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An Overview of Octant Technologies Command & Control Software Products

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Executive Summary

Octant Technologies Inc. has been engaged in developing spacecraft flight software and ground software for a variety of missions since the company was founded in 1997. Our customers have included The Boeing Company, Lockheed Martin, the Missile Defense Agency (MDA), the Naval Warfare Center and the Air Force Research Laboratory (AFRL).

Most recently, Octant developed and delivered Ground Segment software for the XSS-10 and XSS-11 micro-satellites. Our Ground Segment software for the XSS-11 program is currently in use by the operations personnel at Kirtland AFB. The utility and flexibility of our software has been demonstrated in real-world mission operations by these two highly successful AFRL programs.

In supporting the XSS-10 and XSS-11 programs, Octant Technologies Inc. has gained unique insight and experience in working with the Kirtland AFB community and has familiarized and trained their spacecraft operations personnel in the use of our Ground Segment software products. This white paper provides an overview of Octant's Ground Segment software products and tools.

Introduction

Octant's Command and Control (C&C) software provides the following capabilities:

- Performs configuration and de-configuration of a variety of ground system equipment;
- Performs real-time commanding of the Space Vehicle via S-Band;
- Receives, de-commutates, records and displays down-linked Space Vehicle telemetry.

This white paper provides a summary description of Octant Technologies Command & Control (C&C) software capabilities.

Product Overview

Octant Technologies Inc. offers a family of tools primarily for the aerospace market and has used and refined these tools on several spacecraft flight software and ground software development programs.

Octant Technologies Inc. products and tools include the following:

- Orion/MMS[®] represents a rapid prototyping platform that is used to host embedded software developed using design automation tools.
- TlmScope[™] is a general purpose telemetry processing tool used for the de-commutation, display, recording, playback, and trending of real-time telemetry items.
- CmdBuild[™] is a command generation and transmission tool and uses a memory resident real-time database for accessing command formatting information.

Octant Technologies Inc. also provides software modules associated with Star Tracker applications as well as aerospace component modules for both flight software development and space environment simulation.

The TlmScope[™] and CmdBuild[™] product items provide the core processing elements required for a Mission Operations Center (MOC),

the Command & Control (C&C) component in particular. The robust design of these tools is being demonstrated with the day-to-day mission operations being conducted at Kirtland AFB for the XSS-11 micro-satellite.

The Orion/MMS[®] product provides a satellite simulation capability when combined with appropriate aerospace component models. Orion/MMS[®] was used to develop the XSS-11 Mission Simulator (MSIM) that was employed during numerous mission exercises and rehearsals to train the XSS-11 Flight Operations Team (FOT). Early deliveries of the XSS-11 MSIM also enabled the hardware and software components of the ground segment to be fully integrated and tested ahead of Factory Compatibility Testing (FCT).

TlmScope[™]

The TlmScope[™] product consists of a series of modules. These modules are referred to as TlmPlayer, TlmDecom and TlmRecorder. TlmScope[™] makes use of 3rd party tools for a memory resident real-time database and display, alarm, logging and trending capabilities. The TlmScope[™] and CmdBuild[™] products along with the 3rd party tools are illustrated in Figure 1.

The TlmPlayer module allows the user to select between live telemetry and recorded telemetry as the data source. When used in conjunction with TlmRecorder, TlmPlayer provides a telemetry playback capability that replays the raw binary data recorded by TlmRecorder back through TlmDecom.

The TlmRecorder module provides a telemetry recording capability that records the incoming telemetry as raw binary data before the data is de-commutated or converted to engineering units.

