nos3

NASA Operational Simulator for Small Satellites

Tools for Software Based Validation and Verification of Small Satellites

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Overview

What is NOS^3?

- A software test bed for small satellites – Currently a Functional Beta
- Based upon STF-1 hardware, but sufficiently generic
- Easily-interfaces 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^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

NOS^3 Components

- Virtual Machine – for running NOS^3
- 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

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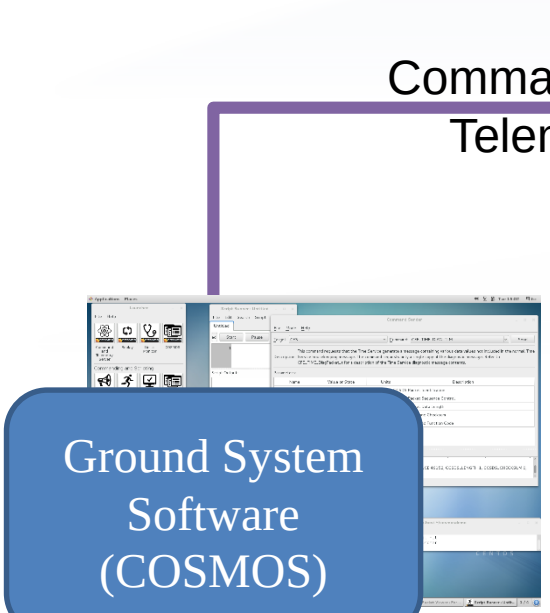
Independent Test Capability

NOS³ Architecture



Ground System Software (COSMOS)

Commanding & Telemetry

NOS³ UI & Control

STF-1

cFS

Hardware Lib

OS Abstraction Layer (OSAL)

Linux (x86, ARM/Pi)

FreeRTOS (AVR32)

NOS Engine

Hardware Models

42

Hardware Adapter i2c / SPI

Flight Hardware

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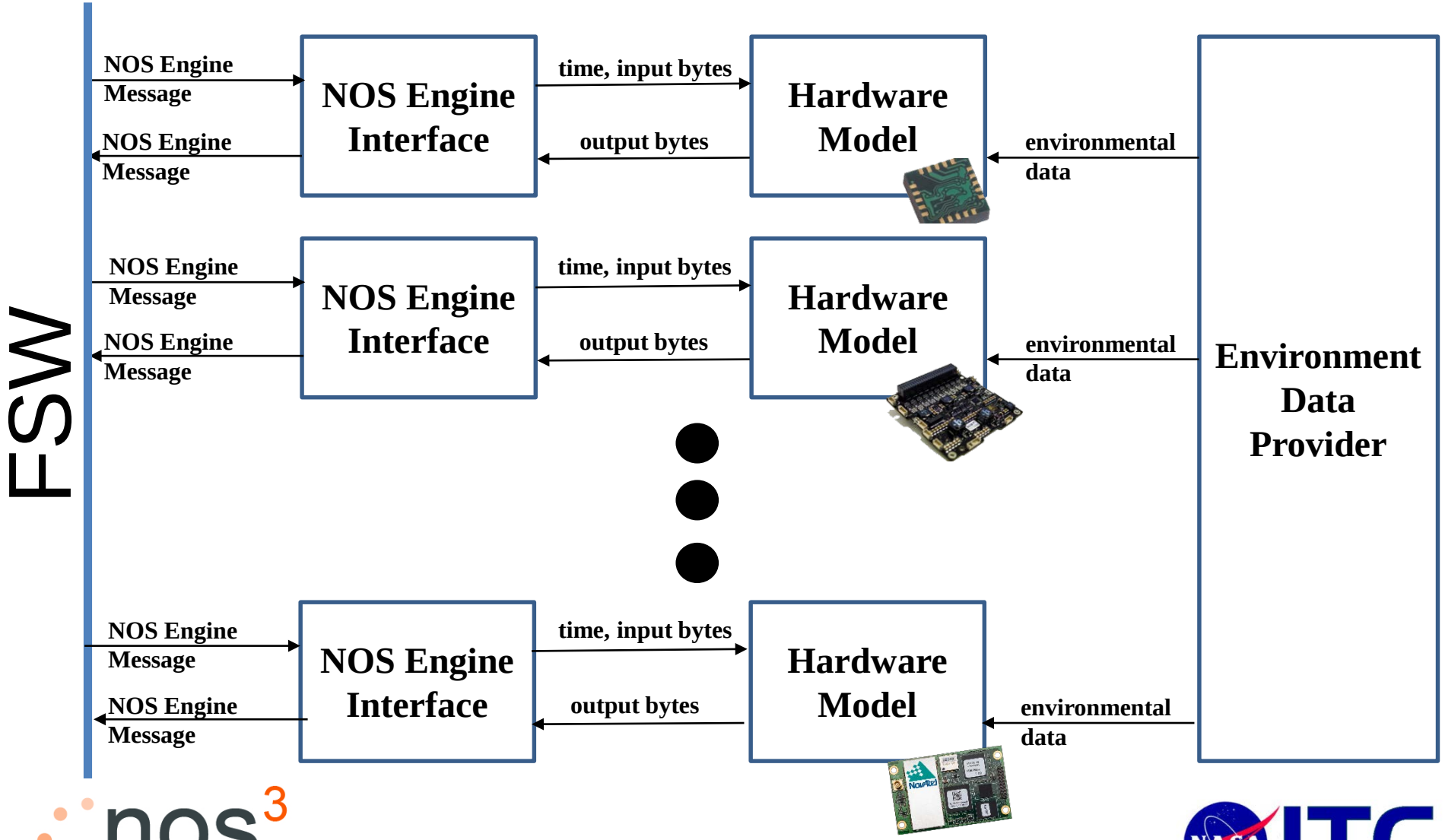
NASA ITC Independent Test Capability

