Clustering Inter-Spacecraft Communications

A document describes a radio communication system being developed for exchanging data and sharing data-processing capabilities among spacecraft flying in formation. The system would establish a high-speed, low-latency, deterministic loop communication path connecting all the spacecraft in a cluster. The system would be a wireless version of a ring bus that complies with the Institute of Electrical and Electronics Engineers (IEEE) standard 1393 (which pertains to a spaceborne fiber-optic data bus enhancement to the IEEE standard developed at NASA's Jet Propulsion Laboratory). Every spacecraft in the cluster would be equipped with a ring-bus radio transceiver. The identity of a spacecraft would be established upon connection into the ring bus, and the spacecraft could be at any location in the ring communication sequence.

In the event of failure of a spacecraft, the ring bus would reconfigure itself, bypassing a failed spacecraft. Similarly, the ring bus would reconfigure itself to accommodate a spacecraft newly added to the cluster or newly enabled or re-enabled. Thus, the ring bus would be scalable and robust. Reliability could be increased by launching, into the cluster, spare spacecraft to be activated in the event of failure of other spacecraft.

This work was done by Michail Zak of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-45241

Simulation of Stochastic Processes by Coupled ODE-PDE

A document discusses the emergence of randomness in solutions of coupled, fully deterministic ODE-PDE (ordinary differential equations-partial differential equations) due to failure of the Lipschitz condition as a new phenomenon. It is possible to exploit the special properties of ordinary differential equations (represented by an arbitrarily chosen, dynamical system) coupled with the corresponding Liouville equations (used to describe the evolution of initial uncertainties in terms of joint probability distribution) in order to simulate stochastic processes with the prescribed probability distributions.

The important advantage of the proposed approach is that the simulation does not require a random-number generator.

This work was done by Michael Cox of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-45241

Genetic Algorithm Optimizes Q-LAW Control Parameters

A document discusses a multi-objective, genetic algorithm designed to optimize Lyapunov feedback control law (Q-law) parameters in order to efficiently find Pareto-optimal solutions for low-thrust trajectories for electronic propulsion systems. These would be propellant-optimal solutions for a given flight time, or flight time optimal solutions for a given propellant requirement. The system design provides multi-fault tolerance for critical operations: for example, to ensure unmating at a critical time, a redundant unlatching mechanism and two independent pyrotechnic release subsystems are included.

This work was done by James L. Lewis and Brandan Robertson of Johnson Space Center and Monty B. Carroll, Thang Le, and Ray Morales of Lockheed Martin Corp. Further Information is contained in a TSP (see page 1). NPO-45241

Low-Impact Mating System for Docking Spacecraft

A document describes a low-impact mating system suitable for both docking (mating of two free-flying spacecraft) and berthing (in which a robot arm in one spacecraft positions an object for mating with either spacecraft). The low-impact mating system is fully androgynous: it mates with a copy of itself, i.e., all spacecraft and other objects to be mated are to be equipped with identical copies of the system. The operational characteristics of the mating system can be easily configured in software, during operation, to enable mating of spacecraft having various masses, center-of-gravity offsets, and closing velocities. The system design provides multi-fault tolerance for critical operations: for example, to ensure unmating at a critical time, a redundant unlatching mechanism and two independent pyrotechnic release subsystems are included.

This work was done by James L. Lewis and Brandan Robertson of Johnson Space Center and Monty B. Carroll, Thang Le, and Ray Morales of Lockheed Martin Corp. Further Information is contained in a TSP (see page 1). NPO-45241

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