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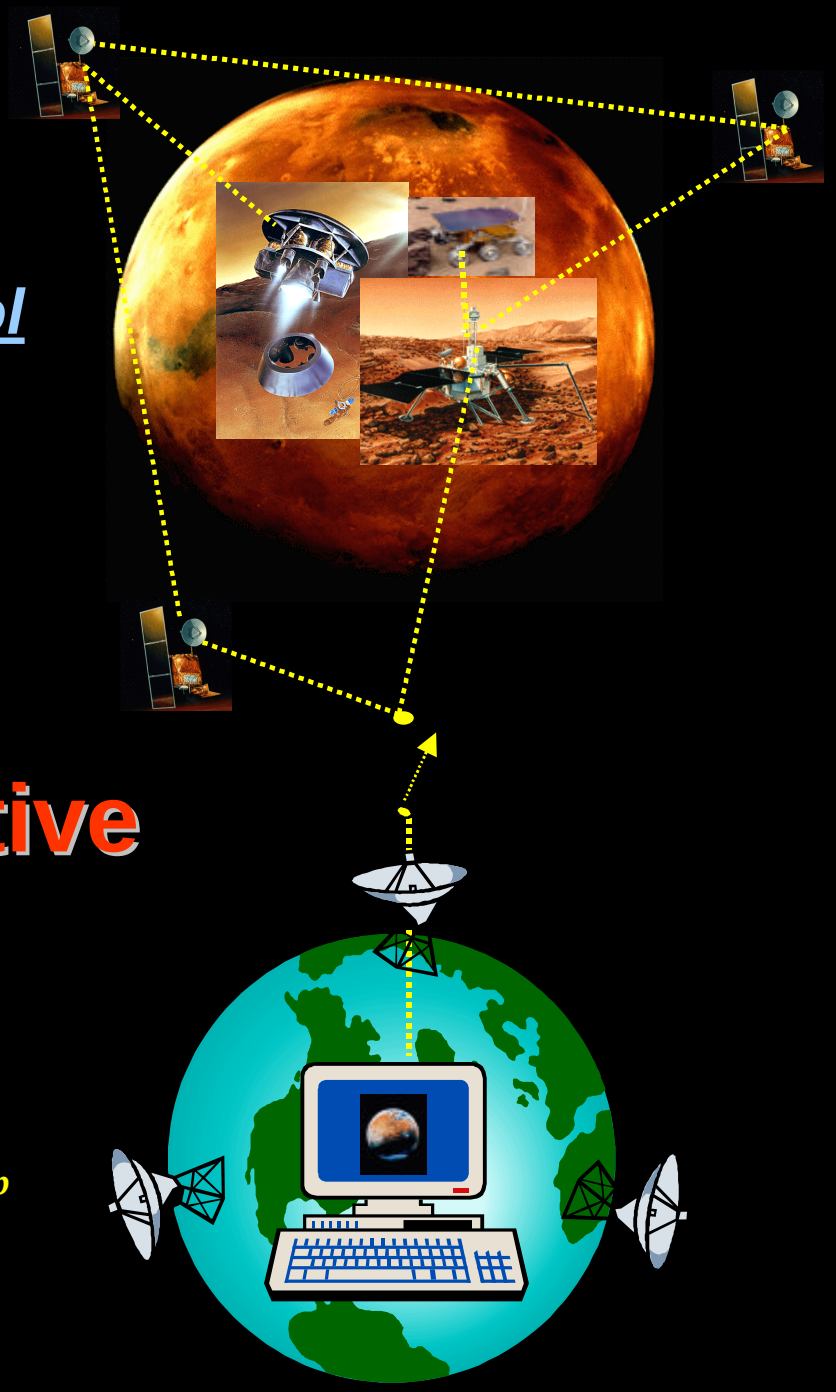
Extending The Reach Of The Internet: The InterPlaNet Initiative



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Leigh Torgerson,Eric Travis, Howard Weiss

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during the 42nd IETF - Chicago, Illinois
26 August 1998

