CS/EGR 230 Semester Projects

CONCEPTUAL DESIGN OF A SPACE-EXPLORATION RELATED ROBOT, SPACE CRAFT, OR AI-CONTAINING COMPUTER SYSTEM

Educational Game for Exploring Space

by Kevin Christie

Exploring Space with AI

by Christine Miller

Mining Space

by Todd Lewellen and Kamron Malik

A Moon Station

by Michael Fleming

A Communications Probe

(Selected Talk for Today)

by Craig Rixham and David Tileson

Architecture of a Communications Probe in a Space Network

Craig Rixham

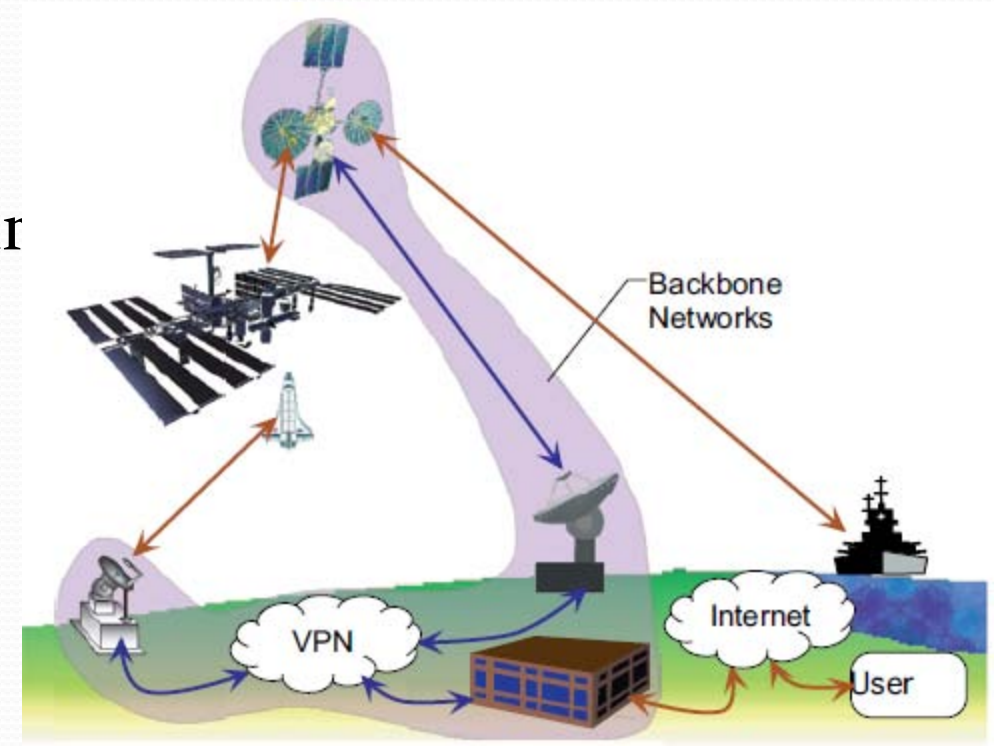
David Tileston

Overview of Current Space Networking

- Most missions use unique protocols.
- Probes communicate with limited numbers of receivers
- Limited timeframe to communicate with probes
- High development costs

Proposed Space Network

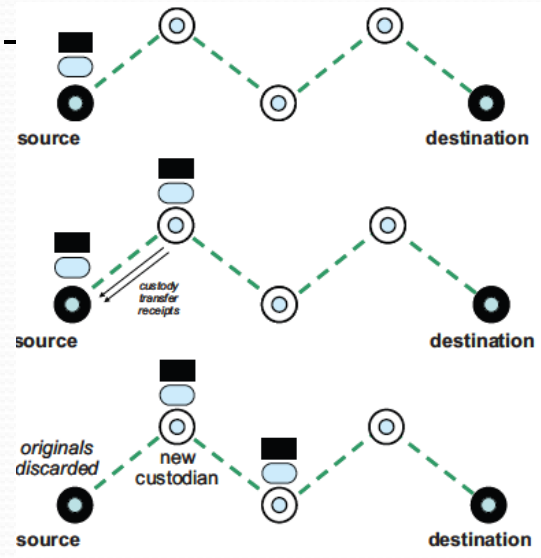
- Space Internet would link NASA infrastructure into one large, widely distributed network.
- Communication times greatly reduced.
- Cost and development time reduced
- Higher transfer speeds could be achieved for near Earth orbits (ISS).



