Ground Segment

Software

Electrical AGE (EAGE) Software
EAGE - Software Requirements (1 of 2)

• Meet CORE Software Requirements

• Perform Spacecraft System & Subsystem Level Validation

• Control & Monitor Test Fixtures Simulating Spacecraft Subsystems:
  – Command, Telemetry, & Data Handling Subsystems
    - Solid State Data Recorder (SSDR)
    - DSPSE Spacecraft Control (DSC)
    - Transponder
  – Reaction Control Subsystem (RCS)
  – Attitude Control Subsystem (ACS)
    - Inertial Measurement Unit (IMU)
    - Reaction Wheels
  – Electrical Power Subsystem
  – Reaction Control Subsystem
  – Sensor Payload
EAGE - Software Requirements (2 of 2)

- Collect Microprocessor Based Ordnance Bridgewire Simulator (MOBS) Data
- Model Spacecraft Environment
- Generate Test Scenarios For Subsystem & Spacecraft System Level Tests
- Synchronize Test Software Components
- Execute Automated Test Procedures
- Validate Test Results
EAGE Software - Overview

- Text Fixture Control
- Equipment Control
- RF Ranging Unit Control
- DSPSE Test Unit Control
- Test Scenario Generator
- Attitude & Navigation Simulator
- Sensor Simulator

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EAGE Software (1 of 3)

- Test Fixture Control:
  - Provide Control Over The Functions For The DSPSE Test Fixtures
    - DSPSE Test Unit (DTU)
    - Microprocessor Based Ordinance Bridgewire Simulator (MOBS)
    - Sensor Simulator
    - Attitude & Navigation Simulator
  - Maintains Time Synchronization Between Test Controller & Test Fixtures
  - Collect Test Fixture Status & Results For Display, Recording, & Distribution

- Equipment Control:
  - Control Power Supply Functions
  - Collect Power Supply Status For Display, Recording, & Distribution

- RF Ranging Unit Control:
  - Control RF Ranging unit Functions
  - Collect RF Ranging Unit Status & Data For Display, Recording, & Distribution
  - Process RF Ranging Unit To Validate Spacecraft Ranging Capability
EAGE Software (2 of 3)

- **DSPSE Test Unit (DTU)**:
  - **DTU Control Component**
    - Support Control & Data Communications With Controller μVAX
    - Support Communications With Attitude & Navigation Simulator
    * Accept Simulated IMU Data
    * Send ACS, RCS, & Reaction Wheel Activities
    - Provide Control Over Other DTU Components
  - **DSPSE Interface Control Component**
    - Send And Collect Data Over Spacecraft Subsystem Interfaces
    - Provide Access To 1750 Virtual Control Port (VCP) Functions
  - **Subsystem Simulator**
    - Accepts Subsystem commands & Sends Simulated Telemetry Responses
    - Simulates Solid State Recorder (SSR) Storage & Retrieval Functions

- **Test Scenario Generator**:
  - Format Scenario Data Required By The Attitude & Navigation Simulator
    - Spacecraft Characteristics
    - Attitude Initial Conditions
    - Initial Position
    - Orbital Path Definition
    - Earth, Sun, Moon, & Target State Vectors
EAGE Software (3 of 3)

- Format Scenario Data Required By The Sensor Simulator
  - Sensor Characteristics
  - Test Images

• Attitude & Navigation Simulator:
  - Models Spacecraft Attitude
    - Accepts Initial Conditions & Time Synchronization Form Test Controller
    - Propagates Spacecraft Attitude In Real Time
    - Attitude Model Reacts To ACS Thruster & Reaction Wheel Inputs
    - Generates IMU Data To Reflect Attitude
  - Models Spacecraft Navigation
    - Accepts Initial Conditions & Time Synchronization Form Test Controller
    - Models Spacecraft position Relative To Earth, Sun, Moon, & Target
    - Propagates Spacecraft Attitude In Real Time
    - Navigation Model Reacts To RCS Thruster & Attitude Inputs

• Sensor Simulator:
  - Simulates Sensor Command & Control Over SASI Bus
  - Provides Simulated Sensor Images Over Video Bus
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Software

Electrical Launch Support Equipment (ELSE) Software
ElSE - Software Requirements

- Meet CORE Requirements
- Spacecraft Pre-Launch & Launch Preparation
- Spacecraft Systems Maintenance (Batteries)
- Control Ordnance Safe Arm Actuator
Automated Launch Support Procedures
Battery Maintenance Unit Status
Ordinance Safe ATM Activator Status
Core Processing External Interfaces

