



SpaceOps 2016

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Mars Cube One (MarCO)

Shifting the Paradigm in Relay Deep Space Operations

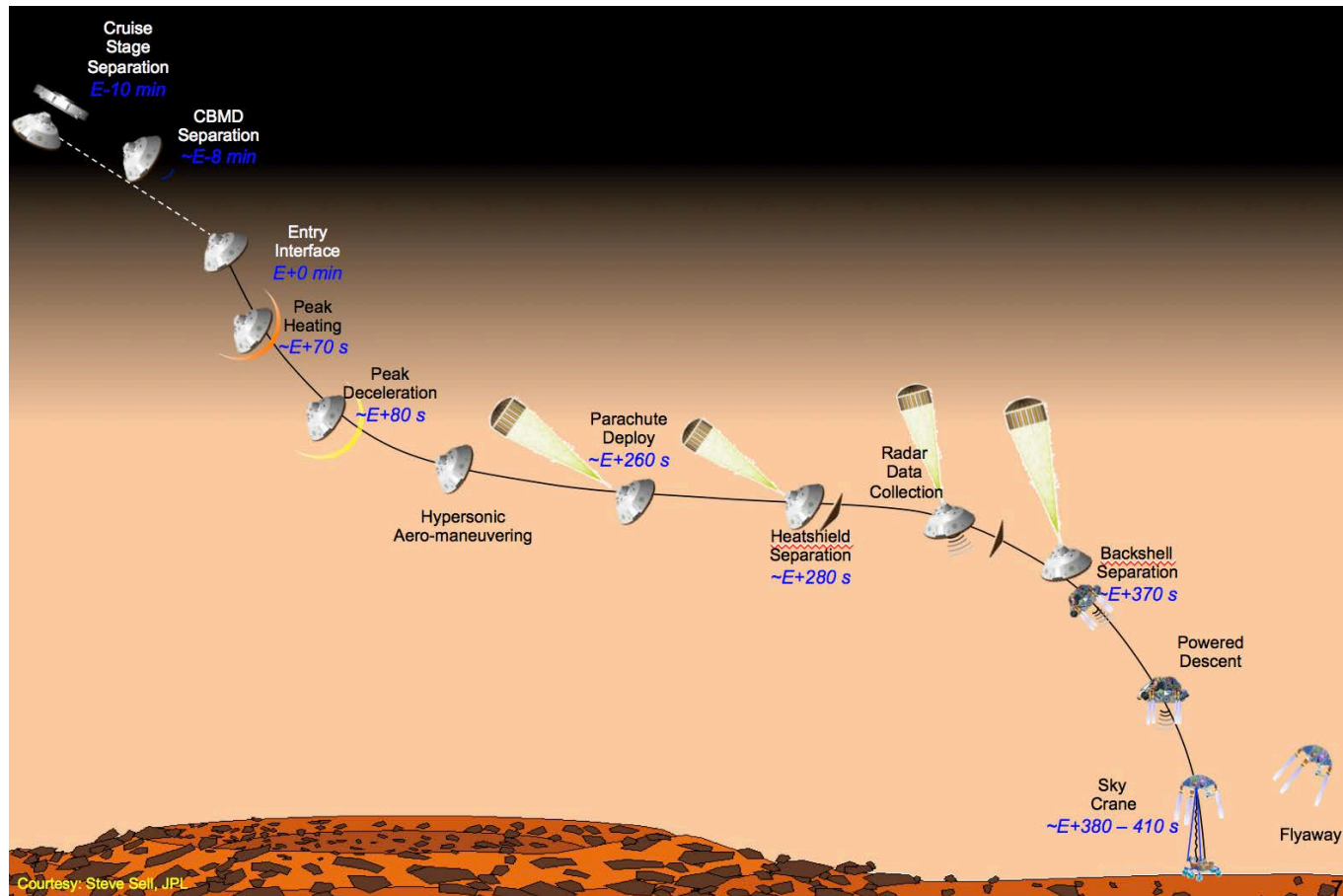
