

Why ARINC 818?

A White Paper by Paul Grunwald

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Introduction

ARINC 818 standardizes the Avionics Digital Video Bus (ADVB). It is a protocol for low latency, high bandwidth, digital video transmission in both commercial and military applications. This white paper will discuss the history, background, and provide information on competing technologies.

History

HOTLink®

HOTLink® was developed by Cypress Semiconductors in the 1980s for high-speed point-to-point serial transmissions. Some of the characteristics of HOTLink include two wire interface, good noise immunity, low latency, and low protocol overhead and complexity. Many infrared cameras use HOTLink® as their digital output, for example, Phoenix Indigo FLIR, WESCAM MX-15 Imaging Turret, and many others. HOTLink® is an 8B/10B physical layer with special characters defined, but no higher level HotLink protocol standards exists.

HOTLink® is still in use today but it is limited to 400 Mbps data rate. HOTLink II supports up to 1.5 Gbps. The lack of a high-level protocol means that many implementations that use HOTLink® are proprietary or one-offs. This can add extra development time to develop and test. The lack of Interoperability can add cost and time to a project.

FCAV

FC-AV – (Fibre Channel, Audio Video) standard

The official designation of the standard is ANSI INCITS 356-2002. FC-AV uses Layers 0-4 of the Fibre Channel (FC) standards. Like HOTLink®, FC-AV can use copper or fiber for the Physical Layer (FC-0) and also uses 8B/10B as part of the transmission protocol (FC-1). FC-2 defines a container system for the video. The container system describes how the video frame is partitioned in Fibre Channel frames for the transmission and is made of a container header and objects. Objects contain ancillary data, audio data, and video data. The container header describes the format of the video and how it is going to be arranged in the following FC frames.

The Fibre Channel Management layer (FC-3) is generally not used in FC-AV, but the Mapping Layer (FC-4) is, specifically the Frame Header Control Protocol (FHCP). The frame header is used as a means to communicate information that is needed to reconstruct the video image that is encapsulated in the container. FC-AV is also a bi-directional protocol. For detailed information on FC-AV, please see <http://fc-av.info>.

Standardization

In 2005, Airbus and Boeing felt a need to add further capabilities for the new 787 and A400M programs, and a new standardization effort was initiated through the Digital Video Subcommittee of ARINC. The primary driver for the standard was to consolidate many proprietary standards that existed in the avionics supply chain. For example, display manufacturers such as Honeywell, Rockwell Collins, and Thales each had their own protocols for their products. The new standard also incorporated increased bandwidth and features discussed below.

ARINC 818 Specification

The ARINC 818 specification was ratified in January 2007 with the participation from wide range of Aerospace suppliers. These include:

AD Aerospace	CAE Electronics	Kollsman
Avionics Interface Technologies	D-Light Systems	L3 Communications
Airbus	Data Device Corp (DDC)	Lockheed Martin
AgustaWestland	EADS	Precision Fibre Channel
ARINC	ELBIT Systems	Rheinmetall Defense
Avtech	Eurocopter	Electronics GmbH
BAE Systems	Gables Engineering	Rockwell Collins
Barco	Goodrich	Smiths Aerospace
Boeing	Great River Technology	Stratos International
	Honeywell	Thales Avionics

Benefits

The major aim of the ARINC 818 specification was to provide a robust protocol to handle the high bandwidth of modern avionics video systems. Fibre Channel remains the physical layer for the bus and also offers the advantages of routing and protocol capabilities found in modern networking protocols. FC also is deterministic with low latency. ARINC 818 includes error detection.

High Bandwidth

At the time ARINC 818 was ratified, the fiber channel protocol supported link rates of 1.0625, 2.125, 4.25, and 8.5 Gbps. Since then, link rates of 14.025, and 28.05 Gbps have been released¹ with even higher speeds planned as the market needs it. For example, a display at WQXGA resolution (2560 x 1600 pixels @ 24 bit color) at 30hz would need a bandwidth of 3,864 Mbps.

