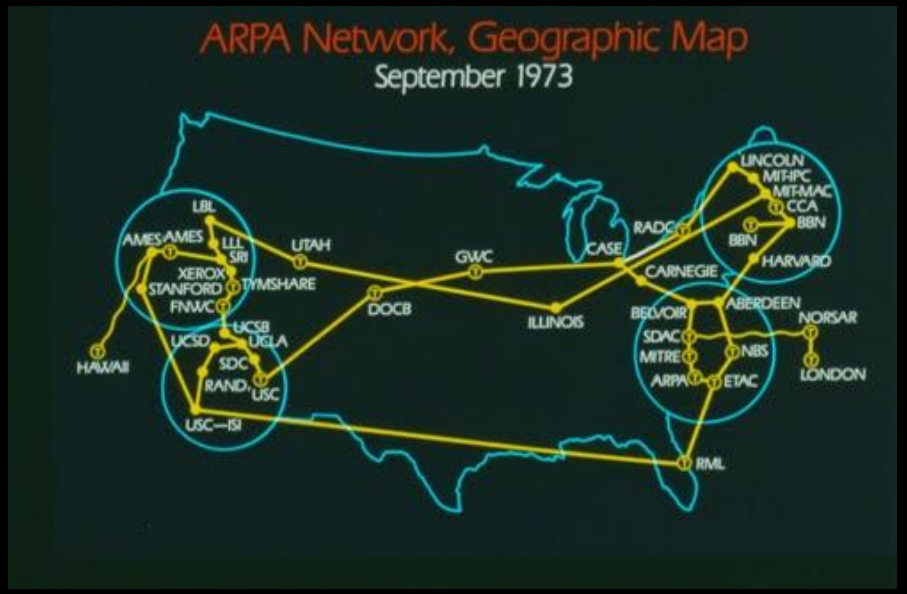

Internet Society
Interplanetary
Chapter
BundleBone
A Resilient Research Backbone
for Prototyping the Interplanetary Internet
Bridging Space and Terrestrial Connectivity
IPNSIG
Scott Johnson
Leigh Torgerson
IPNSIG

The Architectural Parallel

FROM ARPANET TO THE SOLAR SYSTEM

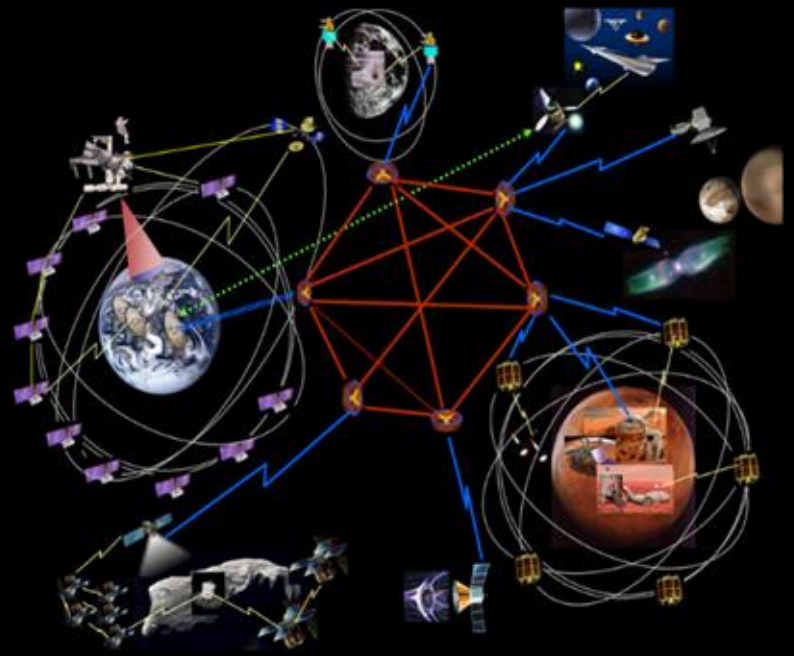
Networking the Networks Together - The Terrestrial Blueprint

The original Internet didn't build a single wire to every computer. It was born by deploying **gateways and standard protocols (TCP/IP)** to develop a backbone to interconnect completely independent, localized networks (universities, military bases, labs.)



The Deep Space Evolution (BundleBone)

The Interplanetary Internet won't replace local planetary networks. Instead, it deploys a persistent backbone running the **DTN protocol suite (Bundle Protocol)** to bridge independent islands of automation across deep space bottlenecks.



