ARINC 818 Avionics Digital Video Bus

The Protocol Standard for High-Performance Video Systems

A White Paper by Tim Keller

Great River Technology

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ARINC 818: Avionics Digital Video Bus: The new protocol standard for high performance video systems

By Tim Keller, Great River Technology

As ARINC 818 is adopted by military programs, graphics and video system designers need to understand the protocol, implementation issues, and available development tools.

Introduction

ARINC 818 is a video interface and protocol standard developed for high bandwidth, low latency, uncompressed digital video transmission. The standard, which was released in Jan. 07, has been advanced by ARINC and the aerospace community to meet the stringent needs of high performance digital video. Even prior to its release, ARINC 818 has already been adopted by two major aerospace programs, the Boeing 787 and the Airbus A400M, and is poised to be the de facto standard for high performance military video systems.

Background

In aircraft, an ever-increasing amount of information is supplied in the form of images, this information passes through a complex video system before reaching cockpit and crew displays. Video systems include: infrared and other wave length sensors, optical cameras, radar, flight recorders, map/chart systems, synthetic vision, image fusion systems, heads-up displays and heads-down multifunction displays, video concentrators, and other subsystems. Video systems are used for taxi and take-off assist, cargo loading, navigation, target tracking, collision avoidance, and other critical functions.

ARINC 818 builds on the Fiber Channel Audio Video (FC-AV defined in ANSI INCITS 356-2002) protocol which was used extensively on video systems in the F18 and the C130AMP. Although FC-AV has been used on numerous programs, each implementation has been *unique*. ARINC 818 provides an opportunity to ***standardize*** high speed video systems.

Overview of ARINC 818 protocol

ARINC 818 is a point-to-point, 8B/10B encoded serial protocol for transmission of video, audio, and data. The protocol is packetized, but is video-centric and very flexible, supporting an array of complex video functions including the multiplexing of multiple video streams on a single link or the transmission of a single stream over a dual link. Four different classes of video are defined, from simple asynchronous to stringent pixel synchronous systems.

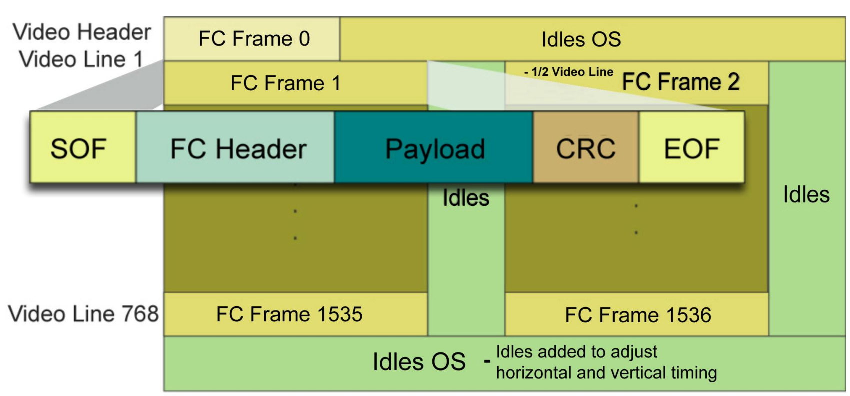

Figure 1. Protocol Example with XGA Video Image

An example of how ARINC 818 transmits color XGA provides a good overview. XGA RGB requires ~141M bytes/sec of data transfer (1024 pixels x 3 bytes per pixel x 768 lines x 60 Hz). Adding the protocol overhead and blanking time, a standard link rate of 2.125Gbps is required. ARINC 818 "packetizes" video images into Fibre Channel (FC) frames. An FC frame is defined in Figure 1, where the maximum size of the payload is 2112 bytes. Each FC frame begins with a 4 byte ordered set, called an SOF (Start of Frame), and ends with an EOF (End of Frame), additionally, a 4 byte CRC is included for data integrity. The payload of the first FC frame in a sequence contains embedded header data that accompanies each video image.

Each XGA video line requires 3072 bytes, which exceeds the maximum FC payload length, therefore, each line is divided into two FC frames. Transporting an XGA image requires the "payload" of 1536 FC frames. Additionally, a header frame is added, making a total of 1537 FC frames, as represented in Figure 1. Idle characters are required between FC frames because they are used for synchronization between transmitters and receivers.

Applications: Cockpit video, Sensor Fusion, Turrets, and Distance

Although ARINC 818 was developed specifically for avionics applications, the protocol is already being used in sensor fusion applications where multiple sensor outputs are multiplexed onto a single high speed link.

Low speed implementations of ARINC 818 (1.0625Gbps) can use copper (twinax or STP) or fiber, and high speed implementations (2Gbps+) can use either 850nm MM fiber (<500m) or 1310nm SM fiber (up to 10km). ARINC 818 lends itself to applications that require few conductors (slip rings turrets), low weight (aerospace), EMI resistance, or long distance transmission (aerospace, ships).

Comparison of ARINC 818 to other Video and Data Buses

The ARINC committee explored various video buses, but selected unidirectional Fibre Channel because of low latency requirements, speed options, data integrity, display timing requirements, and the proven field experience of FCAV in avionics.

For the real time fusion of images, such as symbology or cursor information overlaid on digital map images or real time video, all imagery must be uncompressed. Without compression, video requires significant bandwidth. Current implementations of ARINC 818 use speeds of up to 3Gbps, with provisions for 8.5Gbps. Table 1 compares ARINC 818 against other buses.

