Tools for Software Based Validation and Verification of Small Satellites

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Small Sat Workshop 2016
Overview

What is NOS\textsuperscript{3}?

• A software test bed for small satellites – Currently a Functional Beta
• Based upon STF-1 hardware, but sufficiently generic
• Easily-interfases to CFS, but CFS not required
• Openly distributed solution Ready-to-Run (RTR)
• A collection of Linux executable and libraries
• Test as you fly

What is it used for?

• FSW early-development – NOS\textsuperscript{3} provides real-world inputs to FSW
• FSW V\&V – Testing FSW, invalid inputs, behavior, stress conditions
• FSW Integration – Used for early-app development and payload team integration
• Mission Planning – Example: power analysis

\textsuperscript{3}NASA Operational Simulator for Small Satellites
NOS³ Components

- Virtual Machine – for running NOS³
- NOS Engine Middleware
- Hardware Simulators
- FSW Hardware Abstraction Layer
- Orbit Inview & Power Prediction (OIPP) Tool
- CFS – Flight Software
- 42 – Dynamics Simulation and Visualization
- COSMOS – Commanding & Telemetry

nos³
NASA Operational Simulator for Small Satellites

ITC
Independent Test Capability
Virtual Machine Auto Generation

• Install *Vagrant* and *VirtualBox*
• Run `vagrant up`
• Developer build tools installed
• Convenience scripts for building/running
• Ready-to-run after unpacking a .tar
NOS Engine Middleware

• ITC developed middleware
• Common server to communicate to all data nodes (CFS, Hardware simulators, Time ticker, Command terminals)
• C API
• I2C, UART and SPI protocols
• Asynchronous and Synchronous
Hardware Simulators

• Modeled based on characteristic data, or manufacturers data specifications

• Currently have modeled
  – Novatel GPS
  – Clyde EPS
  – Honeywell Magnetometer
  – ISISpace Antenna System
  – A3200 support chips (FRAM, Gyro
Flight Software (CFS)

• Open source flight software developed by GSFC

• Includes an OS Abstraction Layer
  – Allows building for flight and NOS³ targets on same machine without source code changes

• Additional Platform-Support-Package (PSP) added to sync CFS time with NOS³
42

GSFC Open Source Dynamics Simulator

• NOS$^3$ TCP/IP Socket Integration
• Simulation time synchronized with NOS$^3$
• Moving toward closed loop
COSMOS

• Open Source for embedded system commanding and telemetry
• Currently connects to CFS TO_lab
  – Future plan is to have radio simulator to replace TO_lab
• Can be used for operator training, testing table loads to SC, verifying command and telem databases, etc.
COSMOS
Orbit, Inview, and Power Prediction

• Web page: Generated daily by cron job

• TLE Data pulled from http://celestrak.com as obtained from NORAD

• Time Periods (configurable)
  • Yesterday, Today, Future

• Displays
  • Ground station in-views
  • Sunlight and Eclipse times
Orbit, Inview, and Power Prediction (OIPP)

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**Wallop Antenna Day Shift**
- Wallops Antenna - S/C 39404 Inviews
  - 01
- Morehead Antenna Day Shift
  - 01
- SRI Palo Alto Antenna Day Shift
  - 01

**S/C 39404 In Sunlight Times**
- 01

**Wallop Antenna - S/C 77777 Inviews**: 12:43 pm - 12:50 pm
Duration: 0.12 hours
Backup Slides
NOS$^3$
Utilization Example for STF1