Proposed Network Protocols

- TCP/IP – Ground based network packetized protocol used in the Internet and Earth-based networks.
  - Some issues with use in space

- Delay-Tolerant Network (DTN) - designed for disrupted or intermittent networks.

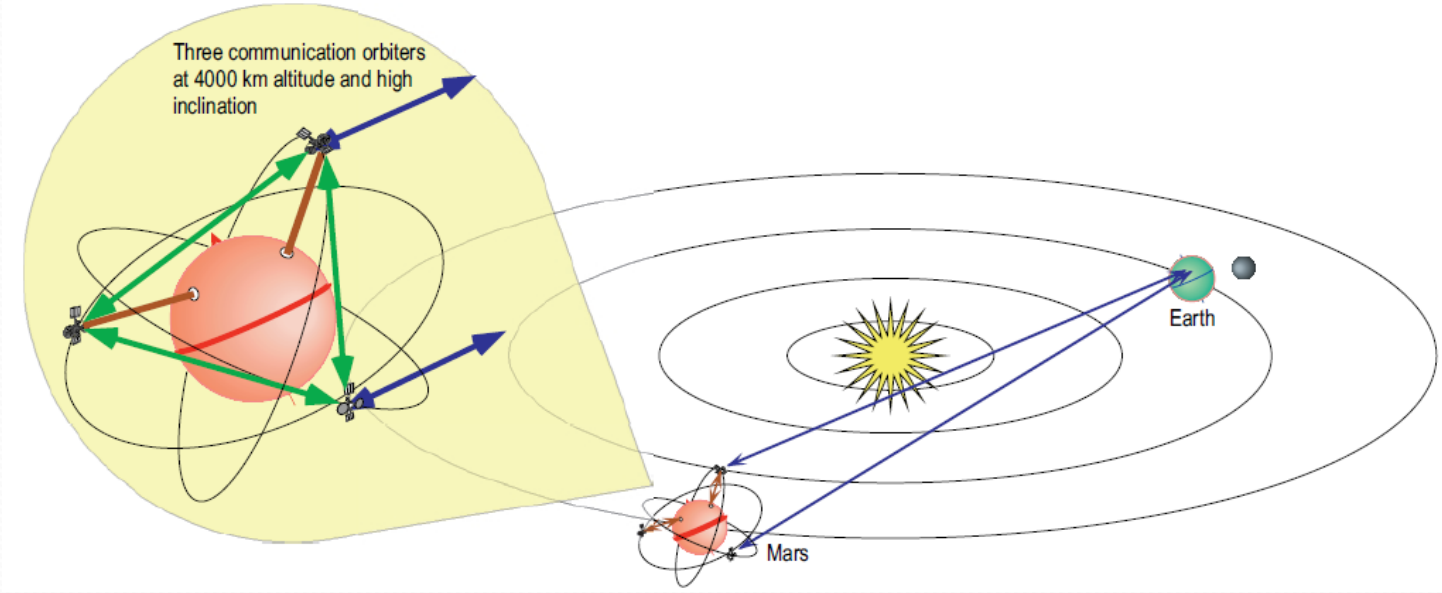


Proposed Network Protocols Comparison

TCP/IP		DTN	
Advantages	Disadvantages	Advantages	Disadvantages
• Decreased cost • “Off the shelf” products • Faster development • Contracted help	• Not compatible with disrupted networks • Requires fast communication • Limited use in space	• Transfer large chunks of data • Less time spent transmitting • Very reliable	• More expensive • Time inefficient • Requires large memory • No existing model

