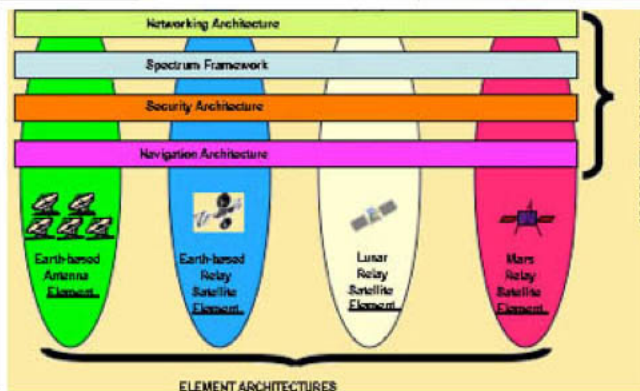
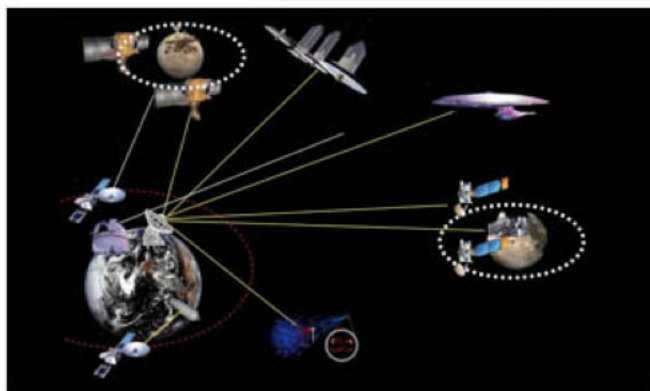
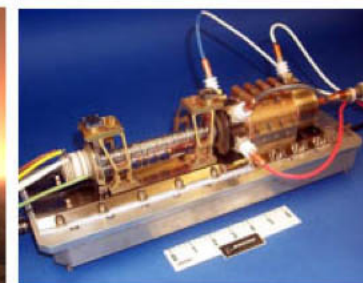
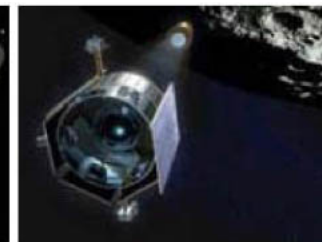




Jet Propulsion Laboratory
California Institute of Technology

Interplanetary Network Directorate Technology Interests

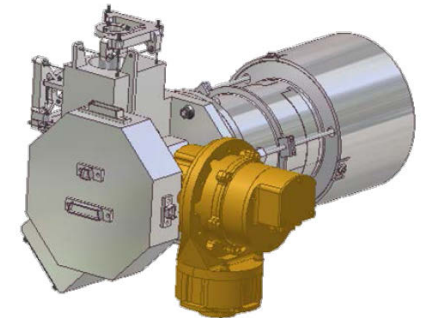
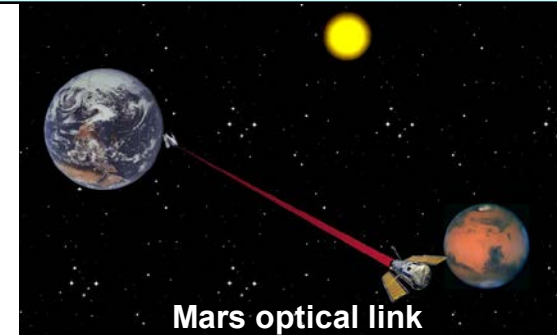
Les Deutsch
IND Chief Technologist
August 25, 2011



Optical Communications

JPL

- Next big step in communications:
factor of 100 performance increase
- Main thrust is in deep space systems:
JPL has lead within NASA
 - Efficient, low-mass flight terminals
 - Pointing and disturbance management systems
 - Earth stations
 - Adaptive optics
 - Photon-counting detectors
 - Atmospheric propagation research
 - Hybrid RF/Optical systems
- Optical in-situ links for Mars-like applications
- Working with Goddard on near-Earth optical systems
- Investigating advanced quantum signaling



