Emerging Technology

Space-Based Telemetry and Range Safety (STARS) 2005

It has been another busy and productive year for the Space-Based Telemetry and Range Safety (STARS)—a multicenter NASA project to demonstrate the performance, flexibility, and cost savings of using space-based communications assets during vehicle launches and landings.

Changes to STARS

After the initial series of F-15 flights at Dryden Flight Research Center in 2003, the range safety low-power transceiver, command and data handler, and the Global Positioning System (GPS) receiver components were combined into a single unit called the range safety unit. The forward (command) flight termination signal link rate was increased from 400 bits per second to 840 bits per second and Triple-DES encryption was added. Reed-Solomon encoding was implemented on both the forward and return (telemetry) links, and the range user system was upgraded to a higher data rate Ku-band system with a steerable, phased-array antenna.

GlobalFlyer Mission

STARS provided the communications system for real-time cockpit video during the historic flight of the GlobalFlyer experimental aircraft that made the first solo non-stop, non-refueled flight around the earth in March 2005. The range safety unit was modified and installed in the aircraft in less than four weeks and provided low-rate video (57 or 114 kilobits per second, corresponding to about 1 to 2 frames per second). The range safety unit inside the GlobalFlyer cockpit is shown below.

A video data compressor converted (PAL) video to compressed digital video, which was then relayed via the tracking and data relay satellite system to the White Sands Complex—the location of the satellite system ground terminal—and sent over land lines to the GlobalFlyer control room at Kansas State University at Salina for display and distribution over the Internet. This video was used in conjunction with an Iridium voice link during pilot interviews throughout the mission. The range safety unit performed well during the three-day flight.

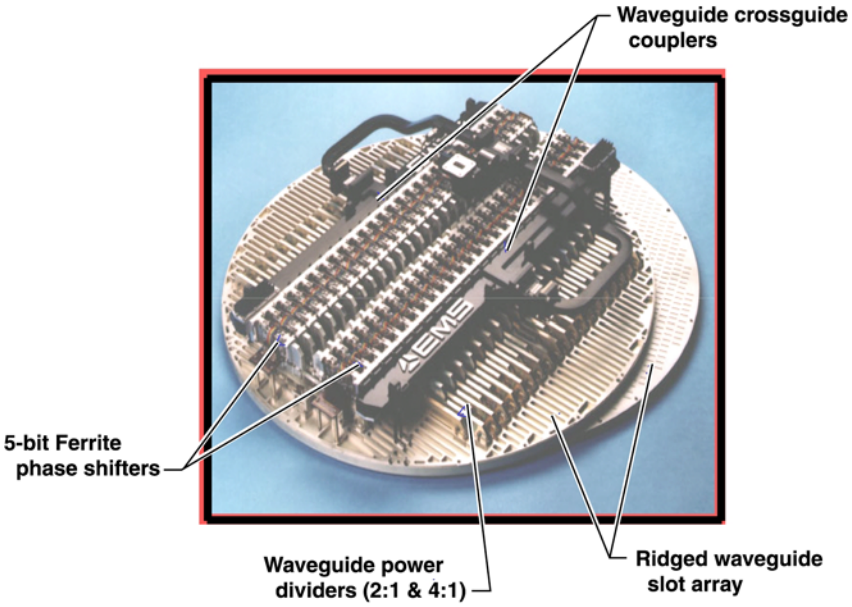
GlobalFlyer presented an excellent opportunity to compare predicted and actual link margins for many hours during mostly straight and level flight using a simple one-antenna configuration on a nonconductive airframe. There were no environmental problems and the measured link margins generally exceeded the predicted by about 3 decibels. No attitude information was available, so the predicted models assumed a straight and level profile. This was a reasonable assumption since GlobalFlyer was not designed for dynamic flight and flew nearly straight and level with only very gradual and careful flight maneuvers. This flight experience and data will be useful for future STARS test flights.