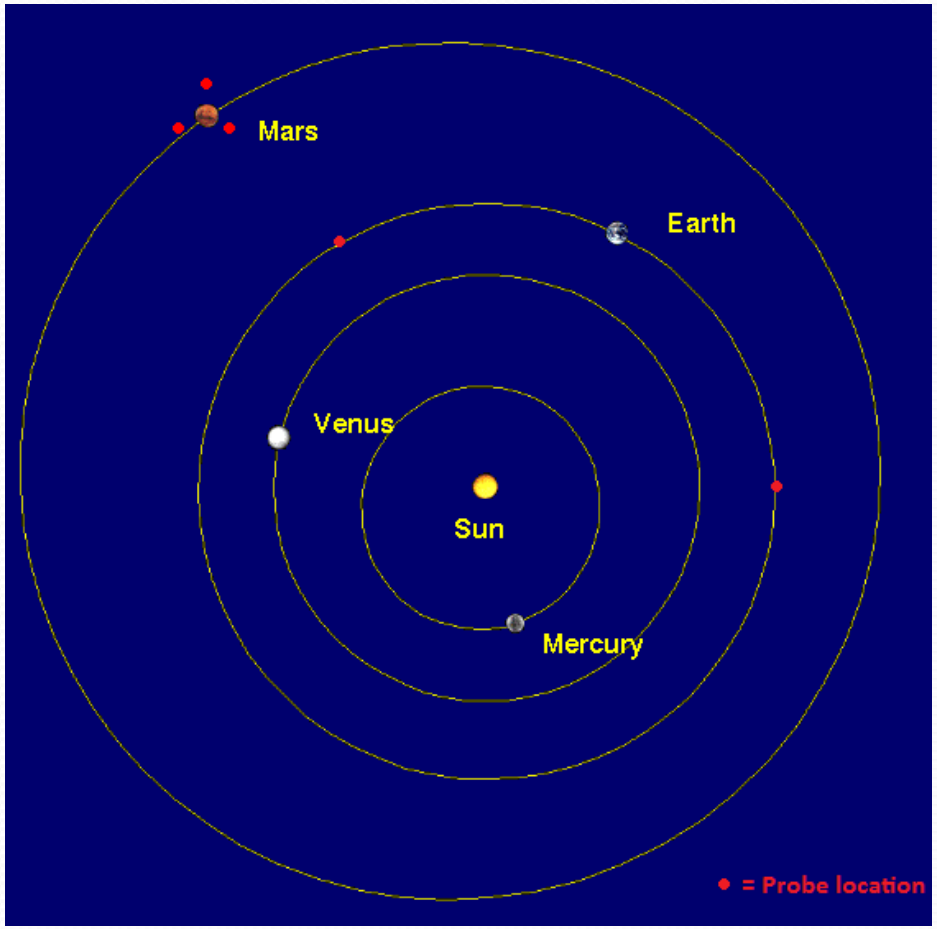
Example of Space Network

- High altitude, networked satellites above Mars
- Constant link between landers/humans on surface
- Satellites serve as comm relays



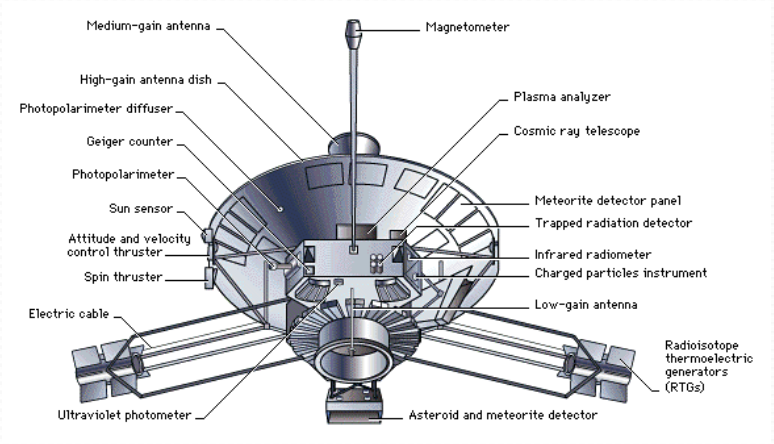
Possible Probe Locations

- Earth-Sun libration points
- Orbiting important bodies (Mars, moons of Jupiter)



