ARINC 629 Data Bus Standard on Aircrafts

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Abstract – In earlier analogue avionic systems the number of cables used to transfer information between the various system components was considerable. With these systems, at least one pair of wires has been required for each signal and so a typical installation requires several pairs of wires. With the equivalent digital systems, all the analogue signals are converted into their equivalent and are assigned unique address labels to ensure there are no conflicts. These signals are then transmitted down a single pair of wires, which makes up a data bus. Aircraft data bus systems allow a wide variety of avionics equipment to communicate with one another and exchange data. The type of language used on an aircraft data bus is known as the protocol. There are currently different data bus standards (protocols) that currently account for most of the avionics data interchange on today's aircraft, and these are: ARINC 429, ARINC 629, MIL-STD 1553, MIL-STD 1773, CSDB and ASCB. In this study after evaluating the main characteristics of data transmission and data bus used aircraft systems, ARINC 629 standard examined in detail.

Key-Words: - Digital data transmission, Aircraft, Aircraft Data bus, Data bus standards, ARINC 629.

1 Introduction

The form and interior configuration of aircrafts are determined by aerodynamic and structural characteristics. Equipments (or devices) location therefore weights and dimensions depend on the interior configuration of aircraft. However some of the equipments such as inertial navigation systems should be installed on some specific locations. This kind of restrictions can change options in device design. Such as devices or equipments can not be located in same place, have extensive cabling between each other. Also, some modernization programs cause some divisions in equipment locations. All these effects create groups of equipment communicate each other but different places [1].

On an aircraft, physical parameters (temperature, pressure, attitude information etc.) and data carried by electromagnetic waves are transmitted to related systems after converting electrical signals and processing. Electrical signals can be analogue or digital forms [2]. Data transmission methods had developed with the rapid development in technology and because of the increase in requirements electronic communication had begun to be insufficient. Using digital data transmission on aircrafts is increased instead of analogue data transmission.

In the literature there are severally some studies about data bus standards for civil and military aircraft. In this study after evaluating the main characteristics of data transmission and data bus used both civil and military aircraft systems, ARINC 629 (Aeronautical Radio Incorporated) data bus standard examined in detail.

2 Data Bus Standards on Aircrafts

Data transmission is the conveyance of any kind of information from one space to another. Historically this could be done by courier, a chain of bonfires or semaphores, and later by Morse code over copper wires. In recent computer terms, it means sending a stream of bits or bytes from one location to another using any number of technologies, such as copper wire, optical fiber, laser, radio, or infra-red light [3]. In earlier analogue avionic systems the number of cables used to transfer information between the various system components was considerable. With these systems, at least one pair of wires has been required for each signal and so a typical installation requires several pairs of wires. With the equivalent digital systems, all the analogue signals are converted into their digital equivalent and are assigned unique address labels to ensure there are no conflicts. These signals are then transmitted down a single pair of wires, which makes up a data bus. A bus is a collection of wires through which data is transmitted from one part of a computer to another. You can think of a bus as a highway on which data travels within a computer. When used in reference to personal computers, the term bus usually refers to internal bus. This is a bus that connects all the internal computer components to the CPU (Central Processing Unit) and main memory. However when used in reference to aircraft, it is the data highway which links

one computer to another within the aircraft, for example, the FMC (Flight Management Computer) and the ADC (Air Data Computer) [4,5].

Bus systems provide an efficient means of exchanging data between the diverse avionic systems found in a modern aircraft as shown in Figure 1 [6].

All buses consists of two parts an address bus and a data bus. The data bus transfers actual data whereas the address bus transfers information about where the data should go. On an aircraft bus, the two parts are incorporated within a single data word.

A bus can be either serial or parallel. A serial bus requires less wiring, but is slower. A parallel bus required one wire for each bit within the data word, but is much faster. Aircraft bus systems use serial data transfer because it minimizes the size and weight of aircraft cabling. With such a large number of avionic systems, a modern aircraft requires a considerable amount of cabling. Furthermore, some of the cabling runs in a large aircraft can be quite lengthy. Aircraft cabling amounts to a significant proportion of the unladen weight of an aircraft and so minimizing the amount of cabling and wiring present is an important consideration in the design of modern aircraft, both civil and military.