ELSE - Software Interfaces

ELSE Processing

Battery Maintenance Unit Control
Ordnance Safe Arm Actuator Control

Core Processing

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ELSE - Equipment Control

- Control Battery Maintenance Unit Functions
- Collect Battery Maintenance Unit Status For Display, Recording, & Distribution
- Control Ordnance Safe Arm Actuator Unit Functions
- Collect Ordnance Safe Arm Actuator Status For Display, Recording, & Distribution
Ground Segment

Software

Ground Station Software
Ground Station - Software Requirements

- Core Requirements
- Support Ground Processing Requirements For:
  - Pomonkey
- Equipment Initialization & Control
- System Confidence Check
- Antenna Pointing Angle Generation
- Ranging Support
Ground Station - Software External Interfaces

Automated Ground Station Operational Procedures

- DTS Commands
- DTS Status

- Analog Tape Commands
- Analog Tape Status

- Uplink Power Monitor Commands
- Uplink Power Monitor Status

- IEEE Data Logger Commands
- IEEE Monitored Data

- GPS Time

Core Processing External Interfaces

Ground Station Processing

- Ground Station Activities And Command Loads

- Antenna Controller Commands
- Antenna Controller Status

- Uplink RF Equipment Commands
- Uplink RF Equipment Status

- Downlink Receiver Commands
- Downlink Receiver Status

- Viterbi Bitsync Commands
- Viterbi Bitsync Status

- RF Ranging Unit Commands
- RF Ranging Unit Status

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Ground Station - Software Components

• Generates Antenna Pointing Angles Based On Spacecraft Ephemeris, Ground Station Position & Time

• Send Control Commands To & Receive Status From Ground Station Equipment
  – Antenna Controller
  – Uplink RF Equipment
  – Uplink Power Monitor
  – Downlink Receiver
  – Viterbi Bitsync
  – Data & Timing Signals (DTS)
  – Analog Tape Recorder
  – IEEE Data Logger
  – GOES Receiver

• Ground Equipment Status Is Made Available For Display, Recording & Distribution

• RF Ranging Unit Control
  – Send RF Ranging Unit Control Commands
  – Collect RF Ranging Unit Status & Data For Display, Recording, & Distribution
  – Process RF Ranging Unit Data To Determine Spacecraft Range
Ground Segment

Software

DSPSE Mission Operations Center (DMOC) Software
DMOC Software Requirements

- CORE Requirements To Support:
  - Trajectory Analysis & Mission Planning (TAMP)
  - Data Assessment (DA)
  - Satellite Operations & Control (SOC)
DMOC Software Interfaces

- Trajectory Analysis And Mission Analysis (TAMP)
- Spacecraft Operations And Control (SOC)
- Data Assessment (DA)
- Core Processing External Interfaces

DMOC Ground Segment Processing

Core Processing

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DMOC Ground Segment - S/W Control And Data Flow

Trajectory Analysis And Mission Planning (TAMP)

Spacecraft Operations And Control (SOC)

Data Assessment (DA)

Core Processing

Data Control

Core S/W Components

Core Processing External Interfaces

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Ground Segment

Software

Spacecraft Operations & Control (SOC)
SOC Software Requirements

- **Scheduling & Planning**
  - Automate Schedule & Plan Management
  - Calculate Ground Station Visibility
  - Generate Command Scripts
  - Generate and Display Events Timeline

- **Operations**
  - Manage Control Sessions
  - Monitor Telemetry Alarm Conditions
  - Display Events Timeline
  - Verify Software Configuration
  - Control Configuration Equipment

- **Engineering**
  - Analyze & Display Trends
  - Generate Command Scripts
  - Specify Telemetry Alarms
SOC Software Overview

SOC

Scheduling & Planning Tools
- Schedule & Plan Management
- Siting & Ephemeris Generation
- Command & Script Generation
- Events Timeline
- Configuration Management

Operations Tools
- Equipment Control
- Configuration Validation
- Telemetry Alarms
- Events Timeline
- Operations Reporting

Engineering Tools
- Trend Analysis
- Command & Script Generation
- Events Timeline
- Alarm Specification

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SOC External Interfaces

TAMP

Orbital Elements
Events Timeline
Command Scripts

SOC SOFTWARE

Telemetry History
Command History

TAMP

Accelerometer Telemetry

GSFC

Validated Orbital Elements

DSPSE GROUND STATIONS

DSPSE GROUND STATIONS

POMONKEY TRACKING FACILITY

DSPSE

Site Configuration Reports

CDRIGRDSOFT

Ground Stations

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SOC Control And Data Flow (Page 3 of 3)

