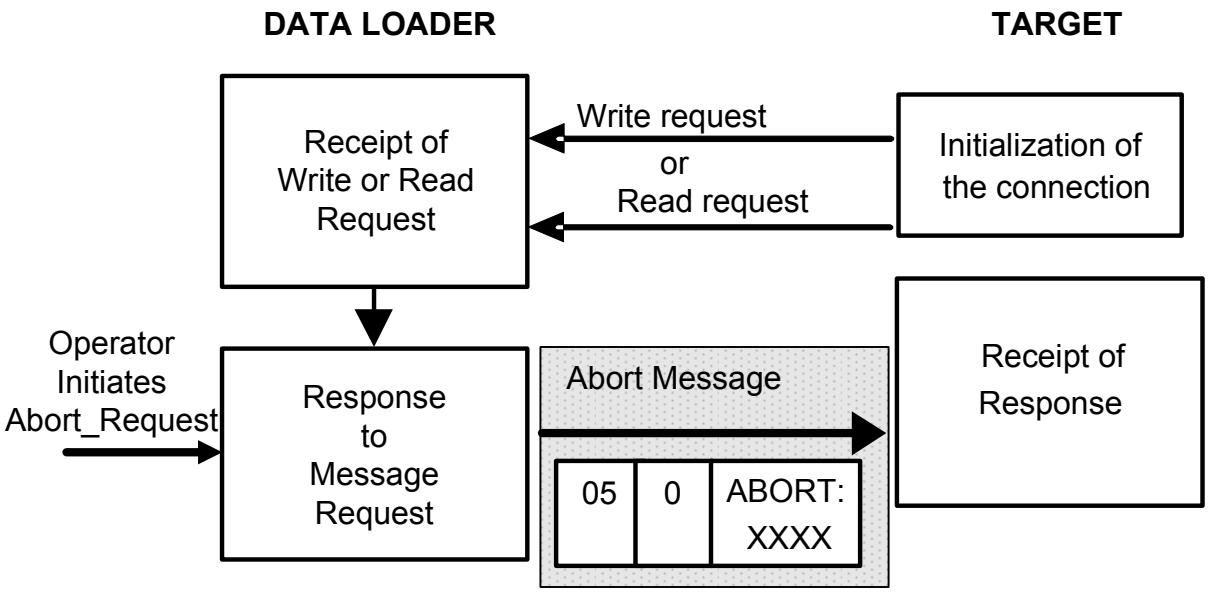


Figure 5-2 Abort Message Processing

5.3.2.3.8 TFTP Option Implementation

COMMENTARY

The following sections define how to implement the currently known options for equipment claiming conformance to this specification. It is important to understand that equipment may implement these options for increased functionality, but must operate with peers that only implement the minimal option values. It is also important that equipment accept any option request, but ignore options that it does not implement.

It is expected that special functionality can be implemented in the future through option negotiation. Since all unknown options should be ignored, equipment can ask for options, but only peers that contain matching functionality will respond. As an example, the desire to zeroize media after loading could be implemented as an option.

5.3.2.3.8.1 Blocksize Option Implementation

The Data Loader should implement the TFTP block size option, including the implementation of Internet Protocol (IP) fragmentation/re-assembly. This capability should be available on any data loader for the target hardware to use.

Target hardware may use the TFTP block size option. The default block size for TFTP is 512 bytes. Generally, a larger block size significantly decreases data load time. The target hardware designer has the responsibility to select adequate capability to ensure adequate performance versus additional complexity or technical needs, such as memory.

RFC 2348 defines the TFTP Blocksize Option.

5.3.2.3.8.2 File Transfer Size

This option may be used in the ARINC Report 615A protocol. If the transfer size value is specified and does not match the size of the data transfer, the transfer session should fail.

RFC 2349 defines the TFTP File Transfer Size Option.

5.3.2.3.8.3 Timeout Interval

This option may be used in the ARINC Report 615A protocol. Attachment 4 defines a simple and reliable protocol to clearly define time-outs and retries on error. The selected solution is based on static and fixed time-outs and maximal retry numbers. Reliable networks ensure low level of transmission error which will reduce retries. However, network latencies for other reasons, such as gateways and switches, may require longer timeouts.

RFC 2349 defines the Timeout Interval Option.

5.3.2.3.8.4 Part Number

This option may be used in the ARINC Report 615A protocol. Attachment 4 defines a simple and reliable protocol to clearly define time-outs and retries on error. The selected solution is based on static and fixed time-outs and maximal retry numbers. Reliable networks ensure low level of transmission error which will reduce retries. However, network latencies for other reasons, such as gateways and switches, may require longer timeouts.

RFC 2349 defines the Timeout Interval Option.

5.3.2.3.8.5 Checksum Option

This option may be used in the ARINC Report 615A protocol. Attachment 4 defines a simple and reliable protocol to clearly define time-outs and retries on error. The selected solution is based on static and fixed time-outs and maximal retry numbers. Reliable networks ensure low level of transmission error which will reduce retries. However, network latencies for other reasons, such as gateways and switches, may require longer timeouts.

RFC 2349 defines the Timeout Interval Option.

Option Purpose for Target Hardware File Read:

- **The Checksum Option provides the 615A protocol a way to distinguish between two files with the same file name in the same LSP during an upload operation.**
- **The Target Hardware should include the 16-bit CRC from the ARINC 665 LSP header file in the TFTP file request. The Data Loader should use the included CRC to locate the requested file.**

COMMENTARY

As originally written, ARINC Report 615A assumed all files in an ARINC 665 LSP would have unique file names meeting a specific file naming convention. As implemented, this is not true for all LSPs. This option enables the transfer of an LSP which contains duplicate file names.

Neither Target Hardware nor Data Loader is intended to calculate the CRC as part of the upload.

Option Purpose for Target Hardware File Write:

- **The Checksum Option provides the ARINC Report 615A protocol a way to provide CRC integrity checking of files written to the Data Loader during a Download Operation or Information Operation.**

COMMENTARY

As originally written, ARINC Report 615A provides no way for the Target Hardware to provide a CRC for Download Operation or Information Operation files. The Data Loader had no method of determining the integrity of data received.

The intent is for the Target Hardware to calculate and include one of the standard check value types described in Section 5.2 of ARINC Report 665-3 to verify the integrity of the received data. The check value type is determined by the Target Hardware designer. The Data Loader uses the information to be sure that it received the data properly.

COMMENTARY

The check value could be stored and exported to ground tools for subsequent validation that the data had not been changed during storage.

TFTP Option Implementation:

- **This option name should be “checksum _<num>”, where <num> identifies the algorithm used for checksum calculation by specifying its decimal number. The option value is a string representation depending on the selected checksum algorithm. “Num” is the Check Value Enumeration of the algorithm defined in Section 5.2, of ARINC Report 665-3.**

COMMENTARY

The Checksum Option operates similar to the transfer size option, except that it specifies the checksum value for the file instead of its size. The textual concatenation of the string "checksum_" and the algorithm number allows this option to behave like any other TFTP option extension.

Option Implementation Details for Target Hardware File Read:

- **The Target Hardware may support this option on some or all file read requests. When supported the checksum should be the 16 bit CRC from the ARINC 665 LSP header file.**
- **If the option is given and acknowledged, the Data Loader should use the 16 bit CRC Checksum Option to determine which file to send to the in the event that the file cannot be determined by filename alone.**

Option Implementation Details for Target Hardware File Write:

- **The Target Hardware may support this option on downloaded files and the LCL file. When supported the checksum should be of sufficient size to insure the integrity of the data transmitted. The checksum type is selected by the Target Hardware implementer. The Target Hardware should return the checksum value such that when the indicated algorithm is used over the entire file, the indicated checksum value is obtained.**
- **If the option is given, the option is acknowledged if the specified algorithm is supported; the Data Loader should calculate the same checksum on the entire data file and validate the integrity of the data received from the Target Hardware after the file transfer is complete.**
- **The Data Loader should not fail the TFTP transfer if the checksum validation fails. The Data Loader should indicate to the user that the downloaded file failed the checksum validation and suggest the operator repeat the operation. Whether or not the checksum validation passes, the Data Loader should handle the downloaded file in the same manner.**
- **The Data Loader may record in a log file or other record the checksum and the result of the checksum validation.**

COMMENTARY

The Checksum Option is only intended as an indicator to the operator as to the integrity of the data written to the data loader and not as an impediment to operations. As it is a value calculated by the Target Hardware (which may be of a higher software level than the Data Loader) and of an algorithm selected by the Target Hardware implementer to be sufficient to protect the data; it may also serve as a value that the Data Loader can store for future reference for long-term data integrity.

5.3.2.3.8.6 Port Option

The Port Option is specified by the ASCII string "port" in the frame. It indicates to the Target Hardware Loader that the Data Loader is requesting that all control port requests from the Target Hardware Loader for the current operation be at the new port value instead of the ARINC 615A default control port value of 59. This "port" option is not defined by TFTP in RFC 2347, but it does follow the option definition specified in RFC 2347, TFTP Option Extension. The Port Option is either accepted by the Target Hardware Loader or rejected by the Target Hardware Loader. If it is rejected by the Target Hardware the load operation may fail. Consistent with IANA (Internet Assigned Numbers Authority) rules, any new port values should be 49152 (decimal) or greater, to avoid confusion with IANA-registered port numbers.

The Port Option is only valid for operation initialization requests sent by the Data Loader, i.e., Upload Operation Initialization, Information Operation Initialization, etc. Use of this Port Option can only change the Data Loader control port from port 59 and cannot change the Target Hardware control port. The Target Hardware control port remains port 59. This supports the operation of the Data Loader in that the Data Loader always initiates any data load operation by sending a read or write request to the Target Hardware's control port, i.e., port 59.

COMMENTARY

This port option is used to give the Data Loader the ability to load itself using ARINC 615A protocol. This port option also allows the Data Loader to have different Target Hardware Loaders initiate communication with the Data Loader on different control ports which allows for less confusion when loading multiple targets.

5.3.2.3.9 TFTP Block Number

Concerning the TFTP block number, which is an unsigned 16-bit counter, the first data block should correspond to block number one in accordance with RFC 1350. A "WRQ" (Write ReQuest) is acknowledged with a "ACK" (ACKnowledge) packet having a block number of zero. If overflow occurs due to the number of transmitted blocks, the next value after 65535 should be one.

5.3.3 FIND Protocol

The FIND protocol allows the data loader to dynamically identify the subscribers present on the network and to obtain for each of them the communication parameters such as MAC address, IP address, target hardware identifier, and position. This protocol is defined in Attachment 3 of ARINC Report 615A. The FIND protocol is based on UDP packets; therefore, MAC addresses are supported by the applicable data link layer fields. In the same way, the applicable IP layer fields support IP addresses. The FIND protocol uses the port number 1001(decimal).

5.3.4 Target Hardware Instance (THW_ID_POS)

The specific instance of a Target Hardware on an airplane is represented as THW_ID_POS. The definition for target hardware type (THW_ID) is found in ARINC Report 665: *Loadable Software Standards.* The POS is 0 to 8 alphanumeric characters. The THW_ID field and the POS field are separated by an underscore character, "_".

COMMENTARY

The <THW_ID_POS> name is composed of two elements as follows:

The THW_ID described in ARINC Report 665 identifies generic equipment.

The POS (Position) identifies the instantiation of generic equipment (e.g., left and right positions)

The THW_ID_POS is obtained by merging the two fields, including an underscore between those two fields (e.g., HNPFMS_L" where the HNPFMS represents the target hardware type and L represents the left unit).

5.4 Operations

5.4.1 Introduction

The Load Protocol defines a set of protocol files to manage communications between the Data Loader Protocol layer and the Target Hardware Protocol layer. These Protocol Files are defined in Section 6.4.

The Load Protocol also defines a set of messages to manage communications between the Data Loader Application (DLA) and the Data Loader Protocol layer on the Data Loader. This section defines those messages. The names in [ ] are the names of the messages passed between the Data Loader Application and the Data Loader Protocol layers. The messages are described in greater detail in Sections 6.1 and 6.2. The applicable message name is shown above each bold black arrow on the very left side of the drawings in Section 6.3.

Complementary messages may be implemented on the target hardware side between the Target Hardware Protocol Layer and the Target Hardware Application layer, but the implementation is left to the equipment manufacturer.

COMMENTARY

The layered approach between the Data Loader Protocol layer and the Data Loader Application layer is used to define the message protocol between the two layers on the Data Loader. The target-hardware or data-loader designer may decide not to implement its equipment this way. Regardless, the protocol files between the Data Loader Protocol layer and the Target Hardware Protocol layer defined in this standard must be implemented.

These messages are used in the operations defined below:

1. Information Operation: The data loader gets information on the configuration of the Target Hardware.
2. Uploading Operation: The data loader uploads files to the Target Hardware.
3. Downloading Operation: The data loader downloads files from the Target Hardware.
4. Registration of all present target hardware through the use of the FIND protocol defined in Attachment 3.

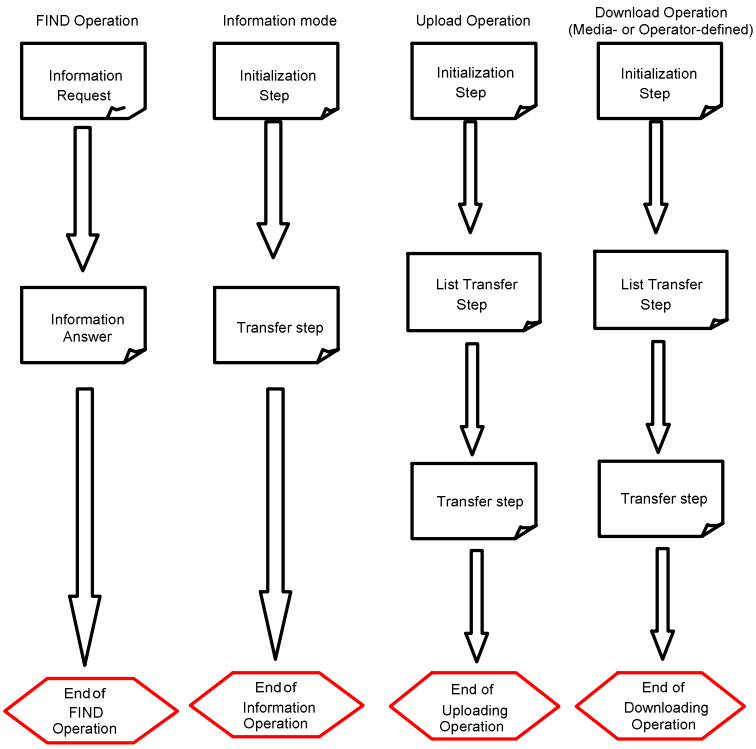


Figure 5-3 Data Loading Operations

These operations and their associated messages are independent and serial in nature. In other words, the data loading system should be able to perform the operations in any order, but a single operation needs to be completed before a second operation can be initiated for specific target hardware. Only the interruption messages are defined for all operations, so that any operation may be aborted.

The data loader should implement all four operations listed above.

The target hardware should implement FIND, information and upload operations and may implement download operations.

Before each operation, the data loader may run the FIND request and register all the answers, in compliance with the FIND definition in Attachment 3.

An answer to an ARINC 615A operation request that is not supported should be performed by a complete and correct initialization step, with the correct TFTP transfer of the first file. This file should contain an Operation Acceptance Status Code with the value of 0x1002, which means “operation not supported by the Target.”

If the Target Hardware does not implement all the operations, it should implement the initialization step of all operations in order to be able to answer to an operation request that it is not supported.

The different Operations and their associated messages are discussed in the following sections.

5.4.2 Information Operation

This operation is used during on-ground maintenance operations, with the intent to recover information on the configuration of the Target Hardware and Loadable Software Airplane parts (i.e., identifiers and part numbers of the hardware and the software).

The Data Loader should implement this operation. The Target Hardware should implement this operation.

In this operation, two steps are defined.

1. Initialization step: In the first step the Data Loader Applicaton (DLA) initializes the Information Operation. This step is used to inform the Target Hardware Application (THA) of this operation request and to determine if the Target Hardware is operational and only this.

   The access to this mode will be achieved through a [TH_Information_Initialization] message. The answer will be [Information_Initialization_Response]. It indicates the acceptance or the refusal of this request to the DLA. If the Target Hardware refuses the request then the DLA notifies the operator and aborts the Information Operation.

2. Transfer step: If the Initialization step is accepted, the target will send the file, <THW_ID_POS>.LCL, which contains Target Hardware information to the Data Loader Protocol. In addition, the Target Hardware periodically sends a status file to indicate the status of the process.

The messages are as follows:

1. [TH_Information]. It reports the requested Target Hardware information and completes the Information Operation.
2. [Information_Status]. It gives the progress and status of this operation. The *DLA* should inform the user of the current status and continue waiting for the [TH_Information] message.
3. TFTP options may be specified to provide data integrity checks for the data transfer. The target may implement the TFTP option. If the data loader supports the check value given, the data loader should validate the data transfer.

5.4.3 Uploading Operation

This operation is used during on ground maintenance operations to upload files from the Data Loader to the Target Hardware.

The Data Loader should implement this operation. The Target Hardware should implement this operation.

In this operation, three steps are defined:

1. Initialization step: In the first step the Data Loader Application (DLA) initializes the Uploading Operation. This makes it possible to inform the Target Hardware Application (THA) of a request for this operation and to determine if it is operational. The access to this mode will be accomplished through a [TH_Uploading_Initialization] message. The answer will be [Uploading_Initialization_Response]. It indicates the acceptance or the denial of this request to the DLA. If the Target Hardware refuses the request then the DLA notifies the operator and aborts the Upload Operation.
2. List transfer step: If the Initialization step is accepted, the Data Loader Application (DLA) will initiate the load list transfer by issuing the [Load List] message to the Data Loader Protocol. The Data Loader Protocol sends the list of loads which are to be potentially uploaded via the file <THW_ID_POS >.LUR. This list is analyzed by the Target Hardware and its sends its status via the file <THW_ID_POS>.LUS. If one of the loads is not accepted by the Target Hardware, the complete list should be rejected.

   The status messages will be [Upload_ Information_Status]. It gives the progress and status of this operation. The DLA should inform the user of the current status.
3. Transfer step: The Target Hardware obtains the loadable files by performing TFTP reads of the desired files of the Load.

The message [Upload_Information_Status] indicates the progress and status of the uploading to the THA.

In the case of a File not being available, the message [File_Not_Available] warns the operator.

The message [Upload_Information_Status] indicates also the completion success or failure of the uploading operation.

TFTP options may be supported and specified by data loader and target to provide data integrity checks. The data loader does not calculate the check values prior to transfer, it only transfers values obtained from the part header file. The target should include the check value for data transfers during the file request for which there is a duplicated file name in the part.

The target may implement the TFTP option and validate the data transfer.

5.4.3.1 Short Load

Short load is the action of transferring only the files of the load that have changed, rather than transferring the entire load when only a small number of files need change, thus greatly reducing the data transfer time.

The ARINC 615A protocol is designed so that the target hardware determines which files to request from the data loader after the header file is transferred to the Target Hardware. The header file contains a data file part number for each load file. The target hardware must keep track of the data file part numbers of the current load installed so that it can compare the data file part numbers of the header file from the new load being presented by the data loader. The target can then request only the data files that have changed to accomplish

the new load. The final load integrity check is still performed on the final NVM memory image and should match the check value contained in the new LSP.

The target hardware may also check CRC values of each file before deciding whether it is the same or different than the currently installed file. If either the file part number or file CRC does not match exactly, the file is transferred. Configuration management rules dictate that two files with the same PN should always have the same CRC value.

Achieving the maximum benefit of short load requires implementation of several items in the LSP structure:

- The load in this case should consist of several smaller files. Note that per RFC 1350 there is an optional two second dally time delay at the end of the transfer of each file during data load where the load stops and potentially nothing happens. Therefore, it is important to weigh the advantage of short loading versus the dally time penalty one will incur for each file during data loading, especially if a full load needs to be done.
- Specific file content should be selected to maximize the potential for the least number of files being impacted when the load is modified. In some cases this may drive the structure of the program or database that constitutes the load.
- Each file should be individually compiled and linked.
- The program memory map should be defined with spare memory (expansion space) for each file. Then a specific file can grow in size without recompiling, reloading or moving files that otherwise would not need to change.

Note: The LSP part number is tracked via the airplane installation authority. The part numbers of the data files of the load are tracked by the supplier configuration management system and not used by the maintenance personnel.

COMMENTARY

When performing short load, checks are made against the part number and CRC of the incoming load, and the part number and CRC of each data file associated with the load.

Short Loading requires the target loader to store much of the information contained in the Header file of each load in NVM so the comparisons can be made. It might be just easier to store in NVM the complete Header File of each load stored in memory so the comparisons can be made.

5.4.3.2 Full Load

As mentioned in the previous section, the ARINC 615A protocol is designed so that the target hardware determines which files to request from the data loader after the header file is transferred to the target hardware. Full load is where, due to target hardware design or load situations that dictate it as mentioned in

the previous section, all the data files of a load are requested by the target hardware from the data loader to be stored in memory.

There is no difference in data load protocol between short load and full load. The only difference is whether the target hardware requests a sub-set of the data file contained in a load from the data loader (short load), or the target hardware requests all the data files contained in a load from the data loader (full load).

If the target hardware does not have the capability to perform the necessary checks to select only those data files of a load that have changed and need to be transferred, then the target load asks for every data file contained in the load and stores the files in NVM.

5.4.4 Download Operation

This operation is used during on ground maintenance operations to download files from the Target Hardware to the Data Loader.

Two modes are considered: Media defined mode and Operator defined mode.

1. In Media defined download mode, a predefined list of Downloadable files is sent to the Target Hardware.
2. In Operator defined download mode, the Target Hardware sends the list of potentially downloadable files and the operator selects from the list the files which are to be Downloaded.

The Data Loader should implement the two modes. The Target Hardware may implement none, one, or both modes.

TFTP options may be specified to provide data integrity checks for the data transfer. The target may implement the TFTP option. If the data loader supports the check value given, the data loader should validate the data transfer. The validation of the checksum by the data loader is for information only and should not prevent data file from being exported.

5.4.4.1 Media Defined Download Mode

In this mode the Data Loader Application (DLA) determines which files, from the locally stored names, are available for download.

Initialization step: In the first step the DLA initializes the Downloading Operation. This makes it possible to inform the Target Hardware Application (THA) of this operation and to know if it is operational.

A <THW_ID_POS>.LNR may be already stored in an ARINC 665 part on the media.

Optionally, the LUH file can be selected by the operator and used to create the LNR file. The data loader should examine each part header file and offer the part numbers of the header files with download bits set to the operator. If more than one header file with the download bit set exists on the media, the operator may select one of these files.

The access to this mode will be achieved through a [Downloading_Disk_Initialization] message. The answer will be a [Downloading_Initialization_Response]. It indicates the acceptance or the denial of this request to the DLA. If the THA refuses the request then the DLA notifies the operator and aborts the Download Operation.

List Transfer step: In this step the Data Loader Protocol sends the list of downloadable files via the <THW_ID_POS>.LNR file. The status messages will be [Downloading_Information_Status]. The status message gives the progress and status of this operation to the DLA.

Transfer step: In this step, the list of downloadable files via the <THW_ID_POS >.LNR file is analyzed by the Target Hardware and it sends the files defined in the <THW_ID_POS >.LNR file.

The messages will be:

- [Downloading_File_Receipt] Informs the end user that the transfer is completed.
- [Downloading_Information_Status] Gives the progress and status of this operation to the *DLA*.

5.4.4.2 Operator Defined Download Mode

In this mode the Target Hardware Application (THA) sends the list of files which can be downloaded.

Initialization step: In the first step the Data Loader Application (DLA) initializes the Downloading operation.

This makes it possible to inform the THA of this operation and to know if it is operational. After this, the THA sends the list of files which can be downloaded.

The access to this mode will be achieved through a [Downloading_Operator_Initialization] message. The answer will be a [Downloading_Initialization_Response]. It indicates the acceptance or the denial of this request to the Data Loader.

List Transfer step: If this operation is accepted, the THA sends the list of potentially downloadable data files in the <THW_ID_POS>.LNL file by the [Downloading_File_List_Receipt] message. After this, the operator selects the downloadable files and the DLA sends this list of selected files via the <THW_ID_POS>.LNA file.

The messages will be:

- **[Downloading_File_List_Receipt] Gives the list of potentially downloadable data files.**
- **[File_Selection] Indicates the selected files to the Target Hardware.**
- **[Downloading_Information_Status] Gives the progress and status of this operation to the DLA.**
- **Transfer step: At the receipt of <THW_ID_POS>.LNA, this file is analyzed by the Target Hardware and it sends the specified file.**

- **[Downloading_File_Receipt] message, it informs the end user that the transfer is completed.**

5.4.4.3 Download Media Organization

When using removable media as the source of the LNR file and as the destination of the downloaded data the data loader may be unable to write to the media. The loader should prompt the operator to replace the download media with writeable media, or select a writeable media, before the loader starts the download operation. After asking the operator for writeable media, if the write to the media fails, the download should fail.

Each time a download is performed, the loader should create a new directory on the download media titled DNLD_DATA_<THW_ID_POS>_<number>. This directory is created in the root directory of the download media.

<number> is an incremental index used to identify unique file names, and incremented on each download. It starts with 1.

Each time a download is performed, the loader may create a file DNLD_INFO_<THW_ID_POS>_<number> to store manufacturer specific download information.

This file could contain information about start and end date/time of the download operation, CRCs and success or failure of the individual file transfers, etc.

Example structure of download media after some downloads:

/DLND_DATA_<THW_ID_POSxxx>_1/filemm
/DLND_DATA_<THW_ID_POSxxx>_1/filenn
/DLND_INFO_<THW_ID_POSxxx>_1

/DLND_DATA_<THW_ID_POSxxx>_3254/filemm
/DLND_DATA_<THW_ID_POSxxx>_3254/filenn
/DLND_INFO_<THW_ID_POSxxx>_3254

/DLND_DATA_<THW_ID_POSyy>_1/fileuu
/DLND_DATA_<THW_ID_POSyy>_1/filevv
/DLND_INFO_<THW_ID_POSyy>_1

5.4.5 Common Services

5.4.5.1 Status Messages

Status messages are used to determine the progress of the operation and to update the operator display. They are periodically sent by the Target Hardware to the Data Loader.

These status files are also used:

- As a “Heart Beat.”
- to abort an operation.
- to close any operation upon completion, i.e., indicate success or failure.

The names of these files are:

- <THW_ID_POS>.LCS for Information operation.
- <THW_ID_POS>.LUS for Uploading operation.
- <THW_ID_POS>.LNS for Downloading operation.

5.4.5.2 Transfer Interruptions

Both the data loader and target hardware have the ability to interrupt the transfer phase of Uploading, Downloading and Information operations.

The data loader initiates an interruption by responding to a TFTP write request for one of the operation status files <THW_ID_POS>.LCS, <THW_ID_POS>.LUS or <THW_ID_POS>.LNS with an Abort Message. The Abort message defined in Section 5.3.2.3.6 contains a status code reporting whether the operator or the data loader initiated the abort. The operator abort is initiated by a [Abort_Request] message to the Data Loader Protocol from the Data Loader Application. On receipt of the Abort Message, the target hardware aborts the operation in progress and responds with an operation status file echoing the status code from the Abort Message in its “operation” status code.

The target hardware initiates an interruption by setting the “operation” status code in the operation status file to 0x1003 indicating an abort by the target and transmits the status file. On receipt of the status file the data loader will abort the operation in progress.

After receiving the status file with the “operation” status code set to indicate an abort (0x1003, 0x1004, 0x1005) the data loader should display informative text about the interruption per the table in Section 6.4.10.

6.1 Data Loader Application Messages

Data Loader Application Messages are control and status messages between the user interface and the data loader protocol engine on the Data Loader. Messages shown in Table 6-1 are passed between the Data Loader Application (DLA) and the Data Loader Protocol (DLP) layers on the Data Loader, as illustrated in the Figure 5-1. The Target Hardware will require a complementary set of messages between the Target Hardware Protocol and the Target Hardware Application (THA) also illustrated in Figure 5-1. The implementation of the Target Hardware messages is left up to the equipment manufacturer, as it is not relevant to the standard as long as the protocol file operations are followed.

Table 6-1 – Summary of Protocol Messages

Operation	Step	Message	DLA DLP
Information	Initialization		
		[TH_Information_Initialization]	→
		[Information_Initialization_Response]	←
	Transfer		
		[TH_Information]	←
		[Information_Status]	←
		[Abort_Request]	→
Uploading	Initialization		
		[TH_Uploading_Initialization]	→
		[Uploading_Initialization_Response]	←
	List transfer		
		[Load_List]	→
		[Upload_Information_Status]	←
		[Abort_Request]	→
	Transfer		
		[File_Not_Available]	←
		[Upload_Information_Status]	←
		[Abort_Request]	→
Downloading Media defined mode	Initialization		
		[Downloading_Media_Initialization]	→
		[Downloading_Initialization_Response]	←
	List transfer		
		[Downloading_Information_Status]	←
		[Abort_Request]	→
	Transfer		
		[Downloading_File_Receipt]	←
		[Downloading_Information_Status]	←
		[Abort_Request]	→
Downloading Operator defined mode	Initialization		
		[Downloading_Operator_Initialization]	→
		[Downloading_Initialization_Response]	←
	List transfer		
		[Downloading_File_List_Receipt]	←
		[File_Selection]	→
		[Downloading_Information_Status]	←
Operation	Step	Message	DLA DLP

Operation	Step	Message	DLA DLP
		[Abort_Request]	→
	Transfer		
		[Downloading_File_Receipt]	←
		[Downloading_Information_Status]	←
		[Abort_Request]	→

6.2 Description of Messages

6.2.1 [TH_Information_Initialization] Message

6.2.1.1 When Generated

This message is generated by the Data Loader Application (DLA) to initialize the Information operation and to obtain the configuration of the Target Hardware.

6.2.1.2 Effect on Receipt

The Data Loader Protocol layer issues a TFTP read request for the file <THW_ID_POS>.LCI and evaluates the response from the Target Hardware. When the Target Hardware completes the TFTP Read, the Data Load Protocol layer generates the [Information_Initialization_Response] message giving the acceptance or the refusal to continue with this operation. If a WAIT message is received the Data Loader Protocol layer will retry the read request after the wait period.

6.2.1.3 Protocol File Used

The Data Loader Protocol layer will generate a TFTP read request of the file <THW_ID_POS>.LCI from the Target Hardware.

6.2.2 [Information_Initialization_Response] Message

6.2.2.1 When Generated

This message is generated by the Data Loader Protocol layer following the successful reception of the <THW_ID_POS>.LCI file or a transfer error.

6.2.2.2 Effect on Receipt

On receipt of the message, the Data Loader Application (DLA) will have the result of the Initialization step.

6.2.2.3 Protocol File Used

This message will be issued when the file <THW_ID_POS>.LCI is obtained by the Data Loader Protocol (TFTP Read).

6.2.3 [TH_Information] Message

6.2.3.1 When Generated

This message is generated following a [Information_Initialization_Response] message indicating the operation is accepted by the Target Hardware and the completion of the <THW_ID_POS>.LCL file transfer.

6.2.3.2 Effect on Receipt

On receipt of the message, the Data Loader Application (DLA) will update the Target Hardware configuration report with data contained in the <THW_ID_POS>.LCL file.

6.2.3.3 Protocol File Used

This message will be issued when the file <THW_ID_POS>.LCL is obtained by the Data Loader Protocol (TFTP).

