

Iris Transponder for Radio Science

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Program: Strategic Initiative

Project Objective

To improve radio science capabilities of JPL's SmallSat-class radio, and to identify SmallSat radio science mission concepts with near-term flight opportunities.

Year 2 of this effort is a transitional year, moving away from science requirements analysis and towards implementation studies and mission identification.

Benefits to NASA and JPL

A radio science-ready CubeSat radio creates opportunities for future CubeSat missions to include class-leading radio science capabilities. It also enables novel mission concepts with cutting edge radio science capabilities and brings SmallSat mission concepts such as constellation missions and small entry probes into the realm of possibility, and continues to enhance JPL's position as a leader in SmallSat technologies and radio science capabilities.

This task has identified and started prototyping enhancements that enable quality radio science using a SmallSat radio.

FY19 Results

Dual-band in a SmallSat Radio

- Completed an architecture study for transmit and receive paths.
- Utilizing a modern technique for waveform digitization and synthesis.

Better Hardware Versatility

- Improved hardware flexibility and parts reduction by moving more signal chain into software.
- Selected key electronic parts for transmitter and receiver.
- Conducted first-pass prototyping of dual-band RF-sampling waveform synthesis.

Mission Exploration

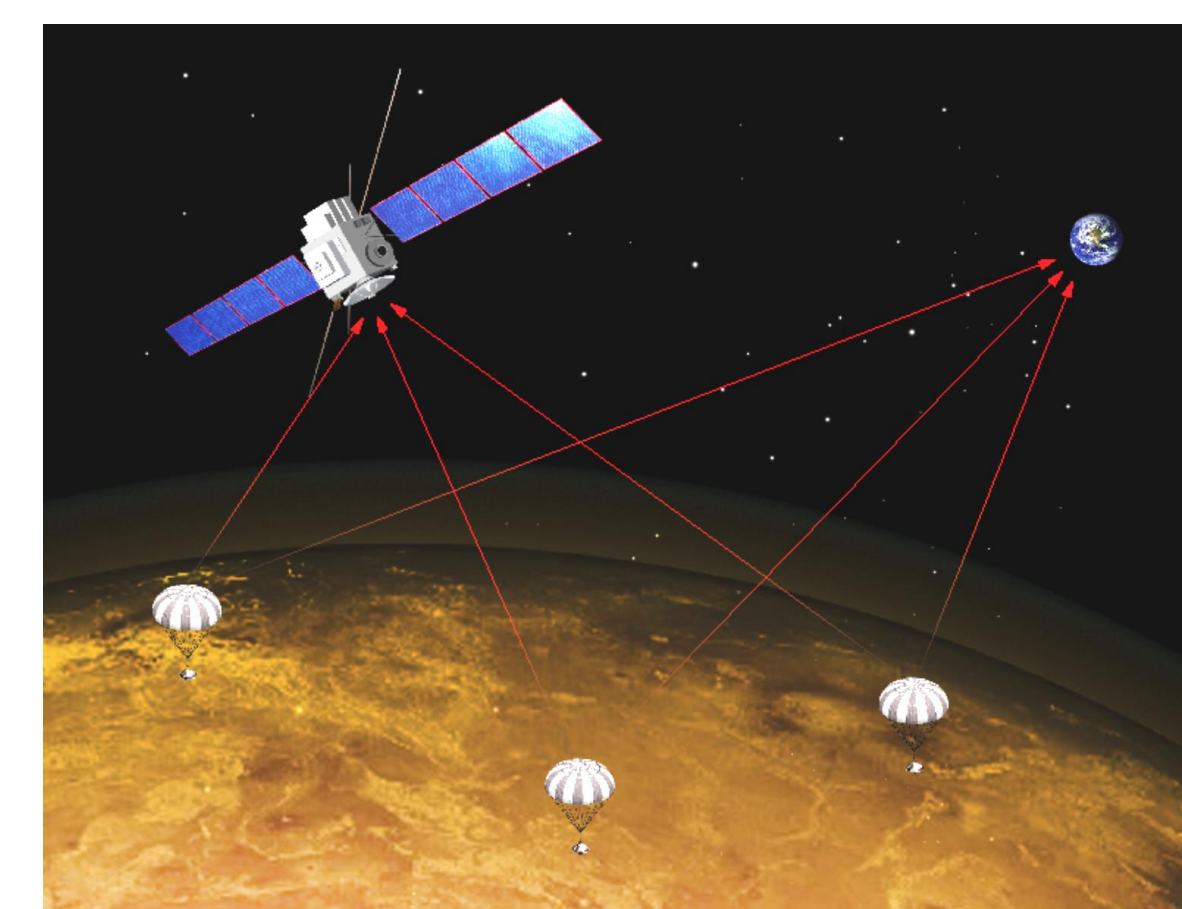
- Based on Radio Science Traceability Matrix, investigated a number of mission concepts appropriate for SmallSat radio science investigations.
- Presented SmallSat radio science concepts at multiple conferences throughout the year.
- Team-Xc Venus SmallSat radio occultation and JPL small Saturn atmospheric entry probe mission concept studies.

