MUX (INCLUDING TM) OVER TCP/IP AND UDP/IP USING APOGEE LABS MODELS 2330 OR 2331 ELIUS

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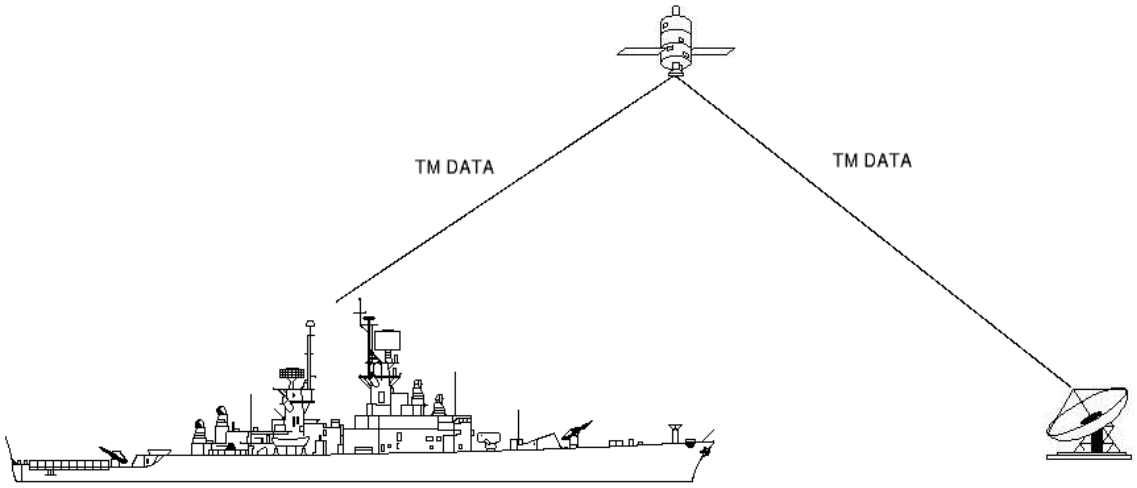

ABSTRACT

The goal of this document is to show how to use Apogee Labs Models 2330 and 2331 Ethernet Link Interface Units to transmit telemetry data over an Ethernet link.

KEY WORDS

BDP	Bandwidth Delay Product
ELIU	Ethernet Link Interface Unit
ESM	Ethernet Support Module
IPv4	Internet Protocol Version 4
MITC	Modular Product for Instrumentation, Telemetry and Communication
MTU	Maximum Transmission Unit
LAN	Local Area Network
TCP/IP	Transmission Control Protocol
UDP/IP	User Datagram Protocol
WAN	Wide Area Network (Internet)

SYSTEM OVERVIEW

The system is comprised of either a MITC *FALCON* and an ELIU (2330) or a standalone ELIU (2331) on each end of the Ethernet link. The Ethernet link may be either LAN or WAN, and these may include hubs, switches, routers, and satellite links.

INITIAL SYSTEM

The MITC *FALCON* Multiplexer/Demultiplexer is an Apogee Labs field configurable multiplexing system for merging multiple data sources into a composite stream for recording on digital cassette recorders or transmitting over communication networks. Input signals can include a mix of serial digital data (PCM Telemetry), digitized analog data (FM multiplexers), voice, time code signals or compressed video or virtually any source that can be converted into a digital format. Using a direct digital synthesizer to guarantee phase continuous frequency adjustment of less than 0.5% at the output, the MITC *FALCON* regenerates a smoothly adjusted, continuous output data stream at the receiving end.

The combined MITC/ELIU system is a rack mountable system which requires 2U rack space for the ELIU and 4U rack space for the MITC. Telemetry data is collected by the MITC, as well as an array of other data links, i.e. Time(IRIG-B), audio, analog, 1553, synchronous/asynchronous serial and video(MPEG2 Compression). The MITC then outputs all of the multiplexed channels into a single composite data stream to the ELIU. Once transmitted over the Ethernet link, the ELIU streams the data to the MITC, which then demultiplexes the stream and outputs with a smooth clock, maintaining channel-to-channel coherency.

The standalone ELIU (2331) accepts synchronous RS-422/RS-485 data and clock up to 10 Mbps, analog voice, and four RS-232 links. The input data does not require a format and accepts different formats. Again, this unit outputs smooth streams and maintains channel-to-channel coherency. This unit only requires 2U rack mount space.

The ELIU contains an embedded PC with 256 MB ram and a 256 MB disk on module, so the only moving parts are the fans. The operating system is RedHat Linux 8.0 which can be downloaded from *ftp.redhat.com*.

