# Client-Server based Arinc-615A Data Loading for Aircrafts

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***ABSTRACT*** *— The development of next generation of aircrafts involves developing a lot of new software for the aircraft's Line Replaceable unit (LRU) which is referred to as Target Hardware. The new software has to be loaded into these LRU's frequently, so that the new software can be tested. This is currently a slow and tedious process. ARINC 615A is the protocol used to load the computers, using the data loader which uses commercial software applications implementing this protocol for the loading process. The Data loader will not be able to load several computers in parallel.In this paper we introduce a system which works on client-server based A615-A data loading that allows users to load the computers in parallel, regardless of the manufacturer using Wi-fi technology instead of the using Ethernet cables. There by reducing the time taken to load the aircraft's on-board computers significantly.*

*ARINC 615-A works on standard TFTP (Trivial File Transfer Protocol) & ARINC 665-3 protocol provides the file format for Data/Software which is involved in transmission. ARINC 615-A standard consists of four operations namely, FIND, INFORMATION, UPLOAD and DOWNLOAD that can be carried out between Data loader and target. The use of the ARINC 615-A protocol reduces the time required for data loading significantly and also speeds up the process with the standardization. Wi-Fi is a technology for wireless local area networking with devices based on the IEEE 802.11 standards.*

**Keywords—***Portable Data Loader (PDL), Line Replaceable Unit (LRU), TFTP, ARINC 615-A, ARINC 665-3, Data Load Protocol (DLP), Wireless fidelity (Wi-Fi)*

## I. INTRODUCTION

Aircraft systems have many units in the network called Line Replaceable Units (LRU). The LRUs all have different roles and responsibilities, such as controlling the displays found in the cockpit, flight mission management etc., which is fulfilled by the units by running different applications. Line Replaceable Units are modular components of an aircraft that are designed to be replaced quickly at the operating location. The software must first be loaded into the units, in order to test the applications either on-board the plane or in simulators. These units have to be reloaded often with new software and data. A loading application is used to load a unit in the aircraft network with new software.

The loading applicationloads the computer according to a protocol defined in a standard called ARINC 615A.

The ARINC 615A standard designates the computers to be loaded as Target Hardware's, and the loading application as the Data Load Application (DLA). The person running the DLA is referred to as the operator and the device it is running on is referred to as the Data Loader.ARINC 665-3 defined standard file formats are loaded into each Target Hardware (LRUs) in the aircraft system.The ARINC 615A operations are carried out over these file formats between Data Loader andTarget Hardware and also ensures the operations are same for data loading over all the units in the aircraft system over the Ethernet.

## II. CONVENTIONAL METHOD OF DATA LOADING

Fig. A shows the work structure of the system. The PDL (Portable Data Loader) and Line Replaceable Unit (Target Hardware) are connected to the switch using Ethernet cables. The operator communicates with both the Target Hardware using utility on PDL (Portable Data Loader) side over the Ethernet. Utility is the ARINC 615A Data Loader which is an .exe application on PDL. The utility shows the IP address of the PDL and IP address of the hardware that is connected to the network when that particular hardware is selected on the utility.

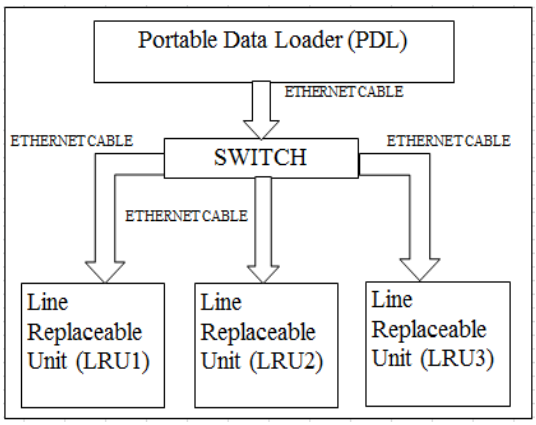


Fig A: CONVENTIONAL DATA LOADING USING ETHERNET CABLE

## III.ARINC 615-A OVERVIEW

ARINC 615A is a protocol used to carry out the process of loading a Target Hardware with software. ARINC 615A refers this as DataLoad Protocol (DLP).A computer with a network interface such as Ethernet can be a Data Loader,which communicates with loadable Target Hardware via Ethernet/IP network. Fig. B shows the protocol stack of a ARINC 615A.The individual Targets can be connected to a Data Loader via network interface.ARINC 615A uses IP, UDP and Trivial File Transfer Protocol to provide, network and file transfer services.TFTP is implemented on top of the UDP (User Datagram Protocol)/IP (Internet Protocol), which uses a port number 69 with additional functionality of file transferring.