Deep Space Optical Terminal

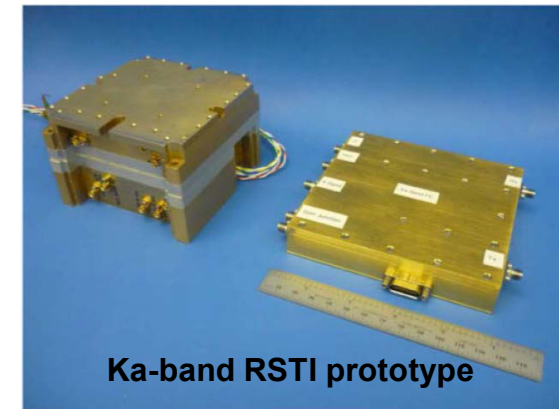
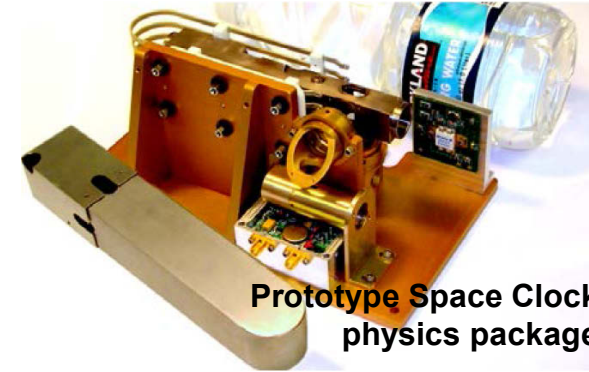


Optical Communication Test
Laboratory (OCTL)

Navigation Technologies

JPL

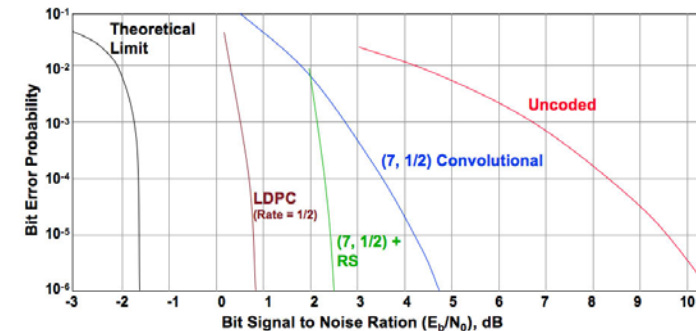
- **Ultra-stable flight clocks**
 - Mercury ion clocks
 - Quantum optical clocks
- **Autonomous spacecraft navigation** – enables missions that cannot wait for “Earth-in-the-loop” decisions
 - Advanced onboard sensors
 - Calculation of trajectories onboard
 - Autonomous GNC
- **Advanced radio science instruments**
 - Synergistic with navigation technology development



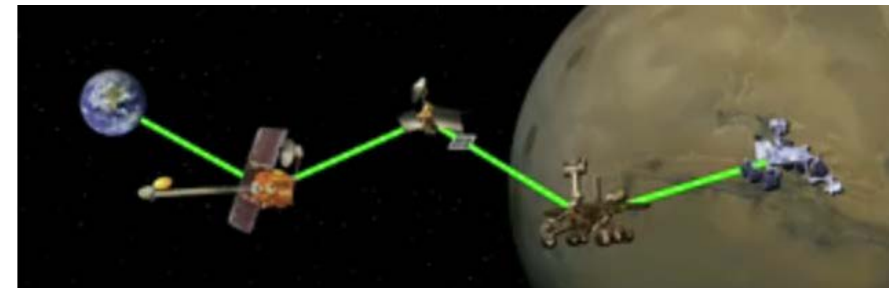
Modulation, Coding, and Networking



- **Spectral and power efficient modulation**
 - Gaussian Mean Shift Keying (GMSK) for maximizing data rate in a limited bandwidth
 - 8- and 16-ary signaling for squeezing the most out of the available spacecraft power
- **Advanced error-correcting codes**
- **Data compression and compressive sampling**
- **Disruption-Tolerant Networking**
 - Robust to long delays of deep space
 - Robust to temporal link availability
 - Guaranteed data quality
 - Management of message priorities
 - Autonomous multi-hop routing



Performance of various codes

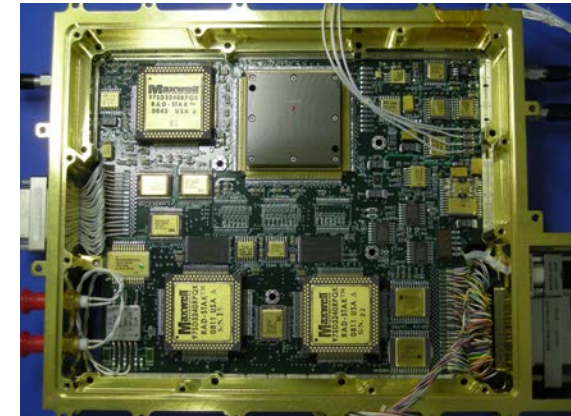


Multi-hop DTN routing

Radio Systems

JPL

- **Next generation spacecraft radio: the Universal Space Transponder (UST)**
 - Software-defined radio building upon JPL's experience with the Mars *Electra* radio, *BlackJack* GPS receivers, and radio science instruments
 - Quick infusion of new modulations, codes, and networking
- **Advanced DSN receiver**
 - Software-defined radio with 100 times the current DSN capability and phenomenal low-SNR performance
- **Continued infusion of Ka-band capability**
 - Characterization of atmospheric perturbations
 - Operational strategies to maximize performance in the presence of weather degradation



Universal Space Transponder
breadboard