Orion Sounding Rocket Mission

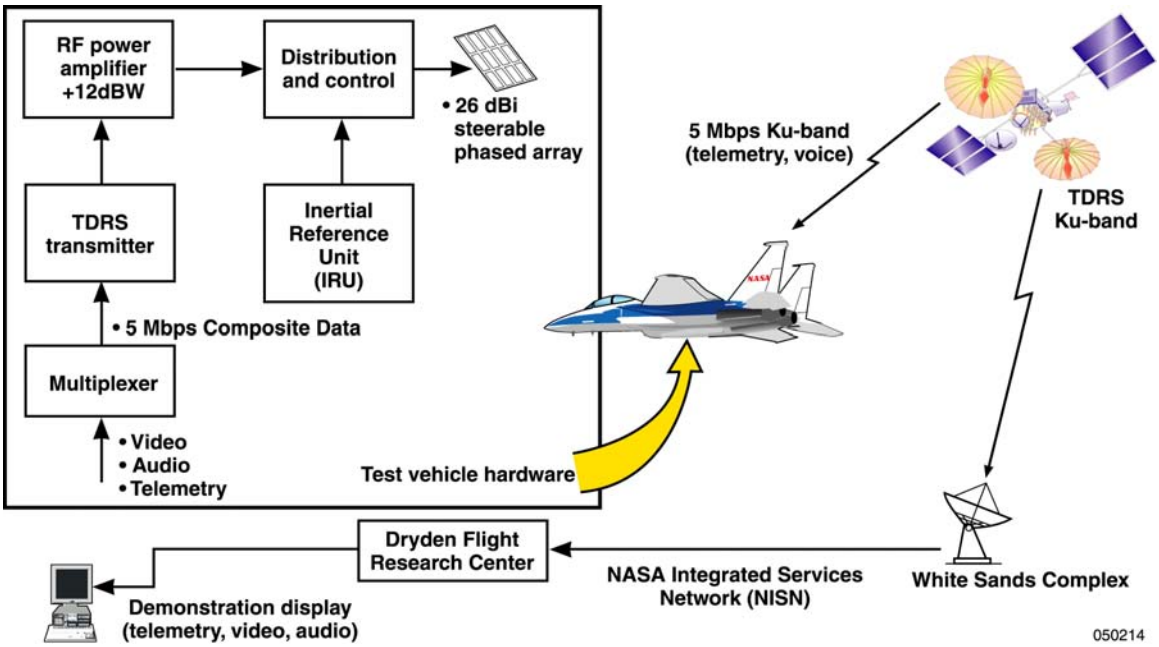
The STARS Range Safety system flew on a Terrier MK70 Improved-Orion sounding rocket at Wallops Flight Facility on December 20, 2005. This flight tested the range safety system at Mach 5 speeds and altitudes up to 200 kilometers on a rocket spinning at 4 to 5 hertz with wrap-around S-band antennas. Two tracking and data relay satellites were used simultaneously for the forward flight termination commands and the return telemetry streams. The hardware was successfully recovered. Preliminary analysis indicates that the system performed well with minimal dropouts and large link margins.

F-15 Flights

There has also been work to prepare for another set of F-15 flights at Dryden Flight Research Center in mid 2006 to test a Ku-band range user system with the phased-array antenna from EMS Technologies shown below.



The goal is to achieve a data rate of 5 megabits per second. The antenna is electronically steerable in elevation and mechanically steerable in azimuth and will be mounted on top of the F-15 behind the cockpit. The test configuration is shown below.


RF power amplifier +12dBW
Distribution and control
• 26 dBi steerable phased array
TDRS transmitter
Inertial Reference Unit (IRU)
• 5 Mbps Composite Data
Multiplexer
• Video
• Audio
• Telemetry
Test vehicle hardware
5 Mbps Ku-band (telemetry, voice)
TDRS Ku-band
Dryden Flight Research Center
NASA Integrated Services Network (NISN)
White Sands Complex
Demonstration display (telemetry, video, audio)
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