



Curiosity - Phone Home!!!



Chad Edwards

Mars Chief Telecommunications Engineer
Jet Propulsion Laboratory
California Institute of Technology
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What's So Hard About Talking to Mars?

Earth GEO
Commsat



~40,000 km



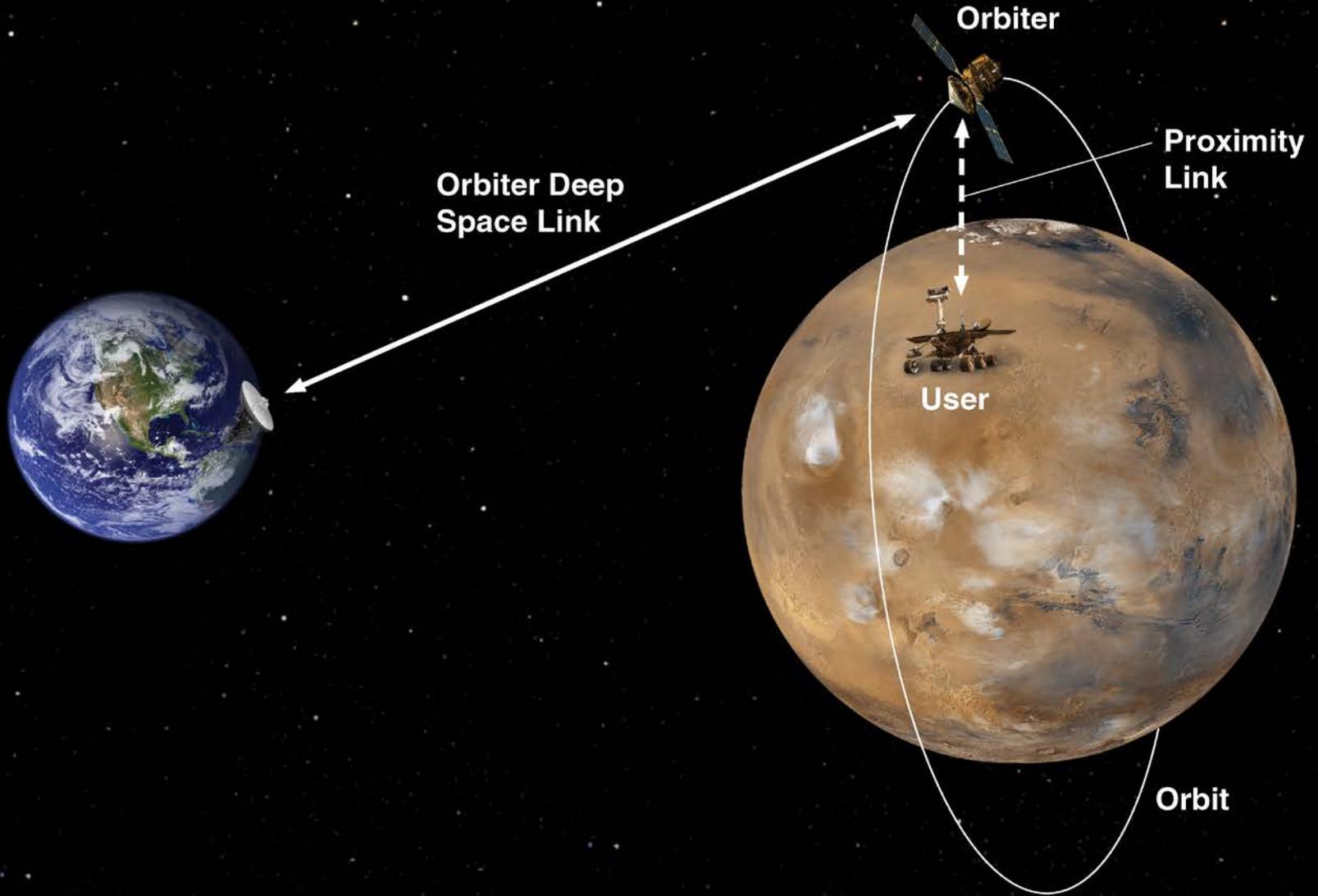
Up to 400,000,000 km



(Not to scale!)