ACHIEVED SPEEDS

The original network that the systems were placed on had a 10 Mbit hub in the link between the two systems. Again, the first test required data, voice, time, and video to be transferred in only one direction. The system was able to achieve a steady rate of 680 Kbytes/s over the 10 Mbit hub.

THEORY

Unlike our first attempt, buffer sizes are dynamically sized. When using TCP/IP, the window size is calculated using the Bandwidth Delay product. The TCP/IP window size is the amount of data which may be transmitted before an ACK is received, or the maximum amount of data received before sending an ACK to the transmitter. To maximize the throughput of a network pipe (point A to point B), it is best to use a window size specifically for this particular pipe. The best way to go about this is to keep the pipe full at all times. The window size should at least be the amount of data on the pipe at one time. This is calculated using the bandwidth delay product.

Window Size = Bandwidth * Link Delay

To improve performance, the window size should be 3 times the BDP (Bandwidth Delay Product).

Another improvement is system throughput delay. Even though the window size is large, the size of the actual packets sent does not need to be this large. If there is a 50 KByte window size, the TCP/IP packets sent may be much smaller than this. The receiving side does not need to wait

for a 50 KByte packet to send this data to the MITC, thus the throughput delay is dropped to a fraction within the ELIU.

To maximize each packet, the data within the packet is a multiple of the MTU packet headers. This way, when the packets are sent, the kernel creates fragments of the original, larger packet, breaks these packets into MTU sized packets and transmits the packets over the network. These packets are always full according to IPv4, which states an MTU size of 1500.

SYSTEM OPERATIONS

A standard setup for sending telemetry through the MITC/ELIU system includes one or more MUX9s (multiplexer), one or more DEMUX9s, a PACK2 (Packetizer), a DEPACK2 and an ESM1 on either end of the chassis.

The data may be transmitted using either TCP/IP or UDP/IP. Once this is selected and the network settings are configured, set both ends of the link to connect and data will begin transmitting in either or both directions.

The ELIU TCP/IP configuration can be setup in either REAL-TIME or NEAR REAL-TIME modes. In REAL-TIME mode, data is transmitted through the system as quickly as possible. With this mode configured, the link delay from a MUX on one end to the DEMUX on the other end is less than 200 milliseconds. REAL-TIME mode should only be used if the Ethernet link between the two ELIUs is guaranteed to always have enough bandwidth for the data flow.

If the Ethernet link may contain users who will also be sending Ethernet packets through any portion of the link, causing bottle necks in routers or switches, then the NEAR REAL-TIME mode should be selected. The NEAR REAL-TIME mode contains a link delay of approximately 5 seconds. When the two ELIUs first connect, the receive buffers hold on to approximately 5 seconds worth of data before sending this data to the MITC. The extra data in the buffers allow for intermittent spikes of Ethernet data on the same link as the ELIU link.

In Ethernet links with large delays (>100 ms) or for less system delay, UDP/IP can be used. Since UDP/IP does not require handshaking, UDP/IP packets over a large delay may be sent at the same speed as when connected with smaller delay. The disadvantage of using UDP/IP is that UDP/IP packets are not resent after a packet has been lost in the Ethernet link. When using UDP/IP to transmit data, it is best to do so over a guaranteed link, where there is little other network activity and the bandwidth is always available.

The ELIU contains a self test using TCP/IP which will test at which rates it can send and receive data. This test also reports the link delay between the two ELIUs. This test is beneficial when the Ethernet link is first established.

To protect vital data against Ethernet link outages, a model 4800 recorder can be placed in the data path before the ELIU for recovery of data which is unable to be transmitted over the Ethernet link. When the link becomes available again, simply replay the data from the 4800 over the link.

ACHIEVEMENTS

Currently, the ELIU is successfully being used to send data from a ship in the Pacific Ocean to a system on Kauai. The Ethernet Link is established by transmitting the Ethernet packets over a satellite link with approximately 500 milliseconds of one way link delay. The customer is transmitting both telemetry data and time over the link from the ship to the shore. The

approximate aggregate rate of this link is 2 Mb/s. Tests have also been run between sites with approximately 20 ms link delay using TCP/IP at 20 Mb/s with no errors.

CONCLUSION

This new product facilitates transmission of data across Ethernet using UDP/IP and TCP/IP packets. The goal of the next development process is to send data in broadcast mode and multicast mode using the current hardware configuration. Having this firm base in Ethernet transport, we will now be able to begin work to simplify our 2U rack mount PC into a single MITC module.

For more information on Apogee Labs, Inc MITC, its modules, and the Ethernet Link Interface Unit, visit *www.apogeelabs.com* and select Multiplexers from the Choose a Product pull down list.