Use of Nack Oriented Reliable Multicast (NORM) protocol for transport of spacecraft telemetry in ground networks

Patrick.A. Baldwin Author[1], D. Zoller[2] and A. Cecil[3]

[1] COLSA Corporation, HP27, MSFC, NASA, USA, Huntsville, AL, 35803, USA, alex.baldwin@nasa.gov
[2] COLSA Corporation, HP27, MSFC, NASA, USA, Huntsville, AL, 35803, USA, david.zoller@nasa.gov
[3] National Aeronautics and Space Administration, HP27, MSFC, Huntsville, AL, 35812, USA, andrew.cecil@nasa.gov

Frequently it is necessary to distribute spacecraft telemetry to multiple destinations on Internet Protocol (IP) networks. There are various methods of delivering this data, but when the data is high rate and there are many destinations IP multicast provides the best solution from a network perspective. However, IP multicast only supports the User Datagram Protocol (UDP) which is connectionless and unreliable.

This nature of UDP and by extension the low priority treatment of UDP packets by some network hardware creates a difficult environment for distribution of high rate telemetry to a number of recipients over IP networks.

Nack Oriented Reliable Multicast (NORM) is defined by IETF RFC 5740 in 2009 by B. Adamson et al. NORM provides a mechanism of retransmission and or forward error correction for UDP packets, potentially overcoming the limits of UDP for the transmission of spacecraft telemetry.

Marshall Space Flight Center's (MSFC) Huntsville Operations Support Center (HOSC) manages the delivery of the International Space Station (ISS) payload science and health data. The ISS IP Ground Routed (IIGoR) network provides the delivery of the data from the ground stations to the control centers. HOSC personnel have been experimenting with the use of NORM on the link between the ground stations and the front end processor equipment in Huntsville, AL.

Thus far, the HOSC has demonstrated use of NORM in our lab environment at a 600Mbps data rate and 1% packet loss over an 80ms round trip time Ethernet link. A number of tests have been performed to determine the additional latency induced by NORM both in a passive state and while actively correcting errors. This paper will discuss the lab environment used to conduct the tests, the test results and future plans.

The Consultative Committee on Space Data Systems (CCSDS) Space Link Extension (SLE) protocol which is favored for use in distributing telemetry across ground networks specifies that SLE utilize a Transport Mapping Layer (TML) that delivers SLE Protocol Data Units (PDUs) in sequence; completely and with integrity; without duplication; with flow control that notifies backpressure to the application layer in the event of congestion; and with notification to the application layer in the event communications between the SLE service user and the SLE service provider are disrupted, possibly resulting in a loss of data. The only known implementations are of such a TML are Transmission Control Protocol (TCP) based as specified in CCSDS 931.1-B-2. This limitation forces the use of SLE only in unicast transmissions. This paper also discusses the possible utilization of UDP/NORM as a compliant SLE Transport Mapping Layer to allow for multicast transmission on IP networks.