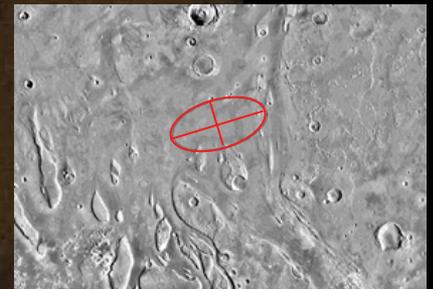
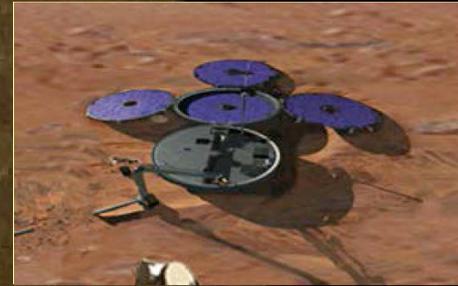
- 10,000 times larger distance
- ➡ 10^8 times harder to communicate

Mars Relay Concept



Mars Relay Network Benefits

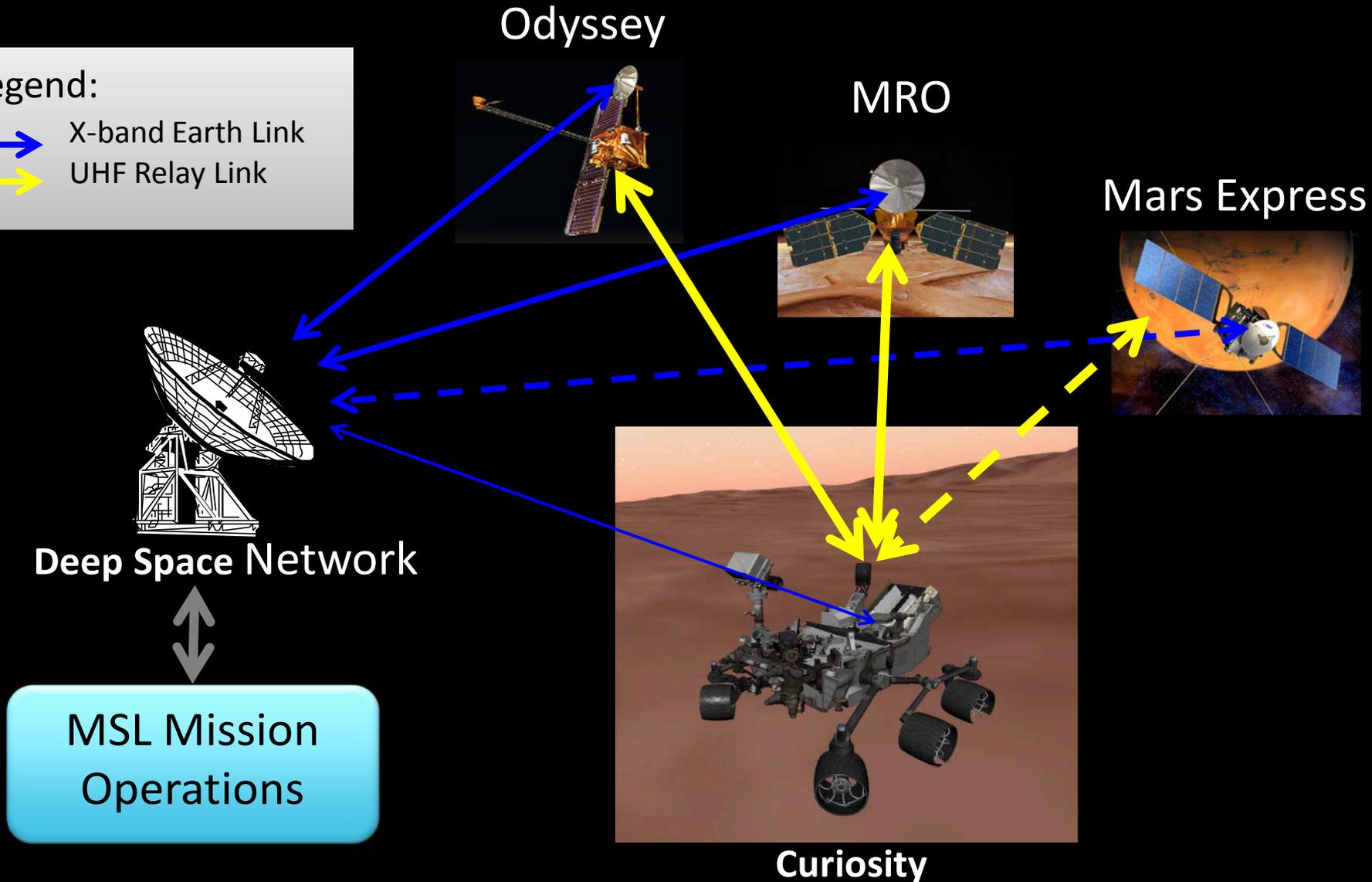
- *Increased data return*
- *Energy efficiency*
- *Critical event telemetry*
- *Radio-based navigation*