Reading and writing files from or to a remote sever is done via TFTP. With anException of FIND operation, all the exchange between a Target Hardware and Data Loader are based on file transfer method. The types of files are:

• Files which are Loadable Software's Part, defined in ARINC Report 665.
• Protocol files which are generated during a loadprocess.

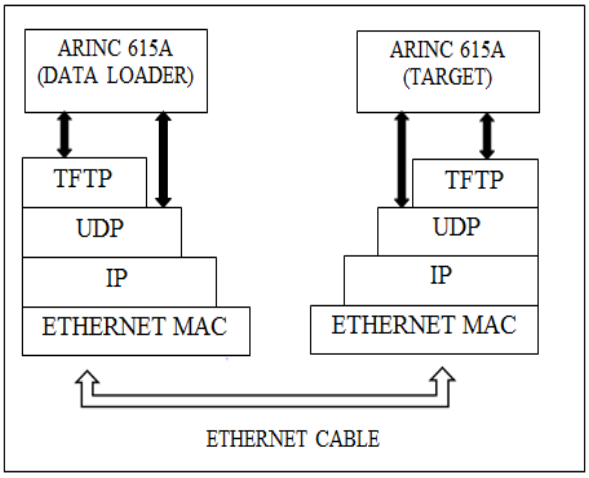


Fig.B: PROTOCOL STACK OF ARINC 615A

FIND operation is initiated through Data Loader via broadcasting/Multicast an IRQ (Information Request)packet message to UDP port 1001.In Ethernet/IPstandard network, the IRQ can be sent through multicastIP (e.g. 192.168.255.255).An Information Answer (IAN) by UDP 1001 is response to IRQ for all Target Hardware which are ready for ARINC 615A. IP address and Ethernet MAC address provided to aData Loader helps in locating the Target Hardware and Data Loader.

## IV.ARINC 665-3 OVERVIEW

ARINC 665-3 is a standard applicable to software transport media intended for, aircraft programs and systems,Equipment's, Line Replaceable Units (LRUs) and all the other loadable software parts (LSP).This standard defines three classes of files and their versions:

- 0x8004:Format version of Load file
- 0x9004:Format version of Batch file
- 0xA004:Format version of Media file

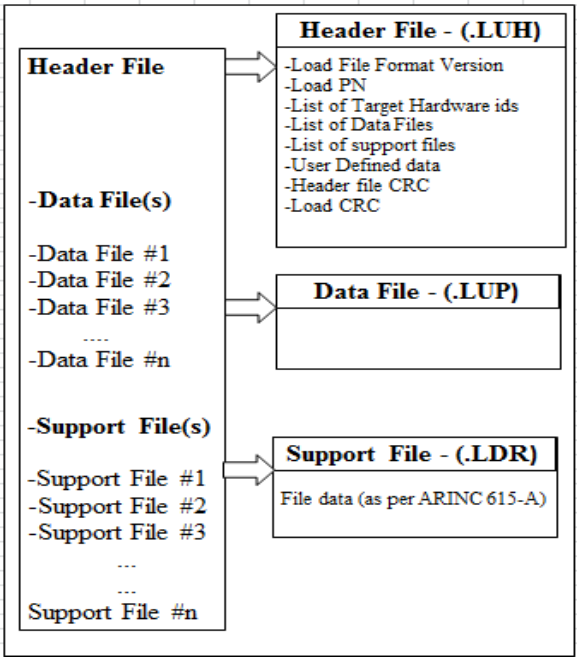


Fig. C: LOAD STRUCTURE of ARINC 665

Each Loadable software parts (LSP) has only one Part Number (PN). Suppliers of a software and aircraft manufactures should mutually agree upon the PN.Any time a change is made to an LSP, a newUnique PN should be assigned. Loadable Software PNs must follow a format:

MMMCC-SSSS-SSSS where

- MMM is aManufacturer's Code,which acts as a uniqueidentifier with the detailed information about softwaresupplier.
- CC is two "check characters".
- SSSS-SSSS is a unique product identifier defined by software supplier.