Potential Missions

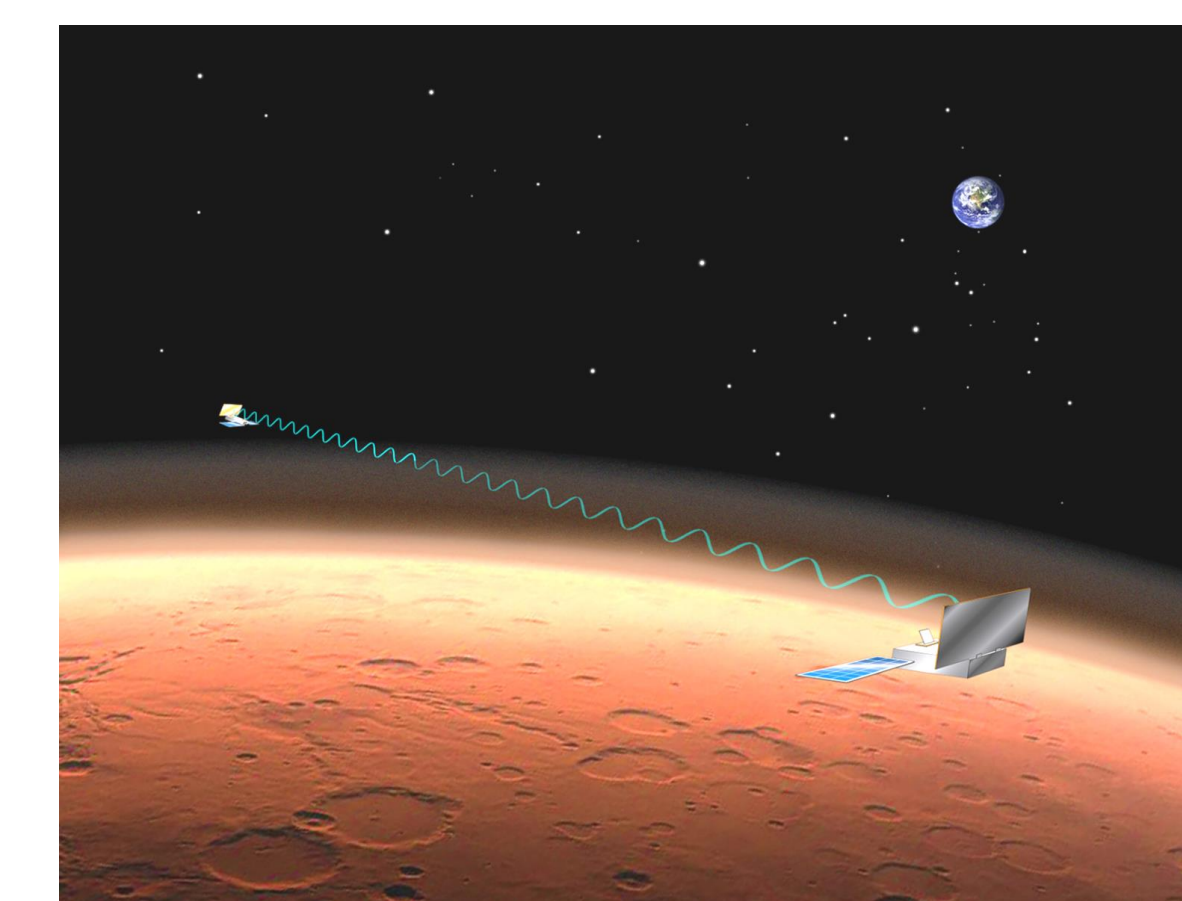
- In-situ SmallSat entry/descent probes at Venus, Titan, and giant planets, and balloons at Venus and Titan.
- Multiple SmallSats as Doppler relay stations for in situ probe missions to Venus, Titan, and giant planets.
- SmallSat constellations for cross-link radio occultation atmosphere studies
- Multiple SmallSat surface landers for precision tracking of planetary rotation parameters.