MSL Telecommunications Network

Legend:

-  X-band Earth Link
-  UHF Relay Link

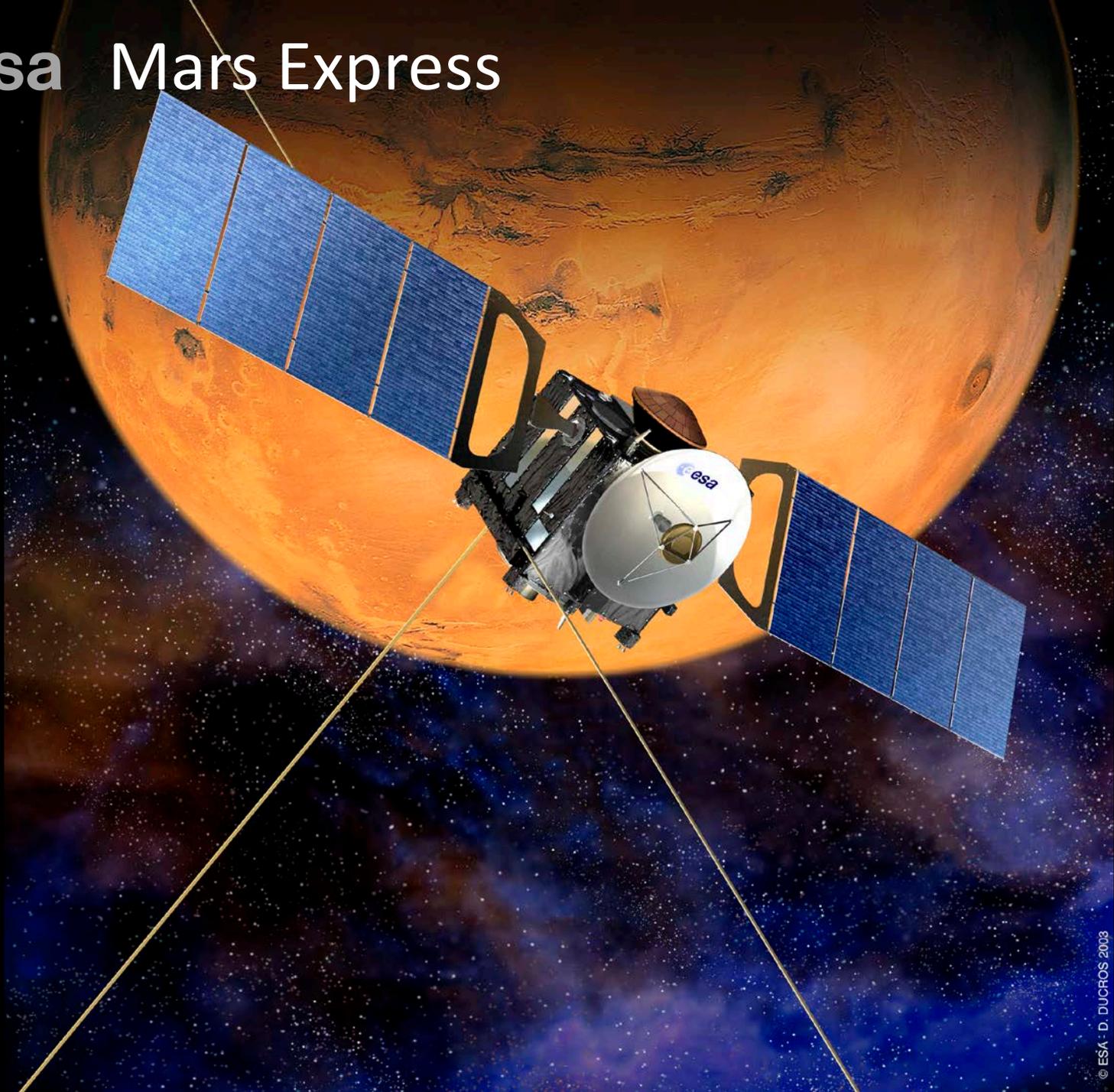




2001 Mars Odyssey

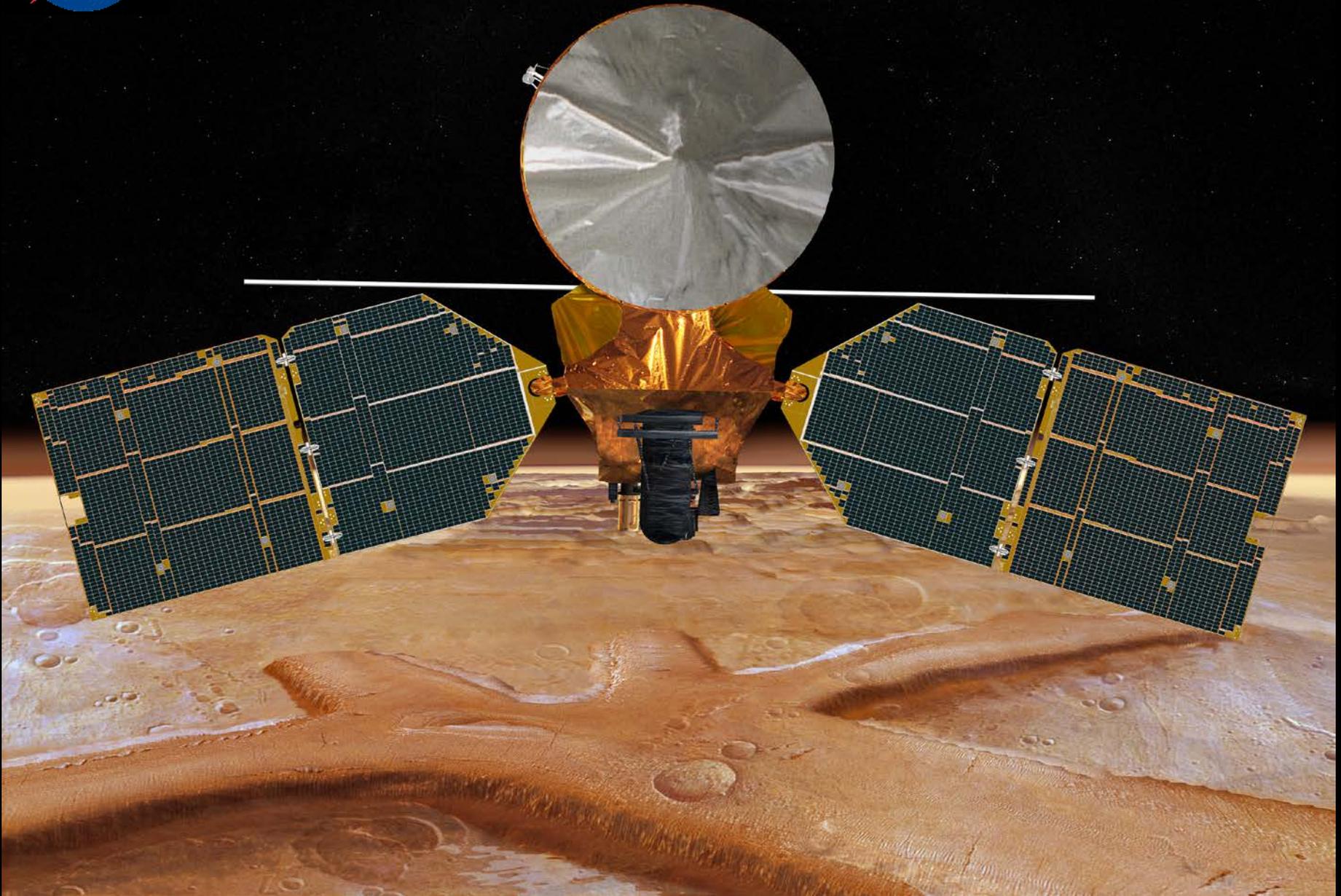


 **esa** Mars Express





Mars Reconnaissance Orbiter



Cruise Stage Separation

Cruise Balance Devices Separation

Entry Interface

Peak Heating

Peak Deceleration

Hypersonic Aero-maneuvering

Heat Shield Separation

Parachute Deploy

Radar Data Collection

Back Shell Separation

Powered Descent

Sky Crane

Flyaway

The 7 min of terror...

