

NASA Range Safety Program 2006 Annual Report

EMERGING TECHNOLOGY SPACE BASED TELEMETRY AND RANGE SAFETY 2006

Space-based range demonstration and certification, formerly called *space-based telemetry and range safety (STARS)*, is a multicenter NASA proof-of-concept project to determine if space-based communications can support Range Safety functions (tracking data and flight termination signals) while also providing broadband Range User data (voice, video, and vehicle/payload data).

Space-based range demonstration and certification is made up of the Range Safety and the Range User systems. The Range Safety system sends tracking data from the vehicle to the ground and receives flight termination commands from the ground. The Range User system sends high-data-rate vehicle telemetry from the vehicle to the ground. Both systems use NASA's Tracking and Data Relay Satellite System.

Rocket Space-Based Range Demonstration and Certification System Test

A successful test of the Range Safety system was held at Wallops Flight Facility on December 20, 2005 on a two-stage, Terrier–Orion, spin-stabilized sounding rocket. A diagram of the rocket is shown below. A photograph of the launch is on the next page.

The first-stage Terrier MK 70 booster was 18 inches in diameter, 155 inches long, and weighed 2177 pounds before ignition. The second stage Improved-Orion sustainer was 14 inches in diameter, 105 inches long, and weighed 965 pounds before ignition. The recoverable payload section was 165 inches long and weighed 526 pounds.

During the sounding rocket launch and flight, the space-based range demonstration and certification Range Safety system generally behaved very well on the highly dynamic, rapidly spinning (~5 hertz) sounding rocket, receiving data from the GPS constellation and maintaining links with two Tracking and Data Relay Satellite System satellites simultaneously during the entire 10 minute flight.

The payload section deployed a parachute and landed in the Atlantic Ocean about 90 miles downrange from the launch site. Its maximum altitude was about 115 miles, and its maximum speed was in excess of Mach 5. The acceleration just after lift-off was about 20 g's.

More than 99 percent of all forward commands were successfully received and processed, and more than 95 percent of all return frames were successfully received and processed at the control center at Wallops Flight Facility.

The latency for a single command to travel over land lines to White Sands Complex and then to the vehicle via a tracking and relay data satellite, and to be processed onboard and received back at the control center at Wallops Flight Facility—again via tracking and relay data satellite and land lines—was between 1.0 and 1.1 seconds, which should meet the Range Safety requirements. The forward link margins for Tracking and Relay Satellite-10

(designated *TDE* and located at 41° W Longitude) were between 11-12 ± 2 dB and between 9-10 dB ± 1.5 dB for Tracking and Relay Satellite-4 (designated *TDS* and

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located at 46° W Longitude). The Range Safety system hardware was recovered dry, but one of the antennas was damaged while the payload was being recovered at sea.

The attached video shows the launch, re-entry, and recovery of the rocket.

F15 Space-Based Range Demonstration and Certification System Tests

A set of test flights on an F15 at Dryden Flight Research Center is currently underway. The primary goal for the Range User is to test a Ku-band, phased-array antenna with a data rate of 5 megabytes per second. The antenna is electronically steerable in elevation and mechanically steerable in azimuth and is mounted on top of the F15 behind the cockpit. Preliminary analysis indicates that the system performed well and additional analysis is underway.

The Range Safety system will test the ability to maintain lock with two Tracking and Data Relay Satellite System satellites simultaneously on a highly dynamic aircraft simulating an out-of-control launch vehicle and hand-off between the launch head and the Tracking and Data Relay Satellite System. Additional measurements will be made of the link margin and data latency.