Science Objectives

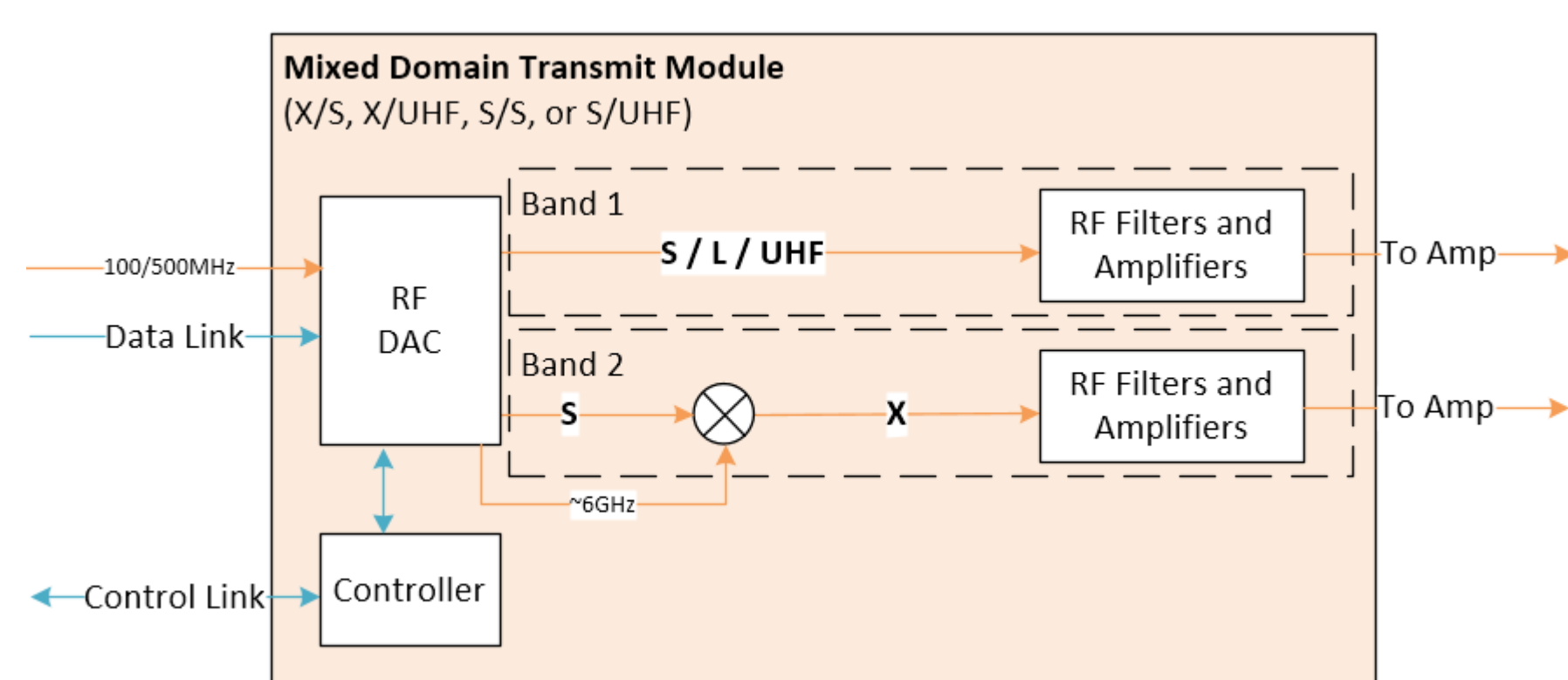
- Precision radiometric measurements of range and Doppler frequency from landers and SmallSat constellations to study planetary interiors, mass, and mass distributions.
- Plane of Sky position and range rate relative to out-of-atmosphere reference to measure atmospheric winds, waves, and tides from probe/balloon instantaneous and integrated velocity.