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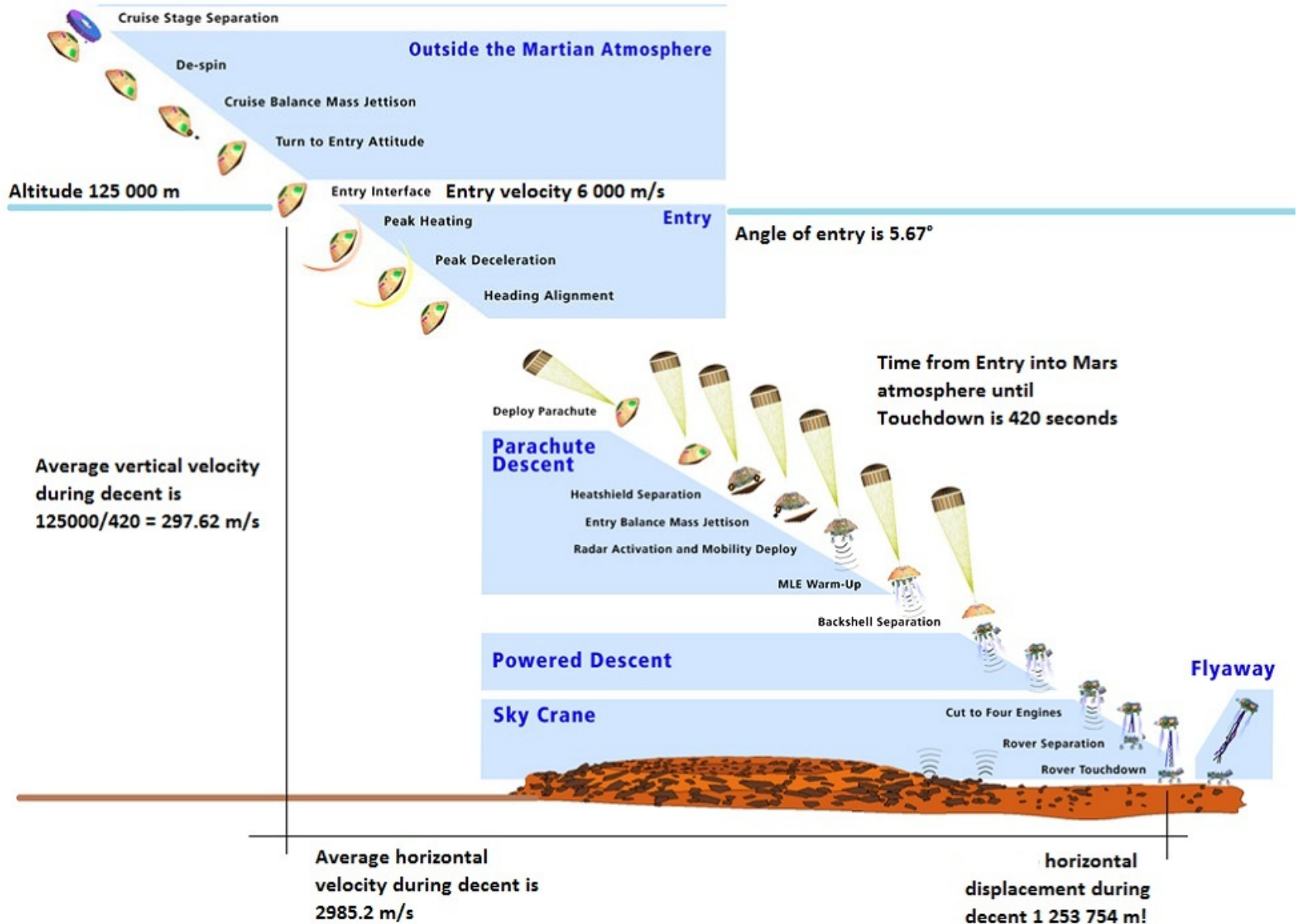
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EDL Minutes of Terror