6.2.4 [Information_Status] Message

6.2.4.1 When Generated

This message is generated zero or more times following an [Information_Initialization_Response] message indicating the operation is accepted by the Target Hardware. This message provides the status of the Target Hardware.

The [Information_Status] message is required when the delay time to recover the <THW_ID_POS>.LCL file is longer than the Data Loader Protocol timeout (DLP_TO defined in Attachment 4).

6.2.4.2 Effect on Receipt

The Operator is informed of the progress of the Information operation.

6.2.4.3 Protocol File Used

A TFTP write of the file <THW_ID_POS>.LCS will be periodically performed by the Target Hardware.

6.2.5 [TH_Uploading_Initialization] Message

6.2.5.1 When Generated

This message is generated by the Data Loader Application (DLA) to initialize the Uploading operation.

6.2.5.2 Effect on Receipt

The Data Loader Protocol layer issues a TFTP read request for the file <THW_ID_POS>.LUI and evaluates the response from the Target Hardware. When the Target Hardware completes the TFTP Read, the [Uploading_Initialization_Response] message is generated giving the acceptance or the refusal to continue with this operation. If a WAIT response is received the Data Loader Protocol layer will retry the read request after the wait period.

6.2.5.3 Protocol File Used

The Data Loader Protocol layer will generate a TFTP read request of the file <THW_ID_POS>.LUI from the Target Hardware.

6.2.6 [Uploading_Initialization_Response] Message

6.2.6.1 When Generated

This message is generated by the Data Loader Protocol following the successful reception of the <THW_ID_POS>.LUI file or a transfer error.

6.2.6.2 Effect on Receipt

On receipt of the message, the Data Loader Application (DLA) will have the result of the Initialization step.

6.2.6.3 Protocol File Used

This message will be issued when the file <THW_ID_POS>.LUI is obtained by the Data Loader Protocol (TFTP Read).

6.2.7 [Load_List] Message

6.2.7.1 When Generated

This message is generated by the Data Loader Application (DLA) in order to propose a list of Loads to be uploaded to the Target Hardware.

6.2.7.2 Effect on Receipt

The Target Hardware will decide which Loads will be uploaded*.*

6.2.7.3 Protocol File Used

The Data Loader Protocol will generate a TFTP write request of the file <THW_ID_POS>.LUR ~~on~~ *to* the Target Hardware. The TFTP write is started after the <THW_ID_POS >.LUS file is received by the Data Loader with the status code indicating the operation is accepted, but not yet started. This makes it possible to synchronize the Data Loader and the Target Hardware in the list transfer step.

6.2.8 [File_Not_Available] Message

6.2.8.1 When Generated

This message is generated by the Data Loader Protocol following a TFTP Read Request from the Target Hardware when the file is not immediately available for transfer The Target Hardware must try again after a delay time given by the Data Loader Protocol in a WAIT message.

6.2.8.2 Effect on Receipt

On receipt of this message, the Data Loader Application (DLA) will give a feed back about the delay to the Operator.

6.2.8.3 Protocol File Used

The answer to the TFTP Read Request of the file <name_of_the file> performed by the Target Hardware is a WAIT message via TFTP error packet with

Error code = 0 and

Error Message = WAIT:<DELAY TIME >

6.2.9 [Upload_Information_Status] Message

6.2.9.1 When Generated

This service is generated after a [Upload_Initialization_Response] message indicating the operation is accepted by the Target Hardware. This message provides the status of the Target Hardware.

6.2.9.2 Effect on Receipt

The Operator is informed of the progress and status of the Uploading operation.

6.2.9.3 Protocol File Used

A TFTP write of the file <THW_ID_POS>.LUS will be periodically performed by the Target Hardware.

6.2.10 [Downloading_Media_Initialization] Message

6.2.10.1 When Generated

This message is generated by the Data Loader **Application (DLA)** to initialize the Downloading in **Media Defined** mode.

6.2.10.2 Effect on Receipt

The Data Loader Protocol issues a TFTP read **request** of the file <THW_ID_POS>.LND and evaluates the response from the Target Hardware. **When** the Target Hardware completes the TFTP read, the [Downloading_Initialization_Response] message is generated giving the acceptance or the refusal, to **continue with** this operation**. If a WAIT message is received the Data Loader Protocol layer will retry the read request after the wait period.**

6.2.10.3 Protocol File Used

The Data Loader Protocol layer will generate a TFTP read request of the file <THW_ID_POS>.LND from the Target Hardware.

6.2.11 [Downloading_Initialization_Response] Message

6.2.11.1 When Generated

This message is generated by the Data Loader Protocol following the successful reception of the <THW_ID_POS>.LND file, or <THW_ID_POS.LNO> file, or a transfer error.

6.2.11.2 Effect on Receipt

On receipt of the message, the Data Loader Application (DLA) will have the result of the Initialization step.

6.2.11.3 Protocol File Used

This message will be issued when the file <THW_ID_POS>.LND or the file <THW_ID_POS>.LNO is obtained by the Data Loader Protocol (TFTP Read).

6.2.12 [Downloading_File_Receipt] Message

6.2.12.1 When Generated

This message is generated by the Data Loader Protocol for each data file received.

6.2.12.2 Effect on Receipt

The Data Loader Application (DLA) informs the operator of the receipt of the data file

6.2.12.3 Protocol File Used

Not applicable.

6.2.13 [Downloading_Information_Status] Message

6.2.13.1 When Generated

This message is generated after a [Downloading_Initialization_Response] message indicating the operation is accepted by the Target Hardware. This message provides the status of the Target Hardware.

6.2.13.2 Effect on Receipt

The Operator is informed of the progress and status of the Downloading operation.

6.2.13.3 Protocol File Used

A TFTP write of the file <THW_ID_POS>.LNS will be periodically performed by the Target Hardware.

6.2.14 [Downloading_Operator_Initialization] Message

6.2.14.1 When Generated

This message is generated by the Data Loader Application (DLA) to initialize the Downloading in Operator Defined mode.

6.2.14.2 Effect on Receipt

The Data Loader Protocol issues a TFTP read request of the file <THW_ID_POS>.LNO and evaluates the response from the Target Hardware. When the Target Hardware completes the TFTP Read the [Downloading_Initialization_Response] message is generated giving the acceptance or the refusal to continue with this operation. If a WAIT message is received the Data Loader Protocol layer will retry the read request after the wait period.

6.2.14.3 Protocol File Used

The Data Loader Protocol layer will generate a TFTP read request of the file <THW_ID_POS>.LNO from the Target Hardware.

6.2.15 [Downloading_File_List_Receipt] Message

6.2.15.1 When Generated

This message is generated by the Data Loader Protocol on the successful receipt of the file <THW_ID_POS>.LNL.

6.2.15.2 Effect on Receipt

The Data Loader Application (DLA) informs the Operator of the receipt of the data file. This file is used by the Operator to select the data files which will be downloaded.

6.2.15.3 Protocol File Used

The Target Hardware will generate a TFTP write request of the file <THW_ID_POS>.LNL ~~on~~ to the Data Loader.

6.2.16 [File_Selection] Message

6.2.16.1 When Generated

This message is generated by the Data Loader Application (DLA) to transfer the choice of Data files to the Target Hardware.

6.2.16.2 Effect on Receipt

The Target Hardware knows the Data files which are to be downloaded to the Data Loader.

6.2.16.3 Protocol File Used

The Data Loader Protocol will generate a TFTP write request of the file <THW_ID_POS>.LNA to the Target Hardware.

6.2.17 [Abort_Request] Message

6.2.17.1 When Generated

This message is generated by the Data Loader Application (DLA) to trigger an abort of an operation (Upload or Download or Information).

6.2.17.2 Effect on Receipt

When the Data Loader Protocol receives from the target a request to open a TFTP request to write the file <THW_ID_POS>.LCS, .LUS or .LNS. It refuses the TFTP request and sends an *A*bort Error message to the target which stops the operation in progress. After this, the target sends the file <THW_ID_POS>.LCS, .LUS or .LNS with the status code 0x1004 (if aborted by the data loader) or 0x1005 (if cancelled by the operator) to inform the data loader that the abort or cancellation has been taken into account.

6.2.17.3 Protocol File Used

The Data Loader Protocol will send an Abort message via a TFTP Error packet on receipt of a TFTP write request of the file <THW_ID_POS>.LCS, <THW_ID_POS>.LUS or <THW_ID_POS>.LNS. The TFTP Error packet has:

Error Code = 0 and

Error Message = ABORT:XXXX

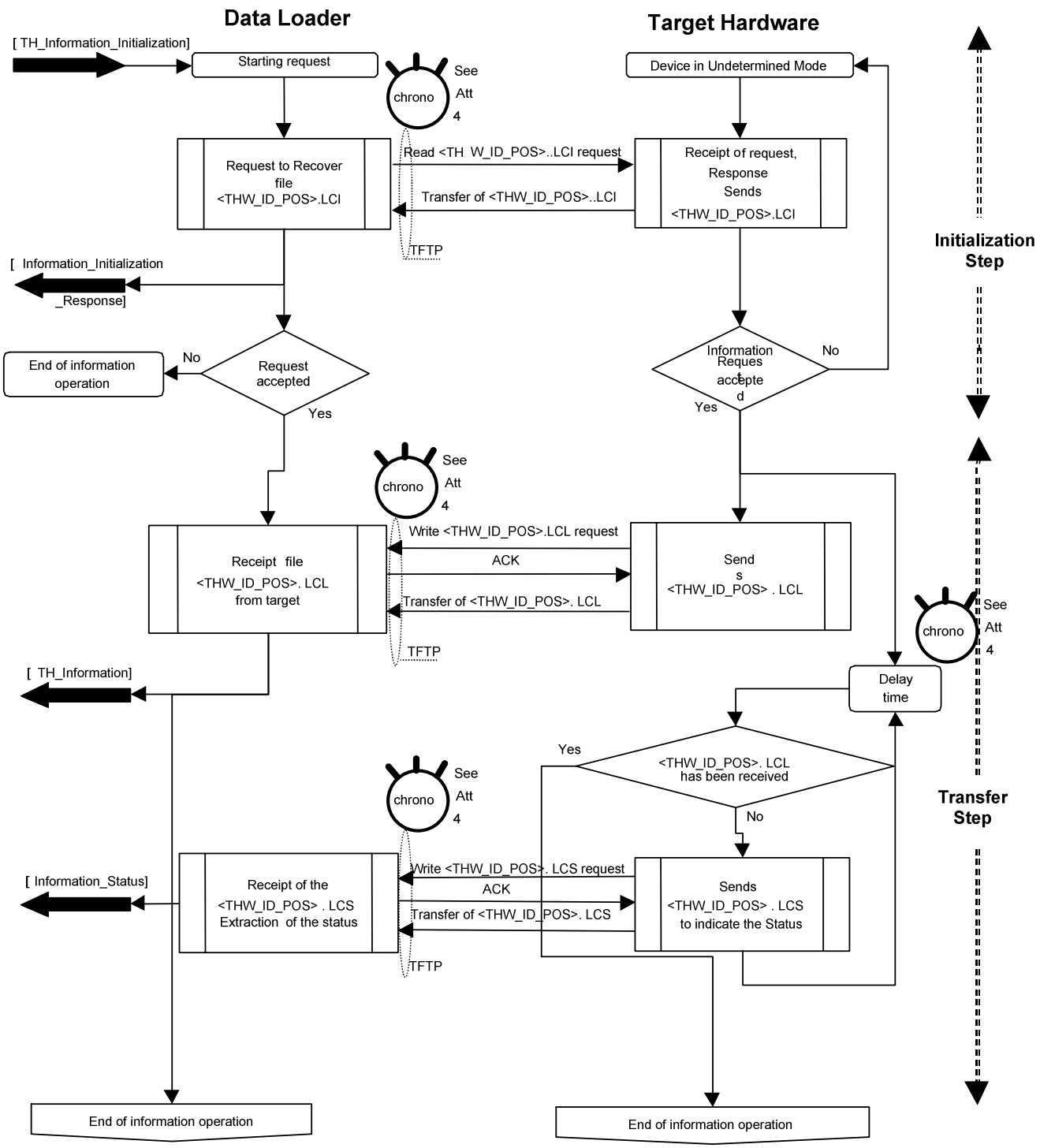
where XXXX = 0x1004 or 0x1005 as defined in Table 6.4.0-1

6.3 Message Sequence Chart

6.3.1 Information Operation: Initialization and Transfer Step

The files used are: <THW_ID_POS>.LCI, <THW_ID_POS>.LCL, and <THW_ID_POS>.LCS.

6.0 LOAD PROTOCOL DEFINITION



Explanation of the diagram above:

- The [message name] and bold black arrows under the [message name] on the very left of the figure indicate the messages passed between the Data Loader Application layer and the Data Loader Protocol Layer.
- The bold chrono circles with three tabs indicate a place in the protocol process that a TFTP time-out (TFTP_TO) may occur. See Attachment 4 for an explanation of the protocol time-outs.
- The steps following the initialization step may have variable duration. So, to check that both sides (data loader and target hardware) are always in data loading operational mode and in a coherent internal state, status files are frequently sent by the target hardware to the data loader, allowing each one to control the other.
- Any invalid structure is considered to be a fatal error.

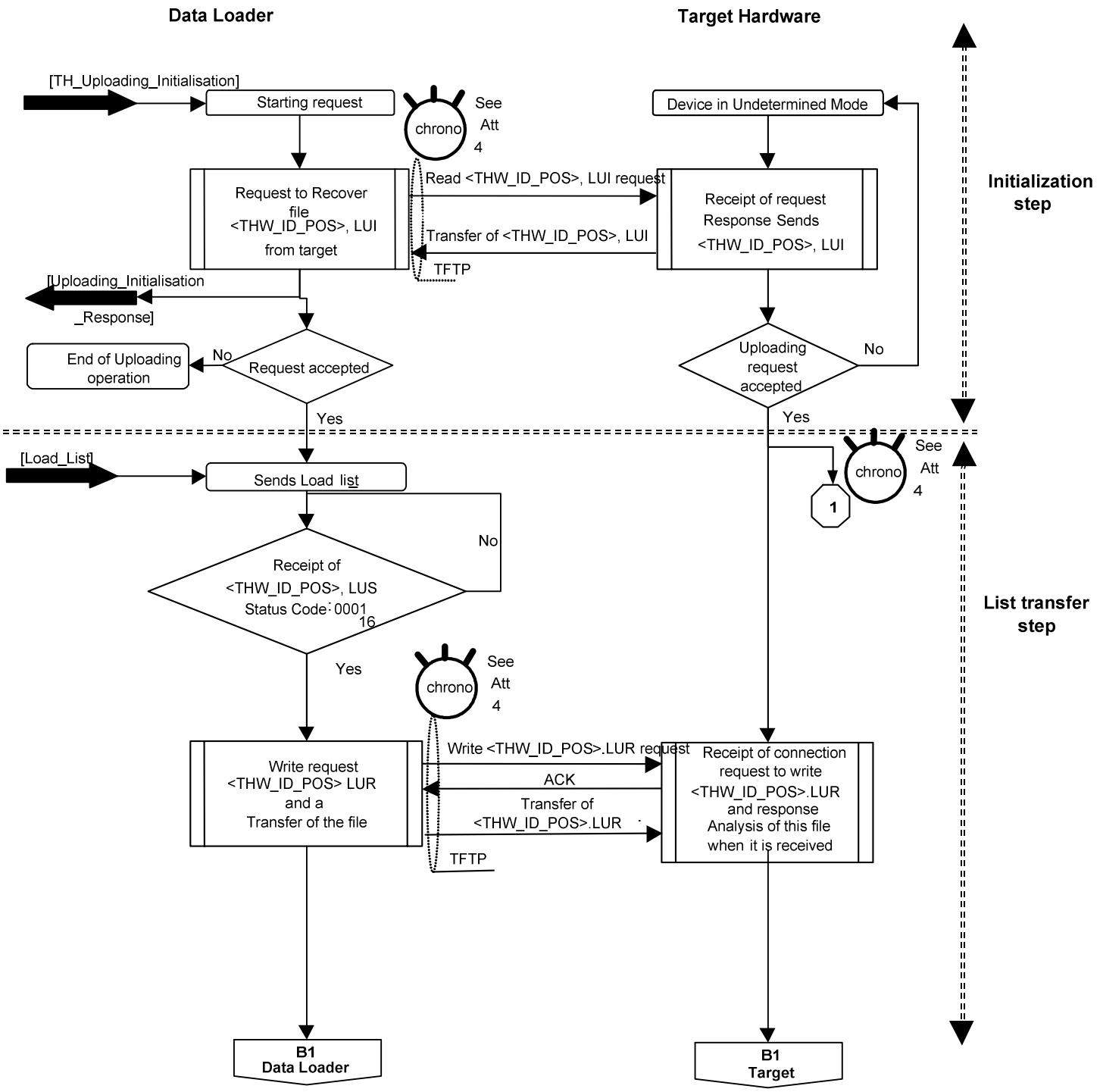
As soon as the transfer step phase begins:

- A status file should be sent once within the maximum delay in compliance with the DLP time-out requirement defined in Attachment 4. The status file is used to periodically update the operator display. It also permits the implementation of an Abort sequence. AI: rto to take this out where ever it appears in Section 6.
- Any fatal error detected by the target should induce production of a status file containing adequate status code and status description, in compliance with time-out requirements.
- A status file may be sent immediately by the target hardware to support the abort message defined in Section 5.3.2.3.6 and the Interruption Service function is defined in Section 6.3.6.
- Note that “Information Operation” represents a particular case. The transmission of the THW_ID_POS.LCL file may be immediate or may take some time.
- In case of a fast response in information mode (i.e., end of transmission of the THW_ID_POS.LCL file before DLP time-out expiration), the target may not send the status file. In this case, the operation will be completed at the end of transmission of the THW_ID_POS_.LCL file.
- In the other case, if at least one status file is produced, the target hardware should send status files in compliance with the DLP time-out requirements. The activity will be completed only after transmission of a status file with a global status code “Operation Completed”0x0003 or fatal error. This status file is the last file sent.
- The WAIT message is used when the target needs to re-boot to switch from operational mode to data loading mode. This mode is required to run data loading operations. During the switch phase, the target hardware will probably not be able to communicate with the data loader. Use of the WAIT message will cause the data loader to abort the TFTP Read Request of the Information/Upload/Download Operation Initialization file and wait the specified time before resending the TFTP Read Request for the Information/Upload/Download Operation Initialization file. This allows the target hardware to make the switch from operational mode to data load mode without having to keep up communication with the data loader during the switch.

- The Exception Timer field, in the status file, is used when the target needs to delay sending the next status file to the data loader. The Exception Timer field allows the target hardware to re-schedule the next status file without the Data Load Protocol-Time Out causing the operation to fail. Using this field, the target hardware informs the data loader that during the "exception timer" wait, the target hardware will be silent (no status file sent) but that the Information/Upload/Download Operation is still in process. If the target hardware responds sooner, the data loader should continue normal operation without waiting for the exception timer to elapse. The target hardware supplier should minimize the "Exception Timer" value to minimize the silent phase. The data loader should receive a new status file before this delay expiration, otherwise the Information/Upload/Download Operation should be aborted.

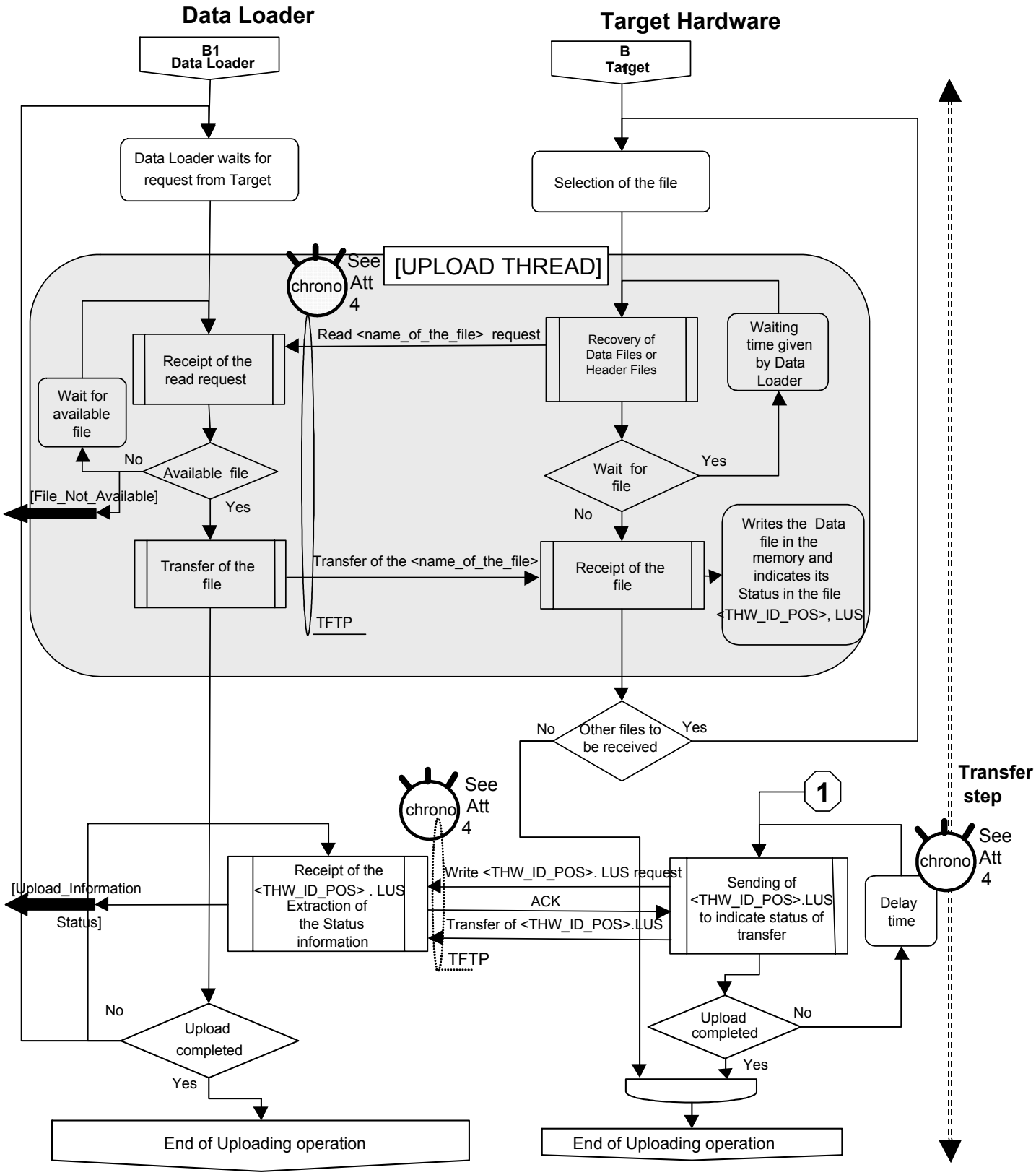
6.3.2 Uploading Operation: Initialization, List Transfer and Transfer

The files used are: <THW_ID_POS>.LUI, <THW_ID_POS>.LUR, and <THW_ID_POS>.LUS.



The Data Loader and Target go to file transfer step

6.0 LOAD PROTOCOL DEFINITION



Explanation of the diagrams above:

- The [message name] and bold black arrows under the [message name] on the very left of the figure indicate the messages passed between the Data Loader Application layer and the Data Loader Protocol Layer.

- The bold chrono circles with three tabs indicate a place in the protocol process that a TFTP time-out (TFTP_TO) may occur. See Attachment 4 for an explanation of the protocol time-outs.

- Steps following the initialization step may have variable duration time. So, to check that both sides (data loader and target hardware) are always in data loading operational mode and in a coherent internal state, status files are frequently sent by the target hardware to the data loader, allowing each one to control the each other.

- Any invalid structure is considered as a fatal error including .LUR or .LUH file structure.

As soon as the list transfer step phase begins:

- Status files should be sent within a maximum delay in compliance with the DLP time-out requirement defined in Attachment 4. Periodicity transmission is not mandatory, just required within the maximum delay.

- Any fatal error detected by the Target HW should induce production of a status file containing adequate status code and status description, in compliance with time-out requirements.

- A status file may be sent immediately by the target hardware to support the abort message defined in Section 5.3.2.3.6 and the interrupt service defined in Section 6.3.6.

- After the list transfer step, the data loader runs as a TFTP server, without any hypothesis in the sequence of the target hardware request files. The only constraint is that the target hardware loads the header file before associated data files, as data files names are only in the header file.

- In the transfer step, only the “UPLOAD THREAD” labeled part may be duplicated to implement a parallel load for one target. Status file exchanges are relative to the whole transfer step, whatever the parallelization level.

- According to its context (floppy disk, hard disk,…), the data load application has to identify if the error “file not available” is an unrecoverable error (inducing a failure of the load process) or if it is a recoverable error (requesting an action of the operator). In the case of request for an operator action, the data loader response will be the wait message defined in Sections 5.3.2.3.4 and 5.3.2.3.5.

- "The WAIT message is used when the target needs to re-boot to switch from operational mode to data loading mode. This mode is required to run data loading operations. During the switch phase, the target hardware will probably not be able to communicate with the data loader. Use of the WAIT message will cause the data loader to abort the TFTP Read Request of the Information/Upload/Download Operation Initialization file and wait the specified time before resending the TFTP Read Request for the Information/Upload/Download Operation Initialization file. This allows the target hardware to make the switch from operational mode to data load mode without having to keep up communication with the data loader during the switch.

- The Exception Timer field, in the status file, is used when the target needs to delay sending the next status file to the data loader. The Exception Timer field allows the target hardware to re-schedule the next status file without the Data Load Protocol-Time Out causing the operation to fail. Using this field, the target hardware informs the data loader that during the "exception timer" wait, the target hardware will be silent (no status file sent) but that the Information/Upload/Download Operation is still in process. If the target hardware responds sooner, the data loader should continue normal operation without waiting for the exception timer to elapse. The target hardware supplier should minimize the "Exception Timer" value to minimize the silent phase. The data loader should receive a new status file before this delay expiration, otherwise the Information/Upload/Download Operation should be aborted.

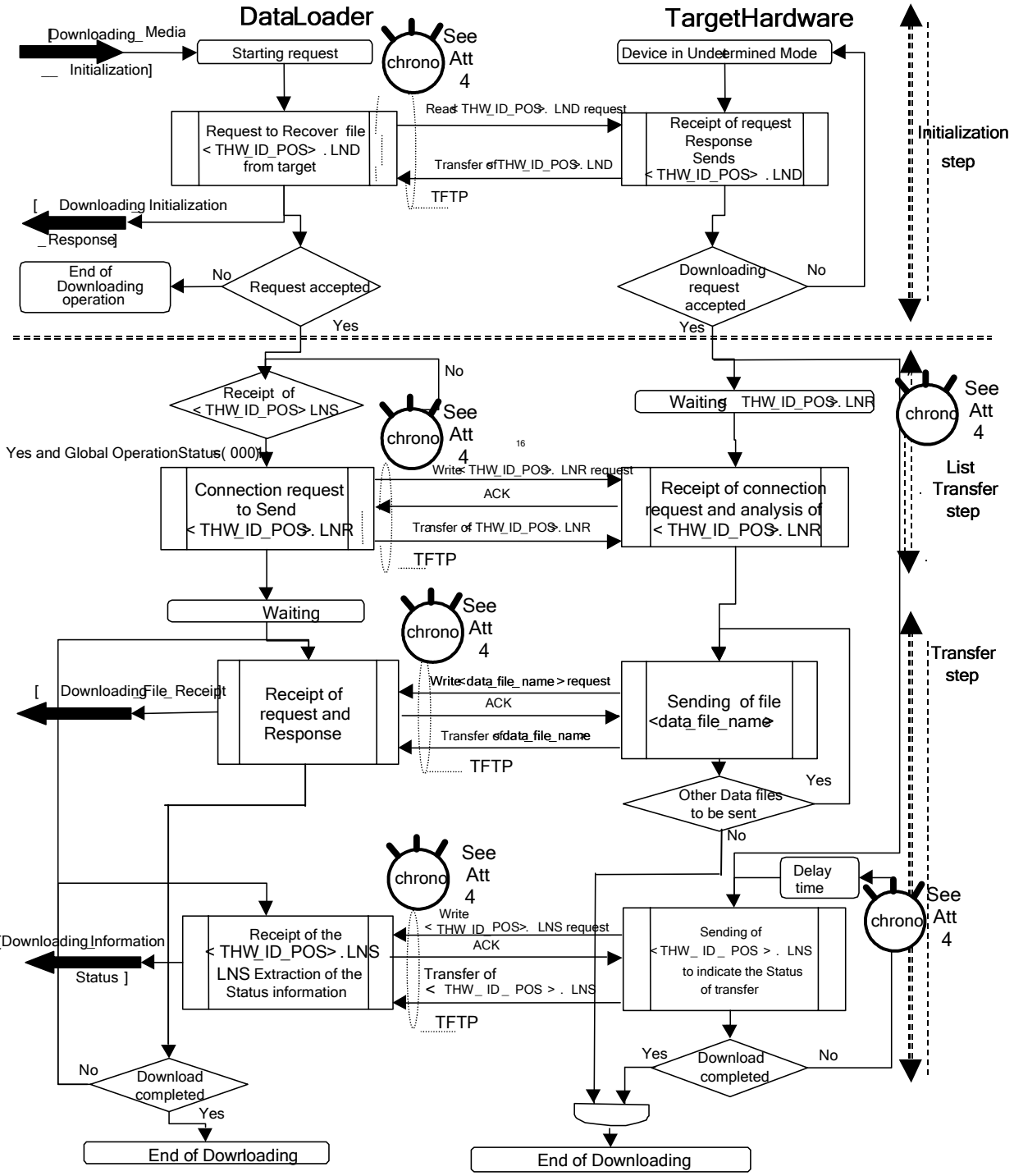
- . . During check computations (CRC, Checksum,…) the status files should still be transmitted, even after all data files have been transmitted.

- The uploading operation is only achieved (an indicator of 100 percent in the status field) after erasing, engraving and correct programmatic checking using an adequate algorithm (e.g. CRC, checksum, etc).

- The activity will be completed only after transmission of a status file with a global status code “Operation Completed” 0x0003 or fatal error. This status file is the last file sent.

6.3.3 Downloading Operation in Media Defined Mode: Initialization, List Transfer and Transfer

The files used are: <THW_ID_POS>.LND, <THW_ID_POS>.LNR, and <THW_ID_POS>.LNS.



Explanation of the diagram above:

- The [message name] and bold black arrows under the [message name] on the very left of the figure indicate the messages passed between the Data Loader Application layer and the Data Loader Protocol Layer.
- The bold chrono circles with three tabs indicate a place in the protocol process that a TFTP time-out (TFTP_TO) may occur. See Attachment 4 for an explanation of the protocol time-outs.
- The operator should select the media type for the download operation.
- Steps following initialization step may have variable duration time. So, to check that both sides (data loader and target hardware) are always in data loading operational mode and in a coherent internal state, status files are frequently sent by the target hardware to the data loader, allowing each one to control each the other.
- Any invalid structure is considered a fatal error.