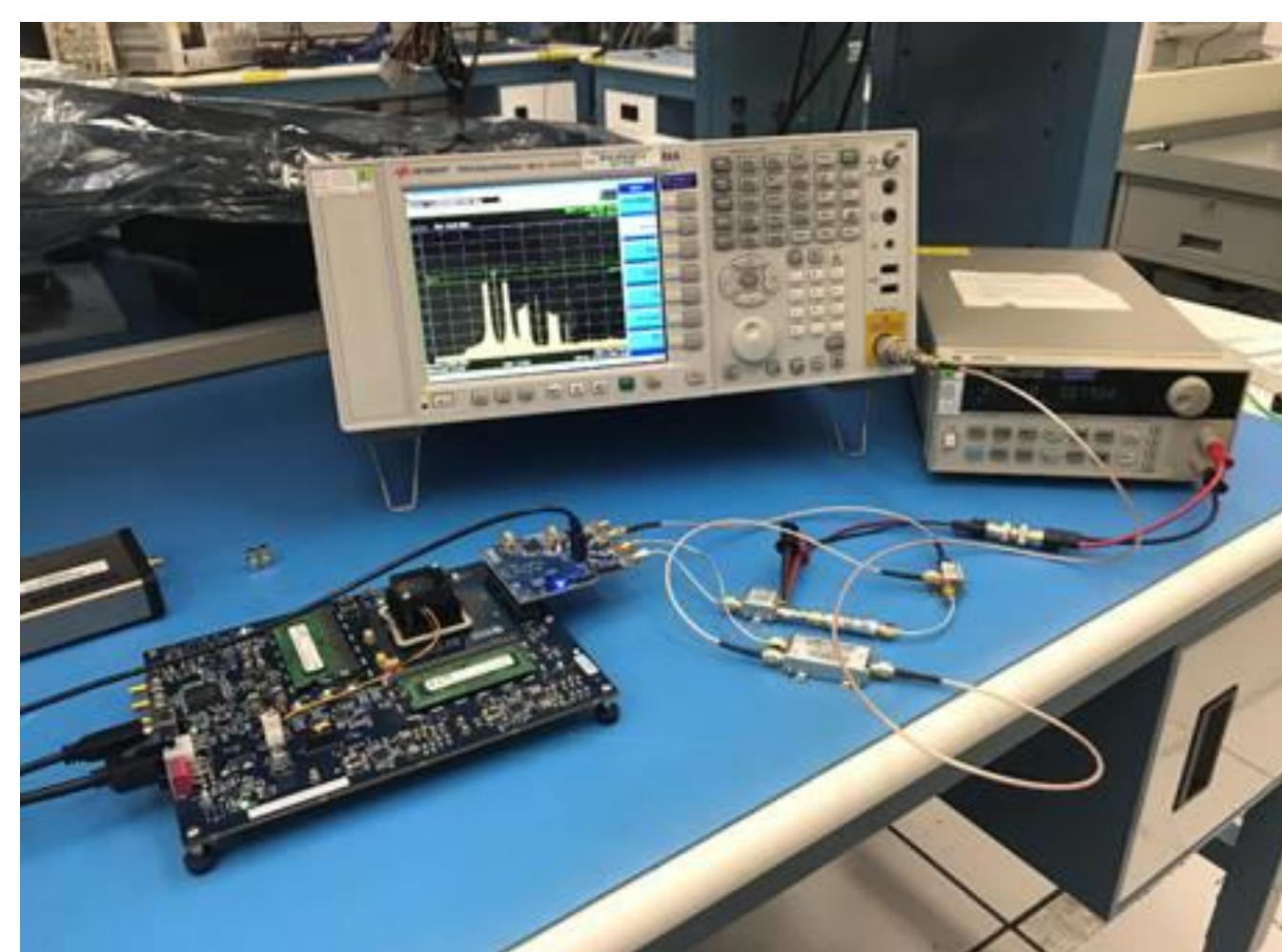
Concept Missions



Concept mixed-domain transmitter



Bench Prototype



Next Steps

- Bench prototyping of receiver electronics, including high-speed serial link.
- Explore packaging options: combining data converters and RF on a card could improve signal processing electronics modularity.
- Finish schematic design, complete board layout, build, and test.

Publications:

- Asmar, S., et al. "Planning Radio Technologies for Future Exploration of Planetary Environments and Interiors," AGU, 2018.
- Asmar, S. W., et al. "Future of planetary atmospheric, surface, and interior science using radio and laser links," *Radio Science*, 54, 2019.
- Asmar, S.W., D.H. Atkinson, et al. "A Review of Communications and Radio Science Techniques with Planetary Entry Probes," IPPW-2019, Oxford, July, 2019.
- Atkinson, D.H., et al. "Iris Transponder for Radio Science," American Geophysical Union Annual Conference, AGU, 2018.
- Vergados, P., et al. "Remote Sensing of Venus's Atmosphere Using Dual-frequency Cross-Link Communication Among CubeSats," American Geophysical Union Annual Conference, Washington, DC, 10-14 December, 2018.
- Vergados P., et al. "Understanding Venus's Seismicity Using SmallSat Radio Occultation Observations," EPSC-DPS Joint Meeting, Geneva, Switzerland, September, 2019.

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