The InterPlanNet Initiative In a Nutshell

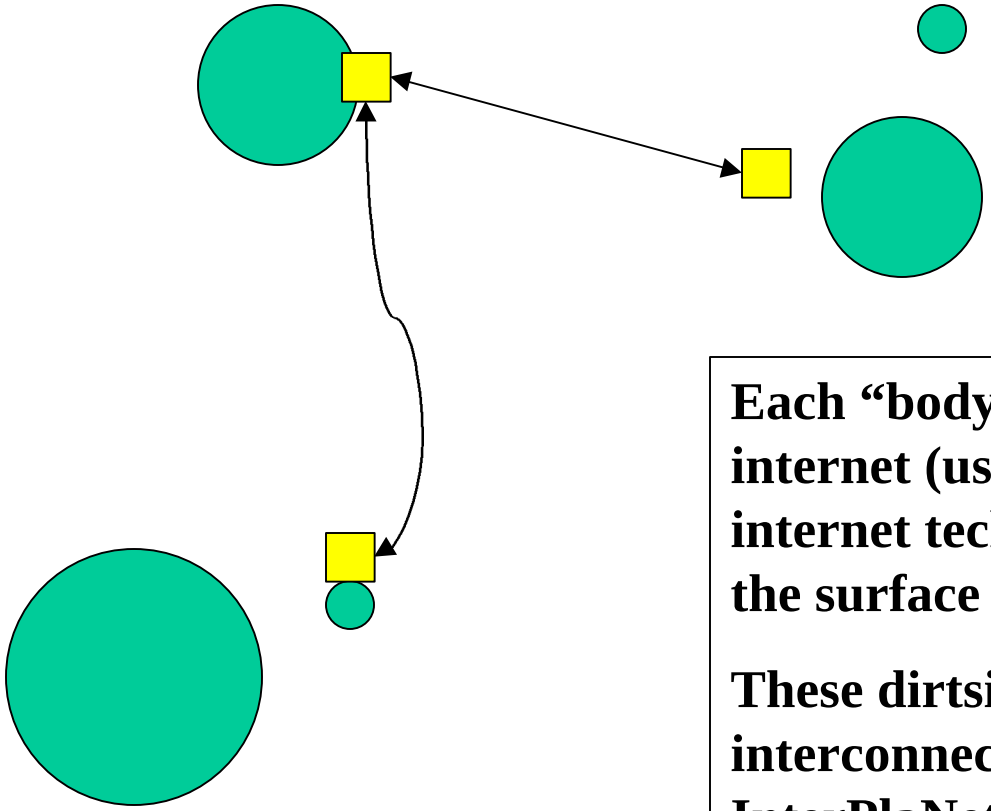
- **The accretion of internets throughout the solar system (places beyond geostationary orbit) and their eventual interconnection into a single "federated Internet"**
- **Supporting the robotic exploration of the solar system and setting the framework for enhanced (physical) human presence elsewhere**
  - **Now is the time to begin supporting the future Internauts**
  - **A 10 year program for robotic exploration of Mars has begun**
  - **Multiple rovers, orbiters and landers are being deployed**
- **This effort requires us to revisit the underlying assumptions that shaped the evolution of the terrestrial Internet and to determine the validity & impacts of those assumptions in other environments**
- **Remember: "From small acorns, mighty oaks grow"**