"-" Hyphen (ASCII 0x2D) areincluded as a part of a software Part Number and also acts asa delimiter.The manufacturer's code (MMM) identification of a Target HW compliant with ARINC 615A.As shown in Fig. C a load can have one or more Data Files plus

Header File and it may also include support files.ARINC 665-3 standard format specifies the Header Files and Data File format.File names in a load must be unique, DataFile Name extensions should be in ". LUP" (Load Upload Part) format and LSP Header Filename Extension should be ".LUH" (Load Upload Header) format.

## V. WORKING OPERATION OF DATA LOADING

ARINC 665-3 standard defines a set of file formats for each LRU in the aircraft.FIND, INFORMATION, UPLOAD and DOWNLOAD operations defined under ARINC 615A.These operations are carried out on a Target Hardware using the file formats defined by ARINC 665-3 over a Target Hardware.

Since all the LRUs are loaded with similar fileformats, the system that has a same file formatsdefined in it can be used as Data Loader to carry outARINC 615A operations. Since all the LRUs have similar file formats known to the Data Loader. The Data Loader can be used to update the different LRUs in an aircraft and on on-board without removing the LRUs from an aircraft network.ARINC 615A protocol automates the Data Loading process which ensures faster completion of a process and standardization of files and operations in each LRU's, which eliminates the need for different procedures to update the LRU.ARINC 615A protocol defines four differentoperations**:**

### *A. FIND:*

This operation helps in getting parameters such as MAC address, IP address, TargetHardware ID, position and dynamicidentification of Target Hardware on the network(PING operation).The port number 1001(decimal) is used by the FIND protocoland remaining operations areallowed to perform only if, Part Number of a Target Hardware matches with therequired Part Number andif not Abort message is displayed.This operation is useful in identifying correcthardware on which loading operation has to beperformed.

### *B. INFORMATION:*

The accurate configuration details like software part numbers and revision levels of the target are obtained during this operation. During on-ground maintenance this operation is performed. Fig D shows a flowchart of Information operation.
This operation defines two steps:

1) ***Initialization step:*** In this step, the Target Hardware Application (THA) is initialized using the Data Loader Application (DLA). With the help of an ". LCI file"(which is an initializationmessage) access to this mode is achieved.The response to the request will be indicated by DLA by accepting or declineingthe request. DLA notifies the operator, if a Target Hardware rejects the request and aborts the Information Operation.

2) ***Transfer step:***The target sends a file in". LCL" format, which holds information about Target Hardwareto a Data Loader Protocol and if the Initialization step is accepted, status of a process is indicated periodically by a Target Hardware through sending a status file.

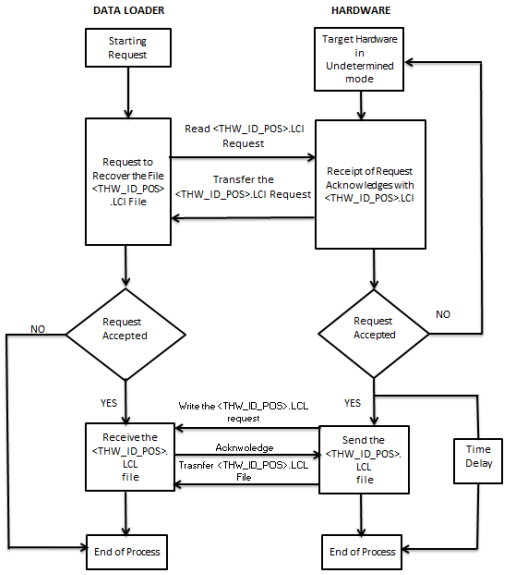


Fig.D: FLOW DAIGRAM of INFORMATION

### *C. UPLOAD:*

This operation helps in configuring files to a Target Hardware,uploading new orupdated software's andARINC 665-3 Media set holds a Loadable file. Fig. E shows the flowchartof Upload operation.