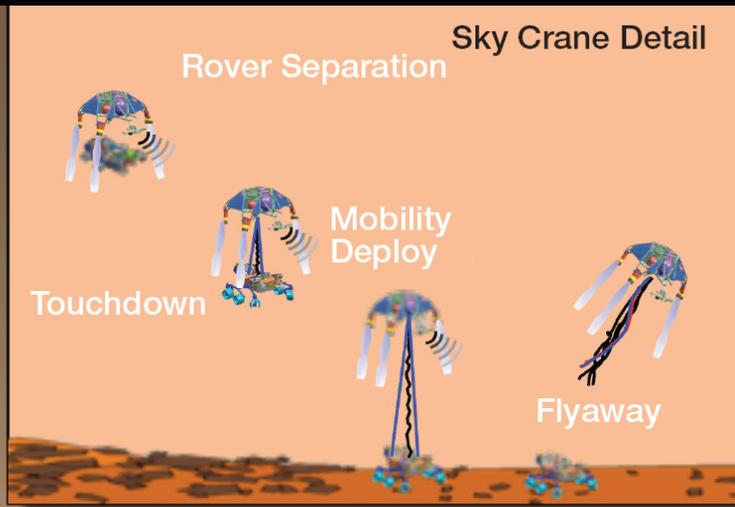
Sky Crane Detail

Rover Separation

Mobility Deploy

Touchdown

Flyaway

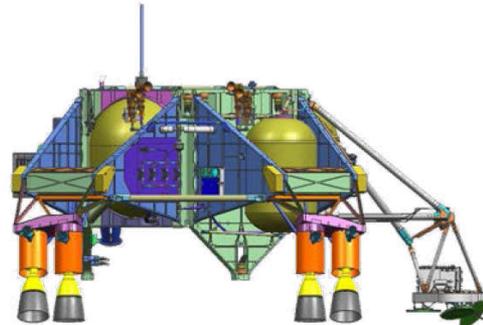




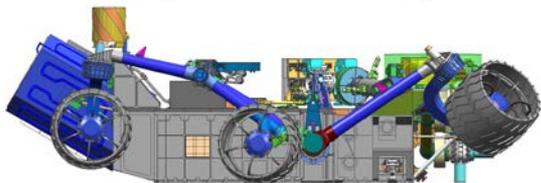
Cruise Stage



Backshell



Descent Stage

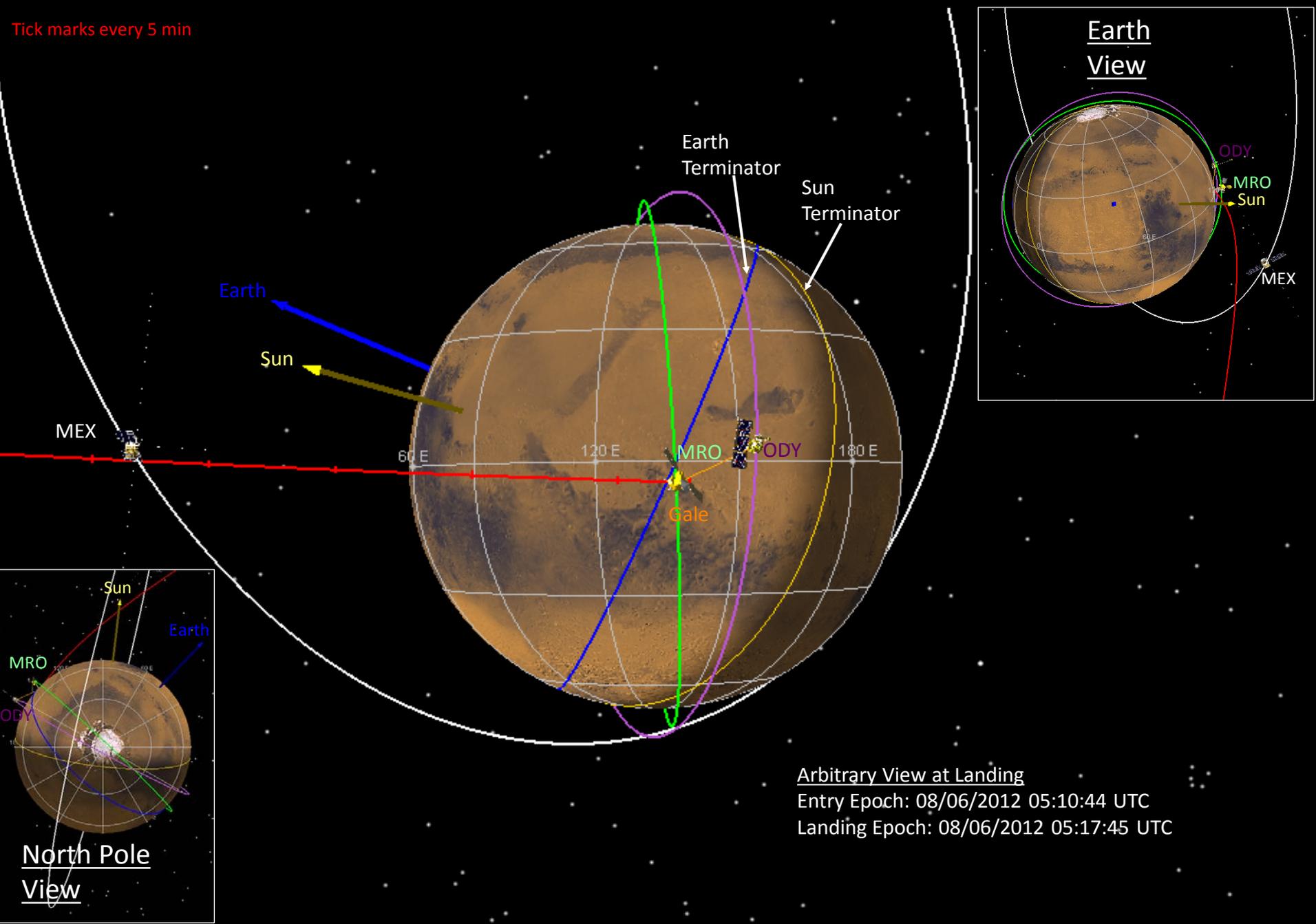


Rover

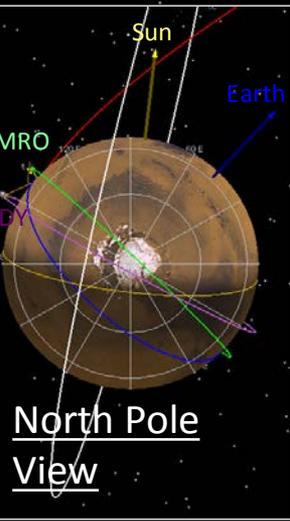
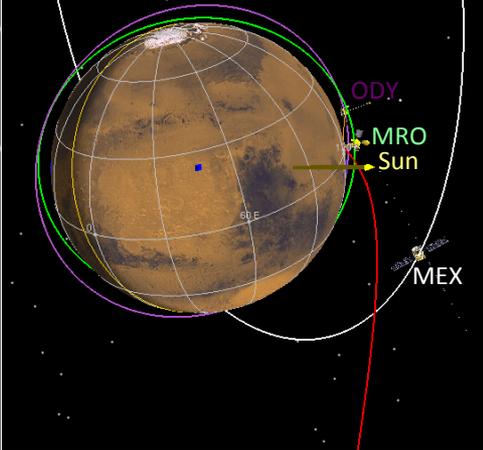


Heatshield

Tick marks every 5 min



Earth View



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 ---> | ---> Surface --->

Cruise Stage Sep Turn to Entry | Jettison Cruise Balance Mass | **Entry Interface** | **Parachute Deploy** | **Landing** Backshell Sep | **Surface** MSL HAZCAM Images

MSL
 X-band: Transmit MFSK Tones (~one 8-bit symbol every 10 sec)
 UHF: Transmit 8 kbps MSL Telemetry (MSL Txmt Until L+19m)

DSN
 Canberra 70m/34m Reception; Real-time Playback to JPL for MSL Carrier & MFSK Tone Demodulation
 DTE Signal Occultation (-40/+60 s)
 HiRISE Imaging
 Potential Short (~1s) UHF Dropouts Due to MSL Parachute Deploy, Backshell Sep, Powered Descent Dynamics

MRO
 High-Fidelity Open Loop Recording, Post-EDL Playback to Ground Post-Processing to Recover Carrier & MSL Telemetry (5 & 10 hrs latency)
 L + 5m 58s
 Nominal Coverage | Add'l Geometric Coverage (Uncertain Telecom Performance)