- Planetary landers' highest risk is during Entry, Descent, and Landing phase
- Communications is vital but very difficult



EDL Complexity



Communications Methods - Relay

- An orbiter overhead receives UHF signal from lander
- Relays telemetry to DSN

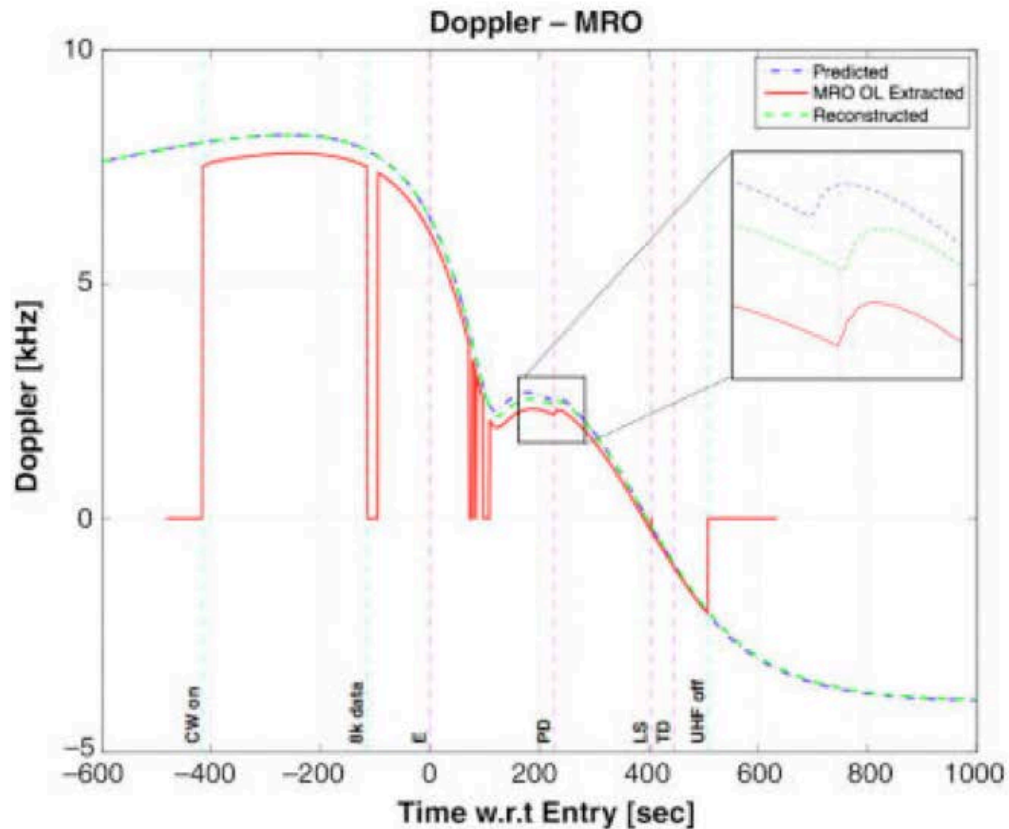
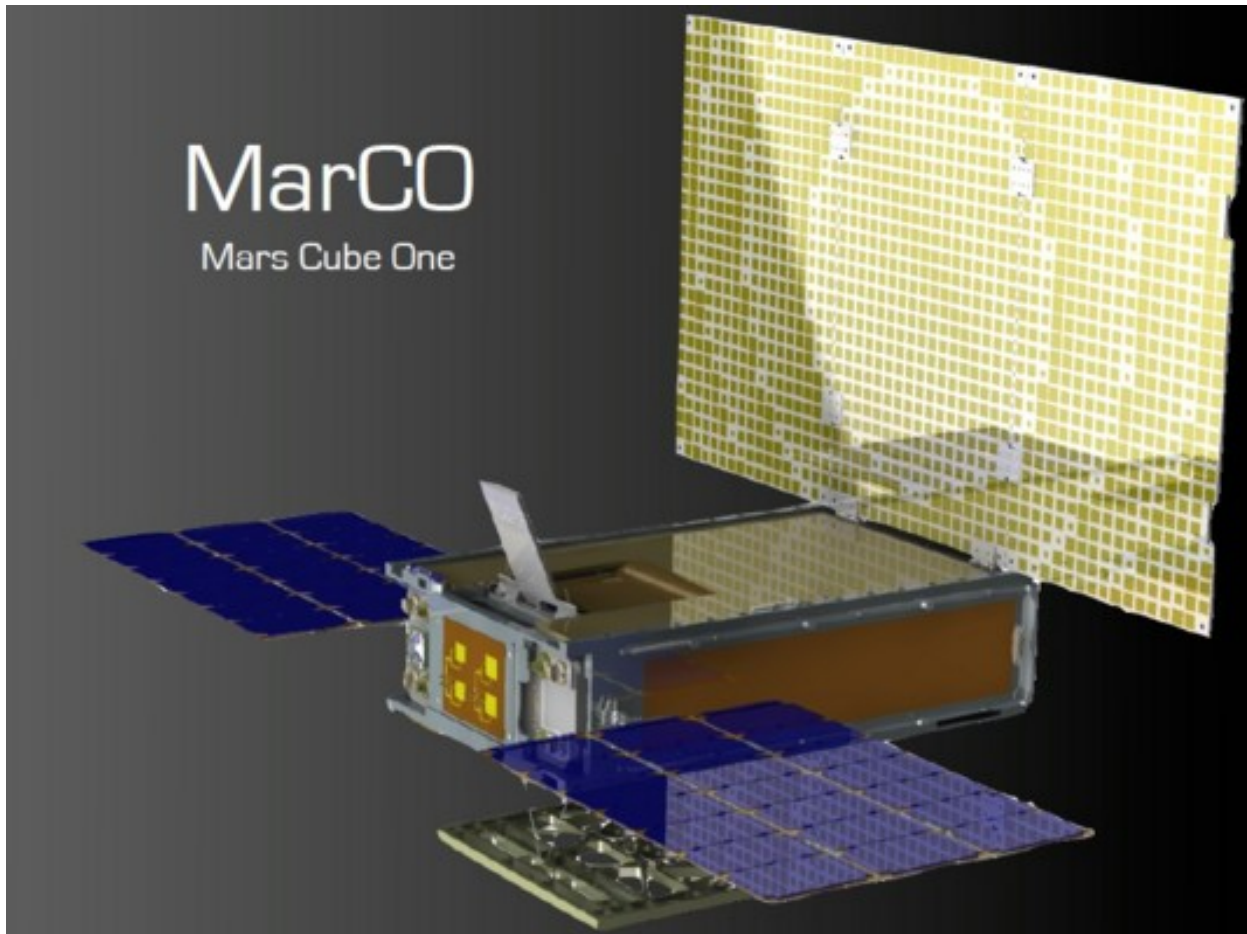