In this operation, three steps are defined:

1) ***Initialization step:*** In this step, uploading operation is initialized by DLA. This helps in informing THA about upload request and to determine, if it is operational. Initialization message helps in getting the access to this mode. A DLA indicates a response to a request by accepting or declining the request. DLA notifies the operator, if the target Hardware has refused the request and then aborts Upload Operation.
2) ***List transfer step:*** The DLA initiates list transfer step by issuing Load List message tothe DLP.if Initialization step isaccepted Via file in". LUR" format andDLP updates the list of loads which are tobe uploaded.
3) ***Transfer step:***TFTP readsthe files of the Load, then Target Hardware obtainsloadable

files. The name of a ". LUH header file" will be present in the ". LUR file". By using the name obtained, target hardware must request for a". LUH file" which DLA will transfer ".LUH file" to THA. The names of ".LUP files" which Target Hardware uses, to request data files will be present in ".LUH file" and this file will be transferred from DLA to THA which contains the data.

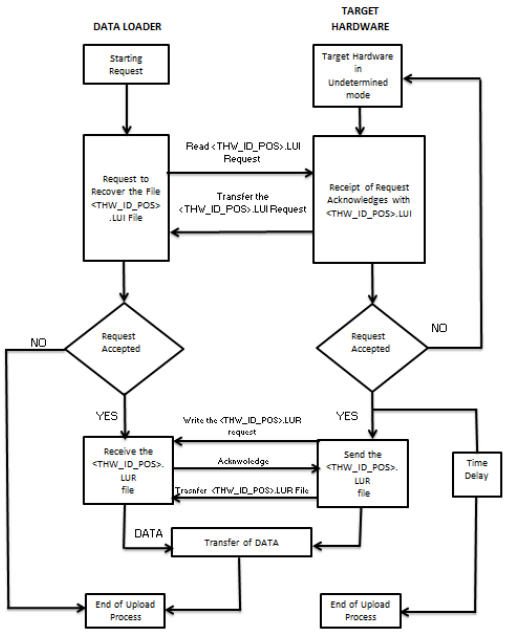


Fig.E: FLOW DAIGRAM of UPLOAD

### *D. DOWNLOAD:*

Using a pre-programmed list of files to be retrieved,this operation allows data files from a Target Hardware to be downloaded by the operator.Thedownload operation works in the Media DefinedMode. Fig. F shows the flowchart of Downloadoperation.

**Media Defined Mode:**A list of files that operator wants to download is given to the target hardware which then sends the files.The DLA determines which files, from the locally stored names are available for download in this mode.

1) ***Initialization step:*** The DLAinitializes the Downloading Operation, in the first step. This helps in informing THA and to know if it is operating. The ".LUH file" can be selected bythe operator and used to create LNR file, optionally. The part numbers of theheader files with download bits set by theoperator are offered by a data loader by examining each part of the header file. Theoperator may select one of these files, if more than one header file has download bit set. Theaccess to this mode is achieved initializationmessage. The DLA gets accepted or declined messageas a response to the request. The DLA notifies the operator, if the THA refuses the request and then Download Operation is aborted.
2) ***List Transfer step:*** In this step,DLP sends list ofdownloadable files in ". LNR file" format.
3) ***Transfer step:*** In this step, list ofdownloadable files isanalyzed by a Target Hardware andresponds with the files defined in".LNR file" format.

The message is:

- [Downloading_File_Receipt] whichtells the user that the transfer iscompleted.

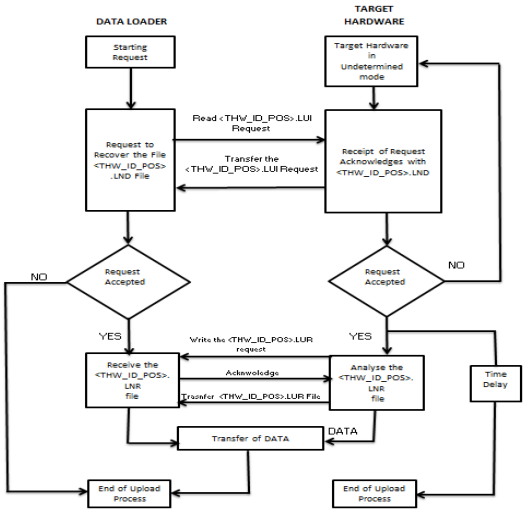


Fig. F: FLOW DAIGRAM of DOWNLOAD

## VI. LIMITATIONS CONVENTIONAL DATA LOADING APPLICATION

The issues facedare listed below and illustrated in Fig.G:

