INTERNET PROTOCOL OVER TELEMETRY TESTING FOR EARTH SCIENCE CAPABILITY DEMO SUMMARY

Summary

The development and flight tests described here focused on utilizing existing pulse code modulation (PCM) telemetry equipment to enable on-vehicle networks of instruments and computers to be a simple extension of the ground station network. This capability is envisioned as a necessary component of a global range that supports test and development of manned and unmanned airborne vehicles.

Objectives

The Hi-rate Wireless Airborne Network Demonstration (HiWAND) project was established to meet the following five main objectives:

1. Demonstrate transparent use of Telemetry (TM) Band for bidirectional Internet Protocol (IP) communications
2. Demonstrate capability of existing telemetry hardware to support bidirectional IP communications
3. Remotely initiate processes and collect results using IP over existing TM Band
4. Demonstrate capability for line-of-sight data links between ground and aircraft systems
5. Evaluate system performance during flight testing up to a 150-mile range

Approach

The approach adopted by the project was to populate an existing equipment rack that was previously flown on the NASA Dryden Flight Research Center (DFRC) King Air, tail number 801 (NASA 801). The rack included similar equipment to the ground-based equipment located at the Aeronautical Tracking Facility (ATF) at the NASA DFRC Western Aeronautical Test Range (WATR), Edwards, California. Since only one shaped offset quadrature phase-shift keying (SOQPSK) transmitter was available, pulse code modulation/frequency modulation (PCM/FM) at 5 Mbps was used for the uplink and SOQPSK modulation at 10 Mbps was used for the downlink.

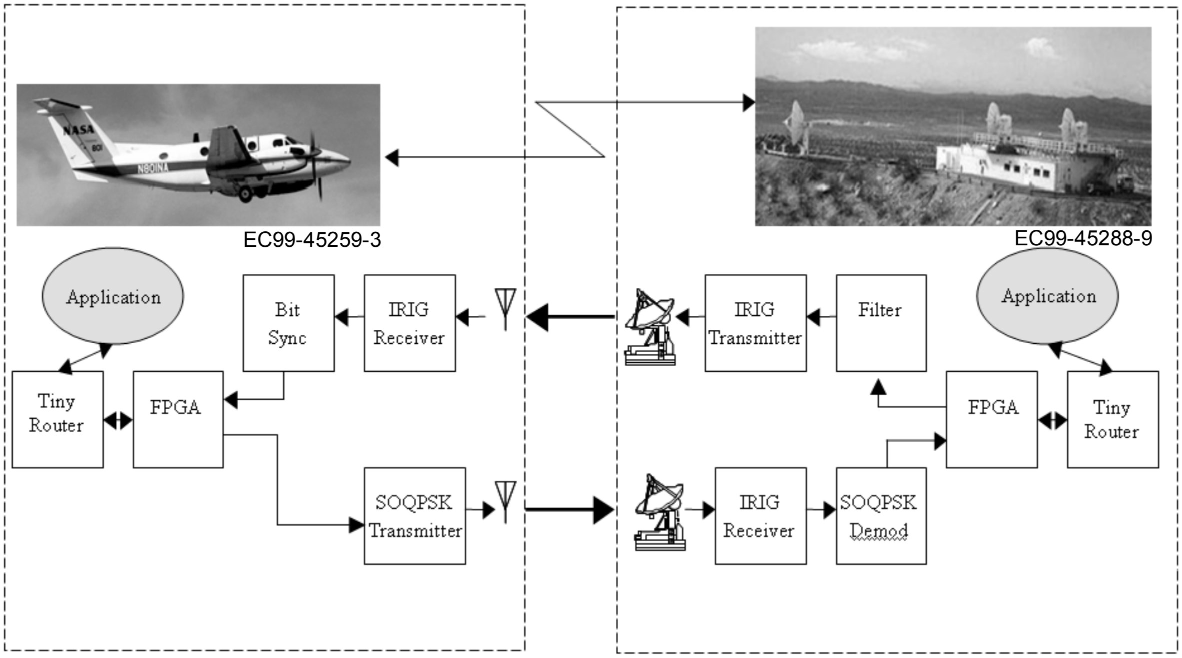

Figure 1. Flight test configuration.

