Real-time Operations Using DSN for HAYABUSA

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Abstract: We performed on-line operations transferring commands and telemetry in real-time using foreign ground stations (i.e., DSN stations of NASA) for HAYABUSA (MUSES-C) for the first time for science spacecraft of ISAS. This paper discusses summary of operations results, the system configuration used for these operations, and lessons learned for future missions.
1. Introduction

Real-time operations were performed using the Deep Space Network (DSN) of NASA for HAYABUSA (MUSES-C). A tracking network that does not belong to ISAS was used for real-time operations of ISAS’s science spacecraft for the first time. Commands were generated at the Sagamihara Space Operations Center (SSOC) and transmitted to the spacecraft through the DSN stations in real-time. Telemetry was received at the DSN stations from the spacecraft and delivered to SSOC in real-time, where it was monitored and analyzed. During some tracking passes, ranging was also performed and range and Doppler data was monitored at SSOC in real-time.

2. Results of Operations

The DSN was used on a test basis right after the launch of HAYABUSA in May 2003, but it was used extensively when HAYABUSA performed touch-down operations in November 2005. For a touch-down trial or a rehearsal of touch-down, operations were performed continuously for 72 hours using the Usuda (JAXA), Madrid (DSN), and Canberra (DSN) stations.

The number of DSN tracking passes used in November 2005 were as follows: Madrid 29, Goldstone 11, and Canberra 3. During critical operations, a backup antenna at the same location as the primary antenna was also used. The above numbers also include these backup passes.

3. Space Link Extension (SLE)

Commands and telemetry were transferred between SSOC and DSN using a protocol called the Space Link Extension (SLE). The SLE is an international standard protocol for transferring commands and telemetry either in real-time or in an off-line manner and was developed by the Consultative Committee for Space Data Systems (CCSDS).

Since the basic functionality of SLE is similar to the Space Data Transfer Protocol (SDTP) that is used as the standard protocol throughout the ISAS space operations system for transferring space data including commands and telemetry, a gateway that converts SLE into SDTP and vice versa
(which is called the SLE Gateway) was developed by ISAS and installed at SSOC. SLE has some functions that SDTP does not have but it has all the functions that SDTP has, and therefore DSN stations can be accessed with SDTP through the SLE Gateway. This means that all the computers of the ISAS operations system (whether they are located at SSOC, Uchinoura or Usuda) can use DSN stations just like the Uchinoura 34m or 20m station or the Usuda 64m station. The only necessary change is to change the station identifier. The system configuration within ISAS is shown in Figure 1.

Later, similar SLE gateways were developed for the JAXA New Ground Network (GN) stations and the Svalbard station in Norway. These gateways have been used for HIKARI (ASTRO-F) and HINODE (SOLAR-B) for using the New GN stations and the Svalbard stations for real-time operations.

4. Lessons Learned

The following are lessons learned through using DSN for operations of HAYABUSA.

1) When critical operations are performed, a backup antenna should be used in case the primary antenna fails.
2) When critical operations are performed, the details of the operations should be explained to the DSN engineers in advance so that they can prepare their internal operations procedures in advance.
Figure 1. System Configuration when DSN is used