- Only one person can operate, Data Loader at any instance of time.
- Operator has to use, different Loading Application depending on the manufacturer of Target Hardware.
- The process of loading multiple Target Hardware's is slow, due to current software not being able to load them in parallel.
- Large number of Ethernet cables are used, which makes the lab a hazardous place and prone location for accidents in working environment
- If a team or an engineer wishes to test their new software, reservations for specific Target Hardware, time and date has be pre-booked and based on the allocation and free time slots, testing in the real time working environment is permitted. If the Data Loader is not free, they will have to wait for the free time slot.

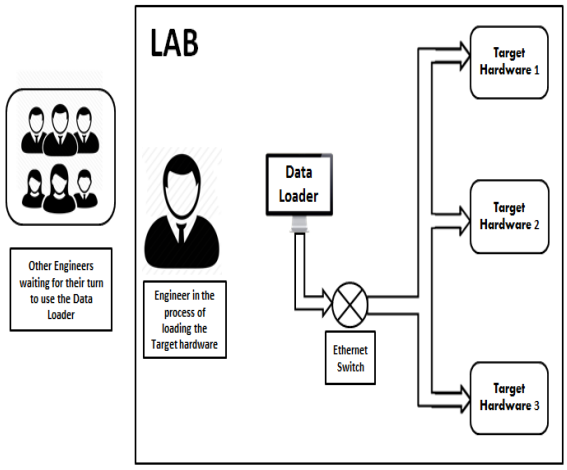


Fig.G: EXISTING SYSTEM

## VII. IEEE 802.11 STANDARD (WIRELESS FIDELITY(Wi-Fi))

IEEE 802.11 contains a set of specifications of Physical layer and media access control-MAC to provide wireless communications.

Wireless Fidelity (Wi-Fi) works similar as in Mobile communications. It is based on the World wide wireless networking technology and the data transfer in Wi-Fi takes place through the radio frequencies and follows IEEE 802.11 standard.As the name suggest, it provides internet connection with high speed without cable connections which results in installation cost reduction.

Wi-Fi allows userto connect internet from anywhere like Hotel, Shopping mart, Restaurant etc. and provides speed which is way faster than dial-up connections.

Wi-Fi is local area wireless computer networking topology which allows user to connect to electronic Gadgets/DeviceswithWi-Fi facility to connect to a network.

Operation of Wi-Fi network takes place using the 2.4 radio bands which is unlicensed and speed of 54 Mbps for 802.11 a standard and 11Mbps for 802.11 b standard.

There are several specifications/subset of 802.11 standards which are listed below:

- 802.11: This was released in the year 1997 which uses eitherfrequency-hopping spread spectrum (FHSS) or direct-sequence spread spectrum (DSSS) modulation technique. It has a bandwidth of 22 MHz with data transmission of 1 to 2 Mbps in 2.4 GHz band.
- 802.11a: 802.11a was the extension of 802.11 standard released in the year 1999. Modulation technique used is Orthogonal frequency-division multiplexing (OFDM). It has a bandwidth of 20 MHz with data transmission up to 54 Mbps in 5 GHz band.
- 802.11b: 802.11b is also the extension of 802.11 standard released in the year 1999. Modulation technique used is direct-sequence spread spectrum (DSSS). It has a bandwidth of 22 MHz with data transmission up to 11 Mbps in 2.4 GHz band.
- 802.11g: which is also the subset of Wireless LANs which was released in the year 2003.Modulation technique used is Orthogonal frequency-division multiplexing (OFDM). It has a bandwidth of 20 MHzwith data transmission up to 54 Mbps in 2.4 GHz band.