A bus can enable communication between a single computer to a single LRU (Line Replaceable Unit) only, known as single source-single sink or a single computer to multiple LRUs, known as single source-multiple sink, or multiple computers to multiple LRUs known as multiple source multiple sink. A data bus also classified on whether or not it can transmit in just one direction it is termed simplex. If it can transmit in both directions, but not at the same time it is termed half duplex. Where a data bus can transmit in both directions at the same time, it is termed full duplex.

The type of language used on an aircraft data bus is known as the protocol. Main data bus standards that currently account for most of the avionics data interchange on today's aircraft, are ARINC 429, ARINC 629, CSDB (Commercial Serial Digital Bus), ASCB (Avionics Serial Communication Bus) and MIL-STD 1553 (Military Standard) [4,5,6].
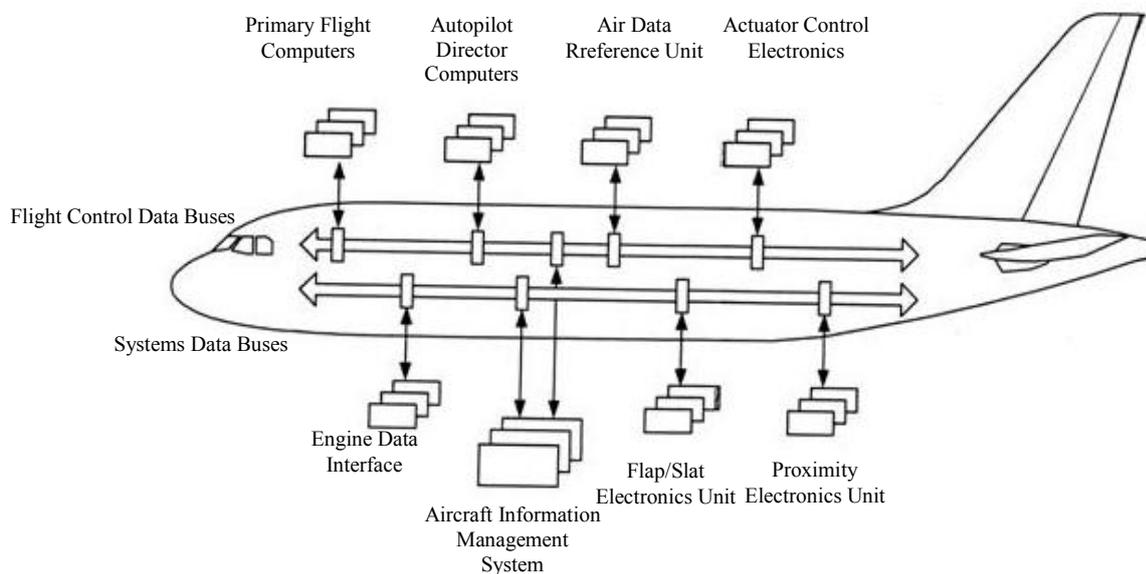

Fig.1 Multiple bus systems implemented on modern passenger aircraft

3 ARINC 629

ARINC is a major company that develops and operates systems and services to ensure the efficiency, operation, and performance of the aviation and travel industries. It was organized in 1929 by four major airlines to provide a single licensee and coordinator of radio communications outside the government [7]. It is now a large international company with headquarters in Annapolis, Maryland and over 50 operating locations worldwide. ARINC has two regional headquarters: London to serve the Europe, middle East, and Africa region and Singapore for the Asia Pacific region. The company has two major thrusts:

~ Communications and information processing services for the aviation and travel industry.
~ System engineering, development and integration for government and industry [4,8].

ARINC 629 was introduced in May 1995 and is currently used on the Boeing 777, Airbus A330 and A340 aircraft. The ARINC 629 bus is a true data bus in that the bus operates as a multiple-source, multiple sink system as shown in Figure 2. That is, each terminal can transmit data to, and receive data from, every other terminal on the data bus. This allows much more freedom in the exchange of data between units in the avionics system.