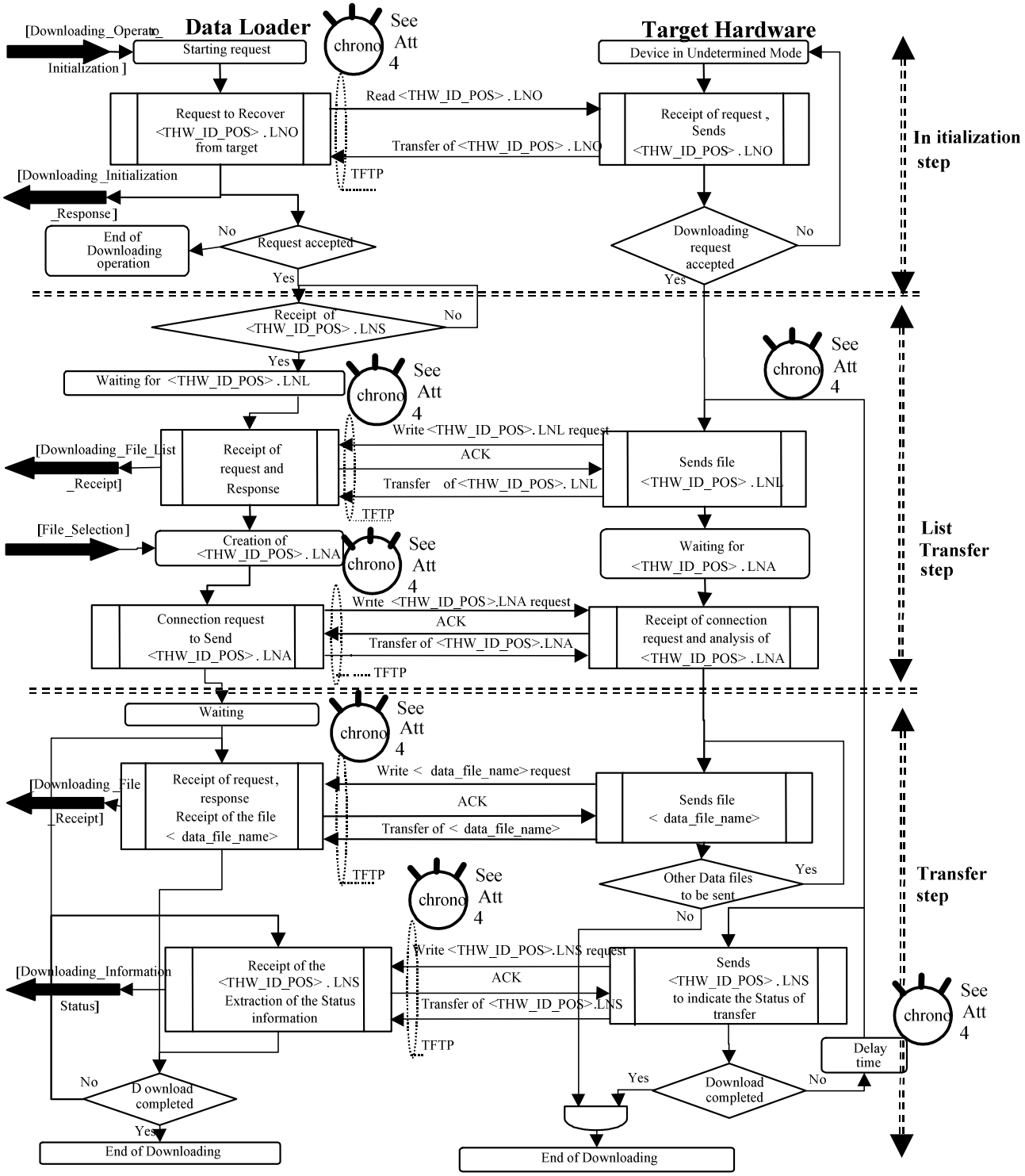
As soon as the list transfer step phase begins:

- Status files should be sent within a maximum delay in compliance with the DLP time-out requirement defined in Attachment 4. Periodicity transmission is not mandatory, just required within the maximum delay.
- Any fatal error detected by the Target HW should induce production of a status file containing adequate status code and status description, in compliance with time-out requirements.
- A status file may be sent immediately by the target hardware to support the abort message defined in Section 5.3.2.3.6 and the interrupt service defined in Section 6.3.6.
- The WAIT message is used when the target needs to re-boot to switch from operational mode to data loading mode. This mode is required to run data loading operations. During the switch phase, the target hardware will probably not be able to communicate with the data loader. Use of the WAIT message will cause the data loader to abort the TFTP Read Request of the Information/Upload/Download Operation Initialization file and wait the specified time before resending the TFTP Read Request for the Information/Upload/Download Operation Initialization file. This allows the target hardware to make the switch from operational mode to data load mode without having to keep up communication with the data loader during the switch.
- The Exception Timer field, in the status file, is used when the target needs to delay sending the next status file to the data loader. The Exception Timer field allows the target hardware to re-schedule the next status file without the Data Load Protocol-Time Out causing the operation to fail. Using this field, the target hardware informs the data loader that during the "exception timer" wait, the target hardware will be silent (no status file sent) but that the Information/Upload/Download Operation is still in process. If the target hardware responds sooner, the data loader should continue normal operation without waiting for the exception timer to elapse. The target hardware supplier should minimize the "Exception Timer" value to minimize the silent phase. The data loader should receive a new status file before this delay expiration; otherwise the Information/Upload/Download Operation should be aborted."

- The activity will be completed only after transmission of a status file with a global status code Operation Completed (0x0003) or fatal error. This status file is the last file sent.

6.3.4 Downloading Operation in Operator Defined Mode: Initialization and List Transfer

The files used are: <THW_ID_POS>.LNO, <THW_ID_POS>.LNL, <THW_ID_POS>.LNA, and <THW_ID_POS>.LNS.



Explanation of the diagram above:

- The [message name] and bold black arrows under the [message name] on the very left of the figure indicate the messages passed between the Data Loader Application layer and the Data Loader Protocol Layer.
- The bold chrono circles with three tabs indicate a place in the protocol process that a TFTP time-out (TFTP_TO) may occur. See Attachment 4 for an explanation of the protocol time-outs.
- The media type should be selectable by the operator for the download operation.
- Steps following initialization step may have variable duration time. To check that both sides (data loader and target hardware) are always in data loading operational mode and in a coherent internal state, status files are frequently sent by the target hardware to the data loader, allowing each one to control each the other.
- Any invalid structure is considered as a fatal error.

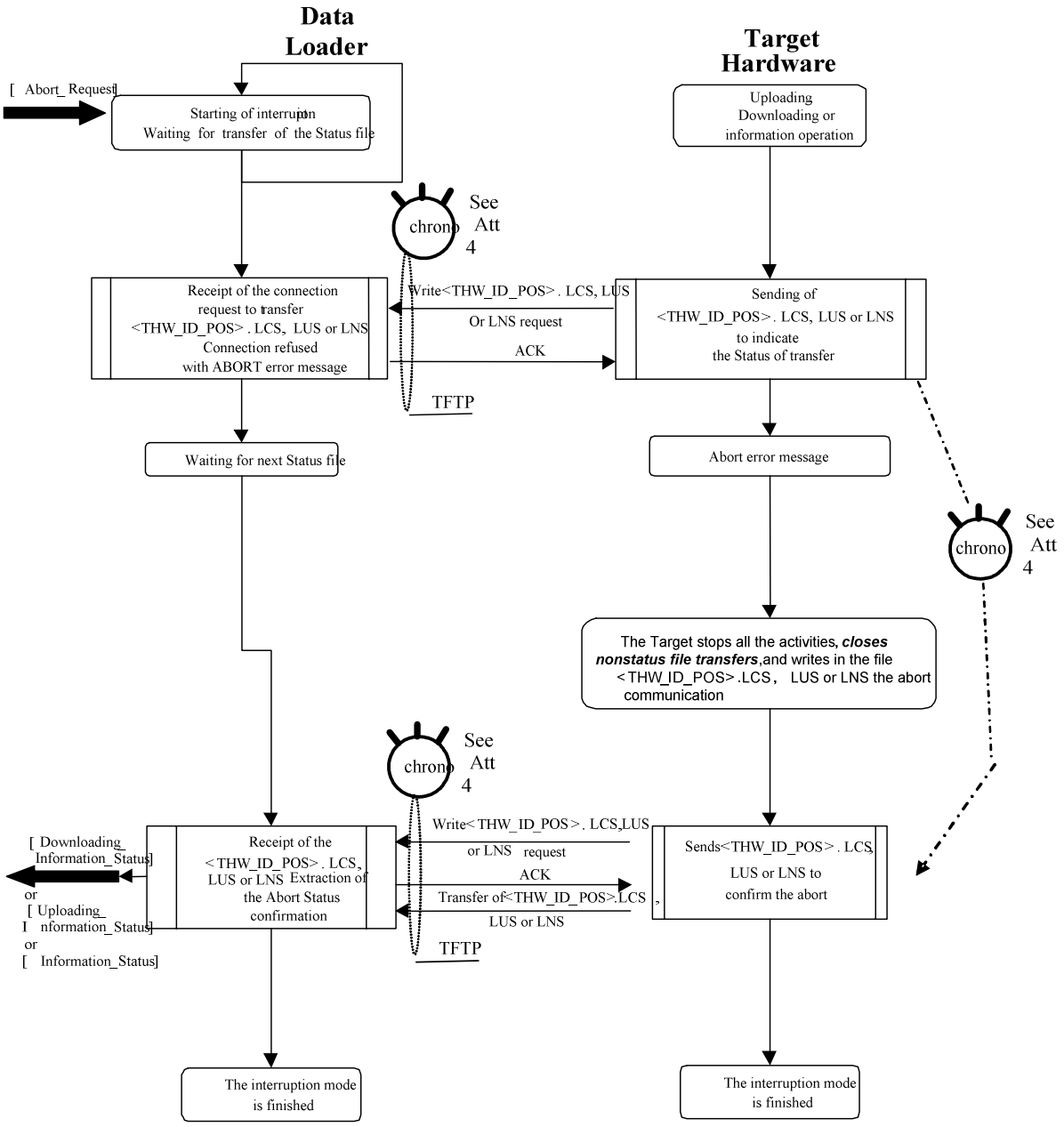
As soon as the list transfer step phase begins:

- Status files should be sent within a maximum delay in compliance with the DLP time-out requirement defined in Attachment 4. Periodicity transmission is not mandatory, just required within the maximum delay.
- Any fatal error detected by the target hardware should induce production of a status file containing adequate status code and status description, in compliance with time-out requirements.
- A status file may be sent immediately by the target hardware to support the abort message defined in Section 5.3.2.3.6 and the interrupt service defined in Section 6.3.6.
- The WAIT message is used when the target needs to re-boot to switch from operational mode to data loading mode. This mode is required to run data loading operations. During the switch phase, the target hardware will probably not be able to communicate with the data loader. Use of the WAIT message will cause the data loader to abort the TFTP Read Request of the Information/Upload/Download Operation Initialization file and wait the specified time before resending the TFTP Read Request for the Information/Upload/Download Operation Initialization file. This allows the target hardware to make the switch from operational mode to data load mode without having to keep up communication with the data loader during the switch.
- The Exception Timer field, in the status file, is used when the target needs to delay sending the next status file to the data loader. The Exception Timer field allows the target hardware to re-schedule the next status file without the Data Load Protocol-Time Out causing the operation to fail. Using this field, the target hardware informs the data loader that during the "exception timer" wait, the target hardware will be silent (no status file sent) but that the Information/Upload/Download Operation is still in process. If the target hardware responds sooner, the data loader should continue normal operation without waiting for the exception timer to elapse. The target hardware supplier should minimize the "Exception Timer" value to minimize the silent phase. The data loader should receive a new status file before this delay expiration; otherwise the Information/Upload/Download Operation should be aborted.

- The activity will be completed only after transmission of a status file with a global status code “Operation Completed” (0x0003) or fatal error. This status file is the last file sent.

6.3.5 Interruption Service

The files used are: <THW_ID_POS>.LCS, <THW_ID_POS>.LUS, and <THW_ID_POS>.LNS.



The diagram in Section 6.3.5 shows this abort scenario. Explanation of the diagram:

- **The [message name] and bold black arrows under the [message name] on the very left of the figure indicate the messages passed between the Data Loader Application layer and the Data Loader Protocol Layer.**
- **The bold chrono circles with three tabs indicate a place in the protocol process that a TFTP time-out (TFTP_TO) may occur. See Attach**ment 4 for an explanation of the protocol time-outs.

Interruption of service is supported by the status file. A status file transmission is initiated by the target hardware:

- If abort is requested by the target hardware, the target hardware may send one status file indicating the abort request. The complete transfer of this status file indicates the acknowledgment of the interrupt request by the data loader.
- The status code in the status file should be 0x1003 (operation aborted by the target hardware).
- Any other TFTP transfers should be aborted using the ABORT message with the status code 0x1003 (operation aborted by the target hardware).
- If abort is requested by the data loader(abort code 0x1004 or 0x1005), the data loader should wait for the next status file write request from the Target Hardware, respond to this request with an abort error message defined in Section 5.3.2.3.6, and then wait for the next status file transmission. This last status file from the Target Hardware supports the Target Hardware acknowledgment of the abort request from the data loader.
- In case of a data loader abort request, any other TFTP transfers should be aborted using the ABORT message with status code 0x1004 (Operation aborted by the data loader) or 0x1005 (Operation aborted by the operator).

6.4 Protocol File Description

This section describes the format of the data files used by the data loading protocol. Table 6.4-1 summarizes all the files used by the protocol.

All protocol files are defined using “Big Endian” byte ordering, that is, the most significant eight bits (MS byte) of each 16-bit word are transferred first, followed by the least significant bits (LS byte) in the next eight-bit byte (n+1). The same byte ordering is used to derive field information in all protocol files. Only byte ordering for data files and support files is up to the supplier.

As the first file exchange is produced by the target hardware, the target hardware provides the protocol version that should be used for the ARINC Report 615A operation. According to this information, the data loader is responsible to adapt its functionality to this request (specifically, reject if not implemented, select this version if more than this one is implemented). On the target hardware side, the protocol version should be the same for all implemented operations.

The structure of the protocol files is referenced by a version of the applicable structure, and supported by a field named “Protocol Version.” This Protocol Version parameter allows the target hardware and data loader to use the correct structure to access the data.

The value of protocol version should be the same for all protocol files defined in one revision of ARINC Report 615A.

If the structure of even one protocol file or the TFTP Adaptation to Data Loading Protocol (Section 5.3.2.3) changes, the Protocol Version value of the ARINC Report 615A revision should be modified, along with all other files affected by the protocol version change, to reflect the protocol version implemented.

The protocol version is sent by the target hardware in the initialization step. The data loader should adapt to this protocol version or abort the load if this protocol version is not implemented.

In the case of incompatibility of protocol versions, the data loader should abort the operation by sending an abort message to the first status file write request.

The protocol version should not be moved from the second field of a protocol file.

The value of the protocol version is $(A4)_{ASCII}$ for Supplement 3 of ARINC Report 615A.

The text string in all textual fields, for example the several description fields, part number name fields, etc., should be zero terminated, shown as 0x00, to indicate the end of the text. For emphasis, this statement is repeated in the appropriate textual field descriptions in the following subordinate sections.

COMMENTARY

The textual field lengths in Table 6.4.1-1 through Table 6.4.9-1 indicate the size of the textual field and not the size of its relevant text string plus terminator. The text is terminated by the string terminator 0x00 and may not fill the entire textual field. For processing efficiency

implementers may want to fix the size of the textual field (and the associated value of textual field length) and then vary the message text as necessary. Others will desire to limit the amount of data transmitted and set the textual field length to the length of the text string plus terminator or to zero when no text is required.

Table 6.4-1 – Protocol Files

Name of File	Operation	File Content	Created by	File type
<THW_ID_POS>.LCI	Information	Used only to initialize an information operation. (Load Configuration Initialization)	Target Hardware	Protocol
<THW_ID_POS>.LCL	Information	Configuration of the target, it gives the list of the P/Ns in the target. (Load Configuration List)	Target Hardware	Protocol
<THW_ID_POS>.LCS	Information	Progress and status of the Information process. (Load Configuration Status)	Target Hardware	Protocol
<THW_ID_POS>.LUI	Uploading	Used only to initialize an uploading operation. (Load Uploading Initialization)	Target Hardware	Protocol
<THW_ID_POS >.LUR	Uploading	Request for Upload of a List of loads. (Load Uploading Request)	Data Loader	Protocol
<HEADER_FILE>.LUH*	Uploading	Contains information to permit the Target Hardware to accept the load data. (Load Upload Header)	Suppliers	File
<Data_File_Name>*	Uploading	Name of the uploaded or downloaded file	Supplier or Target Hardware	File
<THW_ID_POS>.LUS	Uploading	Progress and status of the Uploading process. (Load Uploading Status)	Target Hardware	Protocol
<THW_ID_POS>.LND	Downloading in Media mode	Used only to initialize a downloading operation. (Load Downloading Media) defined	Target Hardware	Protocol
<THW_ID_POS >.LNR	Downloading in Media mode	Used to give the list of files to be recovered. (Load Downloading Request)	Data Loader	Protocol
<THW_ID_POS>.LNS	Downloading in Media and operator mode	Progress of the Downloading process. (Load Downloading Status)	Target Hardware	Protocol
<THW_ID_POS>.LNO	Downloading in Operator mode	Used only to initialize a downloading operation. (Load Downloading Operator) defined	Target Hardware	Protocol
<THW_ID_POS>.LNL	Downloading in Operator mode	Used to give the list of files which are potentially recovered. (Load Downloading List)	Target Hardware	Protocol
<THW_ID_POS>.LNA	Downloading in Operator mode	Used to give the list of files which are selected by the operator and are to be downloaded. (Load Downloading Answer)	Data Loader	Protocol

* Though these files are not protocol files, they are listed here because the data load protocol manages them. They are described in ARINC Report 665.

6.4.1 <THW_ID_POS >.LCI, .LUI, .LND and .LNO

Table 6.4.1-1

Name of Field	Field Size (bits)	Note
File Length	32	
Protocol Version	16	
Operation Acceptance Status Code	16	
Status Description Length	8	
Status Description	0 – 2040	1

Note:

1. Text string termination in a textual field described in Section 6.4.

Detailed description of each field:

File Length:

Binary number of 8-bit words in this file including this field.

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Operation Acceptance Status Code:

Binary unsigned 16-bit value, 0xXXXX: Status Code.

Answer to the information operation initialization.

The Status Codes used in this field are:

0x0001: The operation is accepted.

0x1000: The operation is denied. The reason is described in the status description field.

0x1002: The operation is not supported by the Target

The Status Codes are summarized in Section 6.4.10 “Data Load Status Code Table.”

Status Description Length:

Binary, number of characters in the Status Description field (0 to 255 characters).

Status Description:

Description of the reason or additional information for this status code, it is used only for status code 0x1000. For Status Codes 0x0001 and 0x1002 the content of this field is ignored.

The text should be only printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040bits).

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.2 <THW_ID_POS>.LCL

Table 6.4.2-1

Name of Field	Field Size (bits)	Note
File Length	32	
Protocol Version	16	
Number of target hardware	16	
* Literal Name Length	8	
* Literal Name	8-2040	1
* Serial Number Length	8	
* Serial Number	8-2040	1
* Number of Part Numbers	16	
+ * Part Number Length	8	
+ * Part Number	8-2040	1
+ * Amendment Length	8	
+ * Amendment	0-2040	1
+ * Part Designation Length	8	
+ * Part Designation Text	8-2040	1

Note:

+ Fields repeated for each Part Number

* Fields repeated for each Literal Name

1. Text string termination in a textual field described in Section 6.4

Detailed description of each field:

File Length:

Binary number of 8-bit words in this file including this field

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Number of Target Hardware:

Binary number of target hardware reported in the table

In fact, one piece of equipment could centralize different equipment identification items within a given perimeter.

Literal Name Length:

Binary, number of characters in the Literal Name field (1 to 255 characters).

Literal Name:

This field corresponds to the “Literal Name” field of the FIND answer defined in Attachment 3. The text should be zero terminated, to indicate the end of the data.

Serial Number Length:

Binary, number of characters in the Serial Number Length field (1 to 255 characters).

Serial Number:

1 to 255 characters (8-bits ASCII i.e., 2040-bits) defining the Target Hardware Serial Number of the Target Hardware. The text should be zero terminated to indicate the end of the data.

Number of Part Numbers:

Binary, number of part numbers of the current target hardware item.

Part Number Length:

Binary, number of characters in the Part Number (1 to 255 Characters).

Part Number:

1 to 255 characters (8-bits ASCII i.e., 2040-bits) defining the hardware or any load Part Number. The text should be zero terminated to indicate the end of the data.

Amendment Length:

Binary, number of characters in the Amendment (0 to 255 characters).

If the Amendment Length field value is zero, the Amendment field is omitted and ignored.

Amendment:

0 to 255 characters (8-bits ASCII i.e., 2040-bits) defining the hardware amendment if any.

Amendment is usually related to hardware identification, permitting the tracking of modification for form, fit and function that does not impact interchangeability and interoperability.

Part Designation Text Length:

Binary, number of characters in the Part Designation Text (1 to 255 characters).

Part Designation Text:

1 to 255 characters (8-bits ASCII).

Target Hardware name (acronyms or code) for the hardware parts (e.g., FMGEC 1), and function name or designation for the software parts (e.g., FMS 1 OPS), identifying the specific part and occurrence in the aircraft to be displayed.

The text should only be printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040-bits).

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.3 <THW_ID_POS>.LCS

Table 6.4.3-1

Name of Field	Field Size (bits)	Notes
File Length	32	
Protocol Version	16	
Counter	16	
Information Operation Status Code	16	
Exception Timer	16	
Estimated Time	16	
Status Description Length	8	
Status Description	0 – 2040	1

Note:

1. Text string termination in a textual field described in Section 6.4

Detailed description of each field:

File Length:

Binary, number of 8-bit words in this file including this field.

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Counter:

Initial value is 0x0000.

Binary, 16-bit counter incremented by the Target Hardware before sending the file.

Set to 0x0000 after 0xFFFF. This allows the Data Loader to detect the duplication of status files or the loss of status files.

Information Operation Status Code:

Binary, unsigned 16-bit value, 0xXXXX: Status code

Status of the information operation in progress.

The Status Codes used in this field are:

0x0001: The target accepts the operation (not yet started).

0x0002: The operation is in progress

0x0003: The operation is completed without error.

0x0004: The operation is in progress, details provided in status description.

0x1003: The operation is aborted by the target hardware, target hardware text is required in the Status Description field to know the reason for this interruption.

0x1004: The operation is aborted in the target hardware due to the receipt of an abort error message sent by the Data Loader Protocol.

0x1005: The operation is aborted in the target hardware due to the receipt of an abort error message initiated by an operator action.

The Status Codes are summarized in Section 6.4.10, “Data Load Status Code Table.”

Exception Timer:

Binary, number of seconds during which the target is expected to be silent. During this delay, the status file is not sent by the target and it does not respond to any request from the data loader (0 to 2^{16}–1 seconds).

This field is used only if the Status Code field is 0x0002 or 0x0004, for all other status codes, this field must be set to 0x0000.

Estimated Time:

Binary, estimated number of seconds to complete the *operation* (-1 to 2^{15} -1 seconds). The value "–1" means the Estimated Time is not given. Estimated Time is the time remaining to complete the operation as computed by the target hardware. As soon as possible during the operation, the Target *HW* should provide the Estimated Time.

This field is used only if the Status Code field is 0x0002 or 0x0004. For all other Status Codes, this field is set equal to 0x0000

If the target hardware does not give this value, the Estimated Time field must be set to 0xFFFF.

Status Description Length:

Binary, number of characters in the Status Description field (0 to 255 characters).

Status Description:

Description of the reason or additional information for the Status Code. Used for Status Code 0x1003 or 0x0004. For other Status Codes, the content of this field is ignored, but may contain data (e.g., left over data). Refer to Section 6.4.10 for more information.

The text should only be printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040 bits).

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.4 <THW_ID_POS >.LUR

Table 6.4.4-1

Name of Field	Field Size (bits)	Note
File Length	32	
Protocol Version	16	
Number of Header Files	16	
+ Header File Name Length	8	
+ Header File Name	8 – 2040	1
+ Load Part Number Name Length	8	
+ Load Part Number Name	8 – 2040	1

Note:

+ Fields repeated for each Header File.

1. Text string termination in a textual field described in Section 6.4.

Detailed description of each field:

File Length:

Binary, number of 8-bit words in this file including this field

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Number of Header Files:

Binary, number of Header Files in the Header File List. Any .LUR file should contain at least one Header File.

Header File Name Length:

Binary, number of characters in the Header File Name (1 to 255 characters).

Header File Name:

1 to 255 characters (8-bit ASCII i.e., 2040-bits) as defined by the Header File Name Length field.

The text should be zero terminated 0x00 to indicate the end of the data.

Load Part Number Name Length:

Binary, number of characters in the Load Part Number (1 to 255 characters).

Load Part Number Name:

1 to 255 characters (8-bit ASCII i.e., 2040-bits) as defined by the Load Part Number Length field.

The text should be only printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040-bits).

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.5 <THW_ID_POS>.LUS

Table 6.4.5-1

Name of Field	Field Size (bits)	Note
File Length	32	
Protocol Version	16	
Upload Operation Status Code	16	
Upload Status Description Length	8	
Upload Status Description	0 - 2040	1
Counter	16	
Exception Timer	16	
Estimated Time	16	
Load List Ratio	24	
Number of Header Files	16	
+ Header File Name Length	8	
+ Header File Name	8 – 2040	1
+ Load Part Number Name Length	8	
+ Load Part Number Name	8 – 2040	1
+ Load Ratio	24	
+ Load Status	16	
+ Load Status Description Length	8	
+ Load Status Description	0 – 2040	1

Note:

+ Fields are repeated as a group for each Header File, i.e., software load being uploaded.

1. Text string termination in a textual field described in Section 6.4

Detailed description of each field:

File Length:

Binary, number of 8-bit words in this file including this field

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Upload Operation Status Code:

Binary, unsigned 16-bit value, 0xXXXX: Status code.

It gives the status of this operation.

The Status Codes used in this field are:

0x0001: The Target accepts the operation (not yet started).

0x0002: The operation is in progress.

0x0003: The operation is completed without error.

0x0004: The operation is in progress, details provided in status description.

0x1003: The operation is aborted by the target hardware. Target hardware text is required in the status description field to identify the reason for this interruption.

0x1004: The operation is aborted in the target hardware due to the receipt of an abort error message sent by the data loader protocol.

0x1005: The operation is aborted in the target hardware due to the receipt of an abort error message initiated by an operator action.

The Status Codes are summarized in Section 6.4.10 “Data Load Status Code Table.”

COMMENTARY

The Upload Operation Status Code defines to the Data Loader the status of the entire load list. The Load Status Field is the status of each individual load contained in the List of Loads file sent to the Target Hardware by the Data Loader.

Upload Status Description Length:

Binary, number of characters in the Upload Status description field (0 to 255 characters).

Upload Status Description:

Description of the reason or additional information for the Status Code. Used for Status Code 0x1003 and 0x0004. For other Status Codes, the content of this field is ignored, but may contain data (i.e., left over data). Refer to Section 6.4.10 for more information.

The text should only be printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040 bits).

The text should be zero terminated 0x00 to indicate the end of the data.

Counter:

Initial value is 0000.

Binary, 16-bit counter incremented by the Target Hardware before sending the file.

Set to 0x0000 after 0xFFFF. It allows the Data Loader to detect the duplication of files.

Exception Timer:

Binary, number of seconds during which the target is expected to be silent. During this delay the status file is not sent by the target hardware and it does not respond to any request from the data loader (0 to 2^{16} –1 seconds).

This field is used only if the Status Code field is 0x0002 or 0x0004 for the other status code this field must be set to 0x0000.

Estimated Time:

Binary, estimated number of seconds to complete the operation (-1 to 2^{15} -1 seconds). The value "–1" means the Estimated Time is not given. Estimated Time is the time remaining to complete the operation as computed by the target hardware. As soon as possible during the operation, the target hardware should provide the Estimated Time.

This field is used only if the Status Code field is 0x0002 or 0x0004. For all other Status Codes, this field is set equal to 0x0000

If the target hardware does not provide this value, the "Estimated Time" field must be set to 0xFFFF.

Load List Ratio:

Three characters (8-bit ASCII) representing the percentage of the Load List completed.

Right adjusted field with leading blanks.

Number of Header Files:

Binary, number of Header Files in the Load List. Before and during the list transfer step, the "Number of Header Files" field must be set to 0.

Header File Name Length:

Binary, number of characters in the Header File Name (1 to 255 characters).

Header File Name:

1 to 255 characters (8-bit ASCII) as defined by the Header File Name Length field.

The text should be zero terminated 0x00 to indicate the end of the data.

Load Part Number Name Length:

Binary, number of characters in the Load Part Number (1 to 255 characters).

Load Part Number Name:

1 to 255 characters (8-bit ASCII) as defined by the Load Part Number Length field.

The text should be zero terminated 0x00 to indicate the end of the data.

Load Ratio:

Right adjusted field with leading blanks.

Three characters (8-bit ASCII) representing the percentage of the specific load completed.

Load Status:

Binary, unsigned 16-bits value, 0xXXXX: Status Code.

Status for each Header File, i.e., each software load being uploaded. It gives the status of the load defined by the associated Header File (not only the status of the upload of the Header File.)

The Status Codes used in this field are:

0x0001: The operation is accepted (not yet started).

0x0002: The operation is in progress.

0x0003: The operation is completed without error

0x0004: The operation is in progress, details provided in status description.

0x1003: The operation is aborted by the target hardware. Target hardware text is required in the Status Description field to identify the reason for this interruption.

0x1004: The operation is aborted in the target due to the receipt of an abort error message sent by the Data Loader Protocol.

0x1005: The operation is aborted in the target due to the receipt of an abort error message initiated by an operator action.

0x1007: The load of this Header File has failed. Text is required in the “Status Description” field to explain the failure.

The Status Codes are summarized in Section 6.4.10 “Data Load Status Code Table.”

Load Status Description Length:

Binary, number of characters in the Status Description field (0 to 255 characters).

Load Status Description:

Description of the reason for the Status Code. Use for the Status Codes 0x0004, 0x1003 and 0x1007. For other status codes, the content of this field is ignored, but may contain data (e.g., left over data). Refer to Section 6.4.10 for more information.

The text should be only printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040bits).

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.6 <THW_ID_POS >.LNR

Table 6.4.6-1

Name of Field	Field Size (bits)	Note
File Length	32	
Protocol Version	16	
Number of Files	16	
+ File Name Length	8	
+ File Name	8 – 2040	1
User Defined Data Length	8	
User Defined Data	0 – 2040	1

Note:

+ Fields repeated for each file to be downloaded.

1. Text string termination in a textual field described in Section 6.4

Detailed description of each field:

File Length:

Binary, number of 8-bit words in this file including this field.

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Number of Files:

Binary, number of Files for this Downloading.

File Name Length:

Binary, number of characters in the File Name (1 to 255 characters i.e., 2040-bits).

File Name:

1 to 255 characters (8-bit ASCII i.e., 2040-bits) as defined by the File Name Length field.

The text should be zero terminated 0x00 to indicate the end of the data.

User Defined Data Length:

Binary, number of bytes in the User Defined Data field (0 to 255 bytes).

User Defined Data:

0 to 255 bytes (8-bit) as defined by the User Defined Data Length field.

6.4.7 <THW_ID_POS>.LNS

Table 6.4.7-1

Name of Field	Field Size (bits)	Note
File Length	32	
Protocol Version	16	
Download Operation Status Code	16	
Download Status Description Length	8	
Download Status Description	0 – 2040	1
Counter	16	
Exception Timer	16	
Estimated Time	16	
Download List Ratio	24	
Number of Files	16	
+ File Name Length	8	
+ File Name	8 – 2040	1
+ File Status	16	
+ File Status Description Length	8	
+ File Status Description	0 – 2040	1

Note:

+ Fields repeated for each File

1. Text string termination in a textual field described in Section 6.4

Detailed description of each field:

File Length:

Binary, number of 8-bit words in this file including this field.