We must be careful not to lock ourselves into an Earth-centric architecture

Architectural Drivers

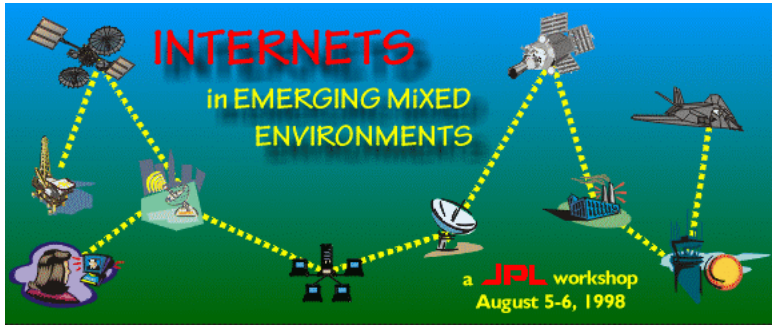
- **Very long round trip light-times requires change in protocol paradigm (chatty don't work)**
  - **Must minimize round trips**
- **Episodic connectivity is a reality - may not have duplex communication during a contact period**
  - **Need a store-and-forward approach predicated on half-duplex operation**
- **Ability to evolve remote hardware base is limited**
  - **Must decouple evolutionary rates**
- **Need to reuse existing Internet technology**
  - **Separate in-situ Internets from interplanetary relay network**

A Cheesy Diagram of Our Initial Thoughts



Each “body” hosts a (virtual) dirtside internet (using *relatively* conventional internet technology) that extends from the surface to (at least) GEO orbits

These dirtside internets are interconnected by a network of InterPlaNetary gateways that provide routing and transport functionality