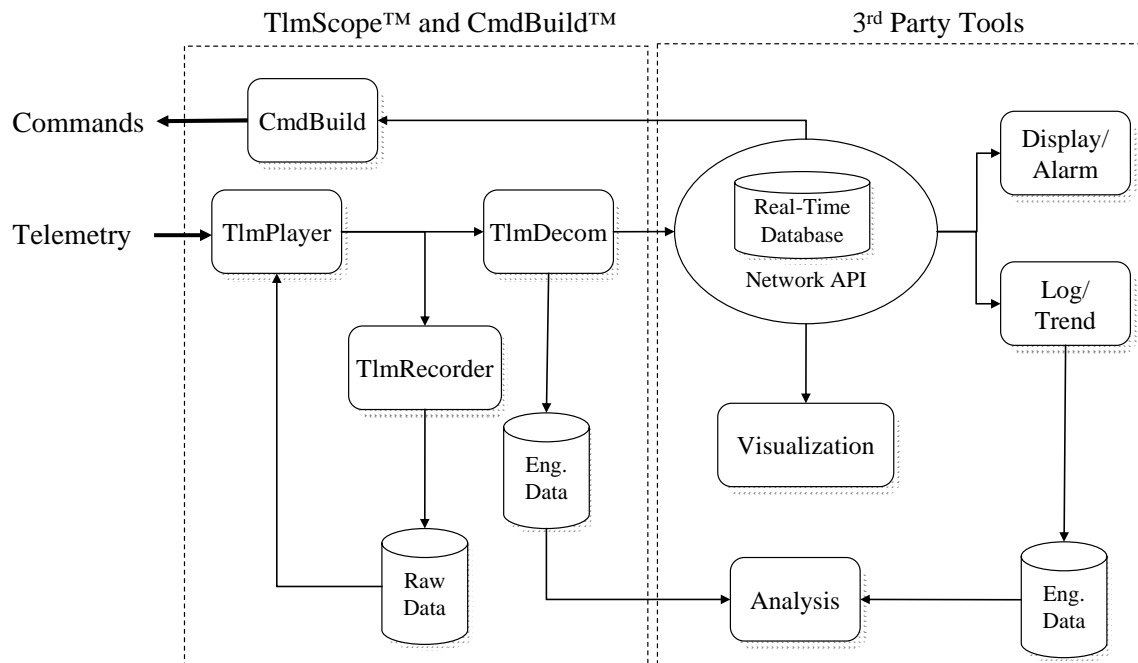


Figure 1 Octant's Command and Control Software Solution

The TlmDecom module collects incoming telemetry data, either live or recorded, via a socket interface, processes the data based on the user defined commutation scheme, performs engineering unit conversion, and interfaces to a memory resident real-time database that other tools may access.

TlmDecom can also be used to write selected telemetry parameters to disk as tab-delimited files to be fed to third party analysis and plotting packages such as StarOffice, Excel, MATRIXx or MATLAB. This can be done for real-time or recorded telemetry data.

The telemetry display, alarm, logging and trending capabilities shown in Figure 1 are all provided by a third party package that is seamlessly integrated with Octant's TlmScope™ and CmdBuild™ products. The telemetry display tool provides the telemetry visualization

capability to create telemetry screens to display the incoming telemetry data as it is written to the real-time database. Figure 2 shows an example telemetry display screen that highlights the capabilities of the third party widget library.

The telemetry trending tool provides a data trending capability that accesses and displays recorded telemetry parameters. The telemetry alarm tool provides an alarming capability. Telemetry parameters can be defined with upper and lower warning and alarm limits with color coded identification of telemetry items exceeding their respective warning or alarm values. This information is defined in the memory resident database.