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Download Operation Status Code:

Binary, unsigned 16-bits value, 0xXXXX: Status code.

It gives the status of this operation.

The Status Codes used in this field are:

0x0001: The Target accepts the operation (not yet started).

0x0002: The operation is in progress.

0x0003: The operation is completed without error.

0x0004: The operation is in progress, details provided in status description.

0x1003: The operation is aborted by the target hardware. LRU text is required in the Status Description field to know the reason for this interruption.

0x1004: The operation is aborted in the target hardware due to the receipt of an abort error message sent by the Data Loader Protocol.

0x1005: The operation is aborted in the target hardware due to the receipt of an abort error message initiated by an operator action.

The Status Codes are summarized in Section 6.4.10, “Data Load Status Code Table.”

Download Status Description Length:

Binary, number of characters in the Download Status Description field (0 to 255 characters).

Download Status Description:

Description of the reason or additional information for the Status Code. Used only for Download Status Codes **0x0004 and** 0x1003. For other Status Codes, the content of this field is ignored, but may contain data (e.g., left over data). Refer to Section 6.4.10 for more information.

The text should only be printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040bits).

The text should be zero terminated 0x00 to indicate the end of the data.

Counter:

Initial value is 0000.

Binary, 16-bit counter incremented by the Target Hardware before sending the file.

Set to 0x0000 after 0xFFFF. This allows the Data Loader to detect the duplication of files.

Exception Timer:

Binary, number of seconds during which the target hardware is expected to be silent. During this delay, the status file is not sent by the target hardware and it does not respond to any request from the Data Loader (0 to 216 –1 seconds).

This field is used only if the Status Code field is 0x0002 or 0x0004, for the other Status code this field must be set to 0x0000.

Estimated Time:

Binary, estimated number of seconds to complete the operation (-1 to 215 -1 seconds). The value “–1” means the estimated time is not given. Estimated time is the time remaining to complete the operation as computed by the target hardware. As soon as possible during the operation, the target hardware should provide the estimated time.

This field is used only if the Status Code field is 0x0002 or 0x0004. For all other Status Codes, this field is set equal to 0x0000.

If the Target does not give this value, the “Estimated Time” field must be set to 0xFFFF.

Download List Ratio:

Three characters (8-bit ASCII) representing the percentage of the download completed. Right adjusted field with leading blanks.

Number of Files:

Binary, number of files in the download selected.

File Name Length:

Binary, number of characters in the File Name (1 to 255 characters)

File Name:

1 to 255 characters (8-bit ASCII) as defined by the File Name Length field.

The text should be zero terminated 0x00 to indicate the end of the data.

File Status:

Binary unsigned 16-bit value, 0xXXXX: Status Code. Thus, the file status is given for each file.

The status codes used in this field are:

0x0001: The download of this file has not yet started.

0x0002: The operation is in progress.

0x0003: The download of this file has been completed without error.

0x0004: The operation is in progress, details provided in status description.

0x1003: The operation is aborted by the target, LRU text is required in the Status Description field to identify the reason for this interruption.

0x1004: The operation is aborted in the target hardware due to the receipt of an abort error message sent by the data loader protocol.

0x1005: The operation is aborted in the target due to the receipt of an abort error message initiated by an operator action.

0x1007: The download of this file has failed, text is required in the Status Description field to explain the failure.

The status codes are summarized in the Section 6.4.10 “Data Load Status Code Table.”

File Status Description Length:

Binary, number of characters in the File Status Description field (0 to 255 characters).

File Status Description:

Description of the reason for the Status Code. Used only for Status Codes 0x0004, 0x1003 and 0x1007. For other File Status Codes, the content of this field is ignored, but may contain data (i.e., left over data). Refer to Section 6.4.10 for more information.

The text should be only printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040-bits).

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.8 <THW_ID_POS>.LNL

Table 6.4.8-1

Name of Field	Field Size (bits)	Note
File Length	32	
Protocol Version	16	
Number of Files	16	
+ File Name Length	8	
+ File Name	8 – 2040	1
+ File Description Length	8	
+ File Description	0 – 2040	1

Note:

+ Fields repeated for each file to be downloaded

1. Text string termination in a textual field described in Section 6.4

Detailed description of each field:

File Length:

Binary, number of 8-bit words in this file including this field

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Number of Files:

Binary, Number of Files which can be downloaded

File Name Length:

Binary, number of characters in the Data File Name (1 to 255 characters).

File Name:

1 to 255 characters (8-bit ASCII) as defined by the File Name Length field.

The text should be zero terminated 0x00 to indicate the end of the data.

File Description Length:

Binary, number of characters in the File Description field (0 to 255 characters).

File Description:

0 to 255 characters (8-bit ASCII) as defined by the File Description Length field.

The text should be only printable characters, should not include control characters, and should have a maximum length of 255 characters (i.e., 2040-bits).

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.9 <THW_ID_POS>.LNA

Table 6.4.9-1

Name of Field	Field Size (Bits)	Note
File Length	32	
Protocol Version	16	
Number of Files	16	
+ File Name Length	8	
+ File Name	8 - 2040	1

Note:

+ Fields repeated for each file to be downloaded

1. Text string termination in a textual field described in Section 6.4

Detailed description of each field:

File Length:

Binary, number of 8-bit words in this file including this field.

Protocol Version:

Two bytes (ASCII characters) defining the Protocol Version as explained in Section 6.4, Protocol File Description.

Number of Files:

Binary, number of Files for this Downloading.

File Name Length:

Binary, number of characters in the File Name (1 to 255 characters i.e., 2040-bits).

File Name:

1 to 255 characters (8-bit ASCII) as defined by the File Name Length field.

The text should be zero terminated 0x00 to indicate the end of the data.

6.4.10 Data Load Status Code Table

The Data Loader should display the text of the below table upon reception from the target hardware of the status code for the corresponding file.

The Data Loader should not have to interpret the status of individual TFTP transfer (e.g. individual data or support file transfer for upload) but should wait for the upload/download/information status code managed at target hardware level. This status code is periodically transmitted to the Data Loader within these files (.LUS, .LNS or .LCS).

Table 6.4.10-1 – Data Load Status Code Table

Status Code	Meaning	Display Text	Files Used in Operation		
			Information	Upload	Download
0x0001	The target hardware accepts the operation. Operation not yet started.	NO DISPLAY Note: for load status, accepted but not started or Global operation Status Code.	.LCI .LCS	.LUI .LUS	.LND .LNO .LNS
0x1000	The target hardware doesn't accept the operation.	*"Operation Denied. " Target hardware text required.	.LCI	.LUI	.LND .LNO
0x1002	This operation is not supported by the target.	*"Operation not supported by the target." No target hardware text is displayed.	.LCI	.LUI	.LND .LNO
0x0002	Operation in progress	No Display but Entertain the user.	.LCS	.LUS	.LNS
0x0003	Operation completed without error	*"Operation Completed." No target hardware text is displayed.	.LCS	.LUS	.LNS
0X0004	Operation in progress, additional information provided by target	Target hardware text required	.LCS	.LUS	.LNS
0x1003	Operation aborted by the target hardware	*"Operation aborted by the Target Hardware. " Target hardware text required Note: if aborted due to transmission failure, the reason should be noticed.	.LCS	.LUS	.LNS
0x1004	Operation aborted by the data loader.	*"Operation aborted by the Data Loader. " No target hardware text is displayed.	.LCS	.LUS	.LNS
0x1005	Operation aborted by the operator.	*"Operation cancelled by the operator." No target hardware text is displayed.	.LCS	.LUS	.LNS
0x1007	Load Part Number failed	<"Load Part Number name> failed. " Target hardware text required		.LUS	
	Download File failed	<"File name> failed." Target hardware text required.			.LNS

* For the Display, the term "operation" must be replaced by the name of the operation: Information, Uploading or Downloading.

ATTACHMENT 1
ARINC 615A ADL AND PDL CONNECTOR SIGNAL ASSIGNMENTS

Function		ADL and PDL	Note
Reserved for ARINC 615 compatibility		1	6
Reserved for ARINC 615 compatibility		2	6
Reserved for ARINC 615 compatibility		3	6
Reserved for ARINC 615 compatibility		4	6
Reserved for ARINC 615 compatibility		5	6
TD + (ARINC 664P2)		6	5
TD - (ARINC 664P2)		7	5
Reserved for ARINC 615 compatibility		8	6
Reserved for ARINC 615 compatibility		9	6
Reserved for ARINC 615 compatibility		10	6
Reserved for ARINC 615 compatibility		11	6
Reserved for ARINC 615 compatibility		12	6
Reserved for ARINC 615 compatibility		13	6
Reserved for ARINC 615 compatibility		14	6
Reserved for ARINC 615 compatibility		15	6
Reserved for ARINC 615 compatibility		16	6
Future spare		17	1
Link – A		18	3
Link – B		19	3
115 Vac input Hot		20	4
Chassis ground / Signal electrical reference	GND	21	
115 Vac input Cold		22	4
RD + (ARINC 664P2)		23	5
Reserved for ARINC 615 compatibility		24	6
Reserved for ARINC 615 compatibility		25	6
ARINC 429 General output bus	A	26	2
ARINC 429 General output bus	B	27	2
Shield (ARINC 664P2)	GND	28	
Reserved for ARINC 615 compatibility		29	6
Reserved for ARINC 615 compatibility		30	6
Reserved for ARINC 615 compatibility		31	6
Reserved for ARINC 615 compatibility		32	6
Reserved for ARINC 615 compatibility		33	6
Reserved for ARINC 615 compatibility		34	6
ARINC 429 General input bus	A	35	2
ARINC 429 General input bus	B	36	2
Reserved 28 Vdc input Hot		37	
Reserved 28 Vdc return Cold		38	
RD - (ARINC 664P2)		39	5
RS-232 Transmit	TXD	40	
RS-232 Receive	RXD	41	
Future Spare		42	1
Future Spare		43	1
Future Spare		44	1
Future Spare		45	1
Future Spare		46	1
Future Spare		47	1
Logic common	(GND)	48	
Logic common	(GND)	49	
Reserved for ARINC 615 compatibility		50	6
Reserved for ARINC 615 compatibility		51	6
Reserved for ARINC 615 compatibility		52	6
Reserved for ARINC 615 compatibility		53	6

ATTACHMENT 1
ARINC 615A ADL AND PDL CONNECTORS SIGNAL ASSIGNMENTS

Reference To Notes

1. Future Spare. Connector pins marked “Future Spare” in the Standard Interwiring list are available for assignment as the airline industry desires. However, if the interchangeability for the system specified in Section 1.4 of this Report is to be retained, any such assignments thought necessary must be coordinated through ARINC and approved by the industry prior to being made. Contact hardware need not be provided in positions labeled “Future Spare” but may be furnished at the equipment manufacturer's discretion. Contact positions labeled “Future Spare (Contact)” will be the first to be selected for use if and when additional contact assignments are needed. Contact positions in equipment mounted service connectors labeled “Future Spare (Contact)” should be furnished with contact hardware (pin or socket as appropriate) and provisions made within the equipment for their easy use.

COMMENTARY

When the definition of a new unit starts with no “Future Spare” signals on the standardized connector, evolutions of this standardized unit will be limited. Consequently, some spare functions on the connector are requested. In ARINC 615 standard, loading a computer by RS 232 link is mentioned but not clearly defined. In this new standard, the RS 232 interface is only mentioned for factory and maintenance tests purpose. For such purpose, hardware flow control is not requested. Discrete input and output signals “RS 232 Baud sel bit 0 to 2” and “select ARINC 429/RS 232” of the previous standard also are not requested for this purpose. Functions 42 to 47 are changed to “Future Spare” functions for this standard. Compatibility with old ARINC 615 loader (PDL and ADL) must be managed if requested by the equipment manufacturer (cut the line in the adaptation cable or extract the pin from the connector).

2. Twisted and Shielded Wires. Wires should be shielded or twisted and shielded as indicated with an insulating jacket over the shield. The shield for each data bus should be connected to the appropriate Bus Shield pin (where provided). This should be a single-point connection at the common Bus Shield pin (not “daisy chained”).
3. Link A,B. The pins Link A and Link B are electrically connected within the data loader. The use of this connection may be defined by the airborne computer designer.
4. 115 Vac Shielding. The 115 Vac (H) and 115 Vac (C) should be shielded or twisted and shielded with an insulating jacket over the shield. The shield should be attached to chassis ground.
5. Twisted Pair Ethernet (TPE) Signal. Wiring should conform to ARINC Specification 664 Part 2.
6. Reserved for ARINC 615 Compatibility. These functions are used in the ARINC 615 connector. For compatibility purposes, they are not assigned on this connector.

ATTACHMENT 2
LOAD SCENARIOS

2-1 Load Scenarios

This Attachment describes different scenarios which must be supported through the Data Load Protocol.

Scenarios	Condition, Hypothesis, Constraints	Actions	Operations
Equipment Configuration Identification	This is the capture of the configuration of the Target Hardware This scenario can be performed at any time.	Operator requests Target Hardware's configuration. The target performs appropriate operations to guarantee P/N validity. Target answers with the up-to-date configuration information	Configuration request using ADL/PDL/DLF
Software Update A new software part is released, all occurrences of Target Hardware must be updated	This is a predicted operation. Compatibility of the new software part must be checked beforehand. Verification of the configuration must be performed afterward.	Operator uses Service Bulletin and new software part. Operator performs load transfer(s) ~~on~~ using ADL/PDL/DLF Configuration is verified by operator after load completion	Upload from ADL/PDL/DLF. Equipment Configuration Identification
Repair A new Target Hardware is installed in place of a failed Target Hardware	This is an unpredicted operation. Compatibility of the loaded code must be checked beforehand. Verification of the configuration against a configuration reference must be performed afterward.	The actual configuration of the new target hardware is verified by the operator against the configuration reference and, if correct, the action is complete. If the configuration is not correct, the operator uses available sources (e.g. ADL/PDL/DLF, file server, media sets) to locate the correct parts. Operator performs load transfer(s) using ADL/PDL/DLF Configuration is verified by operator after load completion	Upload from ADL/PDL/DLF.. Equipment Configuration Identification
Cross-load		This activity is not part of 615A	
Automatic Data Extraction data must be down loaded automatically after appropriate media insertion	The Target Operation is not disrupted during the Down Load operation Target may be interrupted if required to be in a data load mode to be downloaded	Operator inserts the pre-programmed media, supporting the file defining the download to perform. Download is performed automatically	Disk Defined Download to ADL/PDL/DLF

ATTACHMENT 2
LOAD SCENARIOS

Scenarios	Condition, Hypothesis, Constraints	Actions	Operations
User Data Extraction A block of data must be down loaded according to the choice proposed by the target	The Target Operation is not disrupted during the Down Load operation Target may be interrupted if required to be in a data load mode to be downloaded	Operator selects the target to download and storage file destination Operator then selects the software product to be downloaded, according to the list proposed by the target Operator activates the download transfer on ADL/PDL/DLF	Operator Defined Download to ADL/PDL/DLF
Continuous in flight download		This activity is not part of ARINC 615A.	

2-2 Configuration Query From ADL/PDL/DLF

This operation is made via the ADL/PDL/DLF to enable maintenance crew operation. It may also be performed via the Onboard Maintenance System.

Op#	Originator	Action	Means	Result
1.	Operator	Select destination Target	FIND command or Target HW Network Information File. (see Note) Destination selection dialog on ADL/PDL/DLF	The Data Loader gets the Target HW Network Information. The Destination Dialog asks for: Target Name Occurrence (1, 2, 3, ...).
2.	Operator	Request configuration data of the Target	Configuration dialog on ADL/PDL/DLF	Data Loader Application sends a Configuration request message to THA. THA performs appropriate operations to guarantee integrity of configuration information. THA then sends Configuration information to DLA.

Note The ADL/PDL/DLF must get information about the list of installed Target Hardware, their MAC address and their IP address. The FIND broadcast messaging as defined in Attachment 3 is used for this. A second way is to define a Target Hardware Network Information file that contains this data which may be readable by ADLs/PDLs. In this case, no broadcast request is used, as the basic principle uses static addresses defined in the network file. This information retrieved by either method is called the Target Hardware Network Information. These Target Hardware Network Information file formats may be unique to each aircraft type and each manufacturer's ADL/PDL/DLF.

ATTACHMENT 2
LOAD SCENARIOS

2-3 Upload From ADL/PDL/DLF

2-3.1 Upload Preparation

The aim of the first sub-phase is to define the job to be performed, and to check the availability of the implied elements (e.g., media, software parts, etc) as far as possible.

Op#	Originator	Action	Means	Result
1.	Operator	Get Service Bulletin (if any) and new software part(s)	Documentation and software part(s)	The operator knows procedure to be applied
2.	Operator	Select destination Target	FIND command or Target HW Network Information File. (see Note 1) Destination selection dialog on ADL/PDL/DLF	The Data Loader gets the Target HW Network Information The Destination Dialog shows Target Hardware instances
3.	Operator	Select load source media	Source media selection dialog on ADL/PDL/DLF See Note 2.	The Source Dialog proposes a list of sources : File Server ADL/PDL/DLF Floppy drive (legacy) ADL/PDL/DLF PCMCIA slot Etc… After selection, the Data Loader reads the «LOADS.LUM » file of the selected source The Source Dialog proposes a list of SW load P/N extracted from the « LOADS.LUM » file, in compliance with the THW_ID of the selected destination target
4.	Operator	Select one or more load(s)	Available loads for the target Load selection dialog on ADL/PDL/DLF	One or more load(s) are selected by the operator in the load source media. The ADL/PDL/DLF produces the appropriate load list. If possible, the ADL/PDL/DLF checks the presence of all files involved in the selected load(s) and the correct file size (“if possible” means if files can be accessed, caution with floppies).
5.	ADL/PDL/ DLF	Apply Load Request condition to target(s).	Load Request message	The Data Loader checks the presence of the selected target and the availability of the load phase. This initializes the load session for this target. If target response is OK, step 6 is started by the target.

ATTACHMENT 2
LOAD SCENARIOS

Op#	Originator	Action	Means	Result
6.	Target	Monitor target status, file transfer and load programming progress	**Data Load Progress Monitoring**	Target Hardware sends periodic target status and ADL/PDL/DLF updates monitoring dialog with the target status response This step is performed in parallel with other steps until the end of the load session.
7.	ADL/PDL/ DLF	Indicate the pre-check result to the operator.	Information dialog on ADL/PDL/DLF	If errors have been detected in the previous step, messages inform the operator and ask him to abort. If no error, step 8 is started by the ADL/PDL/DLF.
8.	ADL/PDL/ DLF	Transfer Operator selected Load Sources to Target	List of Loads File	The ADL/PDL/DLF sends the load list to the target The target reads the load list and checks the validity of the request, and answers ACK or NACK. At this step, it's not possible to estimate load duration.

Note:

1. The ADL/PDL/DLF must get information about the list of installed Target Hardware, their MAC address and their IP address. The FIND broadcast messaging as defined in Attachment 3 is used for this. A second way is to define a Target Hardware Network Information file that contains this data which may be readable by ADLs/PDLs. In this case, no broadcast request is used, as the basic principle uses static addresses defined in the network file. This information retrieved by either method is called the Target Hardware Network Information. These Target Hardware Network Information file formats may be unique to each aircraft type and each manufacturer's ADL/PDL/DLF.

2. If a remote source is to be used, the ADL/PDL/DLF must be able to access it as a remote network peripheral, without impact on the Data Load Protocol.

2-3.2 UpLoad Process

The aim of this sub-phase is to perform the effective load, erase and program the memory, and control the correct programming. During this sub-phase, the ADL/PDL/DLF is a simple TFTP server, managed by the target.

Op#	Originator	Action	Means	Result
1.	ADL/PDL/ DLF	Continue the target status, monitoring load process progress.	Information Progress Data Loading monitoring dialog load estimation time (if available)	Target Hardware sends periodic Target Hardware status and ADL/PDL/DLF ~~DL~~ updates monitoring dialog with the Target Hardware status response If possible, the target gives the estimate duration of the process.
2.	Target	Send a read request for one file (data file or header file).	Read request message TFTP file transfer	ADL/PDL/DLF checks the availability of the file. If not available, message asks the operator to insert appropriate media or indicates the error. Target reads the file and programs appropriate memories These file transfers are made as many times as identified in the load list and the associated header files.
3.	Target	Check integrity of the loaded code.	Information Progress Data Loading monitoring dialog	The target may compute integrity check values of the loaded software The target reports the final result of the load(s) to the ADL/PDL/DLF. (Load Fail, Load Complete)
4.	ADL/PDL/ DLF	Report the final result of the load to the operator	Information Progress Data Loading monitoring dialog	All previous steps are completed, including step 1 : the load session is closed. Result of correct or incorrect load is reported to the operator

2-3.3 Upload Termination

The aim of this sub-phase is to ask an operator for acknowledgment of the selected load.

Op#	Originator	Action	Means	Result
1.	Operator	Acknowledge final result of the load	ADL/PDL/DLF menu	The Operator can prepare for next phase
2.	Operator	Check new P/N component list	Service Bulletin (if any)	The Operator knows that operation has been completed

Note: That an equipment configuration identification operation must be performed before the airplane can be dispatched.

ATTACHMENT 2
LOAD SCENARIOS

2-4 Disk Defined Download to ADL/PDL/DLF

Op#	Originator	Action	Means	Result
1.	Operator	Give definition of the download to be performed.	Pre-programmed media Function menu dialog on ADL/PDL/DLF	Insertion of the pre-programmed media (floppy or PC-CARD) into the ADL/PDL/DLF Selection of the download function on the ADL/PDL/DLF Selection of the destination media (floppy or PC-CARD).
2.	ADL/PDL/ DLF	List the automatic download definition files Read the selected automatic download definition file	Pre-programmed media Automatic download definition files	If more than one download definition file exists, the ADL/PDL/DLF asks the operator to choose one. ADL/PDL/DLF knows the target to be downloaded and the destination media ADL/PDL/DLF checks the availability of the destination media
3.	**ADL/PDL/DLF**	**Apply Download Request conditions to target(s).**	**Download Request message**	**The Data Loader checks the presence of the selected target and the availability of the download phase.** **This initializes the load session for this target.** **If target response is OK, step 4 is started by the target.**
4.	Target	Monitor target status, file transfer and storage progress	Information Progress Dataloading monitoring dialog	Target Hardware sends periodic target status and *ADL/PDL/DLF* ~~DL~~ updates monitoring dialog with the target status response This step is performed in parallel with other steps until end of download session.
5.	ADL/PDL/ DLF	Send the automatic download definition file to the target	Transfer of the definition file	Target receives the download definition file and determines the job to be performed After this step, the ADL/PDL/DLF is a simple TFTP server, managed by the target.
6.	Target	Write file(s) to the destination media of the ADL/PDL/DLF.	Write request message TFTP file transfer Information Progress Data Loading monitoring dialog	The ADL/PDL/DLF receives the files produced by the target and stores them into the destination media
7.	Target	Writes final status file to the ADL/PDL/DLF final status of Download Operation.	Write request message TFTP file transfer Information Progress Data Loading monitoring dialog.	The ADL/PDL/DLF receives the final status file produced by the target.
8.	ADL/PDL/ DLF	Report final result of the load to the operator	Information Progress Data Loading monitoring dialog	Final status file received from the target with final status, Error or Complete, of Download Operation. Result of correct or incorrect operation is reported to the operator
9.	Operator	Acknowledge final result of the load	ADL/PDL/DLF menu	The Operator can prepare for next phase

ATTACHMENT 2
LOAD SCENARIOS

2-5 Operator Defined Download to ADL/PDL/DLF

Op#	Originator	Action	Means	Result
1.	Operator	Give definition of the download to be performed.	Function menu dialog on ADL/PDL/DLF	Selection of the download function on the ADL/PDL/DLF The Data Loader gets the Aircraft Target Name list The Destination Dialog ask for: Target Name Occurrence (1,2,3...) Selection of the destination media (floppy or PC-CARD).
2.	ADL/PDL/DLF	Target Hardware selection Destination Media selection	A/C target name list Destination selection dialog on ADL/PDL/DLF	The Data Loader checks the presence of the selected media
3.	ADL/PDL/DLF	Send Load Request condition to target(s).	Download Request message	The Data Loader checks the presence of the selected target and the availability of the download phase. This initializes the load session for this target. If target response is OK, the step 4 is started by the target.
4.	Target	Monitor target status, file transfer and storage progress	Information Progress Data Loading monitoring dialog	Target Hardware sends periodic target status and *ADL/PDL/DLF* updates monitoring dialog with the target status response This step is performed in parallel with other steps until end of download session.
5.	Target	Send the list of downloadable software parts and approximated sizes	Download menu file	*ADL/PDL/DLF* receives the list of downloadable parts and presents it to the operator.
6.	Operator	Select one or more download parts	Available downloadable parts for the target Download selection dialog on ADL/PDL/DLF	One or more download(s) are selected by the operator The ADL/PDL/DLF sends the selected list to the target The target reads the load list and checks the validity of the request, and answers ACK or NACK.
7.	Target	Write file(s) to the destination media of the ADL/PDL/DLF.	Write request message TFTP file transfer Information Progress Data Loading monitoring dialog	The ADL/PDL/DLF receives the files produced by the target and stores them into the destination media
8.	Target	Writes final status file to the ADL/PDL/DLF final status of Download Operation.	Write request message TFTP file transfer Information Progress Data Loading monitoring dialog	The ADL/PDL/DLF receives the final status file produced by the target.
9.	ADL/PDL/DLF	Report to the operator final result of the load	Information Progress Data Loading monitoring dialog	Final status file received from the target with final status, Error or Complete, of Download Operation. Result of correct or incorrect operation is reported to the operator
10.	Operator	Acknowledge final result of the load	ADL/PDL/DLF menu	The Operator can prepare for next phase

ATTACHMENT 3
FIND IDENTIFICATION OF NETWORK DEVICES (FIND) PROTOCOL

3-1 Introduction

The Find Identification of Network Devices (FIND) Protocol allows a client (hereafter called the initiator) to dynamically obtain:

- MAC address
- IP address
- Identity and functional characteristics for each available FIND host on the network

ARINC Report 615A allows the data loader (the initiator) to identify all the 615A loadable target hardware devices (the FIND hosts) present at the time of the request. After registering all the available target hardware devices, the data loader can present the list of loadable devices to the operator for selection.

FIND should be run at least once before any data load operations are performed.

Before each operation the data loader may run the FIND request and register all the answers in compliance with the FIND definition.

COMMENTARY

Implementers are cautioned against the assumption that all aircraft networks can or will support FIND. The FIND protocol can be used as either a broadcast message or a series of unicast messages only if the network between the dataloader and target provides the necessary support. Gateways between the loader and target may not forward packets appropriately or network resources may not be allocated which support the FIND traffic. FIND may not be usable for onboard data loading if airplanes have multiple network types or do not allow broadcast messages. FIND is useful for allowing load tools to interface with LRUs on an Ethernet network or in the shop for LRUs that have an Ethernet interface.

The FIND protocol does not support dynamic address allocation. It assumes that all IP address assignments have been performed by some means, for example, static configuration and dynamic allocation, prior to the FIND request.

COMMENTARY

Because the FIND protocol does not support address allocation some other means must be employed to configure the target and dataloader's network addresses. 615A and FIND do not contain nor are intended to contain any definition of network addressing, method of determining network addressing or impose requirements thereupon. Since the initiator does not know how many FIND hosts are on the network or their addresses, a broadcast message is used for the FIND request by the data loader. Each FIND host responds with a unicast answer directed to the data loader address.

The FIND protocol is implemented on top of the UDP datagram. FIND data is encapsulated in a UDP datagram, using the well-known port number 1001 (in decimal notation). The same port number should be used for request and answer packets.

MAC address and IP address information are supported by the classical fields within Ethernet frame and IP packet.

3-2 Overview

The initiator or Data loader sends a broadcast message requesting a response from all FIND hosts on the network, and then waits for responses. The initiator allows a 3-second window for responses. All valid responses are registered as targets for possible loading activity. When the 3 seconds window expires, the registration process is closed.

The Target hardware or FIND host should respond to the request with an answer message within a 2 seconds time-out or risk not being registered by the Data loader. The information needed by the initiator may come in the message structure or the FIND packet data. The values for the target hardware MAC and IP addresses are supported by the classical MAC and IP frame fields in a UDP/IP datagram. Other information, such as LRU Identification Position, is supported by UDP payload itself.

COMMENTARY

The difference between the data loader time out and the target hardware time out is due to network propagation delays.

No errors are managed in the FIND protocol. If the target hardware receives an illegal or invalid request, it should not answer. If the data loader receives an invalid answer, the data loader ignores the answer.

3-3 FIND Packets

There are two types of FIND packets. One is an Information Request packet and the other is an Information Answer packet. Each packet contains a header and a data portion as shown:

2 byte Header	Variable length Data
Opcode	Data List

The FIND packet header contains the opcode associated with that packet:

Opcode	Operation
1	Information ReQuest (IRQ)
2	Information ANswer (IAN)

The data portion of the FIND Information Answer packet contains a list of parameters described in Section 6, List of Parameters, of this attachment.

3-4 Information Request Packet

Source MAC address should be the MAC address of the data loader (or the initiator).

Destination MAC address should be a unicast, multicast, or the broadcast MAC address.

Source IP Address should be the IP address of the Data loader (or the initiator).

Destination IP address should be a unicast, multicast, or a broadcast IP address (full broadcast i.e., 255.255.255.255 or class-relevant broadcast e.g., 220.130.48.255 for a class C).

Opcode value should be IRQ (0x0001).

Data list should be a null ASCII string with terminator: 0x00.

Packet is terminated by 0x10.

3-5 Information Answer Packet

Source MAC address should be the MAC address of the Target hardware (or FIND host).

Destination MAC address should be the source MAC address from the associated Information request.

Source IP Address should be the IP address of the target hardware Identifier (or FIND host).

COMMENTARY

As one target hardware may act as a proxy or concentrator, target hardware may produce more than one answer to the same request.

Destination IP address should be the source IP address from the associated Information request.

Opcode value should be IAN (0x0002).

Data list is a list of null terminated character strings, each containing the variable value of the structure defined in Section 6.0, List of Parameters.

Empty field is coded by only one byte containing the ASCII string terminator or null byte.

Available string should not include “null byte” in part of the string.

A *packet* should be terminated by 0x10.

3-6 List of Parameters

For each Target Hardware Identifier (also referred to as Target_HW_ID and THW_ID), the list of parameters to be obtained by the data loader to perform its initialization is:

Target Hardware Identifier (e.g., “HNPFMS”)

Target Type Name (e.g., “FMS”)

Target Position (e.g., “1”, or “L”)

Literal Name (e.g., “FMS LEFT”)

Manufacturer Code (e.g., “HNP”)

COMMENTARY

The manufacturer should be identified by the method defined in ARINC Report 665.

For the Information Answer packets, the values of above parameters, are encoded in null terminated strings, in the same order as the above list, with the size limits defined below (not including the ASCII string terminator):

- Target Hardware Identifier: 15 characters maximum.
- Target Type Name: 8 characters maximum.
- Target Position: 8 characters maximum.
- Literal Name: 20 characters maximum.
- Manufacturer Code: 3 characters.