Evolution of the Backbones

Architectural Metric	Early Internet Backbone (ARPANET/NSFNET)	Deep Space Backbone (BundleBone)
Core Protocol Suite	TCP / IP (Connection-Oriented, End-to-End)	BPv7 / LTP / IP (Store-and-Forward)
Primary Constraint	Bandwidth limitation & routing convergence	Extreme propagation delays & intermittent links
Data Units	Packets (Dropped if route is unavailable)	Bundles (Stored persistently at nodes until next link is available)
System Interface	Hardwired links / Leased Telecom Lines	Intermittent Internet, RF and Optical comm

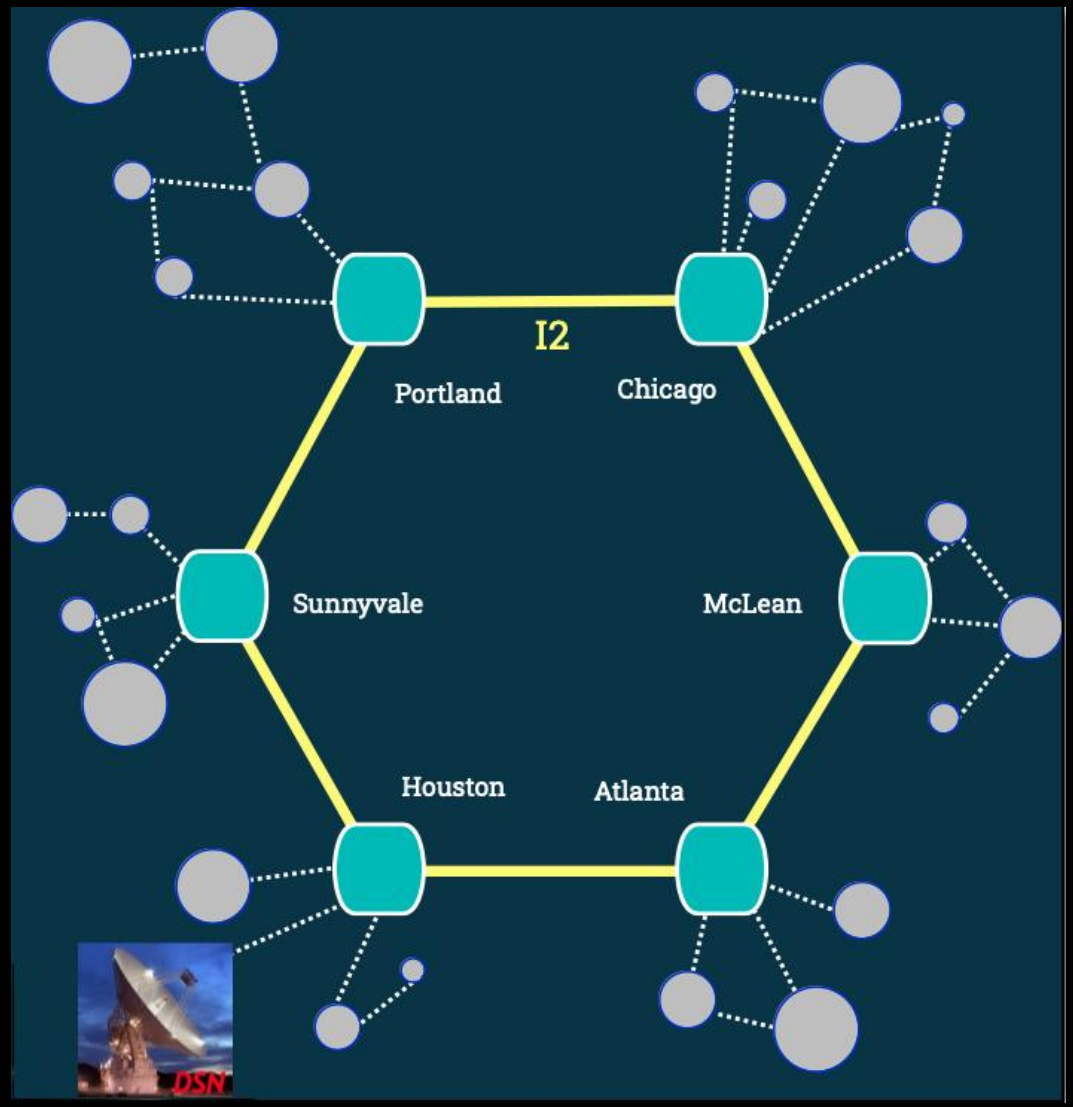
Phase 1 Infrastructure

6 High-Performance Nodes – Operating Over Internet2

The initial deployment of **BundleBone** consists of six computers strategically distributed and running over **Internet2**. This high-bandwidth, research-centric network provides the ideal substrate for large-scale DTN testing and orchestration.

These nodes form the core reference implementation, designed to facilitate cross-institutional protocol validation and telemetry gathering.

Users will include universities, commercial entities who want to develop and certify their DTN implementations, national space agencies and public application developers for terrestrial use of DTN.