Figure 2. The Doppler profile of the EDL sequence of the Phoenix mission as captured and relayed through the MRO spacecraft in 2008.

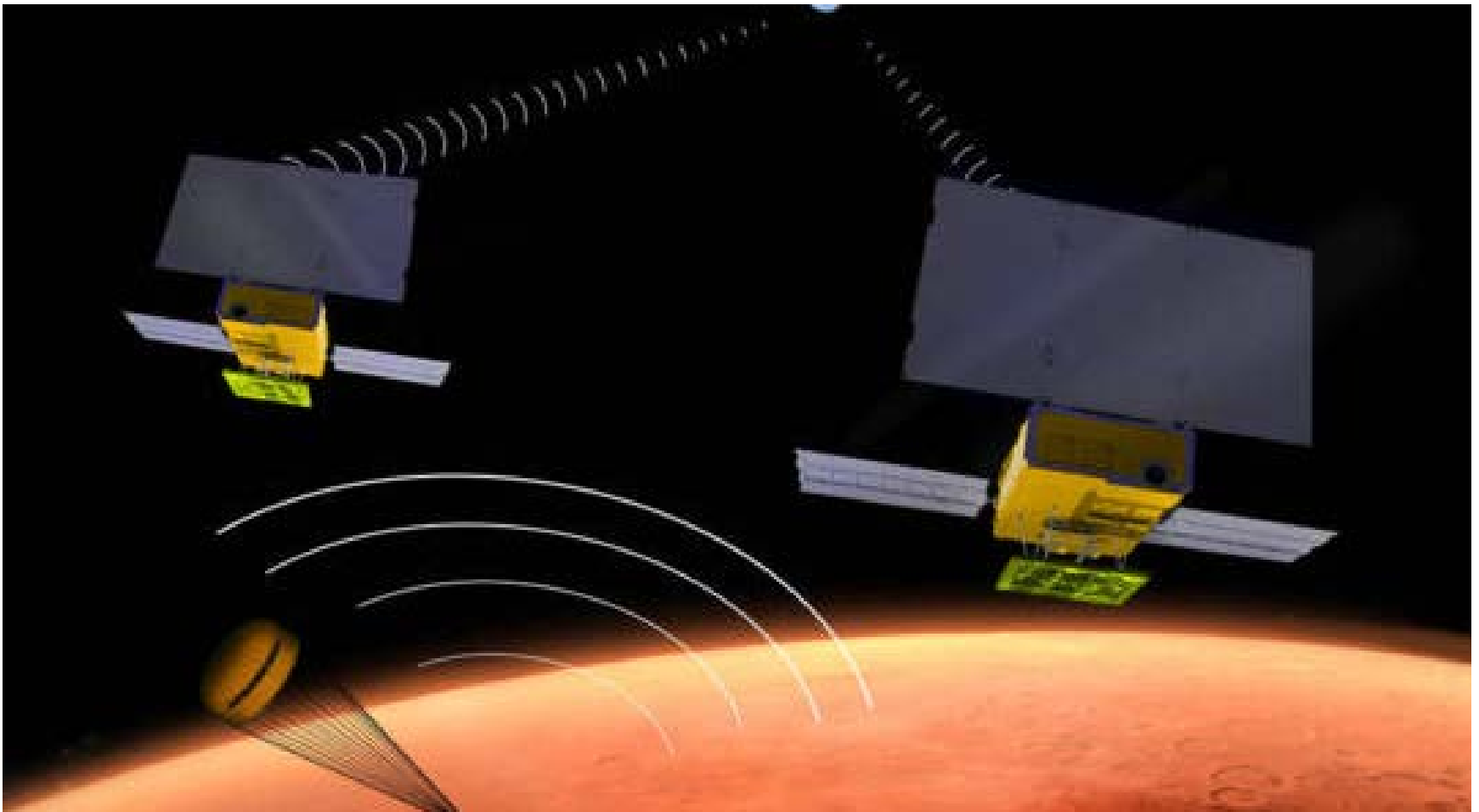
Communications Methods – Introducing MarCO

- CubeSats have not flown in deep space yet
- Fly a CubeSat with the mission to watch EDL event and relay data to DSN