Communication Probe Specifications

- Probe Subsystems and Hardware
  - Power Supply
  - Propulsion
  - Attitude Control
  - Temperature Control
  - Antenna Control



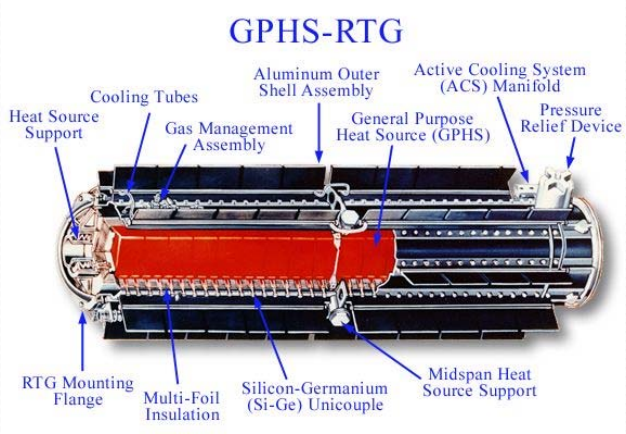
Power Supply

Solar Power - uses solar panels of varying sizes to provide power for rechargeable batteries

Advantages	Disadvantages
• Potentially unlimited supply • Larger panels = more energy • Allow for more demanding systems	• Essentially useless beyond Mars' orbit • As distance increases, so does weight

Power Supply

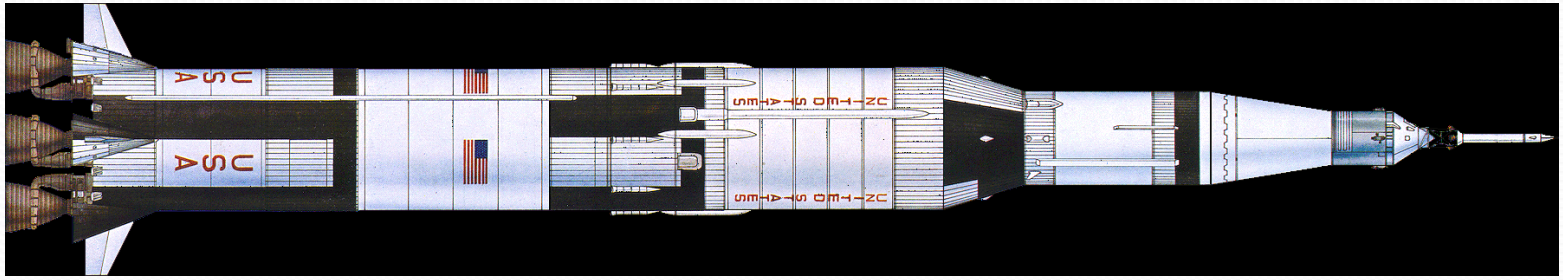
Radioisotope Thermoelectric Generator - uses heat from the decay of radioactive fuel to generate electricity



Advantages	Disadvantages
• Does not depend on an external power source • Can operate at great distances from the sun • Decreased weight	• Power supply is completely internal, therefore limited • Produces less energy than solar panels near the Sun

Propulsion

Solid Chemical Propellant	Liquid Chemical Propellant	Electrical Propellant
• Powerful thrust • More fuel efficient • Lacks thrust control	• Greater amount of thrust control • Lower thrust than solid • Less efficient than solid	• Uses electricity to propel the probe • 10x efficiency • High electrical consumption



Attitude Control

- Star Tracking sensors detect patterns in stars
  - Star tracking provides location and orientation
  - Multiple sensors installed provide three dimensional data
- Gyroscopes detect inertial movement
  - Is not dependent on observation
- Used together for greater accuracy

