Prioritized Technology: Small Satellites – Guidance, Navigation, & Control

Technical Goal

Provide reliable radiation-hardened Guidance, Navigation, and Control Systems configurable for CubeSats and SmallSats and enable the autonomous onboard coordination and control of Constellations and Formations.

- Provide absolute and relative navigation and guidance enabling increased spatial and/or temporal measurements that span large distances or in specific regions of interest:

Guidance: *Autonomous* generation of optimal trajectory and maneuver plans
Absolute Position Navigation: Laser Ranging and Tracking (also Gbps communications), Deep Space GPS, Xray/Pulsar Navigation; Optical Celestial navigation (eg cameras) to sub-km knowledge)
Relative position Navigation : Radio crosslinks for distances up to 100km to 1000km. optical relative navigation (sub arc second accuracy) , micron level accuracy laser relative navigation, terrain relative navigation for small body rendezvous
On-board autonomous guidance and navigation software

- Enable onboard *autonomous* absolute and relative navigation algorithms
- Provide executive control software to enable autonomous onboard planning and coordination of a formation/constellation

Absolute Attitude determination: miniaturized star tracker for CubeSats to arcsecond accuracy
Precise control: µN thrusters for precise position control

Technical Status of the Art

State which technologies exist for large satellites but are immature for smallsats and cubesats due to packaging, volume, power, mass constraints.

Guidance: The ground generates all optimal trajectory and maneuver plans by modeling, simulating, and optimizing parameters
For Absolute Position Navigation: RF/Doppler Near earth Networks and DSN good (up to 50 km at L1)
For Relative position Navigation : all relative position navigation are ground based
For absolute Attitude determination: miniaturized star tracker for CubeSats
For precise control: microNewton thrusters for fine position control

Mission Applications

Examples of applications include:
Venus: extended exploration (atmospheric and surface) for up to 1 year vs 2 hours with current technology.
Moon: multi-point mapping of lunar surface to understand lunar evolution.
Mars: multi-point, simultaneous measurements of Mars environment; observing the Martian environment over a Martian year, furthering knowledge of Mars' composition, temperature, ion escape/sputtering.
Small Bodies: constellations of probes to multiple small bodies or probes utilized to "point and stare" at a specific small body target.
Icy Bodies/Outer Planets/Ocean Worlds: exploration of outer worlds such as Uranus via Probes or provide multipoint measurements to investigate modes of solar wind coupling in Jupiter as well as neutral atoms escape.