Real-Time Intelligent MIL-STD-1553 & ARINC-429 Protocol Converters/Bridges

Avionics data buses have been around since the 1970s and there are different electrical and protocol standards that have been adopted for different aircraft and ground vehicle platforms and applications. As needs arise there are typically many different communication standards that can be used on board a commercial or military aircraft or ground vehicle and its sub systems.

MIL-STD-1553 is a bus standard that defines the electrical and functional protocol of a serial data bus. It was designed for military aircraft but has been adopted on many different types of applications including but not limited to ground vehicles, satellites, and the A-350 commercial aircraft. MIL-STD-1553 was first used on the F-16. Many military aircraft since the introduction of the F-16 have adopted this bus and it has become the de facto standard that provides a reliable and deterministic data bus for many military platforms.

Many platforms today continue to use MIL-STD-1553 due to its determinism and reliability but it does lack speed. The bus runs at 1Mbps so higher bandwidths need to rely on different data buses. Ethernet has made its way into not critical sub systems as a means for getting to higher speeds. Where Ethernet needs reliability and determinism then ARINC-664/AFDX is commonly used. ARINC-664/AFDX® uses a special protocol to provide deterministic timing and redundancy management providing secure and reliable communications of critical and non-critical data. ARINC-664/AFDX® communication protocols have been derived from commercial standards (IEEE802.3 Ethernet MAC addressing, Internet Protocol IP, User Datagram UDP) to achieve the required deterministic behavior for avionics applications. End Systems (or LRU's) based on Virtual Links (VL's) communicate with Traffic Shaping by use of Bandwidth Allocation Gaps (BAGs). This protocol is commonly used in combination with ARINC-429 which is a commercial standard on just about all commercial aircraft.

In the Military space there are non-critical applications that can take advantage of standard Ethernet but when this gets added onto a platform with predominantly MIL-STD-1553 data communication buses then the need arises to get the Ethernet data back to MIL-STD-1553 and vice versa in some cases.

AIM has developed a series of products called ANET that are available in Lab or Rugged on platform configurations that allow the user to create real time translation from one bus protocol to another with the flexibility to put messages into UDP or TCP packets as desired.

Though there are many applications that can use the ANET devices, this article will focus on the need for an Avionics Data bus/Ethernet gateway. A properly implemented protocol gateway will allow traffic to flow from either bus and in either direction.

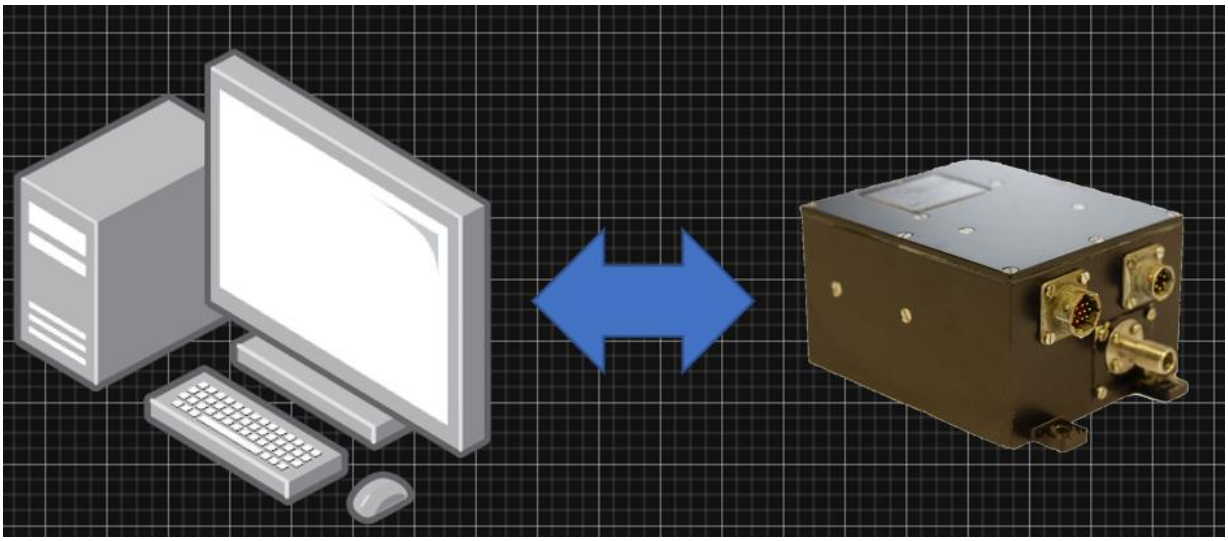
As mentioned above, current defense applications are requiring access between legacy avionics data buses and more modern Ethernet-based architectures.

