DAVINCI Data Prioritization

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Brief Presenter Biography: Colby Goodloe is the lead systems engineer for the DAVINCI Descent Sphere. Prior to this role he was the Lucy project spacecraft systems engineer.

Introduction: The Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI) mission was selected in June 2021 as part of the NASA Discovery Program to explore Venus through remote sensing, in-situ chemistry measurements, and near-surface imaging. This mission will investigate the evolution of Venus' atmosphere using an architecture designed to optimize science-relevant measurements within the atmosphere and on targeted flybys. Slated to launch in 2029 and enter Venus June 2031, DAVINCI's Descent Sphere (DS) will transect the atmosphere acquiring chemistry and environmental measurements, as well as descent imaging of a highland region. This presentation focuses on prioritization and return of the revolutionary datasets. The mission overview and science motivations are summarized in Garvin and others [1][2].

Data Prioritization: During the entry and descent phase, DAVINCI's radio frequency (RF) S-band relay approach maximizes in situ science data return by utilizing a two-way coherent S-band Adaptive Data Rate (ADR) relay system. During relay operations, the link is first configured configured at a fixed rate 500 bps, which is used during the initial entry period when dynamics are high. The ADR algorithm is enabled after heatshield jettison, ~2.8 minutes after Atmospheric Entry Interface. The DS relay data rate will increase or decrease based on the received signal strength detected at the spacecraft, Figure 1 [3]. The implication of ADR is that data volume returned is non-deterministic. Three cases with different but realistic assumptions for the quality of the link demonstrate the wide range of possible data volume returned, Figure 2.

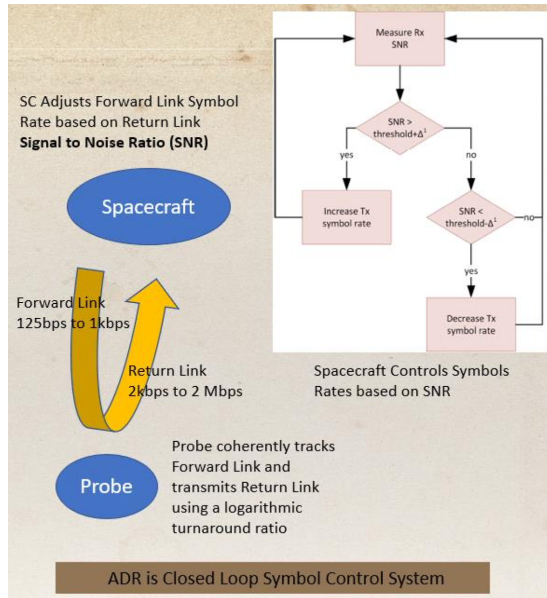

Figure 1: Adapative Data Rate Concept

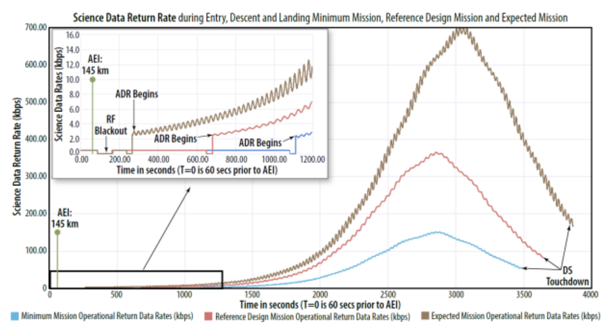

Figure 2: Varying Return Link Data Rate Profiles

The instruments produce significantly more data than is strictly necessary to meet the Level 1 science, especially the Venus Descent Imager (VenDI) camera. The DAVINCI team developed a data prioritization algorithm to guarantee the required data sets are transmitted first. Additional retransmissions are included in the scheme. Finally, if the link is strong on the particular day of descent then additional images, housekeeping, and high rate sensor data is transmitted. The DS flight software team implemented a prototype of data prioritization utilizing the core Flight System (cFS) [4] with the addition of a Data Prioritization (DP) application and a FIFO buffer interface library (FIFO_LIB) that buffers data for the radio. DP utilizes the heritage Software Bus (SB) message publish/subscribe support to implement a live data queue for the highest priority data with the tightest latency requirements. All data is also stored to files using the heritage Data Storage (DS) application with a naming scheme that supports sending the files out over multiple queues. DP periodically scans the stored files and stages the newest, highest priority file with the heritage CFDP application (CF) for class 1 transmission, utilizing two channels to support file interleaving to meet the latency requirements for VenDI priority images at low altitudes. Each processing cycle DP determines the amount of data to transfer to the FIFO_LIB based on the radio rate, and transfers that amount of data utilizing the following order: live data messages, VenDI priority image messages, and remaining file messages.

References:

[1] Garvin, J., *et al.* (2022) *Planetary Science Journal*, 3:117. [2] Sekerak. M., *et al.* (2022) *2022 IEEE Aerospace Conference*. [3] Crifasi, A. (2022) *IAF Space Communications and Navigation Symposium* [4] https://github.com/nasa/cFS