The true data bus topology is much more flexible in that additional units can be fairly readily accepted physically on the data bus. A further attractive feature of ARINC 629 is the ability to accommodate up to a total of 128 terminals on a data bus shown in Figure 3, though in a realistic implementation the high amount of data bus traffic would probably preclude the use of this large number of terminals. It supports a data rate of 2 Mbps.
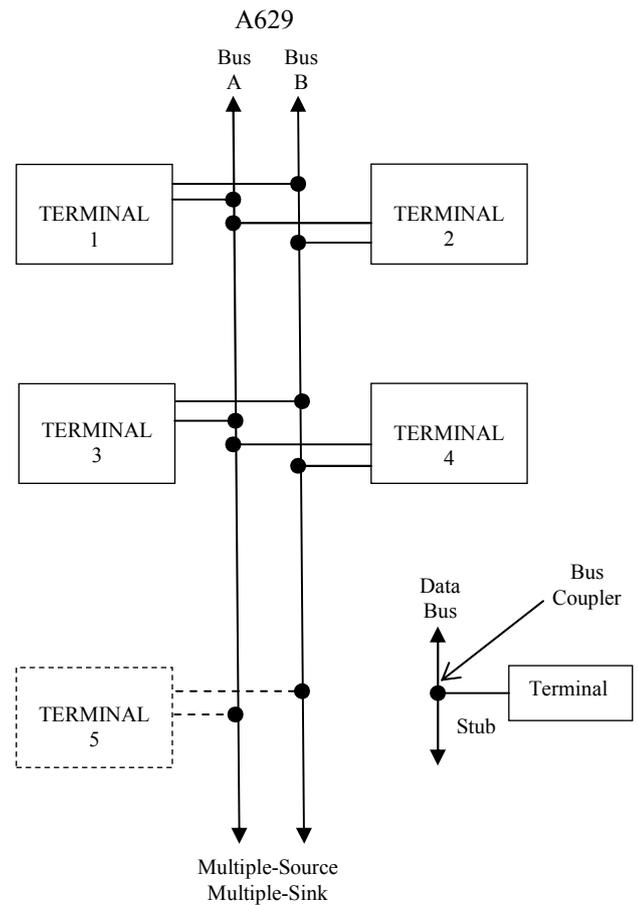

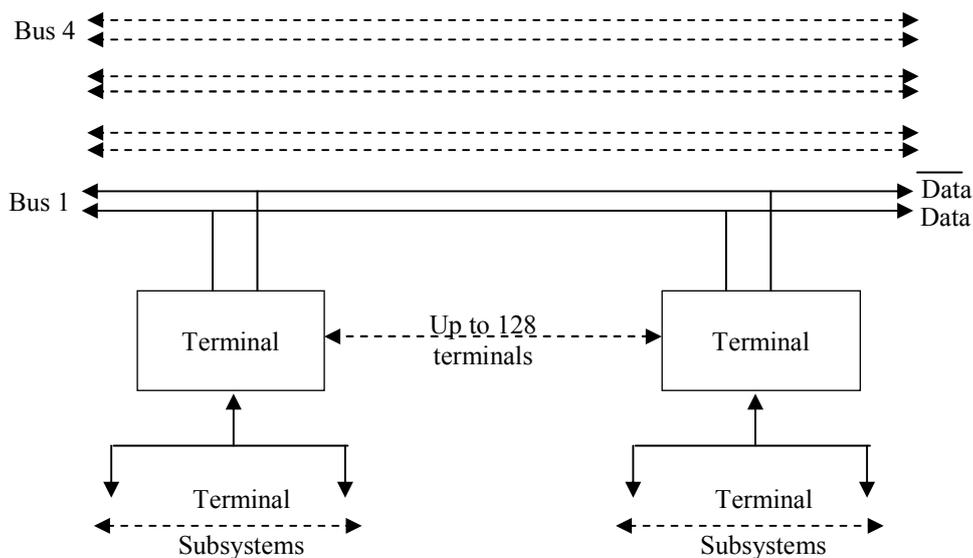**Fig. 2** ARINC 629 Data Bus Topology

Fig.3 ARINC 629 data bus

The protocol utilized by ARINC 629 is a time-based, collision-avoidance concept in which each terminal is allocated a particular time slot to access the bus and transmit data on to the bus. Each terminal will autonomously decide when the appropriate time slot is available through the use of several control timers embedded in the bus interfaces and transmit the necessary data. Figure 4 shows the typical ARINC 629 20 bit data word format which is very similar toMIL-STD-1553B.

The first three bits are related to word time synchronization. The next 16 bits are the data contents, and the final bit is a parity bit. The data words may have a variety of formats depending on the word function; there is provision for general formats, systems status, function status, parameter validity, and binary and discrete data words.