Low Latency

One of the most important features of ARINC 818 is the ability to deliver uncompressed video with very low latency, in many implementations, less than one frame. Low latency is important in real-time cockpit displays and especially in Heads-Up Displays (HUD) where differences in the HUD display images and real-world background can cause vertigo or motion sickness in the pilot.

Latency is generally determined by the implementation. In some cases, the image is streamed through FIFOs and can be almost real-time. Other implementations use two image buffers and display one while the other is filling (“ping pong”) giving a latency of a single frame. At 30 hz, this equals latency of 33 msec, at 60Hz it is 16 msec, which is more than enough for even the most demanding applicationsⁱⁱ. In ARINC 818, there are no limitations on the frame rate and even shorter latencies are possible with high frame rates.

Channel Bonding

For higher bandwidth applications it is possible to use multiple channels to carry a video stream. This is called channel bonding and is similar to Link or Port Aggregation using Ethernet. In most implementations, the input is split at the transmitter device into two or more ARINC 818 frames and the reassembled at the receiver for display or recording. Channel bonding is currently only available from Great River Technologies but will be added in the next revision of the specification.

Networking

Because ARINC 818 uses Fibre Channel as the physical layer as the protocol has support for source and destination ID in the headers, networking is straightforward. Repeaters, routing, and fanout topologies are all possible. This allows a great deal of flexibility in the design of an overall avionics display system. However, ARINC 818 will not work on many Fibre Channel devices due to the bi-directional requirements of the base protocols. Some ARINC 818 switches are on the market today.

Programs

Today, ARINC 818 has been adopted for use on both civilian and military programs such as the F/A-18F, KC-46A, A350XWB, and numerous other programs and COTS products. Commercial Cockpit Displays such as the Rockwell Collins ProLine Fusion system and the Thales TopDeck suite are in production. Numerous programs and systems are currently in development worldwide.

Competing Technologies

Camera Link

Camera Link is another serial and parallel communications protocol used primarily for machine vision and industrial applications. The protocol is based on the National Semiconductors “Channel Link” interface. Camera Link 2.0 supports data rates of up to 850 MBps on copper. Camera Link HS supports higher speeds with the addition of fiber and multiple channels. The primary shortfall of Camera Link in avionics applications is the lack of certifications such as DO-254 and the mass of the 19 wire cable bundle and limited run length.

Ethernet

Ethernet is a fast, low-cost networking standard found in almost every modern home and business. Ethernet has support for speeds up to 10 Gbps on both copper and fiber. Ethernet has not seen a great deal of adoption in avionics video system due the lack of deterministic transmission times. Though the various Ethernet protocols do support Quality of Service (QoS) provisions, they basically say that a

packet will arrive in this time period, not that a packet will arrive at a specific time. As mentioned above, precise, low latency video is critical in modern avionic video systems.

Avionics Full-Duplex Switched Ethernet (AFDX) is based on Ethernet and is standardized under ARINC 664. It does provide for full, deterministic transmission but is limited to 100 Mbps at this time rendering unsuitable for high-resolution and high-bandwidth video.

Other Standards

Other standards such as DVI and Firewire we considered but given the robustness and the proven legacy of FC-AV, the decision was made to stay with Fibre Channel as the basis for ARINC 818.

The Future

ARINC 818-2

The ARINC 818 protocol will be updated in the near future to add some of the implemented features mentioned above as well as other requested items such as compression, bi-directional channels, higher bandwidth (already standardize in the Fibre Channel spec),

Conclusion

ARINC 818 is a robust protocol for mission-critical avionics applications. It can support any video resolution, color depth, and refresh rate. It uses a proven and inexpensive physical layer that supports very high bandwidth and low latency transport from point to point and in switched topologies. There is a large ecosystem of tools and support for the development of systems such as frame grabbers, video generators, switches, and protocol analyzers. ARINC 818 is in use in major programs and platforms and more are coming on line. Instead of “Why ARINC 818?” “Why not ARINC 818?”

Learn more

ARINC 818 Made Easy

ⁱ <http://www.fibrechannel.org/roadmaps>

ⁱⁱ “Latency in Visionic Systems: Test Methods and Requirements”

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