3-7 Examples

3-7 Packet Example

Data loader Request

Opcode (IRQ)	**0x0001**
ASCII string terminator	0x00
Packet Terminator	0x10

Target hardware identifier answer

Opcode (IAN)	**0x0002**
Target Hardware Identifier (text)	HNPFMS
String terminator (ASCII NULL)	0x00
Target Hardware Type Name (text)	FMS
String terminator (ASCII NULL)	0x00
Target Hardware Position (text)	L
String terminator (ASCII NULL)	0x00
Literal Name (text)	FMS LEFT
String terminator (ASCII NULL)	0x00
Manufacturer Code	~~7~~HNP
String terminator (ASCII NULL)	0x00
Packet terminator	0x10

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

4-1 Introduction

ARINC Report 615A protocol is supported by two layers:

1. A TFTP layer to transfer files (protocol files and data files). This layer defines one exchange by one request and its answer (regardless of the type of packet)
2. A DLP layer to manage general process and coordinate activities between the data loader and the target hardware.

There are two levels where time-out and retry should be defined. One level is managed by the TFTP layer in case of a failed TFTP exchange, and another level is managed by the DLP layer due to a failed TFTP file transfer (Figures A4-3, A4-4 and A4-5).

TFTP level: The TFTP layer is activated to transfer one file, and manages objects corresponding to “one exchange.” The TFTP layer does not manage links between file transfers.

Inside one TFTP file transfer, each exchange should be acknowledged within the “TFTP time-out” delay window. Time-out expiration without acknowledgement should induce one error for this exchange. Such an error is not a fatal error.

Inside one TFTP file transfer, each exchange may be retried if a recoverable error has been detected (CRC16 error, CRC32 error, time-out error, etc.). After the number of retries equals the TFTP VALUE (TFTP retry number) for the same exchange and an error still results, the TFTP file transfer should result in an error. The DLP upper layer should be informed of such an error.

DLP level: The DLP layer is activated for each data load operation (upload, download, etc.) for each target hardware, and manages objects corresponding to “one TFTP file transfer.” The DLP layer has no knowledge of the “TFTP exchanges.”

When one error has been signaled by the TFTP layer, the DLP layer should retry this failed TFTP file transfer (the entire file). The number of retries allowed at the DLP layer is noted as “DLP Retry Number.” After the DLP Retry Number has been exceeded for the same TFTP file transfer and an error still exists, this DLP file transfer should be declared as a fatal error. The upper layer (application) should be informed of such a fatal error. For the ARINC 615A protocol definition this implies the end of the data load operation. Between any two TFTP file transfers, the maximum delay is defined and noted as “DLP Time-Out.” This Time-Out expiration, between the end of one TFTP exchange and the beginning of another TFTP exchange, induces a DLP error for the data load operation. This Time-Out applies only to some peer of a TFTP file transfer. Peers are noted as initial and secondary TFTPs. The "initial and secondary" meanings are chronological (the initial TFTP file transfer precedes the secondary one).

This error is classified as a fatal error, without any allowed retries. If the actual DLP Time-Out Value is too constraining, it should be increased. A DLP Retry Number is not applicable if a DLP Time-Out error, a fatal error, occurs.

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

Protocol reliability is dependent on accurate definition of the Time-Out (TO) and Retry Number. It is up to the client to activate the iterations of the Trivial File Transfer Protocol (TFTP) file transfer in accordance with the Data Load Protocol (DLP) Retry Number. The purpose of this attachment is to define Time-Out and Retry Numbers for the TFTP and the DLP protocols.

4-2 Overview

For each protocol, two classes of elements are defined, with different characteristics for each class:

- The Time-Out (TO) is characterized by its definition, value, constraints, and a chronological illustration.
- The Retry Number is characterized by its definition, value and constraints.

4-3 TFTP

4-3.1 TFTP Time Out

Definition:

For each end-system (data loader or target hardware) the TFTP time-out is the time measured between the emission of one TFTP packet (whatever the type of TFTP packet) and the reception of the associated answer packet for the same TFTP exchange (whatever the type of TFTP packet). The generic notation is TFTP-TO.

Value:

The TFTP Time-Out (TFTP-TO) value is indicated in seconds. The time-out value should be 2 seconds.

Constraints:

It is necessary to split this constraint into two parts: the network constraint and the subscriber constraint:

Network constraint: the transmission duration of one TFTP packet should not be longer than TFTP-TO / 4. This is to account for the sending and receiving bus transfer time.

Subscriber constraint: the processing duration between the reception of one TFTP packet and the emission of the associated packet should not be longer than TFTP-TO / 2. This is the time left over after subtracting out the sending network constraint and subtracting out the receiving network constraint.

See Figure A4-1.

COMMENTARY

Using a large TFTP block size, the TFTP-TO Value would be sufficient in a general case. For a particular case, the block size parameter would be reduced to obtain compliance with this time-out value.

No minimal Value is given for the duration between the reception of one packet and the emission of the associated answer packet. According to the policy of the target hardware, this delay may be very short.

4-3.2 Retry Number

Definition:

For each end-system (data loader or target hardware) the TFTP Retry Number is the number of times a TFTP exchange is attempted after one initial failed exchange (inside the same TFTP session), which may be recoverable. It is the number of allowed retries before declaring a TFTP failure (via an error code) to the DLP. The Retry Number value is in addition to the first exchange, e.g., a retry number value of 2 implies that the maximum number of exchange tries is 3. That is 1 original attempt plus 2 retries for a total of 3 tries. The Retry Number is applicable for each exchange inside one TFTP. The retry number has no cumulative notion between various exchanges in the same TFTP. All errors relative to the same exchange are accumulated to compare the number of tries to the TFTP Retry Number. The algorithm applies to any TFTP exchange (initial request, acknowledge, data transfer, last acknowledge, etc).

Value:

The TFTP Retry Number value is indicated as an integer value. The required value is 1.

Constraints:

Any TFTP should use the same Retry Number value. Setting specific retry numbers according to the file type (protocol file, data file, etc.) could increase the complexity of the implementation without any real improvement of reliability.

COMMENTARY

As TFTP is based on the UDP stack, and as the UDP cannot ensure a correct transfer of any block, it is mandatory to provide an error recovery capability to prevent a UDP transfer error (This principle is defined in the TFTP RFC).

A value of 1 is based on an estimation of the reliability on a Standard Ethernet Network.

Note that this Retry Number is linked to the reliability of the network itself (communication aspect), and is not sized to support application errors (such as insufficient CPU allocation, packet lost in the End System Layer, insufficient delay to compute CRC, etc.). The assumption is that the protocol is correctly implemented.

The recommendation is to improve the reliability of the network itself, rather than to increase the Retry Number.

4-3.3 Sorcerer's Apprentice Syndrome

According to the TFTP specification, as described in the RFC 1123, the implementation should contain the fix for a potential Sorcerer's Apprentice problem. The sender, that is, the side originating the data packet, should never re-send the current data packet on receipt of a duplicate acknowledge.

4-4 Data Load Protocol (DLP)

4-4.1 Time Out

Definition:

Applicable to a data loader only, the DLP Time-Out is the time between the emission of the last packet of the initial TFTP (acknowledge) and the reception of the first packet of the secondary TFTP (write request). The Generic notation is DLP-TO.

This DLP Time-Out (DLP-TO) should apply to the sequences of initial TFTP file transfer and the secondary TFTP file transfer listed below. TFTP is referenced using the extension of the protocol file used during the associated TFTP.

Initial TFTP file transfer	Secondary TFTP file transfer
.LCI	.LCS
.LCS	.LCS
.LUI	.LUS
.LUS	.LUS
.LNI	.LNS
.LNS	.LNS

A DLP Time-Out error is classified as a fatal error, without any allowed retry. If an actual DLP Time-Out Value is too constraining, it should be increased. A DLP Retry Number is not applicable if a DLP Time-Out error, a fatal error, occurs.

If the .LCI-.LCL sequence is initiated before expiration of the DLP-TO, the target hardware should not produce the status file (.LCS). The operation is intended to be performed rapidly without the proliferation of status files being generated.

Value:

The DLP Time-Out value is indicated in seconds. The time-out value should be 13 seconds, based on the allowed refresh rate of operator information, balanced with the workload induced by such a process (on both sides, the data loader and target hardware).

Constraints:

To conform to the DLP-TO time-out, the target hardware should have a Duration Time, the time between the reception of the last packet of the previous TFTP file transfer and the emission of the first packet of the next TFTP file transfer, in compliance with the following equation:

Duration_time < DLP_TO
[DLP_retry x (TFTP_retry + 1) x TFTP_TO]
[TFTP_retry x TFTP_TO]
2 x TFTP_TO / 4

Figure A4-2 illustrates DLP TimeOut for example values as follows:

DLP_retry = 2
TFTP_retry = 2
TFTP_TO = 2 seconds

As an example of application of the equation, assuming parameters of:

DLP_retry = 1
TFTP_retry = 1
TFTP_TO = 2 seconds

and assuming a duration time of 6 seconds, when applied to the equation, yields:

DLP_TO > 6
+ (1 x (1 +1) x 2)
+ (1 x 2)
+ 2 x (2 / 4)
> 13 seconds.

Therefore, according to the equation and for the desired maximum duration time of 6 seconds, the DLP_TO should be set greater than 13 seconds.

4-4.2 Retry Number

4-4.2.1 Definition

For each end-system (data loader or target hardware) the DLP Retry Number is the number of times a TFTP file transfer is attempted again, after one initial failed TFTP file transfer (the entire file), which may be recoverable. It is the number of allowed retries at the DLP level before declaring a DLP failure (via an abort message error code). The DLP Retry Number Value is in addition to the first TFTP file transfer, e.g., a DLP Retry Number value of 2 implies that the maximum number of TFTP file transfer tries is 3. That is 1 original attempt plus 2 retries for a total of 3 tries. A DLP Retry Number applies to each file to be transferred (data files and protocol files). The retry number has no cumulative notion between various TFTP file transfers in the same ARINC 615A operation.

4-4.2.2 Values

The DLP Retry Number value is indicated as an integer value. The required value is detailed in the following table.

TFTP is referenced using the extension of the protocol file used during the associated TFTP.

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

TFTP Items	Retry Number
.LCI	1
.LCL	1
.LCS	1
.LUI	1
.LUR	1
.LUH	1
Data File	1
.LUS	1
.LND	1
.LNR	1
.LNS	1
.LNO	1
.LNL	1
.LNA	1

4-4.2.3 Constraints

Today the DLP uses the same Retry Number Value for all files. Setting a specific Retry Number according to the file type (protocol file, data file, etc.) could increase the complexity of the implementation, without real improvement of the reliability.

COMMENTARY

The DLP, just as any layer protocol definition, should include the Retry Number and Time-Out definition.

As a data loader function may be supported by COTS products (for a shop Data loader, for example), with the associated COTS Operating system, a value of 1 is based on an estimation of the reliability on TFTP COTS stacks (such as a temporary error due to file access, etc.).

Note that this Retry Number is linked to the reliability of the communication stack, and is not sized to support application errors. The assumption is that the protocol is correctly implemented.

The recommendation is to improve the reliability of the network itself, rather than to increase the Retry Number.

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

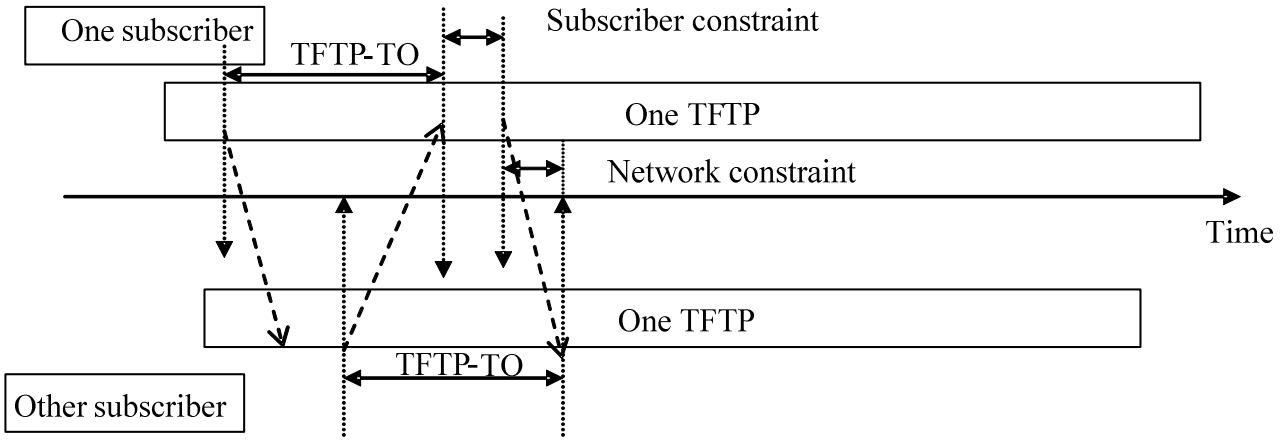


Figure A4-1 - TFTP Time-out

Example with : DLP_retry = 2
TFTP_retry = 2
TFTP_TO = 2 seconds

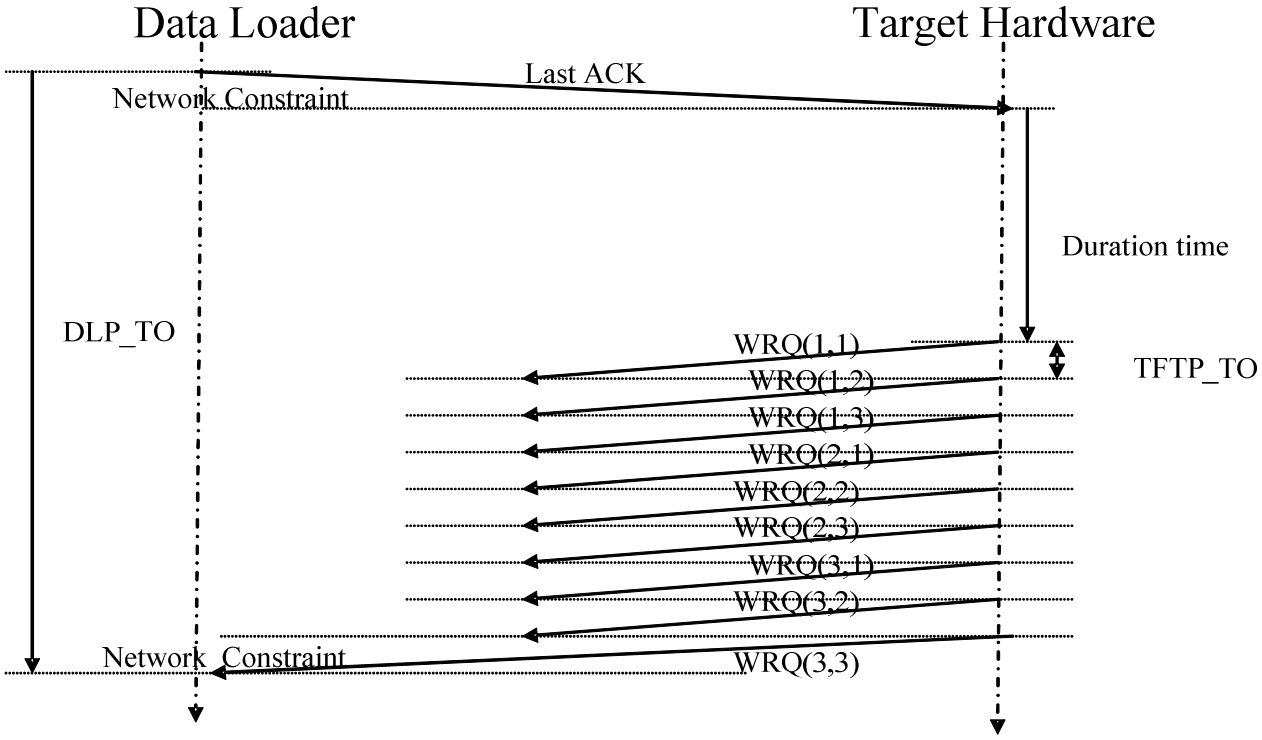


Figure A4-2 – DLP Time-out

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

NOTATIONS for Figures A4-3, A4-4, A4-5, and A4-6:

Send (y): Transmission of one TFTP packet, corresponding to the TFTP exchange number “y”, whatever the type of TFTP packet.

Receive (y): Reception of one TFTP packet, corresponding to the TFTP exchange number “y”, regardless of the type of TFTP packet. This packet acknowledges the send (y) packet. The send (y+1) will acknowledge the receive (y).

Such notation allows the same representation on the client or server side, without differences due to the equipment function (data loader or target hardware).

As a reminder, for TFTP, the WRQ and DATA packets are acknowledged by an ACK or ERROR packet, while RRQ and ACK are acknowledged by a DATA or ERROR packet.

FIGURES:

Figure A4-3 represents the usage and meaning of:

- TFTP Retry Number
- TFTP Time-Out
- DLP Retry Number

on the side of the client with the request.

Figure A4-4 represents the usage of the same parameters on the side of the server with the request.

Figure A4-5 represents the usage of a DLP Time-Out on the data loader side.

COMMENTARY

For the DLP, each subscriber (data loader and target hardware) may play the part of a client and server.

The DLP Time-Out applies only to the data loader side, while the other parameters apply to both sides.

After a fatal error, the data loader operation (upload, download, etc.) should be completed.

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

The Example below is with:

- A TFTP Retry Number set to 3 (a total of 4 possible tries for one exchange).
- A DLP Retry Number set to 1 (a total of 2 possible tries for one file transfer).

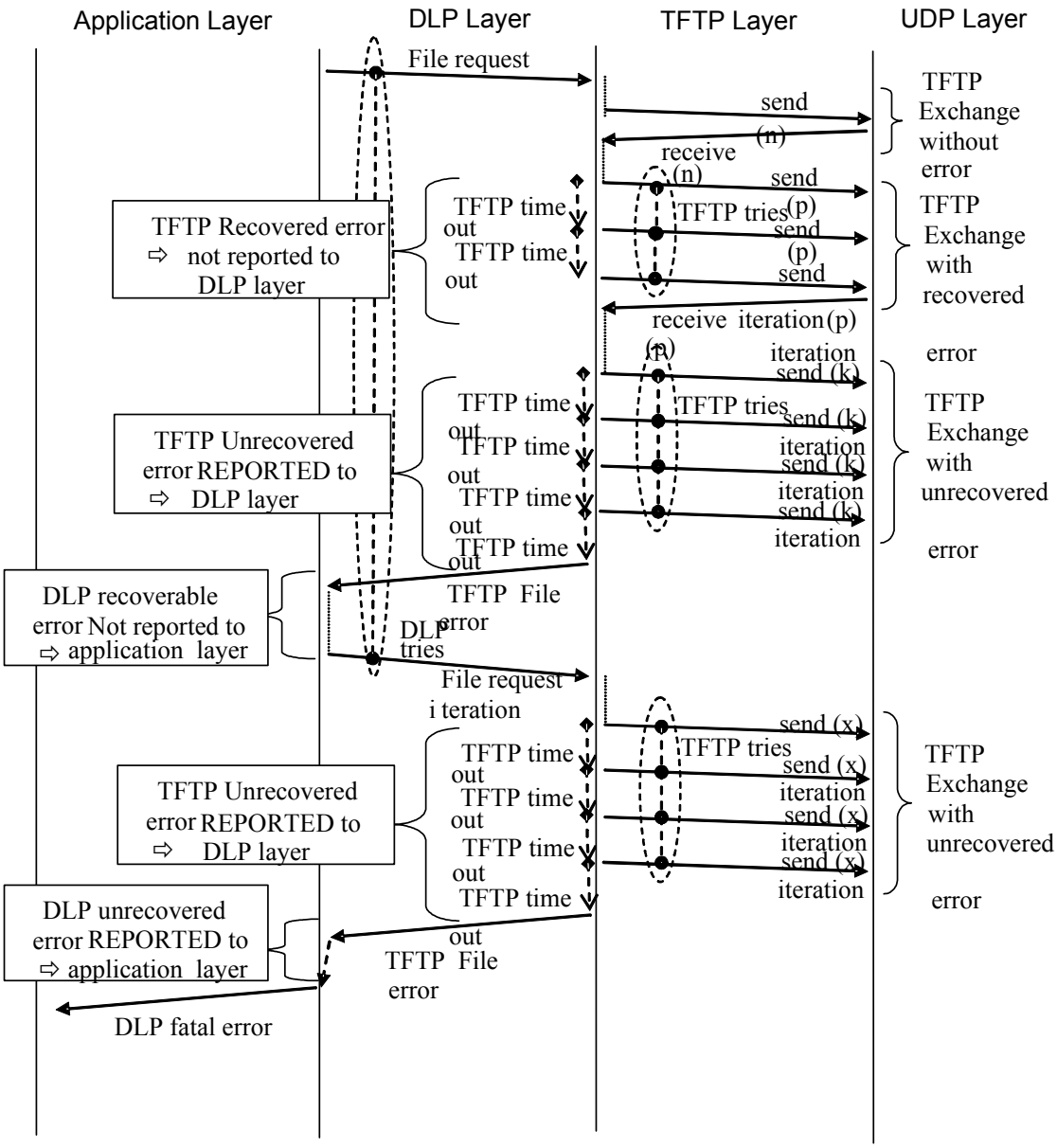


Figure A4-3 – Client Side (Initiator of the File Request)

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

The Example below is with:

- A TFTP Retry Number set to 3 (a total of 4 possible tries for one exchange).
- A DLP Retry Number set to 1 (a total of 2 possible tries for one file transfer).

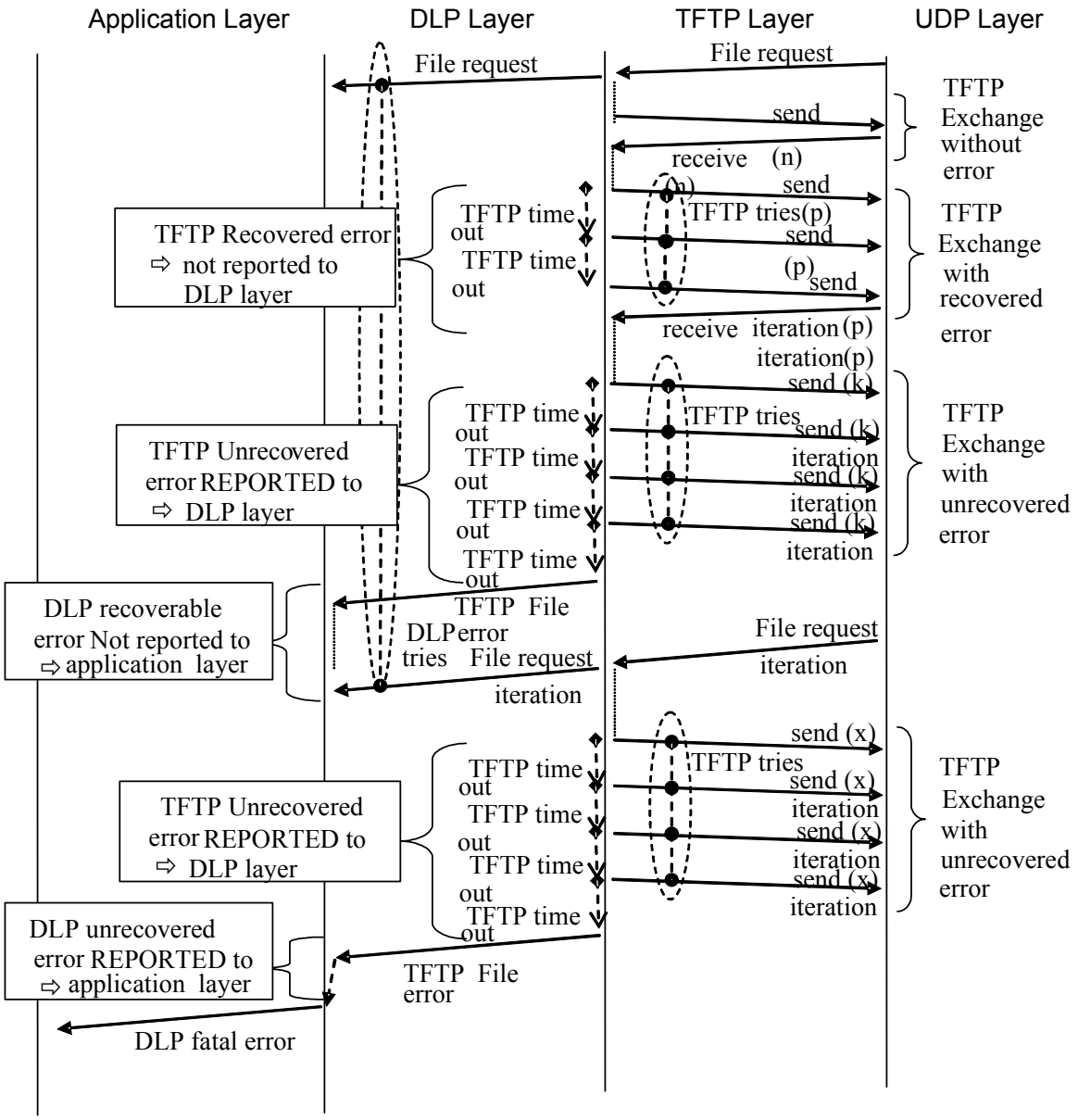


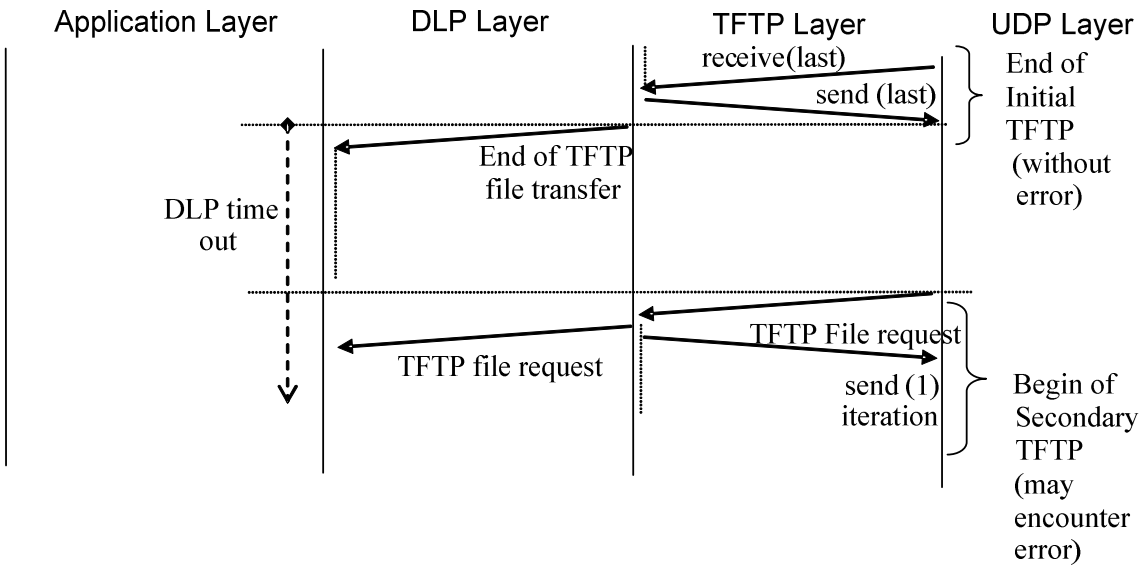
Figure A4-4 – Server Side (Server of the File Request)

COMMENTARY

It is up to the client to activate the iterations of the TFTP file transfers.

ATTACHMENT 4
TIME-OUT AND RETRY NUMBER DEFINITION

CASE WITH NO DLP TIME-OUT ERROR:



CASE WITH DLP TIME OUT ERROR:

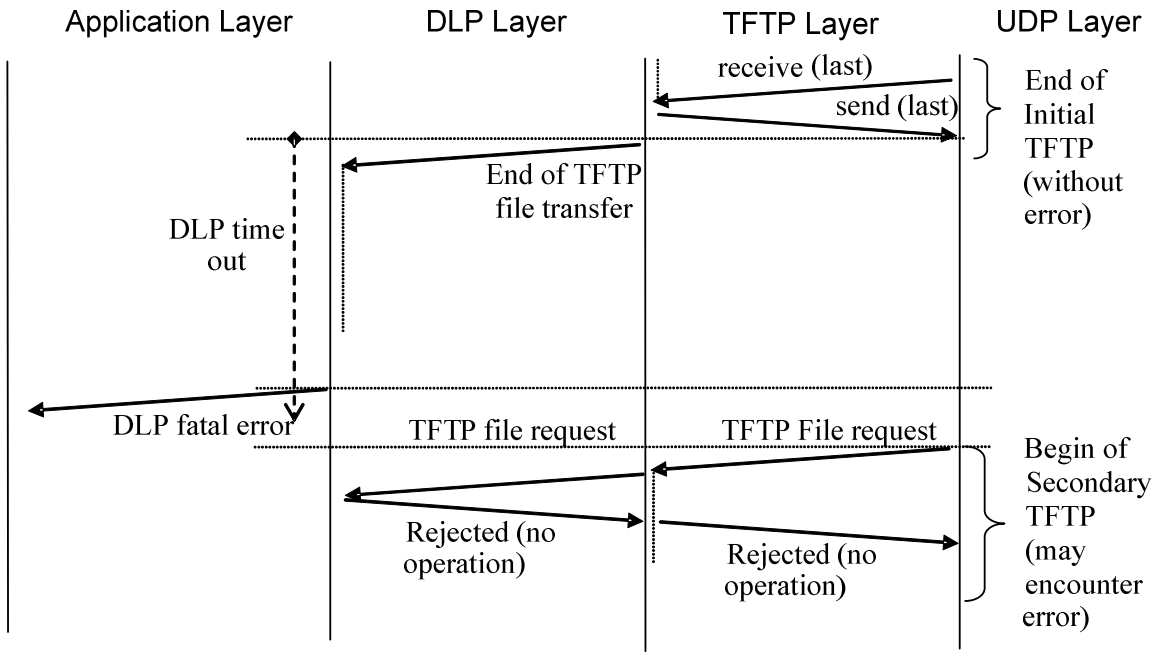


Figure A4-5 – DLP Time-Out (Only On Data Loader)

COMMENTARY

A DLP Time-Out applies only to the peer of a TFTP file transfer [Initial TFTP, Secondary TFTP] referenced in table of Section 4.1 of Attachment 4. A DLP time out is classified as fatal error.

ATTACHMENT 5
ENVIRONMENTAL TEST CATEGORIES

The following example RTCA DO-160 categories apply to the environmental specifications of the airborne data loader (ADL). The latest version of RTCA DO-160 applies to new designs.

Environment	DO-160 Section	ADL	ADL with Optical Media Device(Note 7)
Temperature & Altitude	4	CAT A2	
Temperature Variation	5	CAT C	
Humidity	6	CAT A	
Shock	7	YES	
Vibration (see Notes 1 & 2)	8	CAT K	
Explosion	9	CAT X	
Waterproofness (see Note 2)	10	CAT X	
Fluid Susceptibility	11	CAT X	
Sand and Dust	12	CAT X	
Fungus	13	CAT X	
Salt Spray	14	CAT X	
Magnetic Effect	15	CAT A	
Power Input	16	CAT A	
Conducted Voltage Transient	17	CAT A	
Audio Frequency Conducted Susceptibility	18	CAT A	
Induced Signal Susceptibility	19	CAT A	
Audio Frequency Susceptibility (Radiated and Conducted)	20	CAT A	
Spurious Radio Frequency Emission	21	CAT A	

1. The use of alternative categories may be necessary if the installation is to be made in other than turbine-powered fixed-wing aircraft. Refer to RTCA DO-160 directly.
2. Allows the alternative already provided by DO-160 (sine wave or random).
3. Lightning protection should be provided. When considering lightning protection, the provisions of Section 22 of RTCA DO-160 should be used as a guide.
4. Rack-mounted and cockpit-mounted units should withstand spillages of liquids (beverages).
5. The values specified in this report have precedence over the values specified in DO-160 where the two values differ. The references here are given to clarify the testing procedures needed.

