1st Space Exploration Conference: Continuing the Voyage of Discovery
30 January - 1 February 2005, Orlando, Florida

AIAA 2005-2710

Thriving in the irregular and the unknown: system control for space exploration

Michael L. Rilee*
L-3 Communications GSI, Largo, MD 20774

Steven A. Curtis† and John E. Dorband‡ and Cynthia Y. Cheung§
NASA Goddard Space Flight Center, Greenbelt, MD 20771

David E. Lary**
UMBC/GEST NASA Goddard Space Flight Center, Greenbelt, MD 20771

and

Hamse Y. Mussa††
University of Cambridge, Cambridge, England, UK

Crucial to the development of a system of systems infrastructure for space exploration is a truly scalable control architecture. This architecture must be built on the reliable, adaptable operation and co-operation of autonomous systems at multiple levels. Advances in hardware and software computing technology allow us to consider anew the range of control systems from reactive, low-level to deliberate, heuristic systems.

At NASA's Goddard Space Flight Center (GSFC), we have been developing the means to create space and surface systems that are active participants in their environment rather than being merely visitors that withstand space's hazards as our extended remotely controlled tools. Central to this work has been the development of the Autonomous Nano-Technology Swarm (ANTS) mission architecture and the Neural Basis Function Synthetic Neural System (NBF/SNS) which are included among the subjects of several GSFC provisional patent applications. These are scalable systems with non-linear dynamics built in to deal with irregularity, uncertainty, and unpredictability in their environments. These system architectures outline pathways from existing near-term capabilities to far-term enabling technologies.

Nomenclature

ART	=	Addressable Reconfigurable Technology
ANTS	=	Autonomous Nano-Technology Swarm
ENI	=	Evolvable Neural Interface
GSFC	=	Goddard Space Flight Center
LaRC	=	Langley Research Center
NBF	=	Neural Basis Function
NMP	=	New Millenium Program
PAM	=	Prospecting Asteroids Mission
RASC	=	Revolutionary Aerospace Systems Concepts
SNS	=	Synthetic Neural System
SMART	=	Super Miniaturized Addressable/Autonomous Reconfigurable Technology
1-TET	=	One Tetrahedron
12-TET	=	Twelve Tetrahedron

* Scientist, Planetary Magnetospheres Lab, NASA/GSFC 695.1, AIAA Member.
† Laboratory Chief, Solar System Exploration Planetary Magnetospheres Lab, NASA/GSFC 695, AIAA Member.
‡ Computer Scientist, Planetary Magnetospheres Lab, NASA/GSFC 931, AIAA Member.
§ Astrophysicist/Data System Engineer, Planetary Magnetospheres Lab, NASA/GSFC 695.1, AIAA
** Senior Scientist, Global Modeling and Assimilation Office, Department Name, NASA/GSFC 900.3.
†† Research Scientist, Molecular Informatics Centre, Unilever Centre.