## VIII. PROPOSED DATA LOADING TECHNIQUE USING Wi-Fi

To eliminate, discussed drawbacks developed system follows the client-server model with a server that supports parallel loading regardless of the manufacturer as shown in Fig.H.The users are presented with a client and no longer have to care about the manufacturer of the Target Hardware's which are used, nor have to wait for their turn to use the Data Loader. By enabling users to load all the Target Hardware's parallelly, by using this method, time required to load multiple Target Hardware'sis considerably reduced.

The proposed system makes use of the client-server model with Wi-Fi instead of wired connections like Ethernet cables. The engineers run a client application through which they send instructions to a server. Which may/or may not be located in thesame premises as the Target Hardware.

By using this model engineers, no longer have to make their wayout to a computer lab in order to load a Target Hardware, but can be achieved from their regular workplace.System allows multiple engineers to load Target Hardware's simultaneously without having to go through a shared resource such as Data Loader in the system.

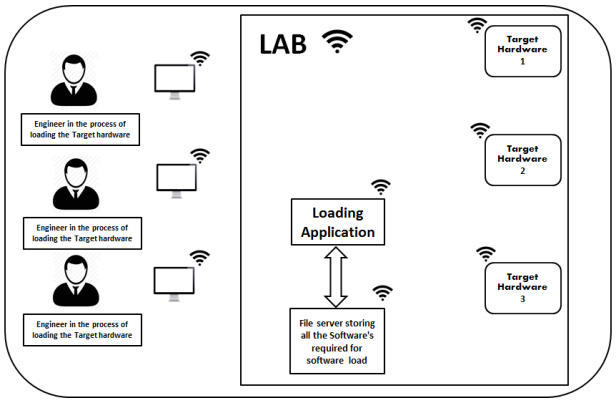


Fig. H: PROPOSEDSYSTEM

## IX.CONCLUSION

The conventional method of data loading will take a lot of time for the operator to analyze a aircraft unit and then load the software, while other operatorshave to wait for their turn to use the Data loader.The use of ARINC 665-3 standard and ARINC 615A standard protocol on a Wi-fi network (IEEE 802.11 STANDARD) in every aircraft unit ensures standardization of data and software in each LRU (Line Replaceable Unit) in the aircraft network,making data loading process simpler and the entire process can be completed within a couple of hours

The main advantages of having a client-server model are listed below:

1)***Centralized:*** In client server network there is a centralized control.But In Peer to Peer, there is no central administration.The entire setup including access rights, resource allocation is done by the servers, there by severs helps in administration.

2)***Management:*** As all the files are stored at a common place, managingof files becomes easy and finding the files is also easier.

3) ***Recovery and Back-up possible:*** If there's some break-down and there is a loss of data, it can be recovered efficiently and easily.Taking a copy of theback-up data is easy as the data is stored on server. While in peer architecture at every workstationuser have to take back-up.

4) ***Client-server set-up upgradation and scalability:*** If any changes are needed user need to simply upgrade a server. Adding of new resources and systems can be done by doingrequired changes in a server.

5) ***Accessibility:***Server can be remotelyaccessed from various platforms which are in the network.

6) Every workstation need not have its own storage capacities increased (which may bein peer-to-peer systems scenario),as and when new information is uploaded in database. But the Central computer is a location where the entire server database exists and the place where the changes needto be made.

7) ***Security:*** Accessing rights and rules to be followed for security can be defined at the time of setting up of server.

8) ***Remote Access:*** Remote accessinghelps employees, customers and partners to gain access to the data which is available on the server, even with the user not physicallybeing in front of the system.

## X.FUTURE-WORK

WiMAX works on the IEEE 802.16 standard which contains a multiple set of Physical layers and media access control-MAC to provide wireless communications.
WiMAX is known as Worldwide Interoperability for Microwave Access which is a family of wireless communication, and the name WiMAX was obtained from the WiMAX Forum.

WiMAX as many applications such as

- Providing the Connectivity across towns, cities and across different countries making use of various devices.
- As part of Business continuity plan WiMAX can provide Internet Connection in case of serious

incidents or disasters and is able to recover to an operational state within a reasonably short period.

Operation WiMAX takes place using the radio bands which is either licensed or unlicensed and as a speed of Several Gigabytes for 802.16 operating in 10-66 GHz.

Since WiMAX enables long distance communication, this feature can be used by companies which have different Sites within a state or country. Perform the data loading operation to the Target hardware located at the different site.

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