FMT (FLIGHT SOFTWARE MEMORY TRACKER) FOR CASSINI MISSION OPERATIONS
- A GROUND DATA ANALYSIS TOOL"

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ABSTRACT

The Flight Software Memory Tracker (FMT) is a ground data analysis “Tool”, developed for
generic mission operations, that has been customized to the specific design of the Cassini
spacecraft.

Tracking flight software (FSW) images on-board spacecraft is a vital activity in ground systems
and mission operations. This is particularly true for one-of-a-kind spacecraft built for space and
planetary exploration, upon which the FSW requires constant maintenance, patches, parameter
changes, and occasionally even complete new memory loads. Complete and accurate knowledge
of current and past FSW images is essential.

In the history of spacecraft operations at the Jet Propulsion Laboratory (JPL), ground mission
operations analysts utilize various degrees of automation, integration of software tools and manual
procedures to track FSW. While dynamic memory addresses can only be tracked by full-up
hardware and software simulation, static memory addresses, constants, and certain quasi-static
parameter addresses are always tracked. For address spaces of interest, an up-to-date FSW image,
a FSW image at a specific time in history, and a trend of certain parameters over time, are often the
basis for analysis, diagnosis and prognosis.

For Cassini mission operations, FMT is used routinely to track FSW code and parameter address
spaces of interest for the AACS (Attitude and Articulation Control Subsystem) and the CDS
(Command and Data System). Multiple ground FMT images are maintained. These images are
living images which are updated per activity commanded or sequenced on-board the spacecraft.

FMT maintains a history of every FSW image copy on-board the spacecraft. AACS has twelve
images, corresponding to the two redundant AACS_A and AACS_B RAM (Random Access
Memory) images, eight SSR (Solid State Recorder, A and B, each with four memory_load
partitions) images, and two BAIL (EPROM backup storage) images. CDS has ten images,
corresponding to the two redundant CDS_A and CDS_B RAM images and eight SSR images.

When on-board FSW images are updated, FMT images are updated accordingly. As living
images, FMT maintains a history of every FSW image copy on-board the spacecraft. FMT images
can be “evaluated” at any specific time of history, can be queried for history and statistics, and can
be processed to produce human readable parameter values in engineering units instead of machine
representation, etc. On-board FSW images are updated by uplink commands transmitted to the
spacecraft. The same commands can be parsed! and interpreted by FMT to produce update data
groups which can be appended to FMT images. Memory readout of spacecraft address spaces (in
addition to normal telemetry downlink) can also be used to update FMT images. Generic
commands to update on-board FSW images and FMT images can also be generated by FMT
through an analysis of differences in specific FMT images subsequent to intended or unintended spacecraft reinitialization, or in order to revive specific images / parameters at specific instances of history.

Providing a capability to handle/archive/query large volumes of data and user friendliness for mission operations analysts presented a design challenge for FMT. This paper is limited to the operations aspects of this tool, software engineering and JAVA software design aspects of FMT are discussed in a separate paper.

FMT is implemented as a program set, comprised of multiple “utility” programs. Some of the utilities are programs that also call other FMT utilities. FMT users are best served by executing scripts, such as UNIX scripts, to achieve the higher-level objectives of FMT.

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