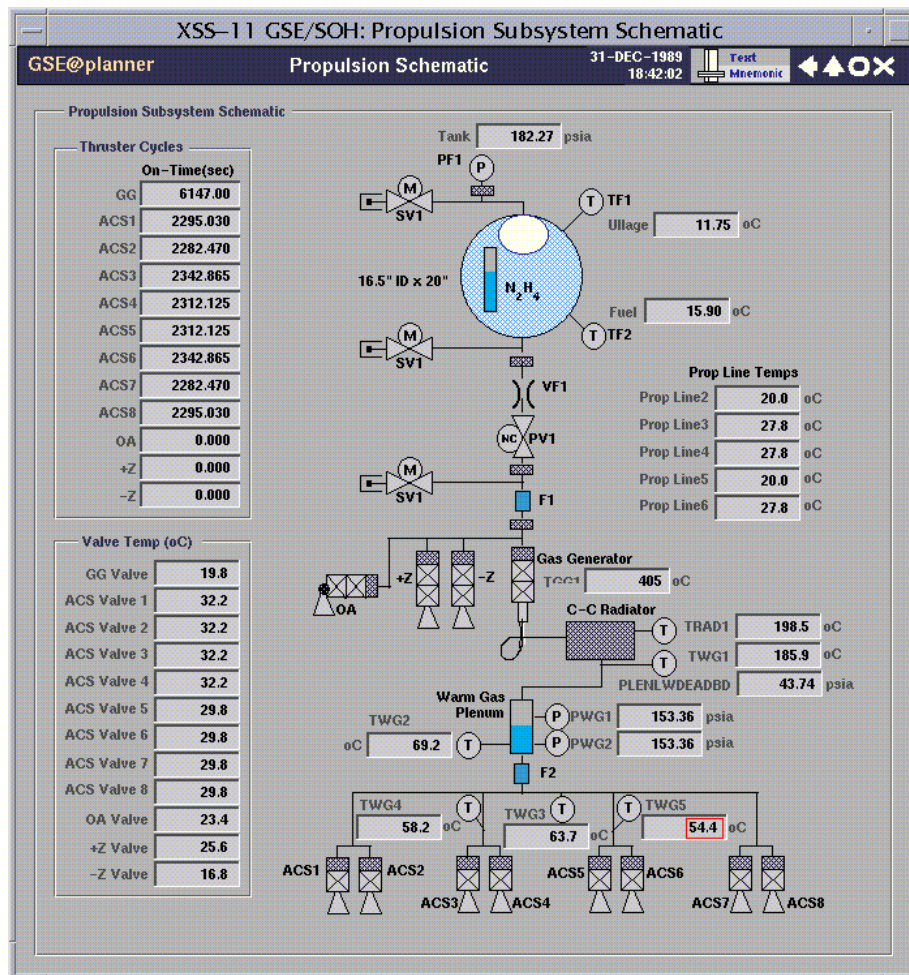


Figure 2 Example Telemetry Display

The telemetry trending tool has the additional capability to trigger external processes when alarm or warning limits are exceeded. For example, given the proper external hardware and software support, an out of limit error could immediately page the appropriate Technical Advisor or issue an audible voice alarm.

The telemetry logging tool is a separate recording capability to that provided by TlmRecorder and uses a recording scheme that records the data after has been de-commutated and written to the memory resident real-time database. For this scheme

the telemetry data can be logged with and without engineering unit conversion.

The telemetry logging tool also provides a playback capability. Contrary to TlmPlayer, the telemetry logging module records the data in a proprietary format and reads back the data from this proprietary format using a playback tool.

For the XSS-11 Space Vehicle, the TlmScope™ product and the tools previously described essentially formed the core components for processing and managing XSS-11 telemetry.

CmdBuild™

The CmdBuild™ product combines a user friendly Graphical User Interface (GUI) environment with the aforementioned memory resident database. The TlmScope™ and CmdBuild™ modules each use the same database for telemetry processing and command formatting. Figure 3 shows the GUI interface for the CmdBuild™ product.

The CmdBuild™ product provides several flexible methods for the user to generate commands to control the Space Vehicle (SV). Options include generating a single command, building a series of commands into blocks and constructing a pass plan which fuses the commanding and telemetry retrieving capability. This latter capability was specifically developed to support the way spacecraft are routinely operated at Kirtland AFB.

The specific command information shown in Figure 3 corresponds to XSS-11 command information. Note that the tool allows command blocks and pass plans to be built ahead of time and saved for later execution. The transmission of commands, blocks of commands and pass plans generated in this fashion can be simulated before actual transmission to the Space Vehicle.

The CmdBuild™ product provides a number of user friendly features typical of a GUI environment. This includes drag and drop and point and click capabilities. A user can quickly drag and drop a single command or block of commands from a list of options to the Command Block

Editor or the Pass Plan Editor. In summary CmdBuild™ features include:

- Capable of creating/editing commands graphically from the memory resident real-time database.
- Capable of loading previously saved or user created command block and pass plan script from the file system into command or script editors.
- Capable of verifying command blocks and pass plans against the real-time database for integrity checks such as operand boundary, checksum and syntax.
- Capable of transmitting the commands to the receiving station.
- Capable of simulating the commands without actually transmitting them to the receiving station.
- Capable of logging and displaying simulated and transmitted commands in the command history section.
- Capable of creating alternate command formats such as spacecraft commands, Vehicle Command Counter (VCC) fill, key index change and data mode via GUI or pass plan editor.
- Capable of pausing, stopping or resuming the execution of commands from the command block or pass plan editor.
- Capable of printing command blocks and pass plans.
- Capable of accessing and displaying telemetry parameters for closed loop command control.

In summary, the TlmScope™ and CmdBuild™ product items provide all the features necessary for the Command & Control (C&C) component of a typical Ground Segment.