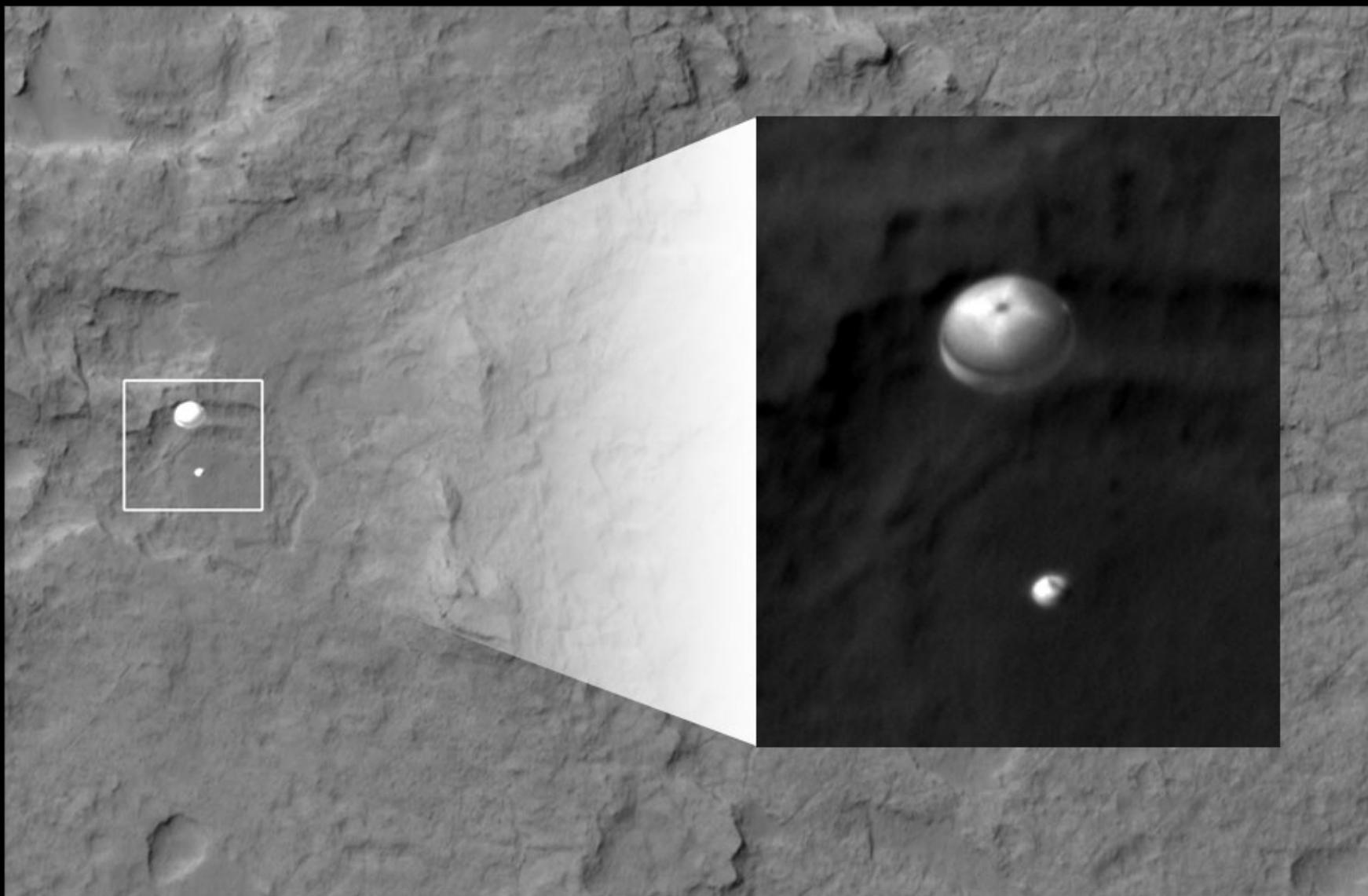
ODY
 Poor link performance | 8 kbps Demodulation & Bent-Pipe Relay to Earth Real-time visibility of MSL Carrier and Telemetry
 L + 7m 07s
 Nominal Coverage | Add'l Geometric Coverage (Uncertain Telecom Performance)

MEX
 "Canister Mode" Open Loop Recording, Post-EDL Playback to Ground for Post-Processing (Carrier-Only; 2.5 hrs latency)
 MEX sets prior to Landing
 + 60 s