Table 1: Comparison of ARINC 818 to other Video Buses

	ARINC 818	**Camera Link®**	**DVI**	**Firewire**	**GigE**
Speeds	1x, 2x,4x, 8x FC up to 8.5 Gbps	1.6Gbps dual 4.7Gbps	4Gbps Dual 8Gbps	800Mbps	1.0 Gbps or 10.0 Gbps
Physical	1 copper pair (1x) or fiber (1x+)	5 to 10 copper pairs	4 copper pairs	1 copper pair	4 copper pairs or fiber
Distance	Copper (1x) < 15M MMF < 500M	<10 m	< 5 m	< 5 m (full bandwidth)	<15m (copper) MMF < 500M
Precision H&V Timing	Yes	Yes	Yes	Yes	No

In large aircraft, video sources and displays can be separated by 50 meters. For its bandwidth, distance, weight, and EMI capabilities, fiber optic cable is preferred.

ARINC 818 provides high data integrity because of the use of FC frame (packet) CRCs. Packetized video permits data to be easily embedded and creates a natural way to time multiplex multiple video streams onto a single link.

Finally, maintaining precise horizontal and vertical timing is crucial for driving many types of display units.

Flexibility vs. Interoperability
ARINC 818 is flexible and can accommodate many types of video and data applications. It is the intention of the standard that all implementation be accompanied by a small interface control document (ICD) that defines key parameters of the header such as: link speed, video resolution, color scheme, size of ancillary data, timing classification, or bit-packing schemes. Interoperability is only guaranteed among equipment built to the same ICD.

Implementation Considerations
ARINC 818 uses a FC physical layer that can be constructed from any FC compatible 8B/10B SerDes, which are common in large FPGAs such as the Xilinx Virtex 2 Pro.

ARINC 818 transmitters must assemble valid FC frames, including starting and ending ordered sets, headers, and CRC. This can easily be done with VHDL state machines, and many PLD SerDes include built in CRC calculations.

The flexibility of ARINC 818 allows for receiver implementations using full image buffers or only line buffers. For either, synchronization issues must be considered at the pixel, line, and frame level.

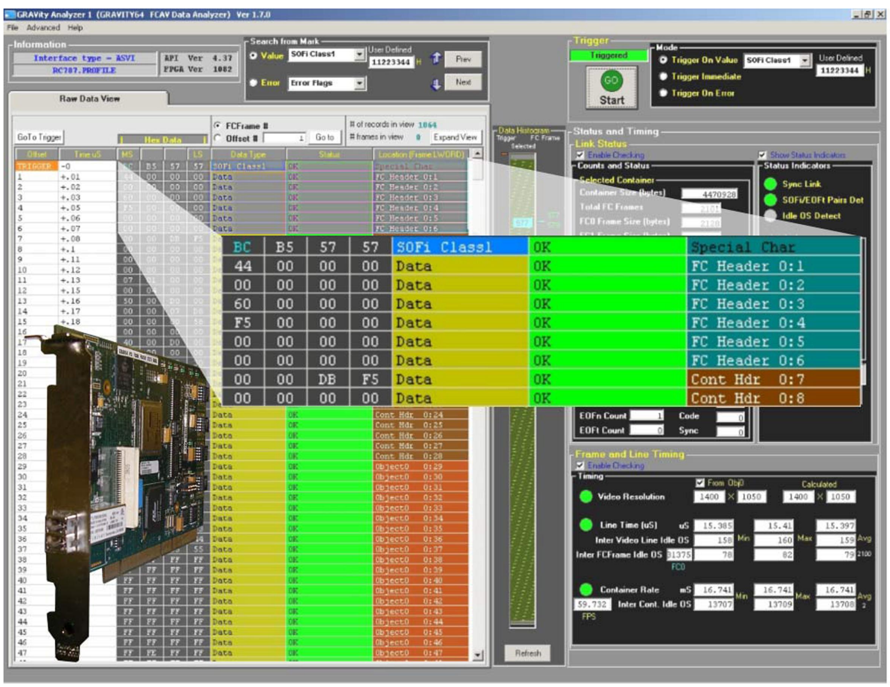

Figure 2: ARINC 818 Protocol Analyzer

Line buffer or FIFO based receivers will require that the transmitter adhere to strict line timing requirements of the display. Since the display horizontal scanning must be precise, the arrival time of lines will also need to be precise. ARINC 818 intends that timing parameters such as these be captured in an ICD specific to the video system.

The authors of ARINC 818 built upon many years of combined experience of using FC to transport different video formats, and key implementation details are included in the specification, including examples of common analog formats.

Existing Hardware and Development tools

Prior to its release, a full set of ARINC 818 tools and a growing knowledge base exists, including: bus and protocol analyzers, frame grabbers, video generators, embedded modules, IP cores, and white papers. To assist new implementers, an industry website has been launched: www.arinc818.com, where developers can find and exchange information, and an ARINC 818 Implementer's Guide is available. COTS development tools for Fibre Channel are readily available from AIM, ITECH, and Finisar. Additionally, Great River Technology offers an ARINC 818 protocol analyzer that is shown in Figure 2. The ARINC 818 protocol analyzer displays all pertinent FC data and video timing information, such as: decoded headers, protocol components, protocol errors, link and sync errors, video resolution, and video image and line timing.

Conclusion:

ARINC 818 is ideal for high speed digital video for military aerospace applications, and due to its flexibility, it is also suited for a wide array of applications that integrate high speed video, audio, and data. With the tools, hardware, and growing knowledge base that already exists, engineers and technical managers can feel confident in embracing this new standard.

Tim Keller MSEE is Director of Marketing at Great River Technology and served on the ARINC 818 committee.