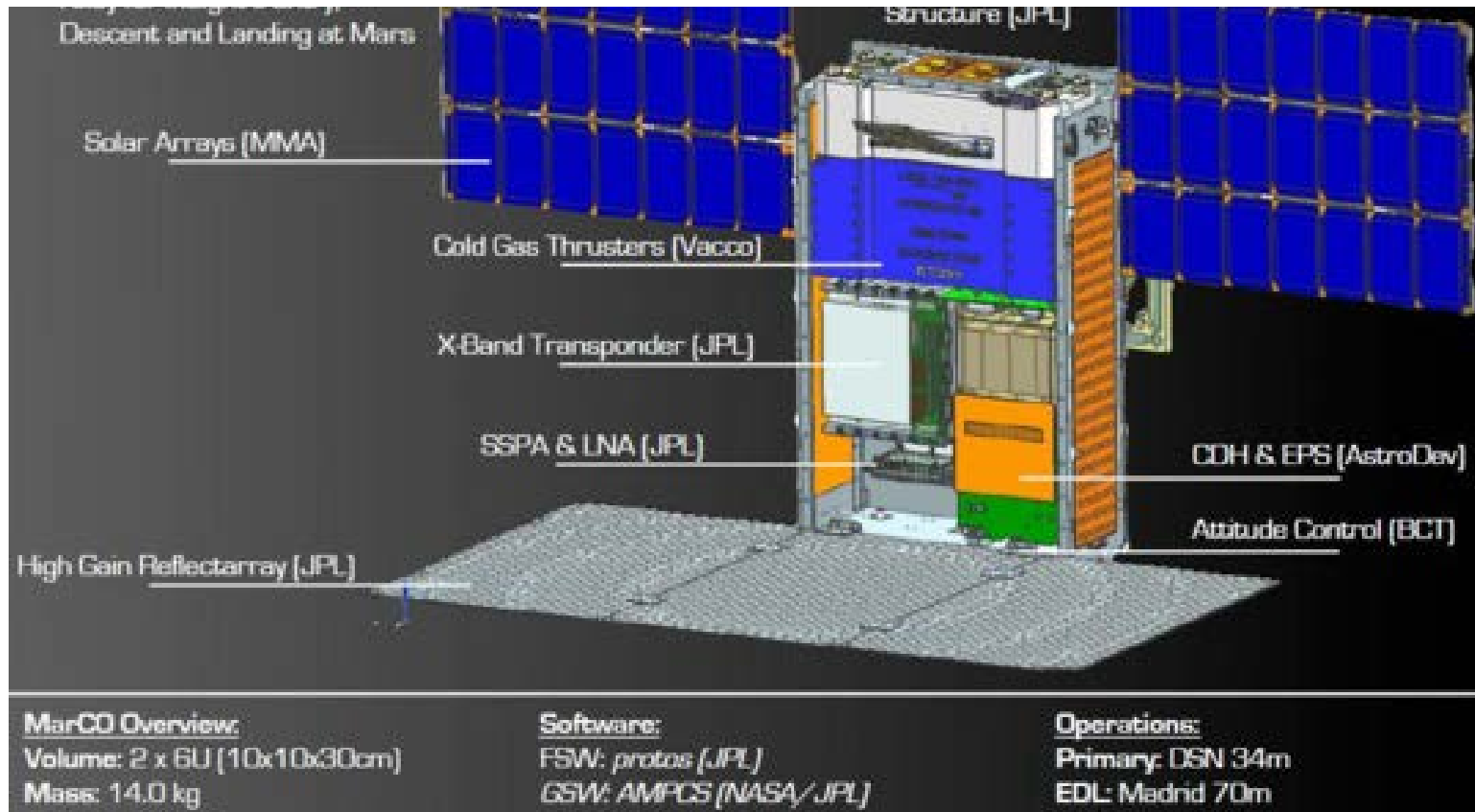
MarCO Special Features

- Enabled via advances in CubeSats and radio communications systems
- Needed to develop antennas that can handle UHF and X-band data rates
- Iris radio (second generation)



Stand Alone Mission

- MarCO carried on the same launch rocket as InSight but released around Earth and travel independently to Mars
- Carry all spacecraft subsystems for maneuvers and other functions



Conclusion

- Innovative concept of *carry your own relay*
- Reduces mission risk significantly at critical phases **at low cost**
- Can become common practice after the initial demonstration of technology
- Future concepts being examined for applications of MarCO-like planetary missions is Radio Science experiments
 - Spacecraft-to-spacecraft links enabled by two or multiple CubeSats around a planet
 - Utilize radio occultations of the atmosphere for profiling the ionosphere and neutral atmosphere
 - Surface scattering from the planet to characterize its material and electrical properties
 - The concept of crosslink radio occultations has been demonstrated between the Odyssey and MRO spacecraft and simulations show significant advantage in global coverage and SNR with two MarCOs around Mars
- Other scientific breakthroughs expected to be enabled with this method.