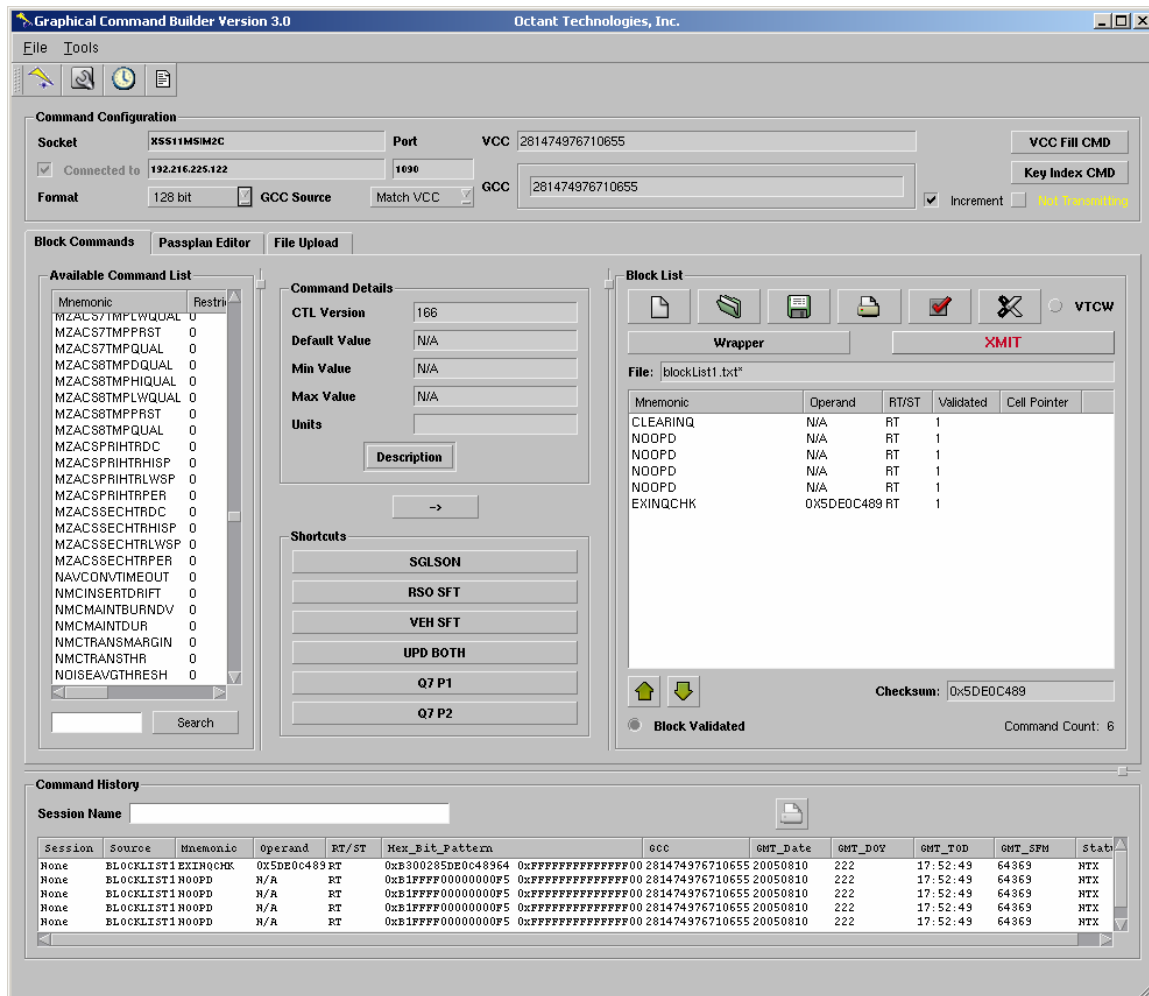


Figure 3 CmdBuild™ Graphical Front End

Summary

In this white paper, an overview of our products and how they could be used to develop a Space Vehicle (SV) Command & Control (C&C) system has been presented. We believe that these products could be effectively deployed as the core elements of a Space Vehicle Mission Operations Center (MOC).

Furthermore, Octant’s engineers and products have a proven track record of success, most recently on the XSS-11 micro-satellite program.

Two of our flagship programs, XSS-10 and XSS-11, have been highly successful programs for AFRL and both micro-satellites were operated from Kirtland AFB using Octant engineers and Octant products.

In summary therefore, we believe that this combination of Octant products and Octant engineers experienced in deploying these products qualifies Octant as an excellent choice for Ground Segment development.