COMMENTARY

References to a PDL, that is, environmental were removed in Supplement 3. The purpose of this removal was the recognition that laptops and other devices were desired for the task. It also was recognized that PDLs, if not rugged were not going to survive and therefore subject to the test of survival of the fittest.

6. Category specifications for the ADL with an optical media device, which may differ from the criteria applicable for the ADL, may emerge as hardware implementations of the software data loading protocol are developed.

APPENDIX A
HUMAN INTERFACE GUIDELINES

Manufacturers of software loader equipment, which is compliant with ARINC Report 615A, should follow the human interface guidelines presented in this appendix. These guidelines have been developed from airline recommendations to mitigate current data loading problems reported from field operations. Adherence to these guidelines should provide a consistent, unambiguous and informative user interface for the software-loading task.

A-1 Physical Interface for Data Loading Devices

1.1 A display should be capable of providing the operator with written status and operating instructions. The display should be readable in daylight and in night conditions.

1.2 Buttons, cursor control, and all other manual control devices should be of appropriate size, shape and placement to allow an operator to operate easily the loader while wearing gloves in cold conditions.

1.3 Simple and secure power “ON/OFF” buttons should be provided, especially, on portable devices.

A-2 Operations and Procedures

2.1 Procedures should be menu driven to guide the operator through the necessary actions and give sufficient information on choices that must be made. Provided this menu-driven criterion could be met, differences in procedures for different loaders or for target systems with the same loader should be acceptable.

2.2 The software configuration loaded in the target system should be capable of being provided at any time.

2.3 Pre-requisite tasks should be clearly and unambiguously presented before starting the data transfer operation.

2.4 Positive confirmation should be required for all selections and button activation; for example, changing a cursor shape to an hourglass is a common and acceptable method.

2.5 Progress of the load operation should be provided continuously to the operator. If a failure occurs, the data loader should indicate the stage of the load operation. During the load-operation transfer-and-verification phases, status bars indicating the percentage of completion should be presented.

2.6 When the loader is performing functions that may take more than a few seconds to complete, an appropriate indication should be presented to the operator. When the task may take more than a minute, an indication of the expected or normal task duration should be provided also.

2.7 Designs should avoid situations in which the operator is presented with a blank or frozen screen for extended periods with no status indications.

2.8 When it is necessary to change the media to the next unit of a set, suitable prompts should be given. These instructions should identify the positive action to be taken, and not simply indicate that the current condition is incorrect. For example, “Wrong Disk Inserted” does not indicate that the normal operation requires insertion of the next disk in sequence.

2.9 Following a successful load, indication should be given that the load is complete and correct.

2.10 Simplified English should be used to accommodate operators who are not native English speakers.

A-3 Mass Storage Devices

For data loaders that contain mass storage devices, the operator should be able to view the contents of the mass memory, load new software parts, and delete unwanted software parts, without the need for the loader to be connected to the aircraft or to an Ethernet network. Display of the remaining storage capacity and any necessary hard drive maintenance utilities should be provided.

A-4 Error Conditions and Recovery

4.1 The data loader should indicate when a load is unsuccessful and display any corrective action or verification steps.

4.2 If the target device detects a failure during the load process, it should set the failure indication on the data loader and display failure information. Simply resetting and restarting should not be acceptable because it results in endless loops without an error indication.

4.3 The data loader should provide the operator with the ability to reinitialize a load in the event of an error. Be aware that often both the target system and the data loader must have power cycled from off to on before a load should be restarted.

4.4 The data loader should have the ability to verify via a standard cyclic redundancy check (CRC) that the loading media has valid data. Be aware that independent verification that the loading media is bad should eliminate the loader and the target system as the source of a load failure.

4.5 Indication of all error conditions should be provided in simple English.

4.6 Use of codes requiring special expertise or knowledge should be avoided.

APPENDIX B
REFERENCE GUIDE

This Reference Guide lists the references in **ARINC Report 615A:** *Software Data Loader Using Ethernet Interfaces*. The references are categorized by their importance to the Portable Data Loader (PDL) developer, Airborne Data Loader (ADL) developer, and Target HardWare (THW) developer. The following numbers identify the categories:

1. Reference document required to implement ARINC Report 615A.
2. Reference document with sufficient information in ARINC Report 615A.
3. Reference document that provides additional information, but not required for implementation of ARINC Report 615A.

Reference Documents	PDL	ADL	THW
American Standard Code Information Interchange (ASCII)	2	2	2
ARINC Specification 664: *Aircraft Data Network, Part 2 – Ethernet Physical and Data Link Layer Specification*	1	1	1
ARINC Specification 664: *Aircraft Data Network, Part 3 – Internet-based Protocols Suites and Services*	1	1	1
ARINC Specification 664: *Aircraft Data Network, Part 4 – Internet-based Address Structures and Assigned Numbers*	1	1	1
ARINC Specification 664: ***Aircraft Data Network, Part 7 – Avionics Full Duplex Switched Ethernet***	**1**	**1**	**1**
ARINC Report 604: *Guidance for Design and Use of Built-in Test Equipment (BITE)*	2	2	2
ARINC Report 609: *Design Guidance for Aircraft Electrical Power Systems*	1	1	1
ARINC Report 615: *Airborne Computer High Speed Data Loader*	3	3	3
ARINC Report 624: *Design Guidance for Onboard Maintenance Systems*	2	2	2
ARINC Report 665: *Loadable Software Standards*	1	1	1
ARINC Specification 429: *Mark 33 Digital Information Transfer System (DITS), Part 1, Functional Description, Electrical Interface, Label Assignments and Word Formats* [Equipment ID for THW ID only]	1	1	1
EUROCAE ED-12: *Software Consideration in Airborne Systems and Equipment Certification*	3	1	1
EUROCAE ED-14: *Environmental Conditions and Test Procedures for Airborne Equipment*	3	1	1
European Computer Manufacturer's Association (ECMA) Standard 267: *120 mm DVD-Read Only Disc*	2	**2**	3
European Joint Aviation Authority (JAA) Regulatory Requirements	3	1	1
Federal Aviation Authority (FAA) Regulatory Requirements	3	1	1
Federal Communications Commission (FCC) Regulatory Requirements	3	1	1
Internet Assigned Numbers Authority (IANA)	2	2	2
MS25212: *ADL Size*	3	1	3
MS27473T-18A-53P: *Airborne Data Loader interface connector aircraft/airborne computer end*	2	**2**	**3**
MS27473T-18A-53S: *Data Loader interface termination at Data Loader End*	**2**	**2**	3
MS27473T-18B-53P: *Airborne Data Loader interface connector aircraft/airborne computer end*	2	**2**	**3**
MS27508E-18A-53P: *PDL and ADL Connector*	**2**	**2**	2
PC Card Slot Standard	2	**2**	3
PC Card Standard	2	**2**	3
Phillips - Sony Orange Book recordable compact disc physical format	2	**2**	3
Phillips - Sony Yellow Book compact disc physical format	2	**2**	3

APPENDIX B
REFERENCE GUIDE

Reference Documents	PDL	ADL	THW
Request for Comment (RFC) 1350, TFTP Trivial File transfer Protocol	**1**	**1**	**1**
RFC 1123: *Requirements for Internet Hosts Application and Support*	2	2	2
RFC 1785: *TFTP Option Negotiation Analysis*	2	2	2
RFC 2347: *TFTP Option Extension*	2	2	2
RFC 2348: *TFTP Blocksize Option*	2	2	2
RFC 2349: *TFTP Timeout Interval and Transfer Size Option*	2	2	2
RFC 768: *UDP User datagram Protocol*	2	2	2
RFC 791: *IP Internet Protocol*	2	2	2
RS232 (legacy)	**3**	**3**	**3**
RTCA DO-160: *Environmental Conditions and Procedures for Airborne Equipment*	3	1	1
RTCA DO-178: *Software Considerations in Airborne Systems and Equipment Certification*	3	1	1
Find Identification of Network Devices (FIND) - (See ARINC Report 615A, Attachment 3)	1	1	1

APPENDIX C
LIST OF ACRONYMS

ACK	ACKnowledge
ADL	Airborne Data Loader
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
ATA	Advanced Technology Attachment (relates to Personal Computer Hardware)
ATA	Air Transport Association of America
BITE	Built-In Test Equipment
CD	Compact Disc
CIS	Cartridge Information Section
CRC	Cyclic Redundancy Check / Cyclic Redundancy Code
DLA	Data Loader Application
DLF	Data Load Function
DLP	Data Loader Protocol
DVD	Digital Versatile Disc
ECMA	European Computer Manufacturer's Association
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FIND	Find Identification of Network Devices
HD	High Density
HW	Hardware
I/O	Input/Output
IAB	Internet Architecture Board
IP	Internet Protocol
JAA	Joint Aviation Administration
LSP	Loadable Software Part
MAC	Media Access Control
MCDU	Multi-Function Control Display Unit
NCITS	National Committee on Information Technology Standards
P&WA	Pratt & Whitney Aircraft
PC	Personal Computer
PDL	Portable Data Loader
PDU	Protocol Data Unit
PMAT	Portable Maintenance Access Terminal

APPENDIX C
LIST OF ACRONYMS

RAM	Random Access Memory
RFC	Request for Comments
ROM	Read Only Memory
RRQ	Read ReQuest
TFTP	Trivial File Transfer Protocol
TH	Target Hardware
THA	Target Hardware Application
THP	Target Hardware Protocol
THW_ID_POS	Target Hardware Identifier Position
UDP	User Datagram Protocol
VAC	Voltage, Alternating Current
VDC	Voltage, Direct Current
WRQ	Write ReQuest (Inherited from A665 acronym list).

APPENDIX D
GLOSSARY

Airborne Data Loader (ADL)
Equipment and Software installed in the aircraft to perform the Data Load function. (1.4.2)

Big-Endian
A process by which 16-bit word data is transferred with the Most Significant byte (8 bits) first followed by the Least Significant byte (8 bits). (Section 6.4)

Cyclic Redundancy Code (CRC)

A value calculated from a block of data and used to detect changes to the data due to, for example, corruption of memory. CRC algorithms are chosen so that changes in the block of data are very likely to change the calculated value.

Data Loader (Software Loader)

Equipment (hardware and software) used to upload or download software (e.g., MAT, PMAT, ARINC 615 data loader, etc.).

Data Loading
See “software loading.”

Download
A data transfer from an LRU to the Data Loader.

Download (Down Load)
Refers to data transfer from a system to a transport or storage media.

Download Operation
The process of downloading files from Target Hardware.

Field-Loadable Software
Synonym for “Onboard Loadable Software.” Per RTCA DO-178B, defines Field-loadable software as executable code or data tables that can be loaded without removing the system or equipment from its installation. Note: DO-178B does not draw a distinction between Field Loadable Software that is configured as part of the target hardware and Field Loadable Software that is configured as part of the airplane (i.e., LSAPs).

FIND
The Find Identification of Network Devices protocol allows a client to dynamically obtain the MAC address, IP address, and Identify (HW Identifier, Manufacturer Code, Unit Literal Name, Position) for each available FIND host on the network.

Full Load
Transfer of all data files of a Loadable Software Part.

APPENDIX D
GLOSSARY

Hardware (HW)
Physical equipment, as opposed to computer programs, procedures, rules, and associated documentation. Contrast with software, firmware.

Load (noun)
Synonym for “Loadable Software” and “Software Load.”

Load (verb)
The process of transferring data into the program-memory of the “target hardware.”

Load List Ratio
Three characters (8-bit ASCII) representing the percentage of the Download completed. (Section 6.4.5)

Load PN (Load Part Number)
The PN of the “loadable software part” (not the PN of media set on which the software load is located).

Load Protocol
The formalized set of rules by which loads are transferred from (download) or to (upload) the Target Hardware. [Defined in Section 5 of this document]

Load Ratio
Three 8-bit ASCII characters indicating the percentage of the specific load completed. (Section 6.4.5)

Load Scenario
A Load Scenario is a description of the intended loading activity. These are detailed in Attachment 2 and include Configuration Equipment Identification, Software Upload, Software Download (operator defined, media defined).

Load Source
The source of the data and header files that are being loaded (CD, Gatelink, PC-Card, etc.).

Loadable Software
A software data set (i.e., group of files) designed for transferring into its “target hardware” without physically altering the hardware.

Mass-Storage Device (MSD)
A large capacity nonvolatile storage medium for software or data entities. Example: A hard disk drive or CD-ROM, which contains multiple files, loads, data bases, etc.

APPENDIX D
GLOSSARY

Media

Devices or material which act as a means of transferal or storage of software, for example; programmable read-only memory, magnetic tapes or Compact discs, etc.

Onboard Load

Transfer of "loadable software" into "target hardware" while the hardware is installed on the aircraft.

Onboard Loadable Software

Synonym for "Field-Loadable Software."

Operator Defined Download

The process by which an operator identifies specific data to download from a Target Hardware to the Data Loader. (Attachment 2.5)

Parallel Load

Parallel loading allows multiple target hardware of the same type to be simultaneously loaded with the same SW.

Part Number

A set of numbers, letters or other characters used to identify a configuration item.

Part Root Directory

A directory in the root directory of a media member, which is the topmost directory level for all files within a single load part number. This same directory name should be used on all media members which contain files for a given load part number.

Portable Data Loader (PDL)

Portable computing equipment which is used to Upload to or Download data from aircraft equipment. The PDL is typically a single portable computing device with a cable which interfaces to the airplane through a connector as defined in Section 2.2.5.1. (1.4.1)

Pre-Load (Preload)

The "shop load" of a "loadable software airplane part" into the same hardware it would reside in if the software were installed on the aircraft.

> **Note: Installation of a pre-loaded LRU on the aircraft does not conform the aircraft to its authorized software drawing configuration. It takes an independent aircraft software configuration verification (after LRU installation) to conform the aircraft to its authorized software configuration.**

Self-Load

The ability of a unit to load itself.

APPENDIX D
GLOSSARY

Shop Load (Bench Load)
Transfer of "loadable software" into "target hardware," while the hardware is not installed on the aircraft.

Short Load
Transfer of only the data files of a Loadable Software Part (LSP) that have changed since the previous version of the LSP.

Software
Data or code (executable or not) that defines, controls or is used by its "target hardware" to perform its function.

Software Load
Synonym for "loadable software."

Software Load PN
Synonym for "load part number."

Software Loading (SW Loading)
Process of uploading software (including data) to the "target hardware."

Software Part Number
Synonym for "load part number."

Status Code
A code used to indicate the current status of the file transfer.

System
A group of components united by interaction or interdependence, performing various tasks but functioning as an integrated whole.

Target Hardware (Target HW)
The subject hardware of an operation. For example: the destination of the load, the hardware/LRU/location selected by the maintenance person as the destination of the load, the hardware the software is designed to operate in, etc.

Target Hardware ID
Target Hardware ID identifies a type of loadable target hardware.

TFTP Time-Out
The time measured between the emission of on TFTP packet and the reception of the associated answer packet. The TFTP Time-Out value is indicated in seconds. (Attachment 4, section 3.1)

THW_ID_POS
The THW_ID_POS identifies a specific instance of loadable target hardware.

APPENDIX D
GLOSSARY

Transfer Interruption
A signal to abort a in-process file transfer. Interrupts can be initiated by operator, Target Hardware, or Source. (Section 5.4.5.3, 6.4)

Unsigned
Word (16-bit) or Byte (8-bit) data which does not reserve a bit for sign (e.g. +/-).

Upload (Up Load)
A data transfer from the software media to the "target hardware."

Upload Operation
The process of uploading files to Target Hardware.

APPENDIX E
DATALOADING OF OVER AFDX

Dataloading according to ARINC 615A over AFDX is defined by sending UDP frames over an AFDX network instead of sending UDP frames over an Ethernet network.

The specification for sending UDP frames over an AFDX network is defined in ARINC Specification 664: *Aircraft Data Network, Part 7 – Avionics Full-duplex Switched Ethernet (AFDX) Network.*

Examples of 615A over AFDX dataloading system are:

- **Ethernet interface based dataloader connecting to an AFDX network through an Avionics Interconnecting Device (AID), as described in a future supplement of the document ARINC Specification 664: *Aircraft Data Network, Part 7 – Avionics Full-duplex Switched Ethernet (AFDX) Network.***
- **AFDX interface based dataloader directly connecting to an AFDX network.**

The FIND protocol or a network configuration file may be used for identifying targets on the AFDX network. Special considerations are necessary for supporting the FIND command over AFDX because AFDX does not directly support broadcast messages. AFDX does support multicast and unicast messages.

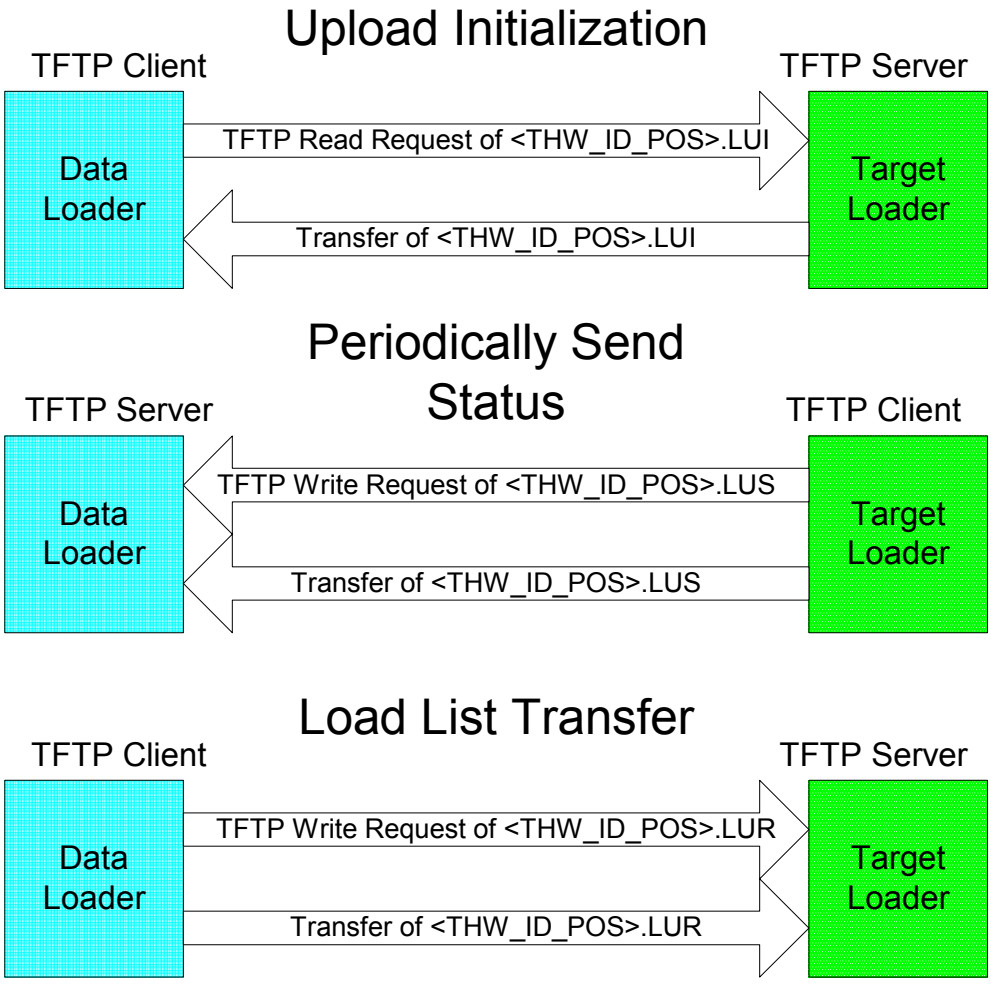
The TFTP protocol as described in this document should be used for ARINC 615A operations.

Specific AFDX details and characteristics are defined in ARINC Specification 664: *Aircraft Data Network, Part 7 – Avionics Full-duplex Switched Ethernet (AFDX) Network.*

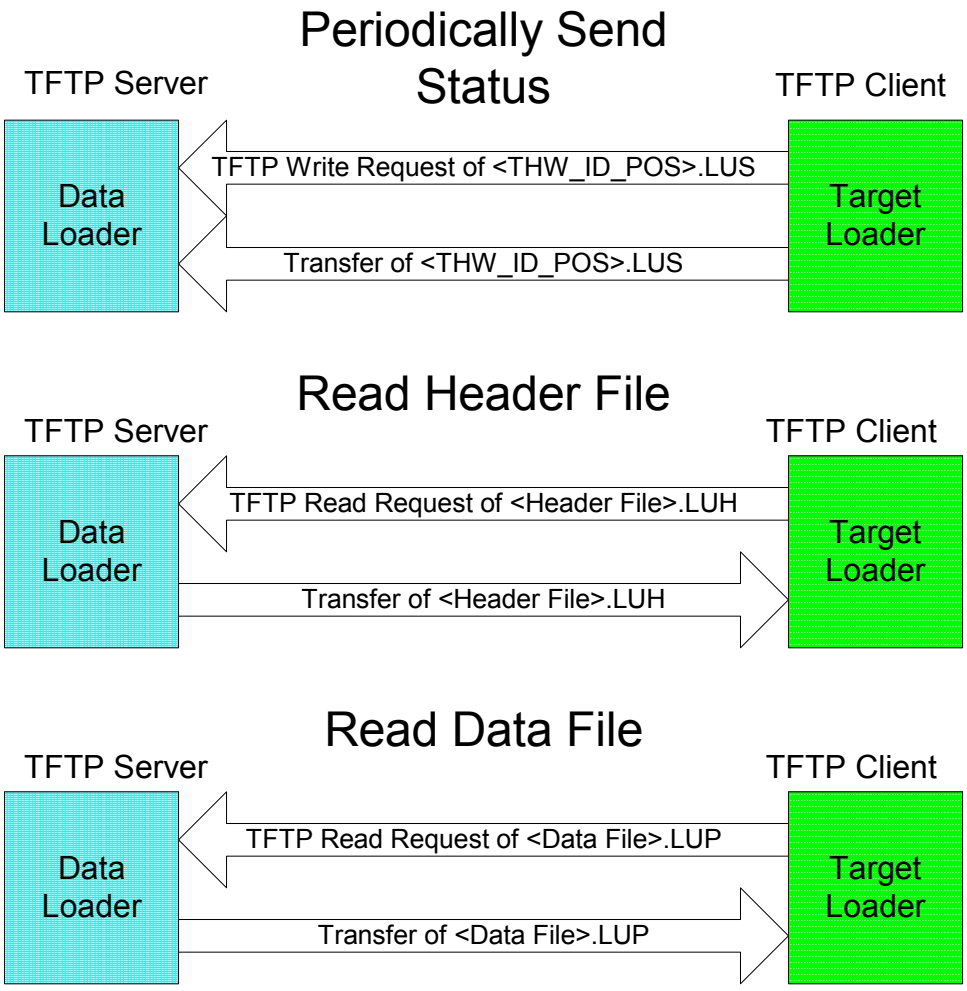
Address rules for aviation data networks can be found in **ARINC Specification 664:** *Part 4 Internet-based Address Structures and Assigned Numbers*, or the system integrator should identify the requirements.

APPENDIX F
DATA LOAD PROTOCOL FILE TRANSFER EXAMPLES

The following figures are examples of the Data Load Protocol File Transfer during an Upload Operation. Other ARINC 615A operations are similar in their file transfers.



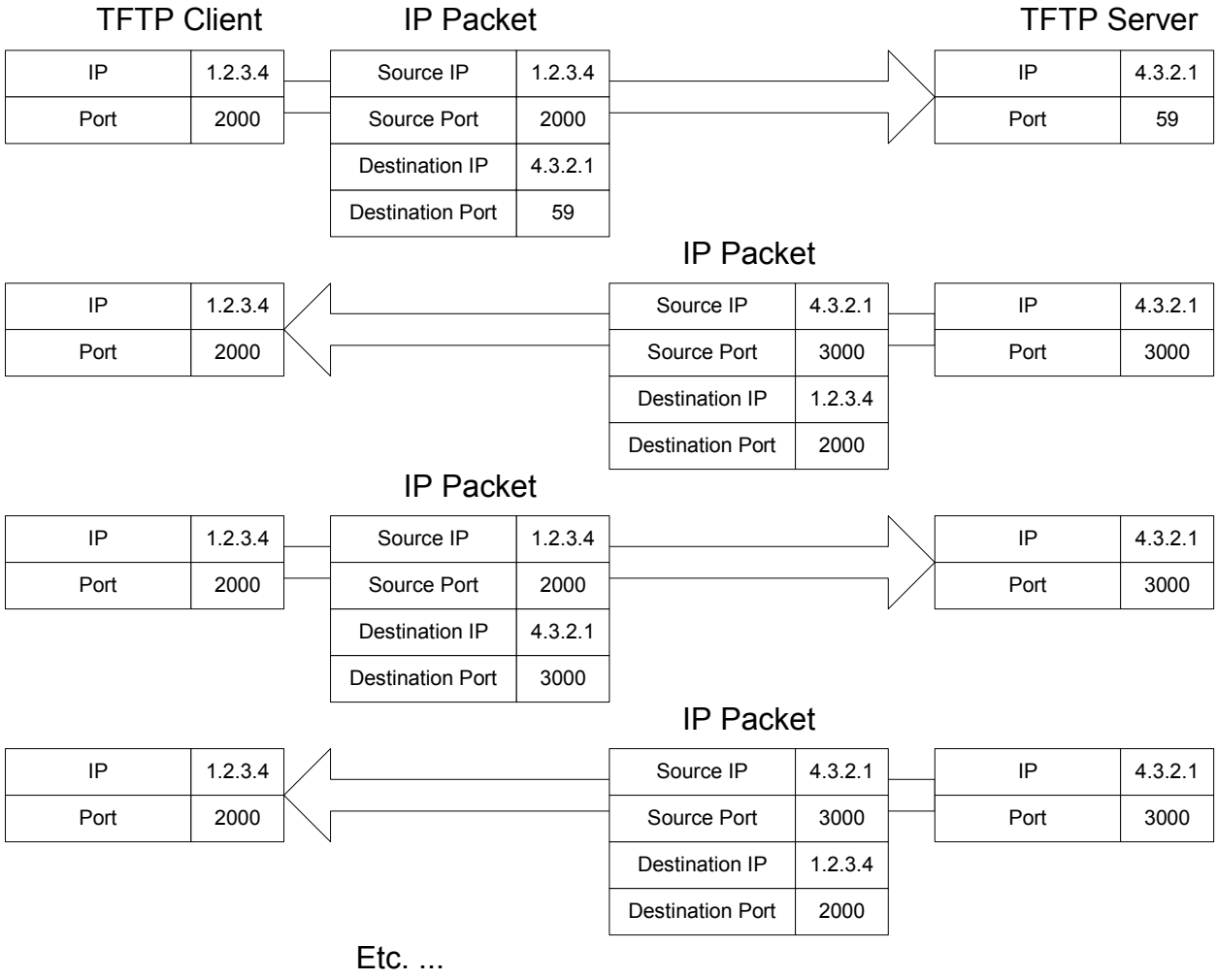
APPENDIX F
DATA LOAD PROTOCOL FILE TRANSFER EXAMPLES



APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES

This appendix contains TFTP file transfer protocol examples. The first two are just a general examples of a TFTP Request from the TFTP Client to the TFTP Server. The subsequent examples are of an Upload Initialization file transfer, a status file transfer, and a data file transfer.

All TFTP transactions are started by sending a TFTP Request, either Read Request (RRQ) or Write Request (WRQ) to the control port on the Server. The control port for RFC 1350-defined TFTP is 69. The control port for ARINC 615A defined TFTP is 59.

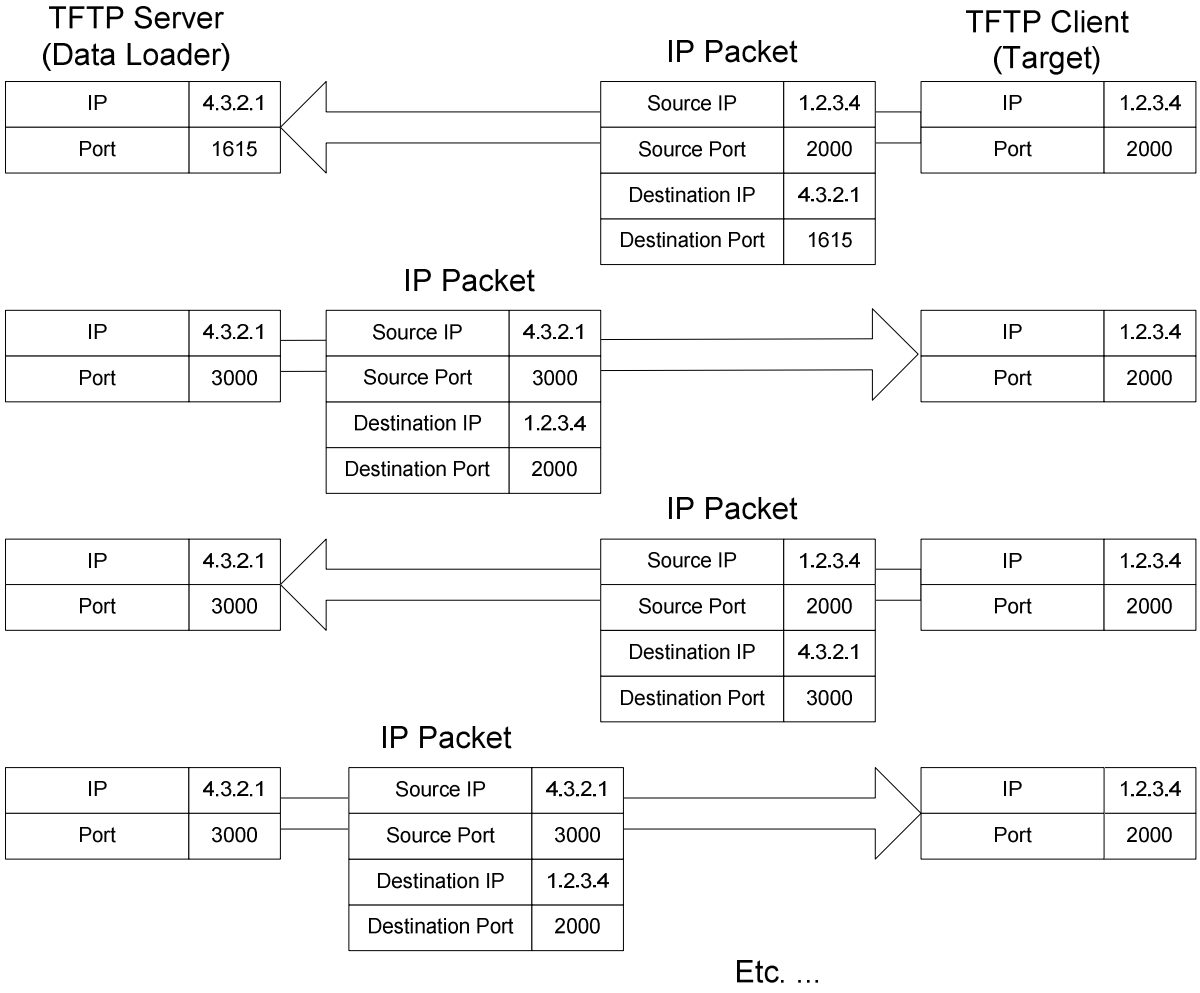


However, during ARINC 615A Upload Operation, the Data Loader will send a TFTP "port" option with the Read Request of the *.LUI file. This "port" option tells the Target Hardware to initiate all TFTP transactions for this Upload Operation at the port indicated in the "port" option, i.e., change the control port value from 59 to the "port" option value when initiating a TFTP transaction with the Data Loader. The Data Loader will still send to port 59 when initiating a TFTP transaction with the Target Hardware.

APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES

Moving off the control port allows the control port to be freed-up to permit other TFTP transactions to be initiated by the TFTP Client.

This is an example of a TFTP transaction initiated by the Target Hardware to the Data Loader using the TFTP control port of 1615, which was the "port" option value contained in the TFTP "port" option included with the TFTP Read Request of the *.LUI file that initiated the Upload Operation sent by the Data Loader to the Target Hardware.

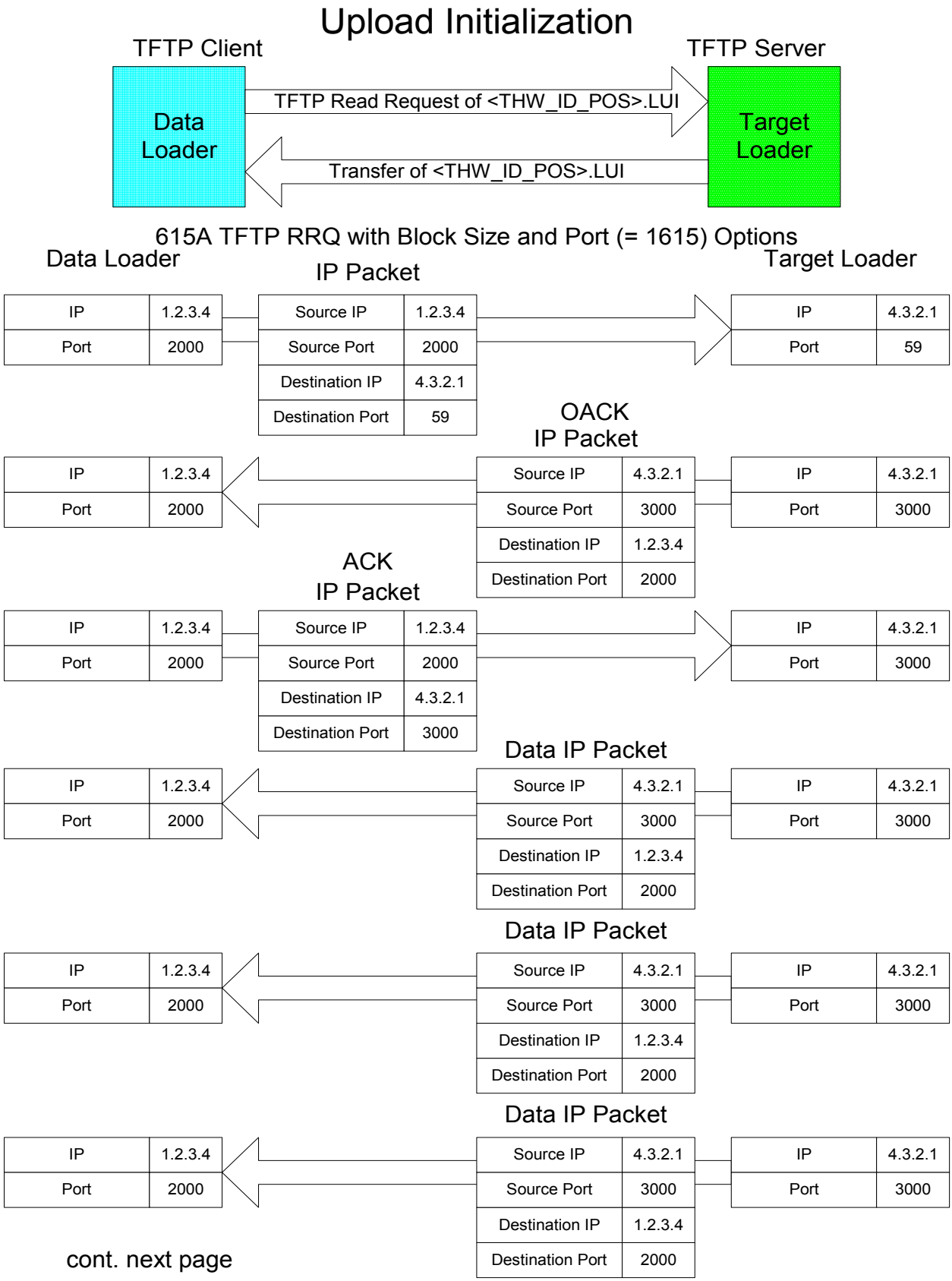


Note: The TFTP transaction still moves off the control port to allow other TFTP transactions to be initiated at the option defined control port of 1615.

Note: The "port" option expires at the end of the current Upload Operation.

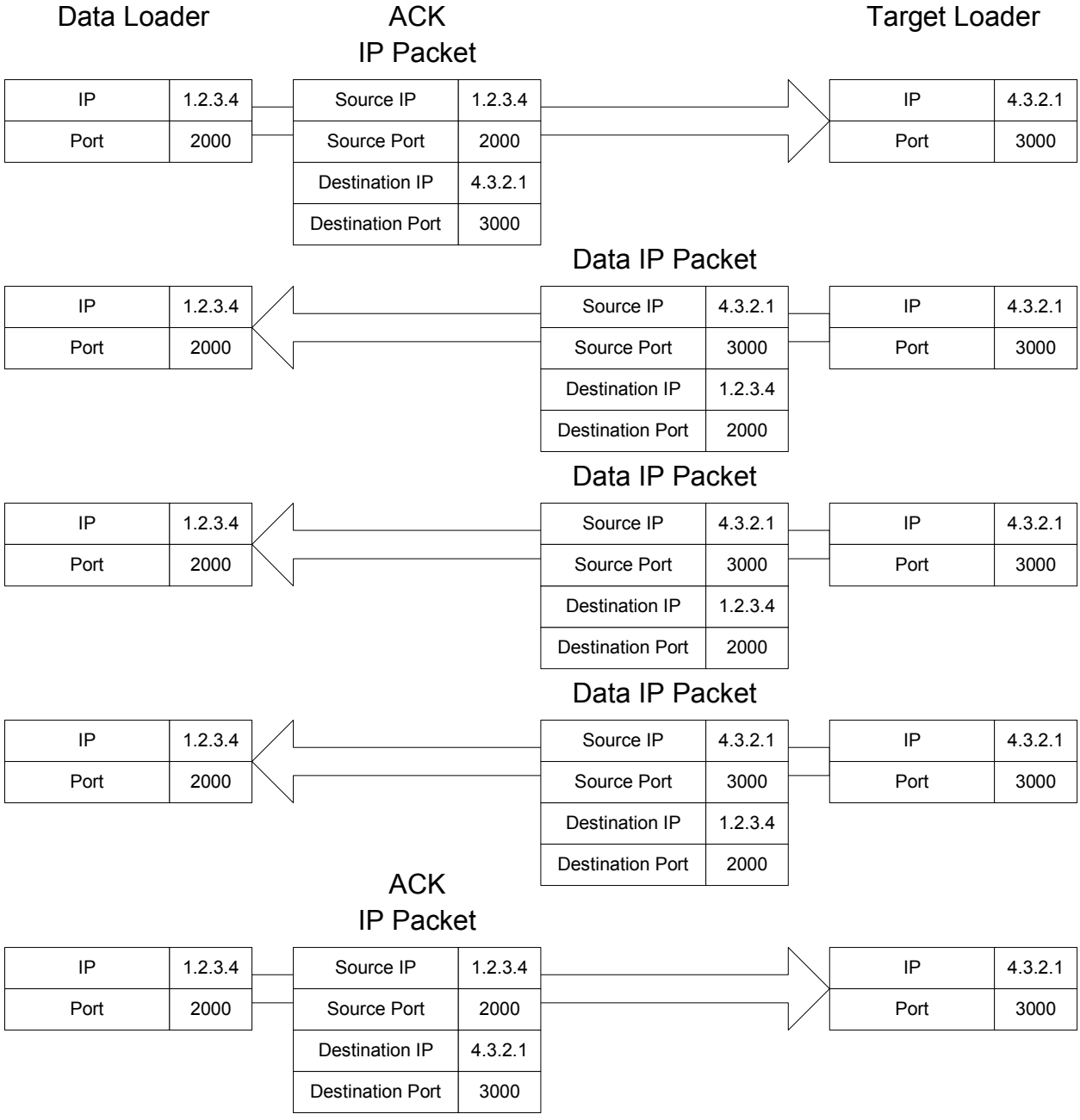
The example on the following two pages is an example of TFTP Read Request protocol from the Data Loader to the Target Hardware during the request and transfer of the Upload Initialization file from the Target Hardware to the Data Loader during an Upload Operation.

APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES



APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES

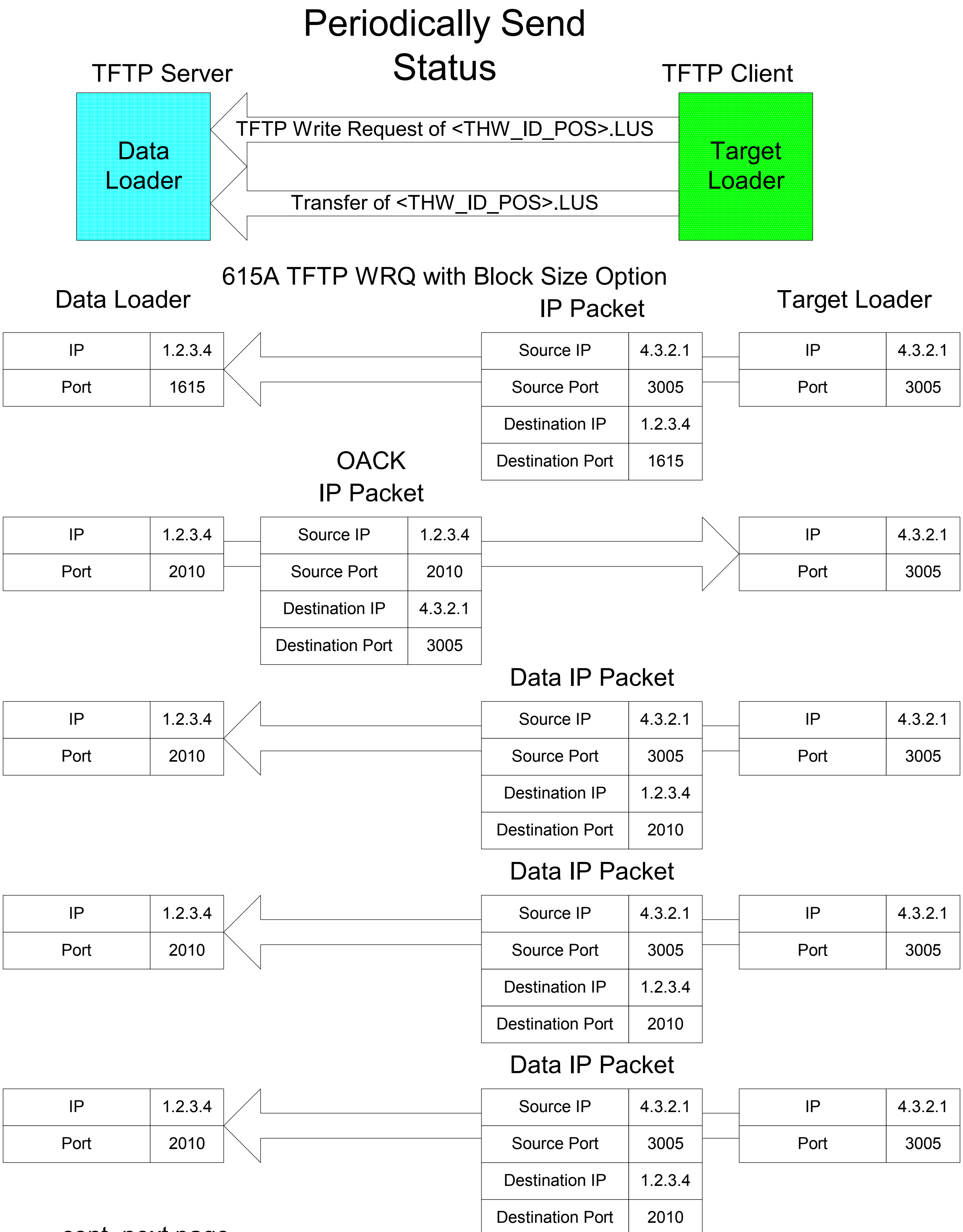
cont.



Etc.....

The example on the following two pages is an example of TFTP Write Request protocol from the Target Hardware to the Data Loader during the request and transfer of the Target Hardware status file from the Target Hardware to the Data Loader during an Upload Operation. This also shows packet fragmentation.

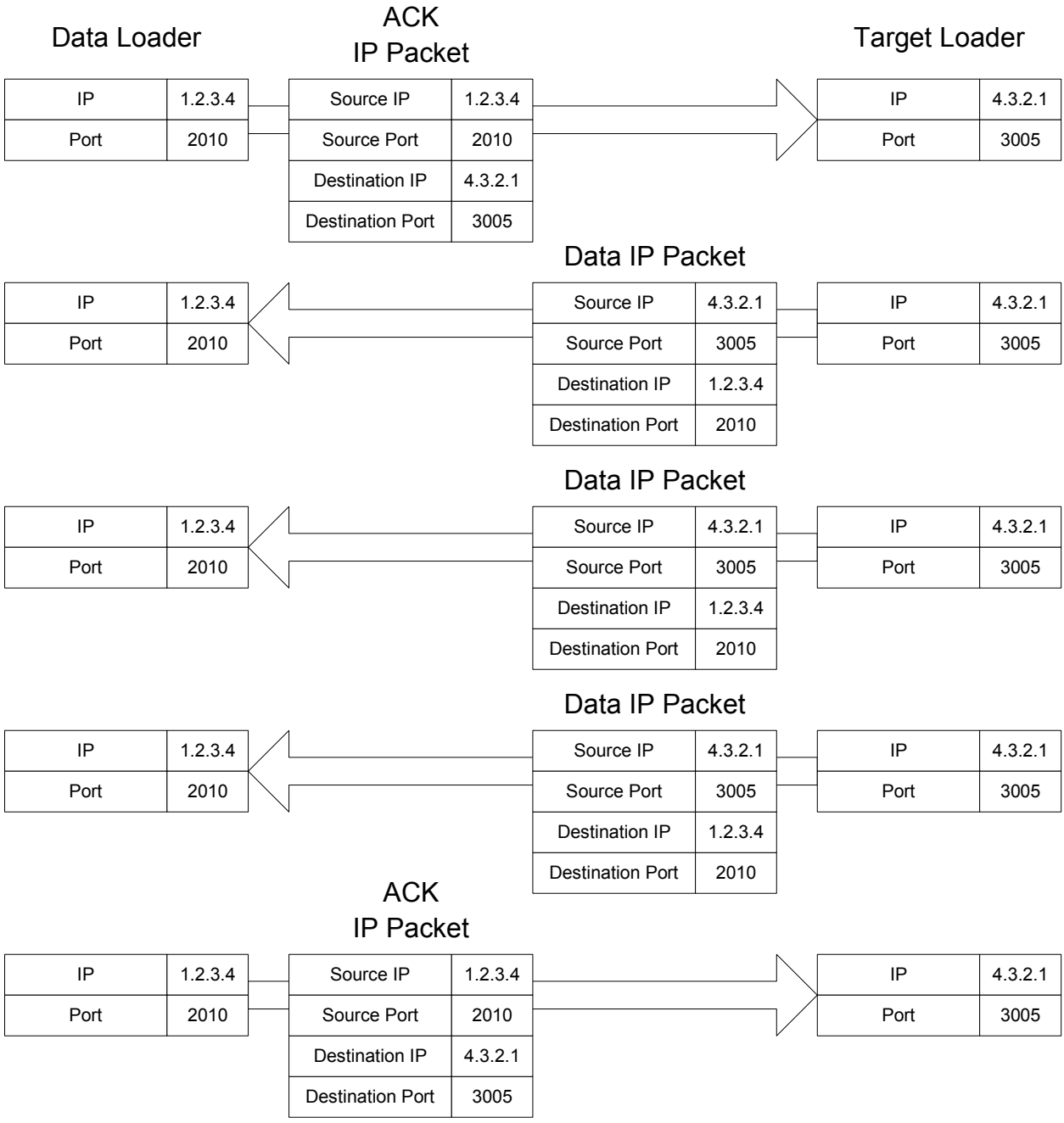
APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES



cont. next page

APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES

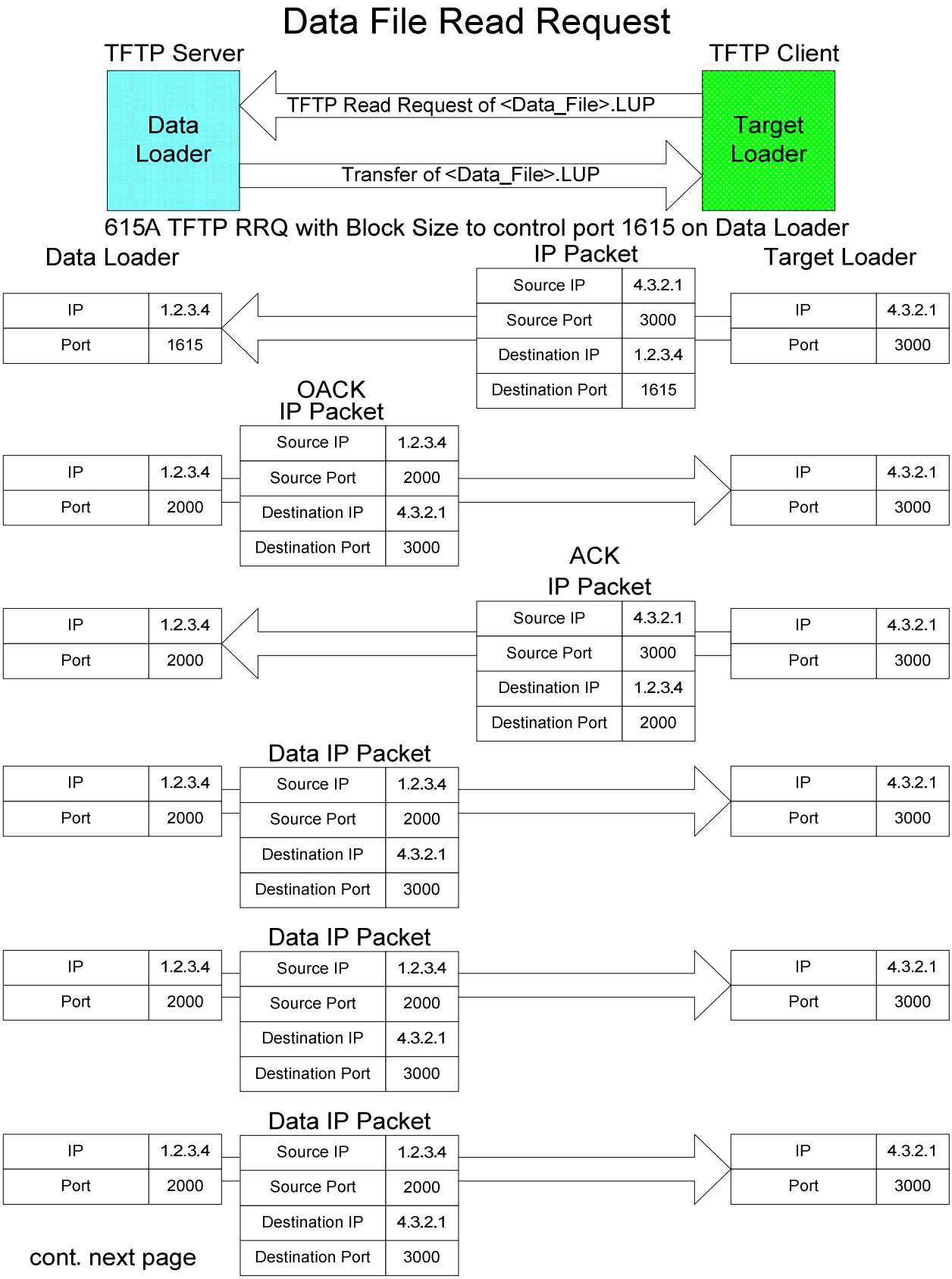
cont.



Etc....

The example on the following three pages is an example of TFTP Read Request protocol from the Target Hardware to the Data Loader showing the request and transfer of a software load data file from the Data Loader to the Target Hardware during an Upload Operation.

APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES



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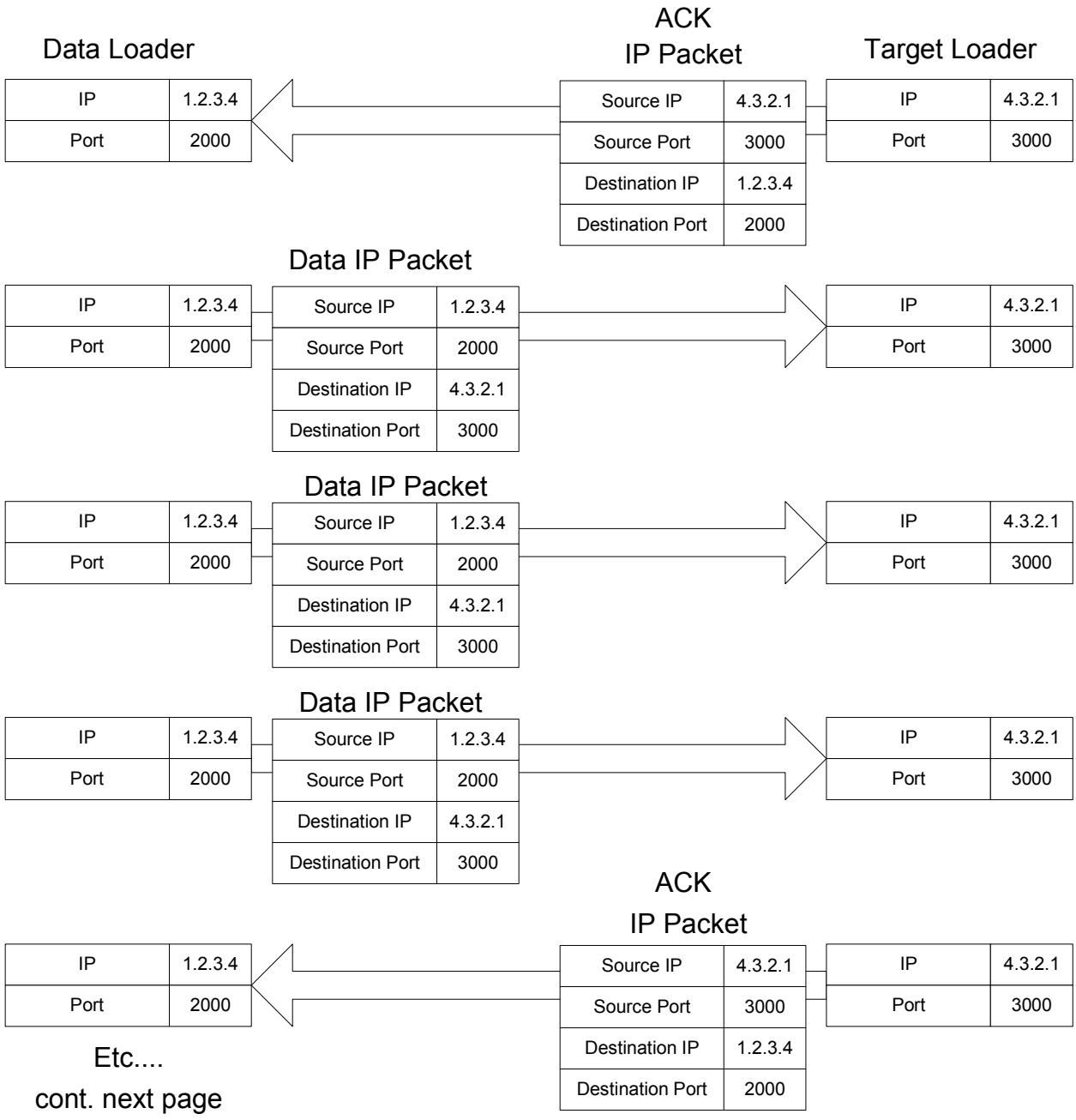
APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES

cont.



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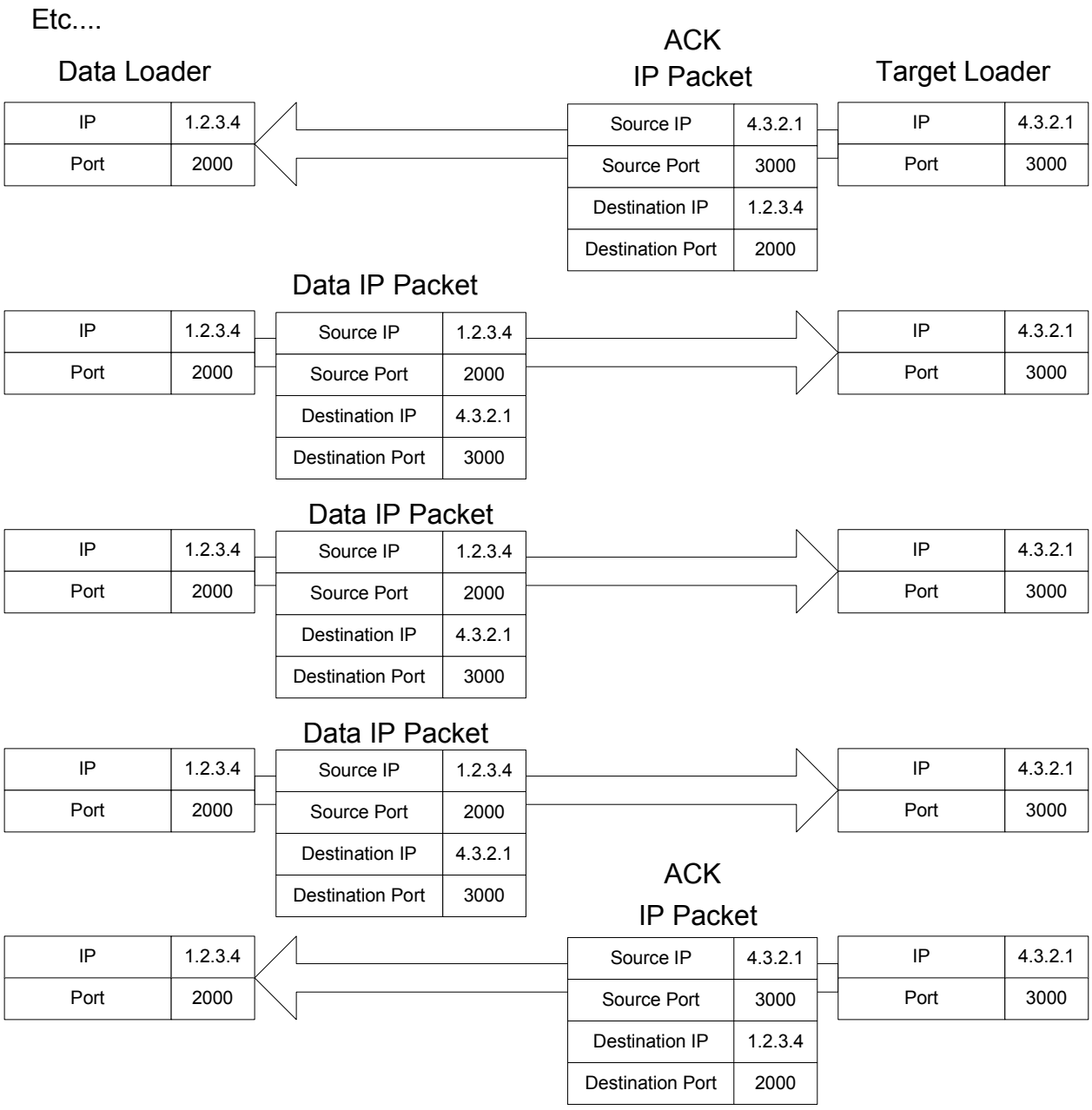
APPENDIX G
TFTP FILE TRANSFER PROTOCOL EXAMPLES

Continuation of file read with file termination in this figure.



ARINC Standard – Errata Report

1. Document Title

ARINC Report 615A: *Software Data Loader Using Ethernet Interface*
Published: April 17, 2007

2. Reference

Page Number: _____ Section Number: _____ Date of Submission: _____

3. Error

(Reproduce the material in error, as it appears in the standard.)

4. Recommended Correction

(Reproduce the correction as it would appear in the corrected version of the material.)

5. Reason for Correction *(Optional)*

(State why the correction is necessary.)

6. Submitter (Optional)

(Name, organization, contact information, e.g., phone, email address.)

Please return comments to fax +1 410-266-2047 or standards@arinc.com

Note: Items 2-5 may be repeated for additional errata. All recommendations will be evaluated by the staff. Any substantive changes will require submission to the relevant subcommittee for incorporation into a subsequent Supplement.

[To be completed by IA Staff]

Errata Report Identifier: _____ **Engineer Assigned:** _____

Review Status: _____

ARINC IA Project Initiation/Modification (APIM)

1.0 Name of Proposed Project **APIM #: _____**

(Insert name of proposed project.)

2.0 Subcommittee Assignment and Project Support

2.1 Identify AEEC Group

(Identify an existing or new AEEC group.)

2.2 Support for the activity

Airlines: *(Identify each company by name.)*

Airframe Manufacturers:

Suppliers:

Others:

2.3 Commitment for resources *(Identify each company by name.)*

Airlines:

Airframe Manufacturers:

Suppliers:

Others:

2.4 Chairman: (Recommended name of Chairman.)

2.5 Recommended Coordination with other groups

(List other AEEC subcommittees or other groups.)

3.0 Project Scope *(why and when standard is needed)*

3.1 Description

(Insert description of the scope of the project. Use the following symbol to check yes or no below. ☒)

3.2 Planned usage of the envisioned specification

New aircraft developments planned to use this specification yes ❑ no ❑

Airbus: *(aircraft & date)*

Boeing: *(aircraft & date)*

Other: *(manufacturer, aircraft & date)*

Modification/retrofit requirement yes ❑ no ❑

Specify: *(aircraft & date)*

Needed for airframe manufacturer or airline project yes ❑ no ❑

Specify: *(aircraft & date)*

Mandate/regulatory requirement yes ❑ no ❑

Program and date: *(program & date)*

Is the activity defining/changing an infrastructure standard? yes ❑ no ❑

Specify *(e.g., ARINC 429)*

When is the ARINC standard required?
_____*(month/year)*_____

What is driving this date? _____*(state reason)*_____

Are 18 months (min) available for standardization work? yes ❑ no ❑

If NO please specify solution: _____

Are Patent(s) involved? yes ❑

If YES please describe, identify patent holder: _____

3.3 Issues to be worked

(Describe the major issues to be addressed.)

4.0 Benefits

4.1 Basic benefits

Operational enhancements yes ❑ no ❑

For equipment standards:

a. Is this a hardware characteristic? yes ❑ no ❑

b. Is this a softwareware characteristic? yes ❑ no ❑

c. Interchangeable interface definition? yes ❑ no ❑

d. Interchangeable function definition? yes ❑ no ❑

If not fully interchangeable, please explain: _____

Is this a software interface and protocol standard? yes ❑ no ❑

Specify: _____

Product offered by more than one supplier yes ❑ no ❑

Identify: *(company name)*

4.2 Specific project benefits

(Describe overall project benefits.)