Control Parameters → Equipment Control → Configuration Update

Telemetry Threshold → Telemetry Alarms → Telemetry Alarm Report

Telemetry

Log Entries → Operations Problem Entries → Software/Hardware Requests

Operations Reporting → Telemetry History

Accelerometer Telemetry

Operations Log

Problem Reports

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Ground Segment

Software

Trajectory Analysis & Mission Planning (TAMP)
TAMP Software Requirements

- **TRAJECTORY ANALYSIS:** Plan Maneuvers; Verify Orbital Elements & Trajectories

- **MISSION PLANNING:** Plan Experiments; Generate Pointing & Sensor Commands

- **GENERAL:** Evaluate Effectiveness Of Maneuvers & Experiments; Provide Low-impact, Multi-level Configuration Control
TAMP Software Overview

TAMP

Trajectory Analysis Tools
- Trajectory Planning & Verification
- Trajectory Evaluation
- Error Analysis
- Events Timeline
- Command & Script Generation

Mission Planning Tools
- Siting & Ephemeris Generation
- Target Visibility & Instrument Pointing
- Planning Evaluation
- Events Timeline
- Command & Script Generation

General Planning Tools
- Configuration Management
- Data Visualization

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TAMP External Interfaces

GSFC
- Maneuver Specification
- Orbital Elements
- Covariance Matrix
- Solar-Lunar-Planetary

NAV SPA SUR
- Orbital Elements
- Geographos Trajectory

JPL
- Orbital Elements

DA
- Sensor Images
- Telemetry History

SOC
- Command History
- Telemetry History

TAMP SOFTWARE
- Maneuver Request
- Trajectory Analysis Report
- Orbital Elements
- Command Script
- Events Timeline
- Attitude History
- Orbital Elements

GSFC
SOC
DA

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Ground Segment

Software

DSPSE Operational Test Bed (DOTB) Software
DOTB - Software Requirements

- Core Requirements
- Mission Segment Functional Simulation
  - Orbit Scenario Workstations
  - Command Sequence Simulator
- Mission Rehearsal
  - Mission Segment Execution With Breadboard Spacecraft Hardware
  - Utilizes A Fully Functional Ground Station
  - Simulate All Spacecraft Subsystems (Unless Breadboard Version Present)
Mission Scenarios

Ground Station Activities And Command Loads

Automated Operational Test Procedures

Core Processing

External Interfaces

DOTB - Software Interfaces

Test Results

Core Processing

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DOTB - Software Components

- All Ground Station Components
  - DOTB Will Provide A Simulated Ground Station Environment To Support Mission Rehearsals

- Equipment Simulation Can Accept Commands From The Equipment Control Component & Provides Simulated Equipment Responses

- Mission Scenario Generator
  - Generates Simulation Inputs Required By The DSPSE Satellite Simulator To Model A Mission Segment

- DSPSE Satellite Simulator
  - DSC Breadboard
  - DSPSE Subsystem Simulator
  - Attitude & Navigation Simulator
  - Sensor Simulator
DSPSE Spacecraft Simulator

- Subsystems Not Physically Present Are Simulated
DSPSE Operational Test Bed (DOTB) Description

• Orbital Development & Analysis Workstation PC

• Sensor Simulator Workstation
  – Consists Of PC Showing Sensor Images From Any Location & Orientation In Space

• Mission Segment Offline Simulation Workstation
  – Consists Of Two PC's: A Sensor Simulator Station & Spacecraft Subsystem PC
  – Executes Command Sequences In Realtime Or Faster-Than-Realtime
  – All S/C Subsystems Simulated, Including Dynamic Model

• Mission Rehearsal Workstation
  – Consists Of Off-line Sim Station & Breadboard hardware
  – Exercises Flight Software
  – Ground Equipment Operation & Setup Simulated (Antenna, Etc.)
DOTB Software Components

- Orbital Development PC-Software From Goddard ("Swingby")

- Sensor Simulator
  - Accesses "Guidestar" Map
  - Displays Earth, Moon, Geographos, & Other Targets
  - FORTRAN & C

- Subsystem Simulator
  - Uses Model Algorithms From NRL
  - Takes Command Stream & Develops Telemetry
  - FORTRAN & C

- Interface Controller
  - VME Controller Passing Commands To Subsystem Simulator & Telemetry Back To S/C Processor
  - C

- Simulation Control Vax
  - Sets Up Initial Conditions For A Sim Run
  - Controls Time Progression