Initial Network Implemention Plan:

Demonstrate ION DTN Network Ecosystem, with focus on:

Bundle Protocol (BP)

Certification focus on the **BPv7** standard, developing reliable custody transfer, network management and BPSec, which enables security provisions for encryption, and integrity checking.

Licklider Protocol (LTP)

Validating **LTP** for point-to-point reliability. LTP is designed to operate over links where retransmissions are expensive due to propagation delays and provides efficient deep space automatic retransmission capabilities.

Planned BundleBone Core Simulation Capabilities

Noise Injection

The ability to emulate noise and signal degradation typical of long-range radio and optical links.

Intermittency

Simulating intermittent connectivity caused by orbital mechanics, planet rotation, or obstacles.

Variable Delay

Injecting multi-second delays to accurately simulate one-way light time for Earth-to-Lunar distances.

Strategic Applications

From the Deep Space Network to remote terrestrial frontiers.

The Lunar Benchmark

A primary goal of the BundleBone is high-fidelity simulation of the **Earth-to-Moon** communication dynamic. By emulating the 1.3 second delays of cislunar space, BundleBone serves as the definitive testbed for lunar missions. It allows for the validation of protocol recovery mechanisms before actual hardware is deployed. NASA's Deep Space Network (DSN) will be able to use the BundleBone to facilitate certification and user testing.

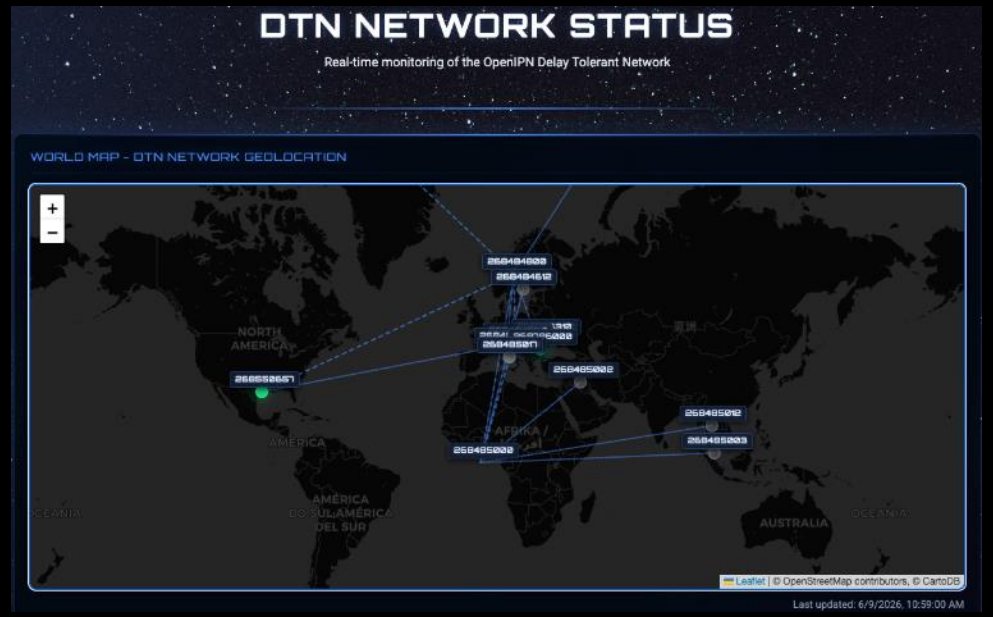


NASA - "LunaNET"

ESA - "Moonlight"

Terrestrial Uses of DTN Studied by the IPNSIG PWG

Since intermittent connectivity and challenged communications paths are not unique to space, many terrestrial uses for DTN are being explored, from IoT applications, to wildlife tracking, lake water quality monitoring and many other applications. The IPNSIG Pilot Projects Working Group has over 30 researchers from 17 countries investigating terrestrial DTN uses.



Future Uses of the BundleBone

- IPNSIG plans to open BundleBone to independent researchers, companies, and university programs. The goal is to support DTN research, testing, and application development—similar to how the original ARPANET backbone helped the Internet develop.

- As of October 2026, IPNSIG is developing an Acceptable Use Policy, exploring sponsorship, and planning how outside researchers can access BundleBone.

- Three possible near-term uses are:
  - Let researchers send application data through the DTN Network Reference Implementation. A simulated LunaNet relay would serve as the network provider, with adjustable contact plans, OWLT, and data-loss settings.
  - Invite researchers to submit project or test plans. IPNSIG could provide virtual machines on BundleBone to study different DTN software, routing methods, and related topics.
  - Test whether commercial and other flight-ready DTN systems work with NASA's standard ION software. This is possible because the DTN Network Reference Implementation uses the same CFDP, BP, and LTP protocols as NASA's Deep Space Network.