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

<table>
<thead>
<tr>
<th>TCP/IP</th>
<th>DTN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• Decreased cost</td>
<td>• Not compatible with disrupted networks</td>
</tr>
<tr>
<td>• “Off the shelf” products</td>
<td>• Requires fast communication</td>
</tr>
<tr>
<td>• Faster development</td>
<td>• Limited use in space</td>
</tr>
<tr>
<td>• Contracted help</td>
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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

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Potentially unlimited supply</td>
<td>• Essentially useless beyond Mars’ orbit</td>
</tr>
<tr>
<td>• Larger panels = more energy</td>
<td>• As distance increases, so does weight</td>
</tr>
<tr>
<td>• Allow for more demanding systems</td>
<td></td>
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</tbody>
</table>
# Power Supply

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

<table>
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<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>• Does not depend on an external power source</td>
<td>• Power supply is completely internal, therefore limited</td>
</tr>
<tr>
<td>• Can operate at great distances from the sun</td>
<td>• Produces less energy than solar panels near the Sun</td>
</tr>
<tr>
<td>• Decreased weight</td>
<td></td>
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</tbody>
</table>
# Propulsion

<table>
<thead>
<tr>
<th>Solid Chemical Propellant</th>
<th>Liquid Chemical Propellant</th>
<th>Electrical Propellant</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Powerful thrust</td>
<td>• Greater amount of thrust control</td>
<td>• Uses electricity to propel the probe</td>
</tr>
<tr>
<td>• More fuel efficient</td>
<td>• Lower thrust than solid</td>
<td>• 10x efficiency</td>
</tr>
<tr>
<td>• Lacks thrust control</td>
<td>• Less efficient than solid</td>
<td>• High electrical consumption</td>
</tr>
</tbody>
</table>
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