Intertwined Technologies

(Earth Orbiting) Satellite
- *High bandwidth-delay products*
- *Potential loss due to bit-errors and/or link outages*
- *Potential asymmetric data rates*

Wavelength Division Multiplexing
- *Data multiplexed onto individual laser wavelengths*
- *Fiber capacities in the Terabits/second*
- *Ultra high bandwidth-delay product*
- *Bandwidth-delay product >> typical transaction size*

Interplanetary In-Situ Network (IPN-I)
- *Power management of preeminent importance*
- *Some losses due to bit-errors*
- *Mobile/wireless self-organizing networks*
- *Initially small to moderate bandwidth-delay products*

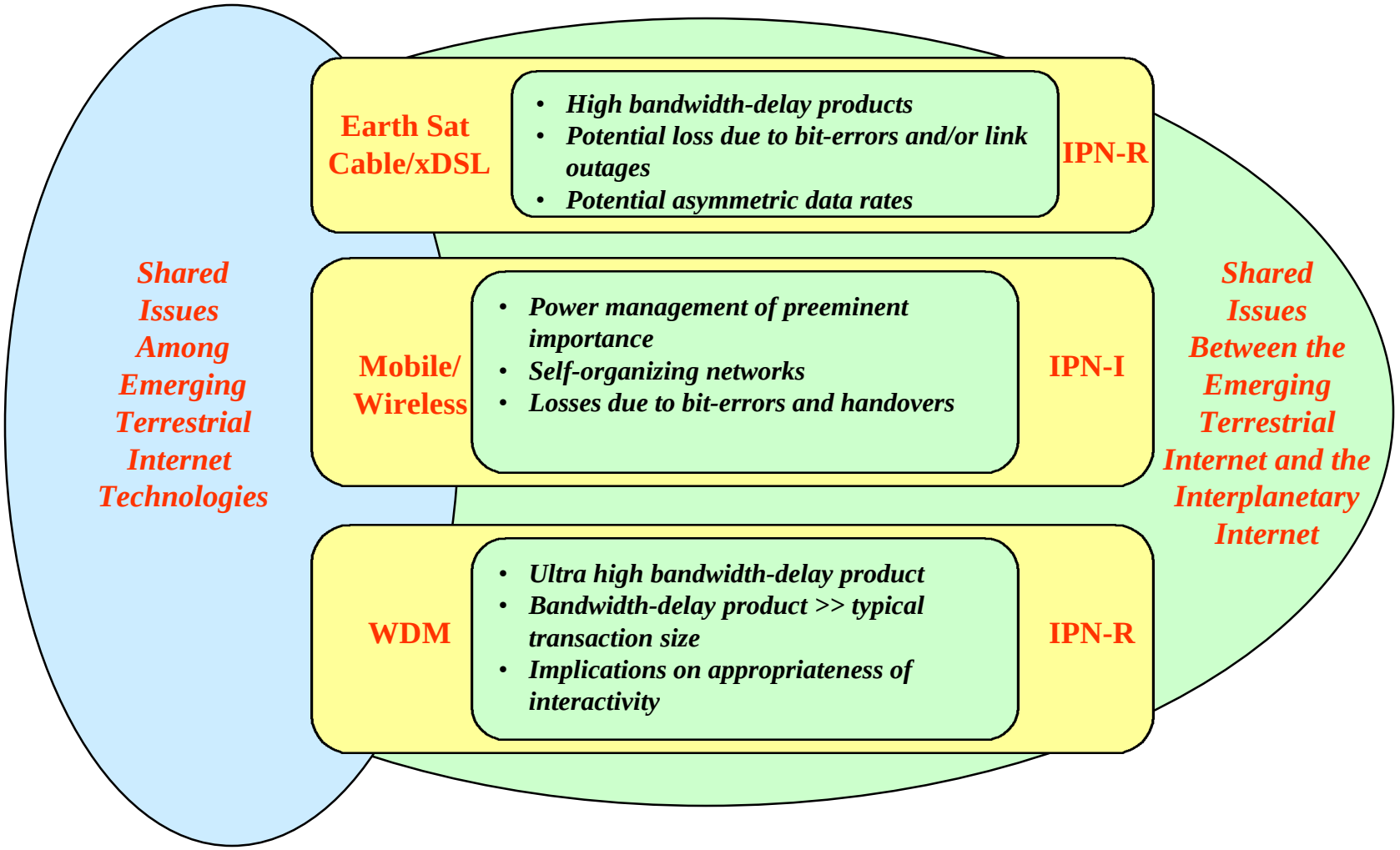
Mobile/Wireless
- *Supports mobile, self-organizing networks*
- *Power management of preeminent importance*
- *Losses due to bit-errors and handovers*
- *Small, but increasing bandwidth-delay products*

