Metric tracking of launch vehicles for range safety purposes is currently based on redundant radars, telemetry receivers, and uplink command transmitters at the launch site with additional assets deployed downrange in order to maintain line of sight communications with the vehicle as it passes over the horizon to orbital insertion. The vision of space-based range architecture is to assure public safety, cut the costs of launch operations, decrease response time, and improve geographic and temporal flexibility by reducing or eliminating these assets. In order to achieve this, a number of advancements in tracking and telemetry are required. Some of NASA's needs are:

**GPS/IMU Metric Tracking and Autonomous Systems**

Realization of a space-based range requires development of GPS receivers that incorporate: (a) low power consumption, (b) low mass/volume, (c) compliance with range safety standards, (d) flexible tracking loop programmability, (e) programmable output formats, and (f) operability in high G environments. Other highly desirable GPS specific characteristics include open architecture supported by development software and the capability of being incorporated onto circuit boards designed for multiple functions.

Tactical grade IMUs are needed which can function on spin stabilized rockets (up to 7 rps) and reliably function during sudden jerk and acceleration associated with launch and engine firings and can be coupled with GPS receivers.

Also needed are approaches to processing the outputs of navigation sensors and combining them with rule-based systems for autonomous navigation and termination decision making.

**Space Based Telemetry**

Small, lightweight, low cost transceivers capable of establishing satellite communications links for telemetry and control during the launch and assent stages of flight are required to provide unbroken communications throughout the launch phase. These may enable use of the NASA TDRSS; or commercial communications satellites. Techniques for multiplexing narrow bandwidth channels to permit increased bit rates and improved algorithms for ensuring smooth transition of support between communications satellites are also needed.
GPS Attitude Determination for Launch Vehicles

Investigate using inexpensive arrays of GPS antennas and receivers on small expendable launch vehicles to
determine the attitude angles and their rates of change as an alternative to traditional inertial measurement units.
The system should be contained entirely on the vehicle and not rely on ground-based processing. The attitude
accuracy should be comparable to gyroscope-based systems and should be free of drift and gimble lock. The
system must be able to maintain attitude output during periods of high dynamics and erratic flight. The attitude
must be determined at a rate of least 10 Hz with minimal processing delay and must be output in a format
compatible with vehicle telemetry systems.