High-Fidelity Telecom Analysis Techniques for Spacecraft Dynamic Events

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Traditional telecom planning is usually limited to single point, worst-case scenario analysis of a static communication link. Communications during spacecraft dynamic events (which are usually critical) like launch, trajectory correction maneuver, and orbital insertion are usually not sufficiently characterized a priori. The lack of high-fidelity simulation of spacecraft dynamic events results in:

1) Limited ability to timely detect and react to spacecraft anomalies. This might lead to loss of encounter opportunities or even loss of mission.
2) Limited ability to plan and analyze mission communication design and operation strategy during the design phase. This might lead to insufficient information to quantify operation impact and subsystem interaction, resulting in bad onboard design, inefficient telecom resource usage, and reduced science return.

In this paper we describe a systematic approach to support telecom planning and analysis for spacecraft dynamic events. This approach involves 1) a standard interface with the NAIF SPICE data to input spacecraft trajectory and attitude information, and 2) a set of attitude heuristic models that simulate the spacecraft attitude in the normal mode and in the safe mode. These techniques are currently implemented in the operational telecom forecaster predictor (TFP) link analysis tool. The TFP tool was used to support the DS1 high-gain antenna pointing activities in the absence of the stellar reference unit (SRU). The TFP tool was also used to support the planning and execution of the Mars Odyssey orbital insertion (MOI) critical event on August 28, 2001. This tool is now being used to support the Space Infra-Red Telescope Facility (SIRTF) launch scenario analysis using DSN and non-DSN stations.

The rest of this paper will describe in details how we apply the above techniques to support telecom planning and analysis of the mission dynamic and critical events.