RESEARCHBRIEF
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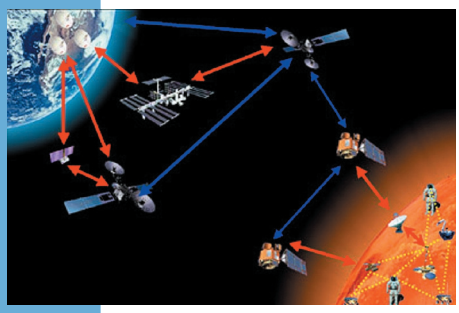
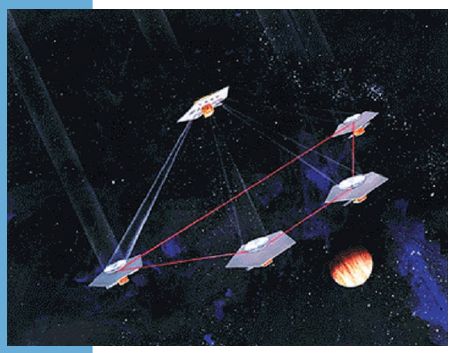
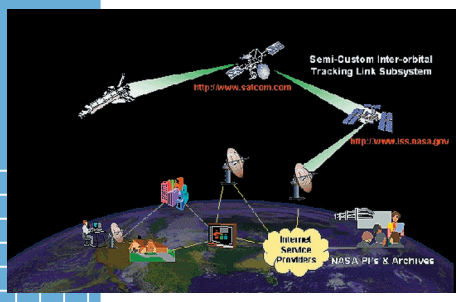
Broadband communication support for NASA



A future NASA mission network, utilizing adaptive, intelligent communications architecture.



Multi-satellite constellation missions introduce the need to support a "network in space."



NASA's transition to dynamic mission operations will require the ability to adapt to changing traffic loads, to accommodate various priorities on different spacecraft and to offer flexible and secure access to addressable spacecraft.

The potential

ISR researchers led by Michael Hadjitheodosiou and John Baras are partners in studying the evolution of the future mission support network for the National Aeronautics and Space Administration (NASA).

Our scientists are developing a quantitative, mathematical and statistical basis for analyzing changes to NASA communications network architectures, enabling NASA's vision of an adaptive and intelligent communications architecture.

They are investigating network control, protocol and communication performance issues for missions consisting of constellations of satellites to maximize science return from several distributed, coordinated spacecraft performing a unified mission.

They are looking into new ways to communicate with the International Space Station that can enable broadband connectivity, and give researchers and the public the opportunity to experience "virtual presence" in space.

They are also investigating system design and communication issues for a new, satellite-based, aircraft communication system that can meet Federal Aviation Administration (FAA) certification requirements and support current and future commercial aviation communication needs.

Focus: Flexible and secure access to spacecraft

ISR researchers have defined a sample mission scenario, using the ESE TERRA mission. They have determined the details of the data generation of the instruments and packetization and queuing on-board.

They also have formulated a conventional access scheme and scheduling policy for traffic relay through TDRSS supporting several similar spacecraft.

Another achievement is the development of the OPNET Simulation Model, which consists of spacecraft, TDRSS and the NASA Ground Network.

The team investigated packet-based scheduling algorithms for data multiplexing and traffic priority assignment on board a spacecraft. They also have started formulating a dynamic access scheme capable of efficiently sharing the space bandwidth between multiple spacecraft and enabling an on-demand mission operation.

Focus: Communication support for constellation missions

ISR researchers have started defining communication requirements for a typical near-term, four-spacecraft constellation mission, the Magnetospheric Multiscale Mission. They have studied design tradeoffs for space routing, protocol support and options for maximizing data download from space to the ground.

They have developed a complete simulation model that includes an empirical model of the traffic (instrument activity), the spacecraft orbits and the network topology needed to support the science on board.

They performed trade-off analysis studies for different communication options, trying to maximize the data download capability.

They are currently developing and implemented dynamic routing algorithms that can be applied in missions of this type, where more than one data relay option is available.

Focus: Supporting broadband communications from the International Space Station (ISS)

The ISS provides a unique platform for research in space such as telescience,

microgravity experiments, human physiology studies, and space and earth observation. These applications require real-time videoconferencing, real-time monitoring and control of experiments, and downloading large amounts of data (e.g. large images).

ISR researchers are looking into the system issues (protocol support, coverage, mobility, cost) associated with the current limited communication capabilities from the ISS and are investigating alternative solutions such as:

- Using the current NASA Tracking Data Relay Satellite System (TDRSS)
- Relaying data through emerging commercial broadband satellite systems
- Communicating directly to ground stations

Focus: Supporting aeronautical communications with next generation satellite systems

ISR researchers are studying the current National Airspace System communication infrastructure and FAA modernization program and are trying to define the communication requirement for a satellite-based solution to broadband aeronautical communications (including traffic load, data rate, delay, bandwidth, coverage). This can support Internet–based services for passengers and crew, and services related to the airplane operation (digital "black box," video surveillance, telemedicine, etc.)

In the problem formulation stage, the team has defined new and emerging applications that need to be supported. They have developed individual system requirements for bandwidth and latency. They also have defined operational scenarios for GEO satellites (Ka-Band), for the network onboard the airplanes and for the ground network topology.

They also have developed basic simulation infrastructure that can be used for system performance and analysis for topics such as link budget and antenna design, protocol support (TCP/IP performance), and Quality of Service support.

The team is currently investigating how much traffic this system can support, and the advantages over the communication capacity of the current system. They are also addressing whether this system can support the more dynamic mobility of aircraft and new Air Traffic Management concepts such as "Free Flight."

Research team

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More information available

More information is available online at:
www.isr.umd.edu/CSHCN/publications/technical/index.html
www.isr.umd.edu/~michalis/satellite/

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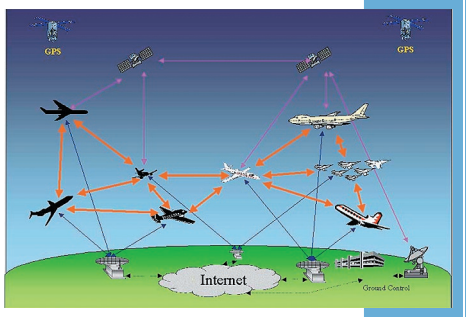
Virtual presence and interaction with the ISS will require new ways to deliver broadband communication support.



A satellite-based solution could revolutionize the National Airspace System's communications system and contribute to a safer, more efficient and more pleasant flight.