Interplanetary Relay Network (IPN-R)
- *Ultra high bandwidth-delay product*
- *Asymmetric data rates*
- *Losses due to bit-errors and handovers*
- *Bandwidth-delay product >> typical transaction size*

Cable Modem/xDSL
- *Asymmetric data rates*
- *Some losses due to bit-errors*
- *Moderate bandwidth-delay products*

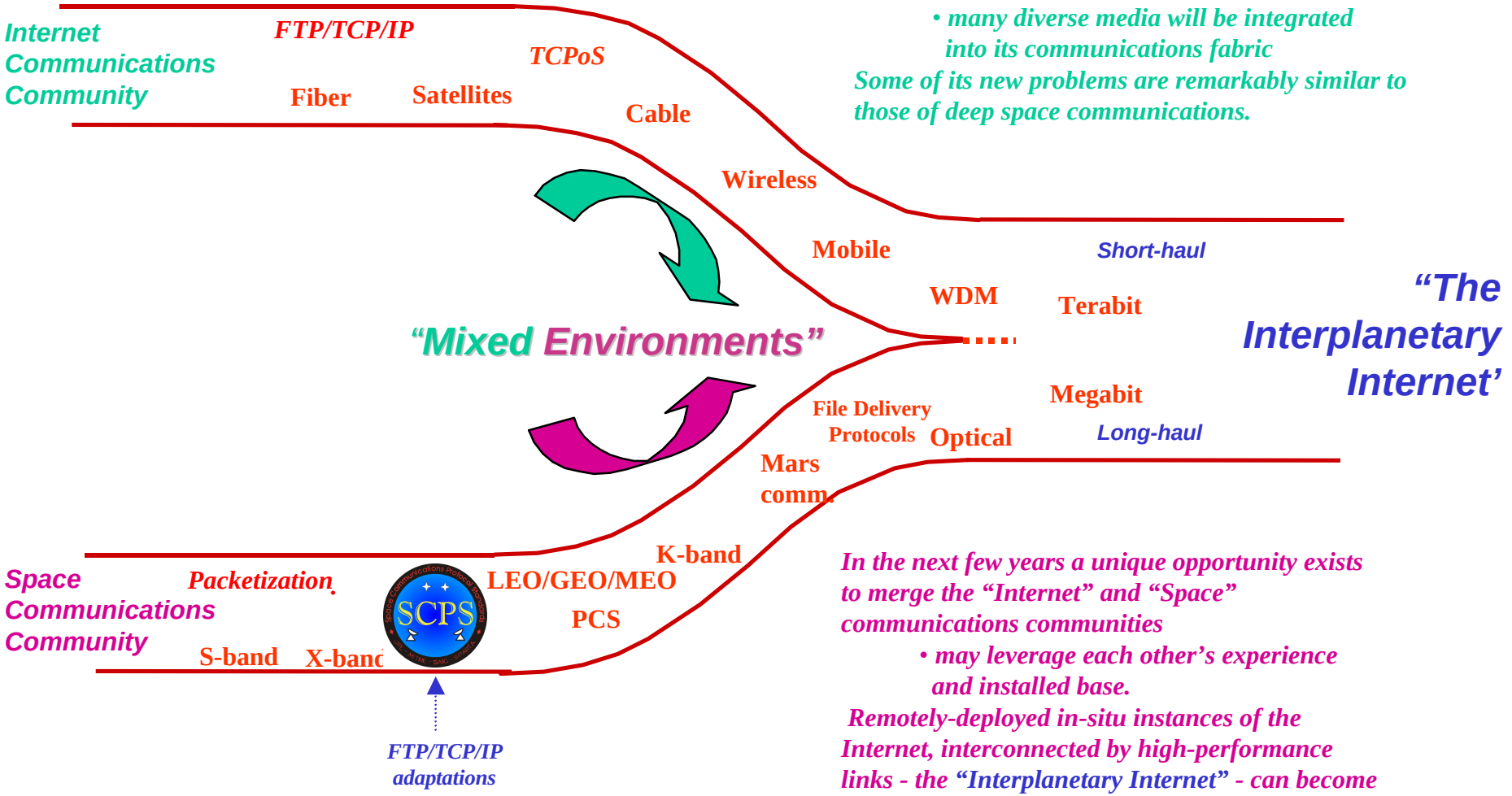
Internet and InterPlaNet (IPN)

Shared Technology Issues



Some Top Level Issues For The InterPlanNet Initiative

- **Naming and addressing**
- **Routing in “very different” environments**
- **Security and Access Control**
- **Efficiency and scalability**
- **Adding “state” into the network**
- **Accommodating different rates of protocol evolution, while maintaining interoperability and connectivity**
- **Resource Discovery**
- **The interrogative nature of existing application models**
- **Applicability of the existing default assumptions inherent in the Internet (both explicit *and* implicit)**



Earth's Internet is rapidly evolving from being primarily fiber-based to an era of "mixed environments"

- *many diverse media will be integrated into its communications fabric*

Some of its new problems are remarkably similar to those of deep space communications.

In the next few years a unique opportunity exists to merge the "Internet" and "Space" communications communities