Temperature Control

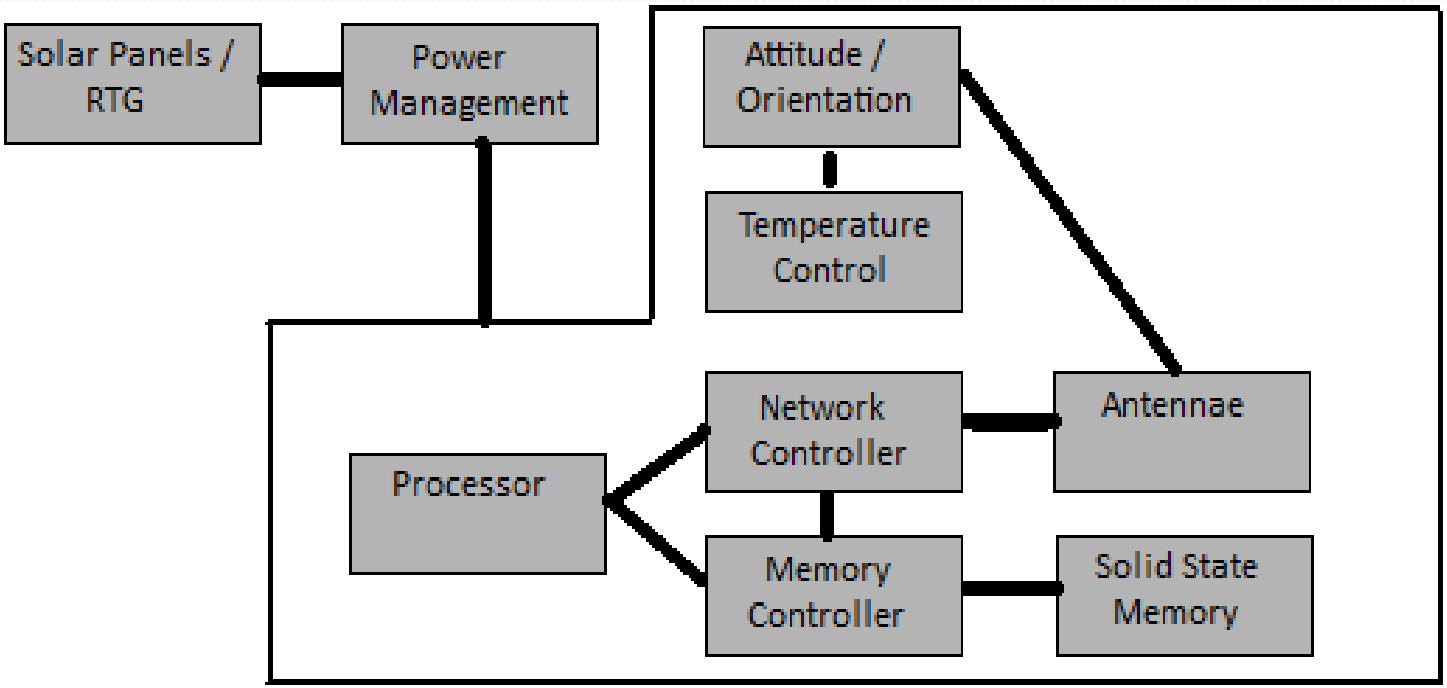
- Solar energy heats one surface while leaving others cold
- Active Methods
  - Require power from the probe
  - Spin probe to equalize exposure
- Passive Methods
  - Do not require power
  - Heat shield
  - Reflective surfaces
  - Black or white paint
  - Make crucial components central

Antenna Control

- Two types of signals
  - Radio Frequency & Lasers
- Multiple antennas on probe
  - Reduces amount of rotation needed
- Very precise aim for long distances
  - Linked to orientation system

Probe Microcontrollers

- Use variety of microcontrollers
- Systems linked together
- Possible use of lightweight, single die in future



Picture Citations

- http://www.cisco.com/en/US/i/Other/Cisco_Press/ITG/10-19-01/TR890702.jpg
- Bhasin, Kul & Hayden, Jeffry. “Space Internet Architectures and Technologies for NASA Enterprises.” IEEE Aerospace Conference, 2001.
- Eddy, Wesley, et. al. “A Bundle of Problems.” IEEE Aerospace Conference, 2009