The ARINC 629 data bus cable consists of an unshielded twisted pair of wires. The wires are #20 AWG and are bonded together continuously along their length. The cables can be up to 100 meters long and have no provisions for field splicing. ARINC 629 is defined for both voltage and current modes of operation. One attractive feature of ARINC 629 is that it will be defined for a fiber optic interface ARINC 629 data transmitted in groups called messages. Messages are comprised of word strings, up to 31 word strings can be in a message. Word strings begin with a label followed by up to 256 data words. Each label word and data word is 20 bits [4,9,10,11,12,13].
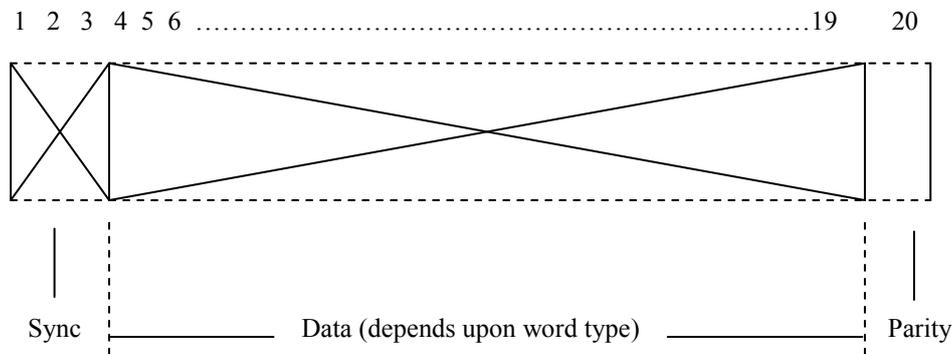

Fig. 4 ARINC 629 Digital word format

4 Conclusion

Data transmission methods had developed with the rapid development in technology and because of the increase in requirements electronic communication had begun to be insufficient. Basically electronic communication is realized by changing the position of the electrons. So, the factors like the type, structure and dimensions of the conductor (copper, etc) that is used affect the speed of the communication. Light is known as the most rapid existence in universe. As a result of investigations, light is begun to use for communication besides the sound and electricity. On the aircraft, physical parameters (temperature, pressure, position information) taken from different points and the information carried with electromagnetic waves are converted into electrical signals is transmitted to the related systems. At this study, after examining the digital data transmission standards in general and for avionic systems, the usage of them on aircrafts are examined and ARINC 629 data bus standard is examined in detail.

References:
[1] B. Codur, MIL-STD 1553,http://www.milscint.com/yazar.asp?yid=6&id=19 (2009)
[2] E. Delipınar, ARINC Standardının Bilgisayar Yardımıyla Simülasyonu, 1. Kayseri Havacılık Sempozyumu, 223-229, (1996).
[3]Data_transmission, http://en.wikipedia.org/w/index.php?title= (2009).
[4] TTS Integrated Training System Module 5, (Digital Techniques Electronic Instrument Systems for EASA Part-66 Licence Category B1 and B2, Vol1,9-36, 2008.
[5] A. Davies, IR Part-66 Aircraft Maintenance Licence, Distance Learning Modules, Module5-Digital Techniques/Electronic Instrument Systems, Barry College, 2002-2005.
[6] M. Tooley, Aircraft Digital Electronic and Computer Systems:Principles, Operation and Maintenance, Elseiver, U.SA.,33-44, 2007
[7] ARINC 429 Protocol Tutorial,

http://www.ecrin.com/downloads/ARINC-429-tutorial.pdf (2009).

[8] ARINC, http://en.wikipedia.org/wiki/ARINC (2009)

[9] M. Tooley, Aircraft Digital Electronic and Computer Systems:Principles, Operation and Maintenance, Elseiver, U.SA.,33-44, 2007.

[10]R.P.G. Collinson, Introduction to Avionics, Chapman & Hall, London,1996.

[11] I.Moir, A. Seabridge, Civil Avionics Systems, AIAA, U.S.A, 2003.

[12] A. D. Helfrick, Principles of Avionics, Avionics Communications, Leesburg, Bt, 2002.

[13] I. Moir, A. Seabridge, Aircraft Systems mechanical, electrical, and avionics subsystems integration, AIAA, U.S.A, 2001.