- *may leverage each other's experience and installed base.*

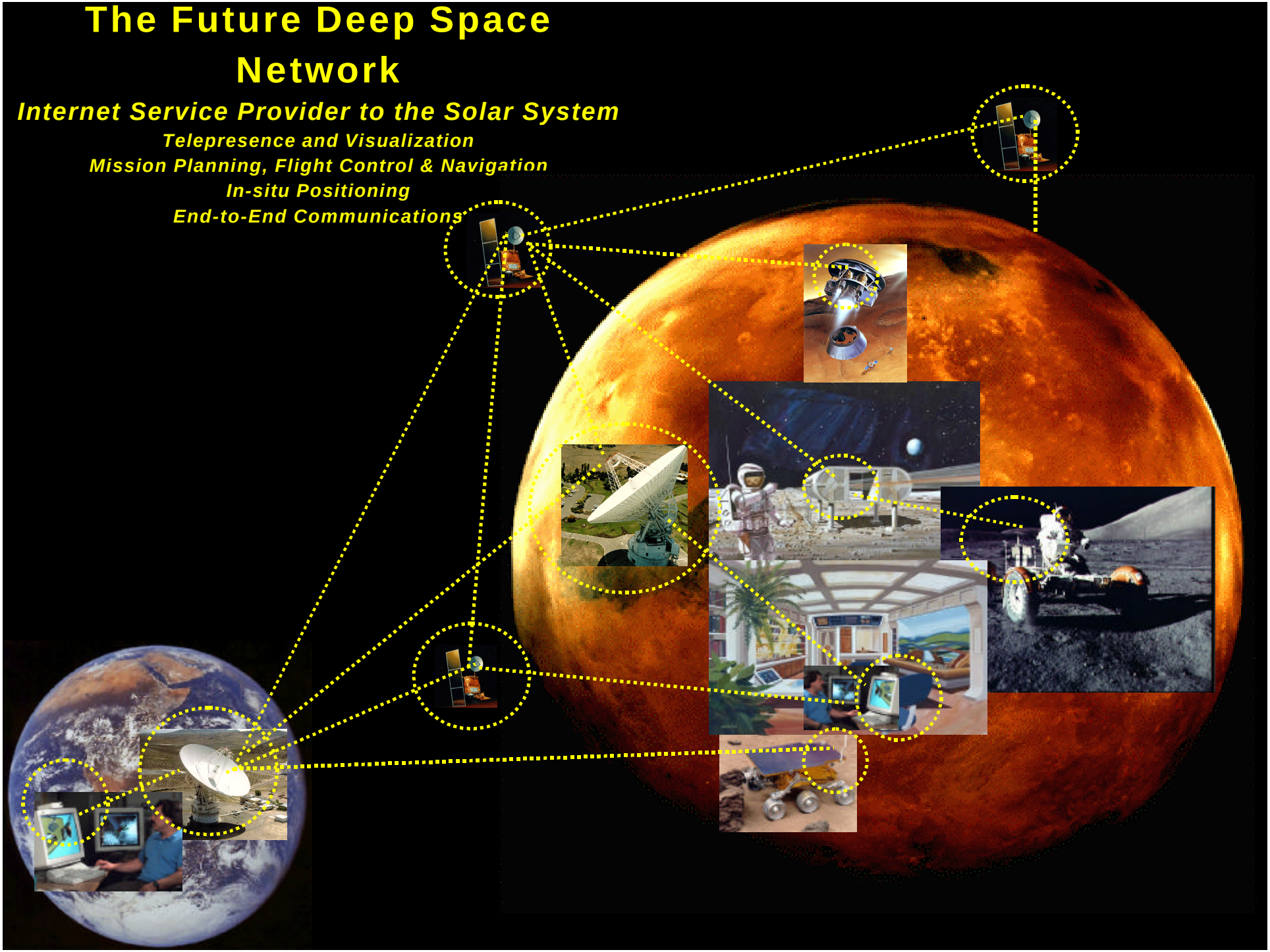
Remotely-deployed in-situ instances of the Internet, interconnected by high-performance links - the "Interplanetary Internet" - can become commonplace.

1998 1999 2000 2001

The Future Deep Space Network

Internet Service Provider to the Solar System

Telepresence and Visualization
Mission Planning, Flight Control & Navigation
In-situ Positioning
End-to-End Communications



Where To From Here?

- This is NOT IETF WORK!!!
  - ***Visionary (Fringe?) research is a better description***
- However, it has real issues that need to be addressed in the near term
  - NASA Mars missions in ‘01, ‘03, & ‘05 present opportunity to leave architectural elements in place

Pointers for Further Information and Participation

- IPN Study Group discussion mailing list

  join-ipn-public@list.jpl.nasa.gov

  (no message title or body necessary)

  or

  http://list.jpl.nasa.gov - follow subscription link
- WWW: to be established shortly; check

  http://www.scps.org/scps

  during the first weeks of October 1998 for a URL pointer