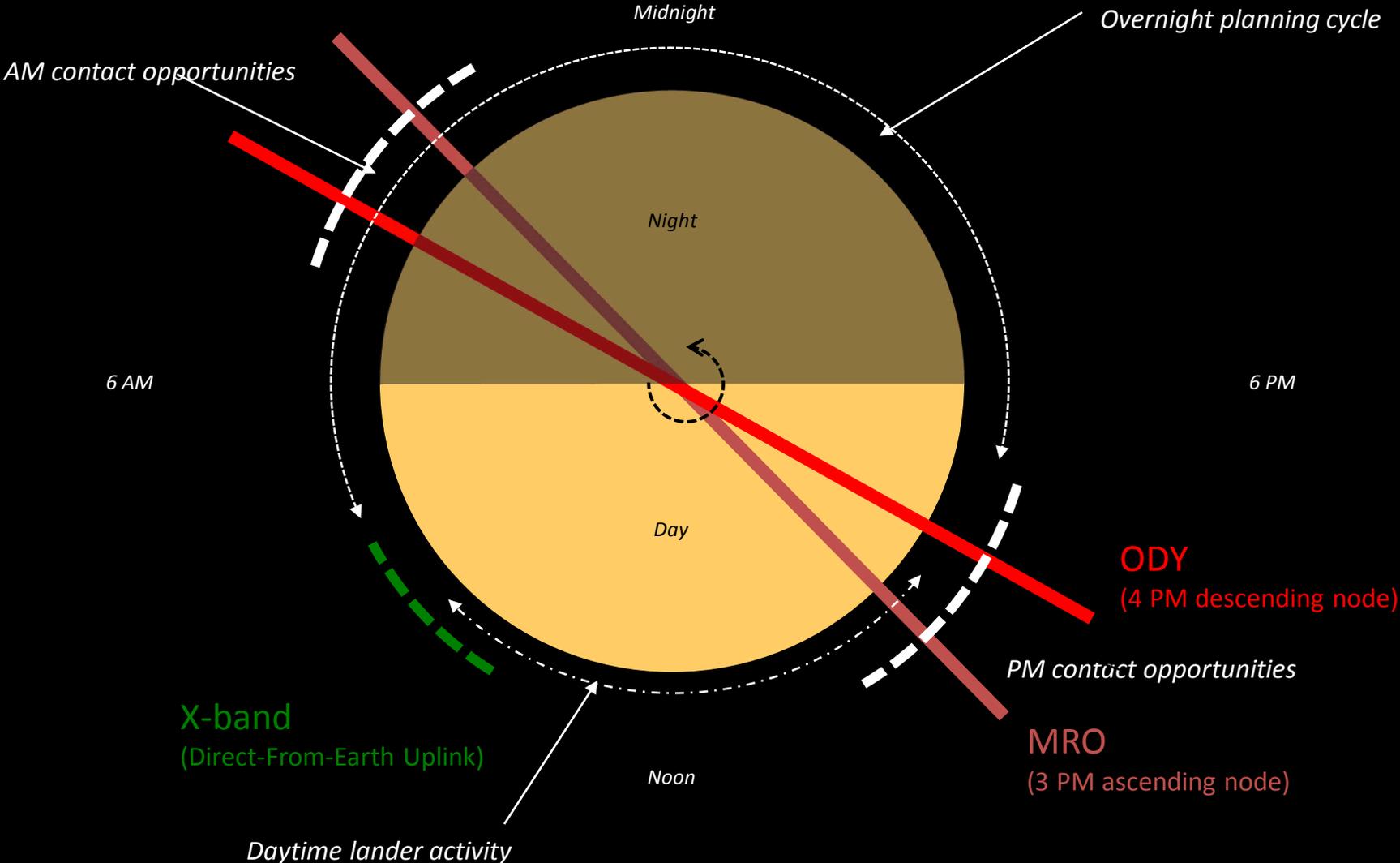
Time from Entry (sec)







MSL Surface Communications



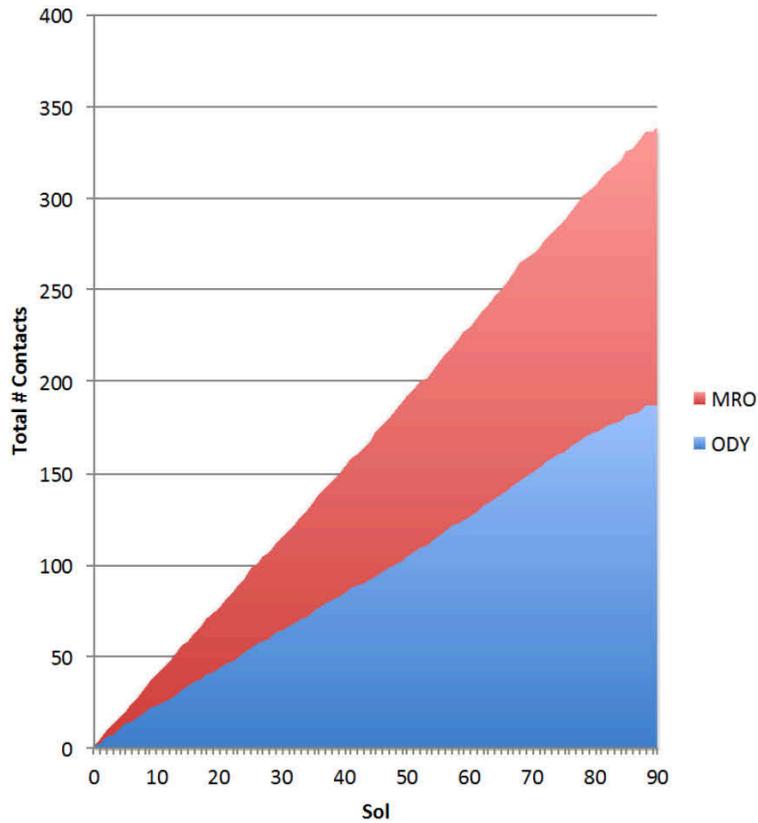






Surface Relay Metrics Through Sol 90

Cumulative Relay Contacts



Cumulative Relay Data Volume