System performance was quantified in the following ways:

1. Data throughput – file transfer protocol (FTP) file transfers, and transmission control protocol (TCP) and user datagram protocol (UDP) throughput tests
2. Packet loss – Transmission of UDP packets at various bit rates
3. Latency – Ping tests with various size data payloads
4. Repeatability – The above tests were repeated at the same flight conditions.

A custom graphic user interface (GUI) (fig. 2) was developed to automate testing, record results, allow for remote initiation of tests, and provide "chat-like" communications between the ground and aircraft test conductors.

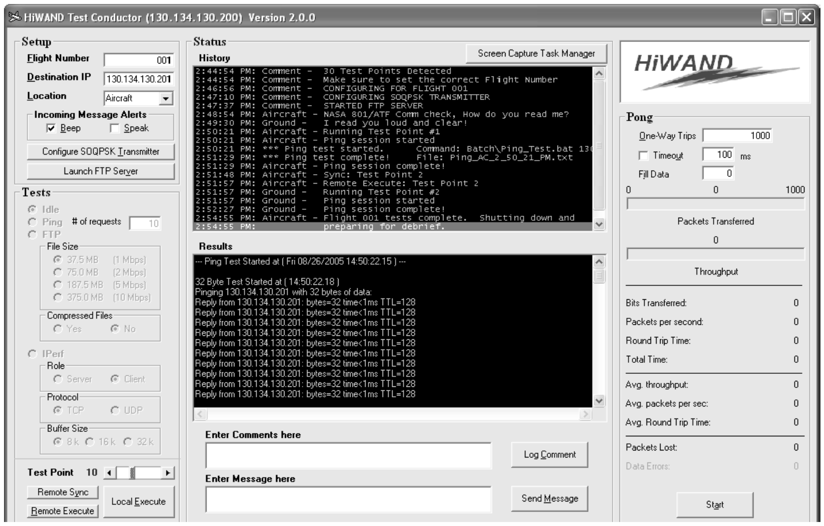

Figure 2. Test conductor graphic user interface.

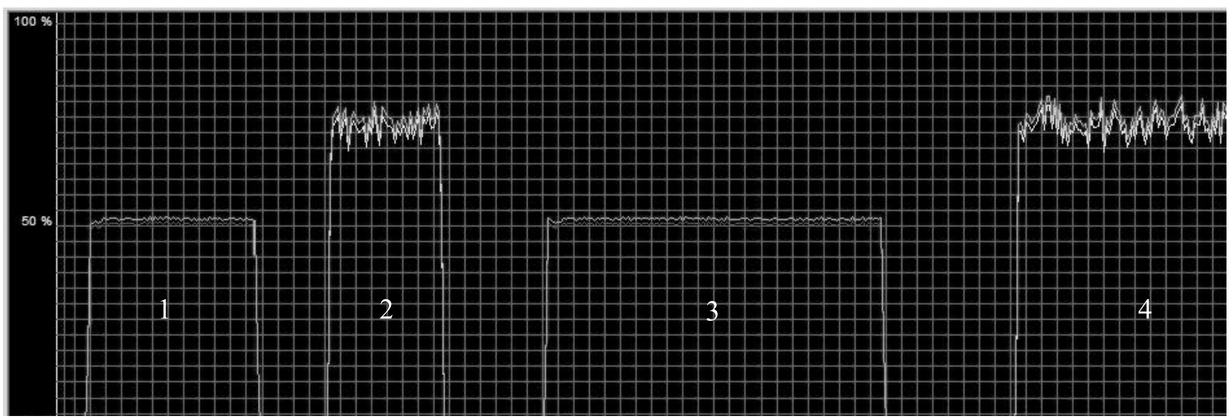

Figure 3. Flight test data throughput.

The throughput test results are depicted in figure 3, where 100 percent is based on 10 Mbps. The graphs labeled 1 through 4 are results from a 37.5 MB FTP transfer uplink and downlink and a 187.5 MB FTP transfer uplink and downlink, respectively.

Status

A total of seven flights were conducted, the last of which culminated in a UDP throughput of 9.4 Mbps, and TCP throughput of 7.2 Mbps at a range of 165 miles. Internet connectivity was also established in flight allowing for World Wide Web surfing, downloading satellite imagery, and sending e-mail. Future work for system miniaturization and aircraft-to-aircraft testing is being discussed.

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