What’s So Hard About Talking to Mars?

- ~40,000 km
- Up to 400,000,000 km

- 10,000 times larger distance
- \(10^8\) times harder to communicate
Mars Relay Concept
Mars Relay Network Benefits

- Increased data return
- Energy efficiency
- Critical event telemetry
- Radio-based navigation
2001 Mars Odyssey
Mars Reconnaissance Orbiter
The 7 min of terror...
Tick marks every 5 min

Arbitrary View at Landing
Entry Epoch: 08/06/2012 05:10:44 UTC
Landing Epoch: 08/06/2012 05:17:45 UTC
### Exo-Atmospheric Entry, Descent and Landing

- **X-band:** Transmit MFSK Tones (~one 8-bit symbol every 10 sec)
- **UHF:** Transmit 8 kbps MSL Telemetry

### Surface

- **HiRISE Imaging**
- **MSL HAZCAM Images**

### Potential Short (~1s)

- UHF Dropouts Due to MSL Parachute Deploy, Backshell Sep, Powered Descent Dynamics

### MSL

- **Cruise Stage Sep**
- **Turn to Entry**
- **Jettison Cruise Balance Mass**
- **Entry Interface**
- **Parachute Deploy**
- **Backshell Sep**

### DSN

- **Canberra 70m/34m Reception; Real-time Playback to JPL for MSL Carrier & MFSK Tone Demodulation**
- **Canister Mode** Open Loop Recording, Post-EDL Playback to Ground for Post-Processing (Carrier-Only; 2.5 hrs latency)

### MRO

- **Nominal Coverage**
- **Addl Geometric Coverage (Uncertain Telecom Performance)**

### ODY

- **Nominal Coverage**
- **Addl Geometric Coverage (Uncertain Telecom Performance)**

### MEX

- **Nominal Coverage**
- **Addl Geometric Coverage (Uncertain Telecom Performance)**
- **MEX sets prior to Landing**
- **+60 s**

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### Cruise Stage Sep

- **Turn to Entry**
- **Jettison Cruise Balance Mass**

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### Entry Interface

- **Parachute Deploy**
- **Backshell Sep**

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### Landing

- **MSL HAZCAM Images**

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### Time from Entry (sec)

-600 -540 -480 -420 -360 -300 -240 -180 -120 -60 0 60 120 180 240 300 360 420 480 540 600 660 720 780 840 900
MSL Surface Communications

AM contact opportunities

PM contact opportunities

Overnight planning cycle

6 AM

6 PM

Midnight

Night

Day

X-band
(Direct-From-Earth Uplink)

Daytime lander activity

ODY
(4 PM descending node)

MRO
(3 PM ascending node)
Surface Relay Metrics Through Sol 90

**Cumulative Relay Contacts**

- **Sol**
  - 0 to 90
  - Y-axis: Total # Contacts
  - Graph shows the cumulative number of contacts over Sol 90.

**Cumulative Relay Data Volume**

- **Sol**
  - 0 to 90
  - Y-axis: Total Retained Data Volume (Gb)
  - Graph shows the cumulative data volume over Sol 90.