The International Workshop
on Instrumentation for Planetary Missions
Oct 10-12, 2012, Greenbelt, Maryland

MULTISENSOR NETWORK DEPLOYMENT USING LOW COST DELIVERY SPACE VEHICLE

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Introduction

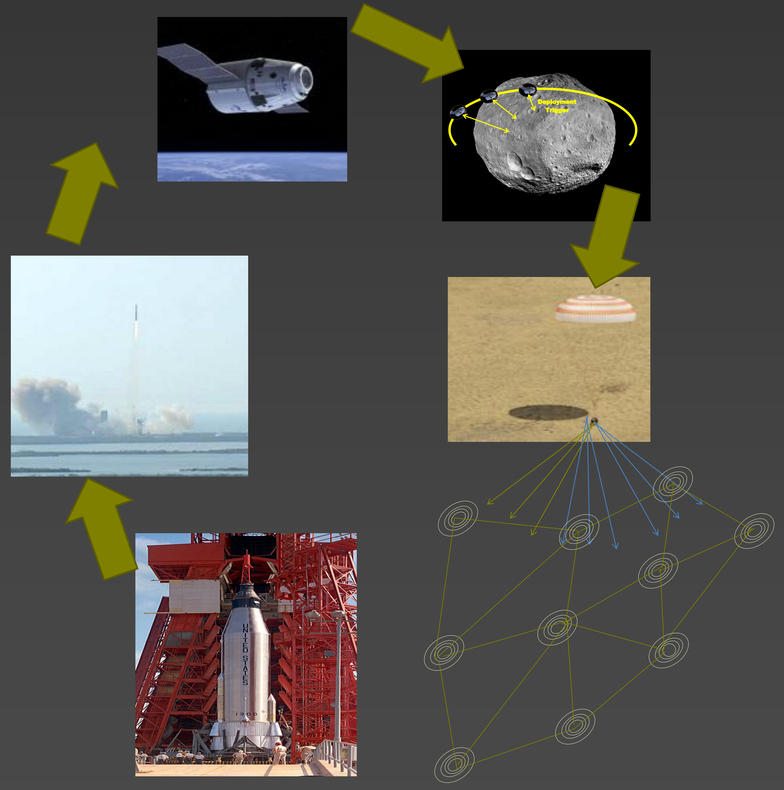
At the present time, there are no sensor networks that operate and transmit data on planets and non-terrestrial moons [1]. Multisensor networking however is a proven technology with high success rate in a number of applications. These include forest stand management, bridge and dam fatigue measurement, real time monitoring of tactical theater of combat operation, and others. The envisioned system represents a multiphase mission that leads to deployment of multisensor network [2] to transmit real time or near-real time observation of multiple phenomena, environmental factors, and events, at the surface and subsurface of the selected solar system body (planet, minor planet, or natural satellite). Unlike other envisioned systems [3,4], the core idea of this

Rationale

The envisioned system would offer real time, cost effective, long term, observation of multiple phenomena and critical events at the surface and subsurface of planets and non-terrestrial moons. Examples include geochemical changes, seismological activities, catastrophic events such as impacts or volcanic activity, transient phenomena such as mass wasting or atmospheric storms, and environmental monitoring.

Conceptual Design

The network, or multiple net-works, is/are emplaced by using specialized delivery pods. These pods are equipped with semi-autonomous guidance and deployment mechanisms. The pods are carried, and later ejected, using low cost space vehicles. A pod is ejected as a result of specific environmental triggers with or without control from ground station. Once a pod is ejected, it travels towards the surface of the target body to deploy the sensor network. Deployment of the sensors is executed in a way that ensures largest spatial distribution and safe landing. Once the sensors are deployed, a signal activates the network to initiate validation and operational protocols. The sensor network is programmed with intelligent logic to control selectivity of master/slave nodes, wake up/sleep periods, phenomenon re-focus, data management, and transmission epochs.



Challenges/Solutions

Several technological challenges must first be overcome to realize the desired out-come. These and some of the solutions being developed include the need for a sustainable power source [5], survivability during entry, descent, and landing and in the hostile environment of the target surface [6], connectivity failures, and transmission limitations [7]. Development of a full-scale planetary sensor network can readily be executed in phases, to ensure flexibility, refined cost estimates, addressing and solving technological challenges, and design review and optimization during the transition from one phase to the next.

Production Phases

In phase 1, a sensor network and the pod delivery system would be designed. In this phase, a target body consistent with NASA strategic plans for space exploration would be identified. The target planet or moon would be of least environmental hostility, yet of highest interest for scientific observation. For a proof of concept, an adequate number of highly inaccessible sites on Earth would be selected for prototype testing and evaluation. The added benefit of this project is its applicability for inaccessible Earth areas, such as pending volcanic eruptions or increasing seismological activities. In phase 2, the sensor network prototype would be produced, and then tested at selected sites using simplified airborne delivery mechanism. Based on test results, a detailed end-to-end system with accurate cost estimate would be defined. In phase 3, the end-to-end system would be produced, the pods tested, and mission launch plans be finalized. At phase 4, the space vehicle would be launched, and the sensor network be deployed, validated, and become operational.

Requested

Feedback on the challenges and the solutions are solicited for the envisioned system.

References

[1] Tinker, M. (2012) "Mi-cro/Nanosatellite Mars Network For Global Lower At-mosphere Characterization," Proc. Concepts and Ap-proaches for Mars Exploration.

[2] Noca, F. et al. (2001) "Nanotube-Based Sensors and Systems for Outer Plane-tary Exploration," Innovative Approaches to Outer Plane-tary Exploration 2001–2020.

[3] Clark, P. et al. (2002) "ANTS: Applying a New Paradigm to Lunar and Plane-tary Exploration," Solar System Remote Sensing.

[4] Clark, P. et al. (2002) "ANTS: Exploring the Solar Sys-tem with an Autonomous Nanotechnology Swarm" 33rd Lunar and Planetary Science Conference.

[5] Stürmer, A. (2012) "Design for a Micro-Sized Mars Probe," Proc. Concepts and Approaches for Mars Exploration.

[6] Thornblom, M. et al. (2012) "Systematic And Widespread Exploration With Aerocoasting And Reconnaissance Of The Martian Sub-Atmosphere (Swarms)," Proc. Concepts and Approaches for Mars Exploration.

[7] Kuiper, T. et al. (2012) "Cubesat Constellation for Communications and Mars Radio Monitoring," Proc. Concepts and Ap-proaches for Mars Exploration.