4.2.1 Benefits for Airlines

(Describe any benefits unique to the airline point of view.)

4.2.2 Benefits for Airframe Manufacturers

(Describe any benefits unique to the airframe manufacturer's point of view.)

4.2.3 Benefits for Avionics Equipment Suppliers

(Describe any benefit unique to the equipment supplier's point of view.)

5.0 Documents to be Produced and Date of Expected Result

5.1 Meetings and Expected Document Completion

The following table identifies the number of meetings and proposed meeting days needed to produce the documents described above.

Activity	Mtgs	Mtg-Days (Total)	Expected Start Date	Expected Completion Date
Document a	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*
	*# of mtgs **	*# of mtg days **		
Document b	*# of mtgs*	*# of mtg days*	*mm/yyyy*	*mm/yyyy*
	*# of mtgs **	*# of mtg days **		

** Indicate unsupported meetings and meeting days, i.e., technical working group or other ad hoc meetings that do not requiring IA staff support.*

6.0 Comments

(Insert any other information deemed useful to the committee for managing this work.)

For IA Staff use

Date Received: _____ IA Staff Assigned: _____

Estimated Cost: _____

Potential impact: _____

*(**A**. Safety **B**. Regulatory **C**. New aircraft/system **D**. Other)*

Forward to committee(s) (AEEC, AMC, FSEMC): _____ Date Forwarded:_____

Committee resolution: _____

*(**0** Withdrawn **1** Authorized **2** Deferred **3** More detail needed **4** Rejected)*

Assigned Priority:_____ Date of Resolution:_____

*(**A** High - execute first **B** Normal - may be deferred.)*

Assigned to SC/WG:_____

SUPPLEMENT 1
TO
ARINC REPORT 615A©
SOFTWARE DATA LOADER USING
ETHERNET INTERFACES,
PHYSICAL STANDARDS AND PROTOCOLS

Published: January 12, 2001

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: November 14, 2000

A. PURPOSE OF THIS DOCUMENT

This Supplement introduces various changes and additions to ARINC Report 615A. This includes the addition of a third media type of an optical disc drive capable of reading Compact Disc – Read Only Memory (ROM) and Digital Video Disc – ROM for loading data onto airliners.

B. ORGANIZATION OF THIS SUPPLEMENT

Changes introduced by Supplement 1 are too extensive to make the integration of replacement pages from a separate supplement into Specification 615A practical for our readers.

The changes introduced by Supplement 1 have been identified using change bars and are labeled in the margin by a "c-1" indicator.

C. CHANGES TO ARINC REPORT 615A INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to the Report introduced by this Supplement. Each change or addition is identified either by the section number and title currently employed in the Report or by the section number and title that is employed in the supplement. In each case there is a brief description of the addition or change. A replacement white page document is included in the second part of this document, as noted in B above. In this way an accurate record of the development of the Report is preserved.

Title: Initially ARINC Report 615A, Software Data Loader Using Ethernet Interfaces, was developed in two parts: Part 1 – Physical Standards and Protocols, and Part 2 – Loadable Software Standards. Supplement 1 of ARINC Report 615A, Part 1 is published with the title: Software Data Loader Using Ethernet Interfaces. Supplement 1 of ARINC Report 615A, Part 2 is published as Supplement 1 of ARINC Report 665, Loadable Software Standards.

1.3 Function of the Equipment

For clarity, a sentence to state that the protocol file names are case sensitive and to provide a reference.

1.6 Interoperability

A reference was changed to ARINC Report 665, "Loadable Software Standards."

1.10 Related Documents

An ECMA document was added for reference.

2.2.6 Data Bus Interface

For clarity, a COMMENTARY was added to state the data loader capability for 10BaseT connection.

4.1 Media Interchangeability

A third media type of "Optical Disc" was added to the list of specified media types. The statement that a mix of any of the media types for a single data load was not supported by the data loader was expanded to include the third media type. Cautionary statements were added to the COMMENTARY to emphasize this point. A reference was changed to ARINC Report 665.

References were revised to "disc" instead of "disk" for consistency.

4.1.2 PC Card Device

The definition of "ATA" was deleted to correct an error. A reference to the PC Card Slot standard was added for accuracy.

An added sentence stated that the use of PC Card for uploads is not supported by this standard.

An added COMMENTARY stated that airlines do not want PC Cards to be used for uploads. However, non-commercial operators could perform certain optional functions that are not defined in ARINC Report 615A or ARINC Report 665.

4.1.3 Optical Medium

This section and its subordinate sections were added to specify the storage media for the optical medium and define various methods of recording and their capacities.

5.0 Load Protocol

Section 5.0 has been revised in its entirety and reproduced for clarity and readability. These changes include:

5.1 Introduction

A sentence was added to clarify protocol file name format. A reference was changed to ARINC Report 665.

5.2 Scope

This section was modified to add scope to the Load Protocol specification to obtain scriber information using the Simple Network Identification Protocol (SNIP).

5.3.1 General Description

This section was modified to add an explanation of the role of the SNIP and a reference to Attachment 3, which defines SNIP for ARINC Report 615A. Also, for User Datagram Protocol (UDP), Internet Protocol (IP) and Medium Access Control (MAC) / Physical Layer, references were added for definition of these protocols and layers to ARINC Project Paper 664, Parts 3 and 2.

An added COMMENTARY stated that ARINC Report 615A does not specify MAC or IP addresses and referenced where address rules were defined.

5.3.2 TFTP Protocol

This section was modified to define maximum file size and block numbering.

5.3.2.1 5.3.2.1 TFTP Reference Documents

"TFTP" was added to the title of this section for clarity.

5.3.2.2 TFTP Options

This section was modified to include a statement about the status of UDP and IP data after the last TFTP option.

5.3.2.2.1 Block Size

This section was changed to correct errors in size descriptions.

5.3.2.2.2 Transfer Size of the File

This section was changed for clarity.

5.3.2.2.3 Timeout Interval

This section was changed for clarity.

5.3.2.3 TFTP Adaptation to Data Loading Protocol

The title of this section was changed for clarity.

5.3.2.3.1 TFTP Super–set

This section was added for clarity.

5.3.2.3.2 Dedicated Port Number

This section was added for clarity.

5.3.2.3.3 Error Message General Description

The title of this section was changed and the section was re-numbered. A sentence was added to clarify the use of the error code message field.

5.3.2.3.4 Definition of the Waiting Message

A maximum value for wait delay was defined.

5.3.2.3.6 Definition of the Abort Message

This section was changed for clarity to complete the definition of the ABORT error message.

A statement was added to clarify the maximum value for the wait delay.

5.3.2.3.8 Blocksize Option Implementation

This section was added for clarity.

5.3.2.3.9 TFTP Block Number

This section was added for completeness.

5.3.2.3.10 File Transfer Size

This section was added for clarity.

5.3.2.3.11 Timeout Interval

This section was added for clarity.

5.4 Operations

The term “LRU” for Line Replacement Unit was changed to “THW” for Target HardWare to avoid ambiguity. This resulted in revisions from <LRU_ID_POS >.LNR to <THW_ID_POS >.LNR in many places within section 5.4.

6.0 Load Protocol Definition

Section 6.0 has been revised in its entirety. These changes include:

- “LRU_ID” was changed to “THW_ID” to avoid ambiguity.
- New figures and explanations for the message sequence charts were added.
- “Time Out” feature and the new option of “Exception timer” was added.
- Added a definition of an initial value for “Counter.”
- Added “Big Endian” byte ordering for all protocol files.
- Deleted “initial” from all prior references to “initial value.”
- Added a COMMENTARY on Airborne Data Loader displays.

ATTACHMENT 3 – SIMPLE NETWORK IDENTIFICATION PROTOCOL (SNIP)

This Attachment was changed for clarity and completeness in its entirety. Changes include:

- Added a statement about MAC address and IP address.
- Amplified a COMMENTARY on SNIP.
- Added Manufacturer code to parameter list.
- Added an Exchange Example.
- Added a COMMENTARY on manufacturer identification.
- Deleted two COMMENTARIES and an example on MIB syntax, which are no longer required.
- Changed a reference to ARINC Report 665 for accuracy.

ATTACHMENT 4 - TIME-OUT AND RETRY NUMBER DEFINITION

This attachment was changed as follows:

- Added a sentence in Section 3.2, “Retry Number,” to clarify the definition of retry number.
- Added “Section 3.3 Sorcerer’s Apprentice Syndrome” to eliminate this problem for retry numbers.

ATTACHMENT 5 – ENVIRONMENTAL TEST CATEGORIES

A column and note were added to the table for "ADL with Optical Media Device."

APPENDIX B – REFERENCE GUIDE

This entire appendix was added to guide implementers through the references cited in the ARINC Report 615A.

SUPPLEMENT 2
TO
ARINC REPORT 615A©
SOFTWARE DATA LOADER USING
ETHERNET INTERFACES,
PHYSICAL STANDARDS AND PROTOCOLS

Published: May 10, 2002

Prepared by the Airlines Electronic Engineering Committee

Adopted by the Airlines Electronic Engineering Committee: April 8, 2002

A. PURPOSE OF THIS SUPPLEMENT

This Supplement introduces various changes and additions to ARINC Report 615A. The revisions include clarification of the following: length of the IP layer, operations that should be performed for a successful up-load operation, configuration information to include fields for the number of target hardware and associated parameters, definition of the value for packet terminator for the target hardware answer table, and a new equation for calculation of Data Load Protocol (DLP) timeout.

B. ORGANIZATION OF THIS SUPPLEMENT

The first part of this document, printed on goldenrod-colored paper, is the Supplement itself. It contains descriptions of the changes introduced into the Report and, where appropriate, extracts from the original text for comparison purposes. The second part consists of the Report, modified as required by the Supplement.

The changes introduced by Supplement 2 have been identified using change bars and are labeled in the margin by a "c-2" indicator.

C. CHANGES TO ARINC REPORT 615A, INTRODUCED BY THIS SUPPLEMENT

This section presents a complete tabulation of the changes and additions to the Report introduced by this Supplement. Each change or addition is identified either by the section number and title currently employed in the Report or by the section number and title that will be employed when the Supplement is eventually incorporated. In each case there is a brief description of the addition or change. Sections that are modified by this Supplement are reproduced. In this way an accurate record of the development of the report is preserved.

3.2.2 Selector Controls

"Target Hardware Identification" is an added function desired of all data loaders. This function should be implemented by Find Identification of Network Devices (FIND) and that reference should be made to Attachment 3.

4.1.2.1 PC Card Interface

For clarity, the first paragraph is replaced with an explanation of "AT Attachment (ATA)."

5.3.1 General Description

To avoid potential conflict with another avionics protocol with the acronym SNIP, the SNIP protocol used in ARINC Report 615 A is renamed the Find Identification of Network Devices (FIND) protocol.

5.3.2.2 TFTP Options

The term "no-option implementation" is changed to "non-implemented option" for clarity.

5.3.2.2.1 Block Size

In this section, the value for the length of the Internet Protocol (IP) layer is corrected from "64" to "60" bytes.

5.3.2.2.3 Timeout Interval

The term "PDU" is revised to "packet" for accuracy.

5.3.2.3.1 TFTP Super-set

Trivial File Transfer Protocol, (TFTP), super-set adapts the standard TFTP, which is defined by the communication industry, to the specific environment of aircraft data loading. Additional text in this section clarifies the need for the TFTP super-set.

5.3.2.3.3 Error Message General Description

The explanation of Error Code Value 3 is revised for clarity.

5.3.2.3.8 TFTP Option Implementation

This section and its three subordinate sections:

5.3.2.3.8.1 Blocksize Option Implementation
5.3.2.3.8.2 File Transfer Size
5.3.2.3.8.3 Timeout Interval,

provide a new definition for a minimum implementation for equipment to claim conformance to this specification.

5.3.2.3.9 TFTP Block Number

For accuracy and clarity, the last sentence is changed to "If overflow occurs due to the number of transmitted blocks, the next value after 65535 should be 1."

5.3.2.3.10 File Transfer Size

This section is deleted and the material is reorganized as Section 5.3.2.3.8.2. For accuracy, the verb "be" is inserted in "should not be used" and the reason for not using this feature is added.

5.3.2.3.11 Timeout Interval

This section is deleted and the material is reorganized as Section 5.3.2.3.8.3. For accuracy, the clause "since timeout is defined in ARINC 615A, Attachment 4…" is deleted and the explanation of Timeout Interval is expanded.

5.4.1 Introduction

For accuracy, the acronym "SNIP" is changed to "FIND."

In this section, the verb is changed from "should" to "may" to change from a recommended FIND request to an optional FIND request before each operation in the load protocol. This provides more flexibility to data loaders.

5.4.5.3 Transfer Interruption

This section clarifies the ability of data loader and target hardware to interrupt the transfer phase during certain operations.

6.2.17.2 Effect on Receipt

The Status Code word is revised to $1004_{16.}$

6.3.2 Information Operation: Initization and Transfer Step

Clarification is added for recommended actions after the transfer step begins. A statement is added to clarify when a status file may be sent during this operation.

6.3.3 Uploading Operation: Initialization, List Transfer and Transfer

In this section at the end of the explanation of diagrams, clarification on which operations should be accomplished for a successful up-loading operation and an explanation of the exception timer field are added.

6.3.4 Downloading Operation in Media Defined Mode: Initialization, List Transfer and Transfer

In this section at the end of the explanation of diagrams, clarification on which operations should be accomplished for a successful down-loading operation is added.

6.3.5 Downloading Operation in Operator Defined Mode: Initialization, List Transfer and Transfer

In this section at the end of the explanation of diagrams, clarification is provided on which operations should be accomplished for a successful down-loading operation is added.

6.3.6 Interrupt Service

In this section at the end of the explanation of diagrams, clarification is provided on the role of the data loader during an interruption of service.

6.4 Protocol File Description

The "THW_ID system" is clarified.

For accuracy, added text specifies when the Protocol Version Value should be set and used.

An added statement clarifies that all textural fields should be zero terminated.

An added commentary provides guidance on the Description Length field and the Description field.

6.4.1 <THW_ID_POS>.LCI,.LUI,.LND and .LNO

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

The maximum length of the text of 255 characters (i.e., 2040 bits) is clarified. The allowed length of 80 characters is clarified, and text termination is specified.

In the commentary, clarity is provided by expanding the explanation of the role of the Status Description Length field parameter.

6.4.2 <THW_ID_POS>.LCL

Clarity is provided in the table of configuration information to include fields for number of Target Hardware and for associated parameters.

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

For consistency, the max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified. Detailed descriptions of all fields are provided for completeness.

In the commentaries, clarity is provided by expanding the explanation of the role of the THW Code Length field parameter and the Part Designation Length field parameter.

6.4.3 <THW_ID_POS>.LCS

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

For accuracy, Status Codes 0004_{16} and 0005_{16} are changed to 1004_{16} and 1005_{16}, respectively.

For consistency, the max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified.

For accuracy, the definition of Estimated Time is expanded.

In the commentary, clarity is provided by expanding the explanation of the role of the Status Description Length field parameter. In the first paragraph, the text is revised for clarity and a reference is added to Section 6.4.10 for more information.

6.4.4 <THW_ID_POS>.LCR

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

For consistency, the max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified.

In the commentaries, clarity is provided by expanding the explanation of the role of the Header File Name Length field and the Load Part Number Length field parameters.

The field Load Part Number Name in the table of configuration information is harmonized with the Load Part Number Name description.

6.4.5 <THW_ID_POS>.LUS

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

For consistency, the max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified.

In the commentaries, clarity is provided by expanding the explanation of the role of the Upload Status Description Length, Header File Name Length, Load Part Number Length, and the Status Description Length field parameters.

For clarity, a definition of Estimated Time is provided.

In the first paragraph, the text is revised for clarity and a reference is added to Section 6.4.10 for more information.

6.4.6 <THW_ID_POS>.LNR

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

For consistency, the max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified.

In the Commentary, clarity is provided by expanding the explanation of the role of the File Name Length field parameter.

6.4.7 <THW_ID_POS>.LNS

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

The max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified.

In the Commentary, clarity is provided by expanding the explanation of the role of the Download Status Description Length, File Name Length, and File Status Description Length field parameter.

In the first paragraph, the text is revised for clarity and a reference is added to Section 6.4.10 for more information.

6.4.8 <THW_ID_POS>.LNL

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

In this section for consistency, the max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified.

In the commentaries, clarity is provided by expanding the explanation of the role of the File Name Length and the Part Description Length field parameter.

6.4.9 <THW_ID_POS>.LNA

For clarity in the Protocol Version field description, a reference is added to the Protocol Version described in Section 6.4, Protocol File Description.

The max length of the text of 255 characters (i.e., 2040 bits) is clarified, the allowed length of 80 characters is clarified, and text termination is specified.

In the commentaries, clarity is provided by expanding the explanation of the role of the File Name Length field parameter.

6.4.10 Data Load Status Code Table

A reference to Table 6.4.10 is added for clarity.

In Table 6.4.10 the following changes are made:

The "Operation aborted by Data Loader" message is redefined as Status Code 1004_{16}.

The "Operation cancelled by operator" message is redefined as Status Code 1005_{16}.

For Status Code 1007_{16} under "Meaning" the term "Or Download File failed" is added for accuracy.

For accuracy, the acronym "LRU" is replaced by "THW."

ATTACHMENT 1 – ARINC 615A ADL ANDPDL CONNECTOR SIGNAL ASSIGNMENTS

For accuracy, references are revised to ARINC Specification 664, Aircraft Data Network from "ARINC 646."

ATTACHMENT 3 - FIND IDENTIFICATION OF NETWORK DEVICES (FIND) PROTOCOL

The title of this attachment and the name of the protocol itself are changed from "Simple Network Identification Protocol" to "Find Identification of Network Devices (FIND)" Protocol," to avoid a potential conflict with an avionics company that is producing an aviation product with a communication protocol whose acronym is "SNIP." The Acronym SNIP is replaced by FIND throughout the attachment.

1.0 Introduction

Adding guidance as to when to perform a FIND request provides clarity. For clarity, an added commentary provides guidance on the minimum implementation of a FIND request and on good practice when target hardware is changed.

2.0 Overview

In the second bullet, the phrase: "MIB compatible structure" is deleted for clarity.

An added Commentary explains the difference between the Data Loader Time Out and the Target Hardware Time Out.

3.0 FIND Packets

The acronym SNIP is replaced by FIND.

4.0 Information Request Packet

The termination for Data List is revised.

5.0 Information Answer Packet

The termination for Data List is revised.

7.1 Examples

For accuracy in the target hardware answer table, the value for Packet terminator (ASCII EOF) is revised to "10_{16}."

ATTACHMENT 4 -TIMEOUT AND RETRY NUMBER DEFINITION

For clarity and accuracy, this attachment is revised with an explanation of the composition of the ARINC 615A protocol in two layers, their operations, and their interactions. This attachment includes a revised equation and figure for Data Load Protocol (DLP) Time-out and three new figures that illustrate operations of time-out and retry numbers.

AERONAUTICAL RADIO, INC.
2551 Riva Road
Annapolis, Maryland 24101-7435

SUPPLEMENT 3

TO

ARINC REPORT 615A

SOFTWARE DATA LOADER USING ETHERNET INTERFACE

Published: June 30, 2007

Prepared by the AEEC

Specification 615A-3 Adopted by the Airlines Electronic Engineering Executive Committee: October 11, 2006

A. PURPOSE OF THIS DOCUMENT

This Supplement introduces various changes and additions to ARINC Report 615A. Principal revisions include the following:

- Restore Section 5.3.1 from Supplement 1.
- Addition of a new section explicitly adding the Checksum option for checking the integrity of TFTP files.
- Deletion of redundant information that is available in the TFTP Request for Comments (RFC).
- Revisions to Section 6.4.2, Attachment 2, and Attachment 3 for naming consistency.
- Add Appendix C, List of Acronyms; Appendix D, Glossary; Appendix E, Data Loading over AFDX; Appendix F, Data Load Protocol File Transfer Examples; and Appendix G, TFTP File Transfer Protocol Examples.

B. ORGANIZATION OF THIS SUPPLEMENT

In the past, changes introduced by a Supplement to an ARINC Standard were identified by vertical change bars with an annotation indicating the change number. Electronic publication of ARINC Standards has made this mechanism impractical.

In this document **blue bold** text is used to indicate those areas of text changed by the current Supplement only.

C. CHANGES TO ARINC Report 615A INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this Supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.1 Purpose of this Report

The term "Data Loading Function" or DLF is added to this report to generally define a data loading software function. The section was revised in its entirety to support this new definition.

1.3 Function of the Equipment

The section was revised to support the new term Data Loading Function.

1.3.1 Interrelationship of ARINC Standards Relating to Data Loading

Added words describing the relationship between ARINC standards that define the context in which data loading is performed.

1.4 Unit Description

The section was modified to indicate that the trend of the next generation PDLs is moving away from dedicated ground support equipment and moving toward Ruggedized COTS and Section 1.4.3 was added to describe the new term Airborne Data Loading Function (ADLF).

1.4.3 Data Load Function (DLF) Description

New section added.

1.5.2 Unit Interchangeability

The section was revised to generalize its applicability.

1.6 Interoperability

The text was clarified.

1.7 Reliability of Portable Devices

The section title was revised to specifically indicate PDLs, instead of data loaders in general.

1.8 Maintainability of the PDL

The section was modified in to emphasize modularity.

1.9 Regulatory Approval

The text was deleted.

1.10 Related Documents

A new section was added to refer to Appendix B.

2.1 Introduction

Text was deleted to support the new term Airborne Data Loading Function.

2.2.3.1 PDL Controls and Indicators

The section was modified to indicate that the controls should also include a graphical interface.

2.2.4 Drive/Interface Mechanisms

The section was deleted as it directly refers to specific media interface.

2.2.5 Connector

This section was reconstructed to accommodate the ADLF as well as ADL and PDL.

2.3.1 Primary Power Input

The section was updated to indicate that the data loader should be able to operate from a variety of power sources and/or autonomously via battery power.

2.3.1.1 PDL Primary Power Input

This section was deleted as it is now redundant as Section 2.3.1.

2.3.1.2 ADL Primary Power Input

This section was deleted as it now redundant with Section 2.3.1.

2.3.3.1 PDL Internal Circuit Protection

The text was revised to remove the references to internal heater.

2.4.2 Pressure

The text was clarified

2.4.4 Solvent Resistance

The text was clarified.

2.4.6.1 PDL Shock/Handling

The Commentary was revised to specifically refer to ruggedized COTS equipment.

2.4.71 PDL Electromagnetic Compatibility

The text was clarieifed.

2.4.8 Dust

The text was clarieifed.

2.4.9 Explosive Atmosphere

The text was clarieifed..

2.4.10 Fungus Resistance

The text was clarieifed.

3.2 Controls

New paragraph inserted.

3.2.1 Media Ejector

The section was deleted as it is obsolete text. The remaining Subheading, 3.2.2, was removed.

3.5 Self-Load Capability

Added words to allow loading by network connection.

3.5.1 Equipment Data Base

Change “should” to “may” and “the” to “an” to reflect flexibility in specifying the role of data loaders ability to load an airplane-specific data base of loadable target hardware.

3.6 Special Physical Provisions

The section was deleted as it is obsolete text Subsequent sections were renumbered.

4.1 Removable Media Support

The section was modified in its entirety to review the different media types and to indicate that they are described for legacy use only.

4.1.1.3 Logical Format

Change the reference from: ARINC Report 615A to: ARINC Report 665 for accuracy.

4.1.1.2 Logical Format

Change the reference from: ARINC Report 615A to: ARINC Report 665 for accuracy.

4.1.3 USB Memory Device

The section was added to indicate that the storage media will meet the USB 1.0 or 2.0 Standard. Subsequent sections were renumbered.

4.1.4 Optical Medium (CD and DVD)

Commentary was added advising that the DVD/optical disc technology will evolve during the life time of this report. The subsequent sections were reorganized.

4.1.4.3 Drive Mechanism

Text was added supporting of the optional write capability.

4.1.4.3.2 Logical Format

Change the reference from: ARINC Report 615A to: ARINC Report 665 for accuracy.

4.1.3.4 Disc Replication

The section was deleted as unnecessary because equipment is available for replication of all discussed disk formats.

5.1 Introduction

Port number notation is specified for clarity.

5.2 Scope

Replace: Simple Network Identification Protocol (SNIP) with: Find Identification of Network Devices (FIND) for accuracy.

5.3.1 General Description

Text for this section is restored from Supplement 1. The Data Loading Functional Architecture is illustrated in a new Figure 5-1 and a description of the six layers of the architecture is provided. Three new Commentaries are provided for guidance.

5.3.2 TFTP Protocol

Files are clarified.

5.3.2.2 TFTP Options

The sentence: “The options are described in the following sections” is replaced with: “The options are defined in Section 5.3.2.3.8.” The subordinate sections of 5.3.2.2.1, 5.3.2.2.2, and 5.3.2.2.3 are deleted because they contain redundant information to Sections 5.3.2.3.8.1, 5.3.2.3.8.2, and 5.3.2.3.8.3, respectively.

5.3.2.2.1 Blocksize

The section was deleted.

5.3.2.2.2 Transfer Size of the File

The section was deleted.

5.3.2.2.3 Timeout Interval

The section was deleted.

5.3.2.3 TFTP Adaptation to Data Loading Protocol

A number of references to octal numbers in this section were clarified. Also, references to “NETASCII” were changed to the modern reference “ASCII.”

5.3.2.3.4 Definition of the Waiting Message

Add guidance that the wait message may be generated in response to any TFTP transfer request.

5.3.2.3.8 Flow Control Command “WAIT_ACK”

This function was deleted and subsequent sections renumbered.

5.3.2.3.8.1 Blocksize Option Implementation

Add a reference to RFC 2348, which defines the TFTP Blocksize Option.

5.3.2.3.8.2 File Transfer Size

This section is modified to enable the transfer size option as intended in the TFTP RFCs.

Add a reference to RFC 2349, which defines the TFTP File Transfer Size Option.

5.3.2.3.8.3 Timeout Interval

The provisions of this section are softened from a “should” statement to a recommendation.

Add a reference to RFC 2349, which defines the Timeout Interval Option.

5.3.2.3.8.4 Part Number

This section is added to allow the data loader to resolve the LSAP P/N of a currently requested data or support file within an upload schedule. Two different files of identical name may be part of an upload schedule. This TFTP option allows a data loader to resolve the location of such a file using the LSAP P/N referencing the file.

5.3.2.3.8.5 Checksum Option

This section is added to specify the Checksum Option for data loading to validate binary transfers at the TFTP level.

5.3.2.3.8.6 Port Option

This section is added to specify the Port Option for data loading.

5.3.2.3.10 File Transfer Size

This section is deleted because it contains information redundant to Section 5.3.2.3.9.2 and removes inconsistency.

5.3.2.3.11 Timeout Interval

This section is deleted because it contains information redundant to Section 5.3.2.3.9.3 and removes inconsistency.

5.3.3 FIND Protocol

This section is added to specify the FIND Protocol for data loading.

5.3.4 Target Hardware Instance (THW_ID_POS)

This section is added to define Target Hardware Instance (THW_ID_POS).

5.4.1 Introduction

The section was modified to clearly define the set of protocol files to manage communication between the data loader protocol layer and the target hardware protocol layer.

5.4.2 Information Operation

This section is modified to specify that TFTP options may be used to provide data integrity checks for data transfers.

5.4.3 Uploading Operation

This section is modified to specify that TFTP options may be used to provide data integrity checks for data transfers.

5.4.3.1 Short Load

This section is added to define a new feature in this standard.

5.4.3.2 Full Load

This section is added to improve the definition of the load that has always been defined by this standard.

5.4.4 Download Operation

This section is modified to specify that TFTP options may be used to provide data integrity checks for data transfers.

5.4.4.1 Media Defined Download Mode

The initialization step definition is revised to a media-defined download to clarify the media definition for media-defined downloads.

5.4.4.2 Operator Defined Download Mode

The [Downloading_Information_Status] message is modified for clarity.

5.4.4.3 Download Media Organization

This section is added to describe the organization of the download media and to provide an example download.

5.4.5.1 Addresses and Data Loadable Equipment Recovery

This section was deleted. All subsequent sections were renumbered.

5.4.5.1 Status Messages

The text was clarified.

5.4.5.2 Transfer Interruptions

The text was clarified

6.1 Load Server Application Messages

The title of this section is changed for clarity.

An introductory text is added to introduce and put in context Table 6-1, Summary of Protocol Messages.

Throughout Section 6.0, all references for “Target Hardware _ Identification_ Position” are made consistent to: THW_ID_POS and the name “Data Loader Application (DLA)” is made consistent.

6.2 Description of Messages

The introductory text is deleted and incorporated into the introductory text in Section 6.1.

Revised text throughout this section and its subsections adds precision to the provisions.

6.3 Message Sequence Chart

The diagram explanations in sections 6.3.2, 6.3.3, 6.3.4, 6.3.5, and 6.3.6 are augmented with definitions of the bold arrows and bold chrono circles for clarity.

6.3.1 Information/Uploading/Downloading Operation: Summary Description

This section was moved to 5.4.1.

6.3.3 Uploading Operation: Initialization, List Transfer and Transfer

Revised text throughout this section and its subsections adds precision to the provisions.

6.4 Protocol File Description

Delete the second paragraph and first Commentary to remove redundant information.

To the first table, add the title of: Table 6.4-1, Protocol Files for identification and references.

6.4.1 <THW_ID_POS >.LCI, .LUI, .LND and .LNO

Identify the first table as Table 6.4.1-1 and add Note 1 to the table for clarity

6.4.2 <THW_ID_POS>.LCL

The term Target Hardware Identifier is changed to Target Hardware Code for clarity. In addition, a Commentary is added to explain the relationship between Target Hardware Code and the Literal Name.

This section is revised for naming consistency.

6.4.3 <THW_ID_POS>.LCS

This section is changed to include Status Code 0x0004.

6.4.4 <THW_ID_POS>.LUR

Note 2 is added to Table 6.4.4-1.

6.4.5 <THW_ID_POS>.LUS

This section is changed to include Status Code 0x0004.

6.4.7 <THW_ID_POS>.LNS

This section is changed to include Status Code 0x0004.

6.4.10 Data Load Status Code Table

Table 6.4.10 is modified to include Status Code 0x0004.

The Status Code notation is changed to decimal for consistency.

Attachment 1 Connector Signal Assignments

Various minor clarifications were made and a reference to 10BaseT was deleted.

Attachment 2 Load Scenarios

This attachment is revised for naming consistency.

Attachment 3 FIND Identification of Network Device (FIND) Protocol

This attachment is revised for naming consistency.

Add a second way to get address information in the note to the table

Attachment 4 Time-Out and Retry Number Definition

Specific references to the 16-bit and 32-bit CRC TFTP options are added because they are considered recoverable errors within the TFTP protocol and have the same semantics as any other recoverable TFTP error like timeout.

Appendix C List of Acronyms

This appendix is added for clarity.

Appendix D Glossary

This appendix is added for clarity.

Appendix E Dataloading Over AFDX

This appendix is added for clarity or using dataloading over AFDX.

Appendix F Data Load Protocol File Transfer Examples

This appendix is added for clarity.

Appendix G TFTP File Transfer Protocol Examples

This appendix is added for clarity.