Some applications are as follows:

- Adding MIL-STD-1553 to a brand-new Ethernet-centric platform (e.g., UAV/UAS)
- Adding Ethernet devices to a classic MIL-STD-1553 platform (e.g., Fighter/Cargo aircraft)
- Adding Internet/Intranet awareness to a MIL-STD-1553 network (Ground vehicles/SATCOM)
- Test and Simulation network bridging (e.g., SILs, Labs)

These applications will require a protocol gateway solution that can exist on both networks without requiring a major redesign of the existing network architecture of the platform. The ANET product line is ideally suited for this application and has a wide amount of flexibility to fit any unique requirements.

The simplest approach to developing a gateway is a data-mapping table. With this design, a specific message on the avionics bus is identified and its payload is copied to a specific message on the Ethernet network (and vice versa). In more simple terms, data is just simply copied from one data bus and pasted onto the other.



Simple Translation of data (copy/paste concept)

Though this does satisfy some very simple applications and is implementable on the ANET products, the translation between buses such as MIL-STD-1553 and ARINC-429 to Ethernet will require much more translation and real-time computing.

In most cases, accurate protocol conversion is not achievable with data mapping tables.

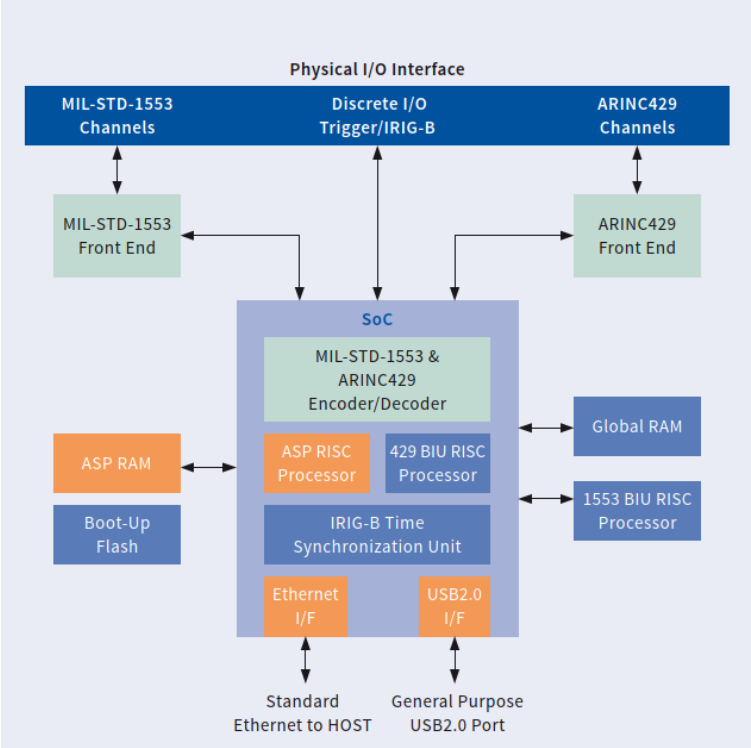
Some additional requirements are:

- Data might need to be concatenated, segmented, reassembled, converted in real-time.
- Data may need to be buffered or delayed to deal with asynchronous bus traffic
- Real-Time routing based on data payload interpretation
- On-Board real-time decryption/encryption
- Adding IRIG-B time or synchronization with Discrete-IO

The ANET product line includes on-board processing to address any unique protocol conversions allowing gateway applications to leverage off-the-shelf technology and avoid custom designs.

This allows the user to create a specific conversion algorithm that will execute in real time directly on the ANET hardware, thus reducing any additional processing and conversion from either network.

The application resides inside of the ANET device and will execute upon power-up.



ANET-MXAY Hardware Architecture

Redesigning existing flyable LRUs that are already qualified on existing aircraft and ground platforms requires a large amount of Engineering effort, as well as recertification. This most efficient way of bridging data protocol technologies on a platform is by adding an ANET to act as an external hardware gateway. This becomes the most optimal, cost-effective solution. Thus, you don't need to redesign or requalify any of the existing systems on board.

ANET product family

The ANET product series is available in Lab and Rugged configurations and supports both MIL-STD-1553 and ARINC-429 protocols with 10/100/1000 Ethernet. It is the perfect off-the-shelf and proven solution for implementing an Ethernet/Avionics gateway and will meet your objectives with optimal efficiency.