NOS³ Components



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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

nos engine

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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 NOS^3 targets on same machine without source code changes
- Additional Platform-Support-Package (PSP) added to sync CFS time with NOS^3

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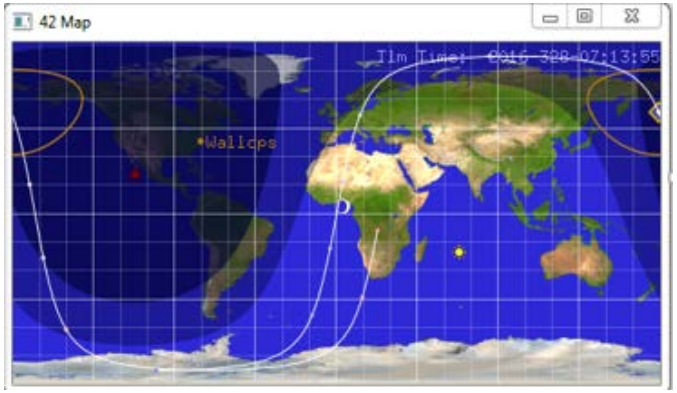
GSFC Open Source Dynamics Simulator

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



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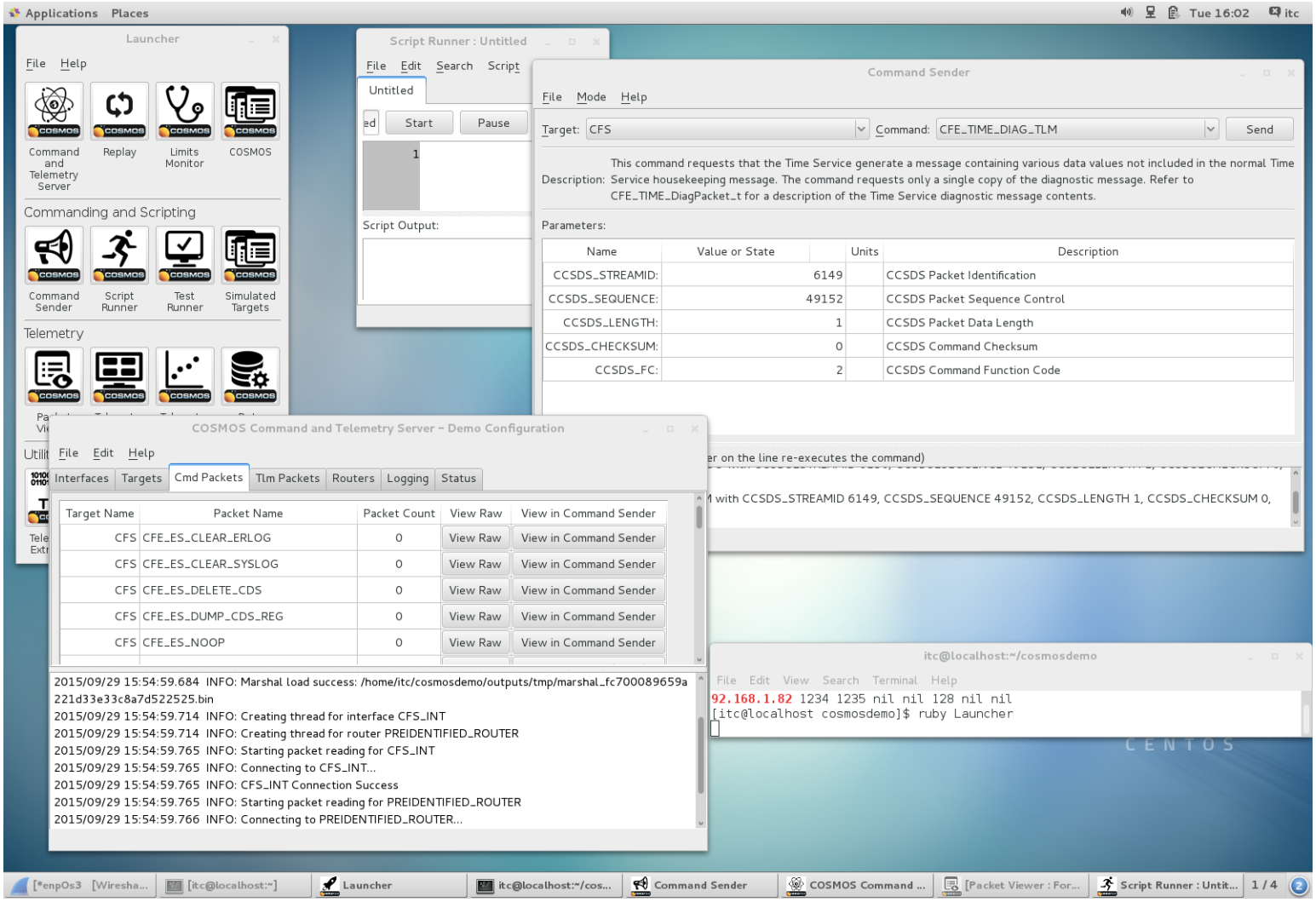
COSMOS

- 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



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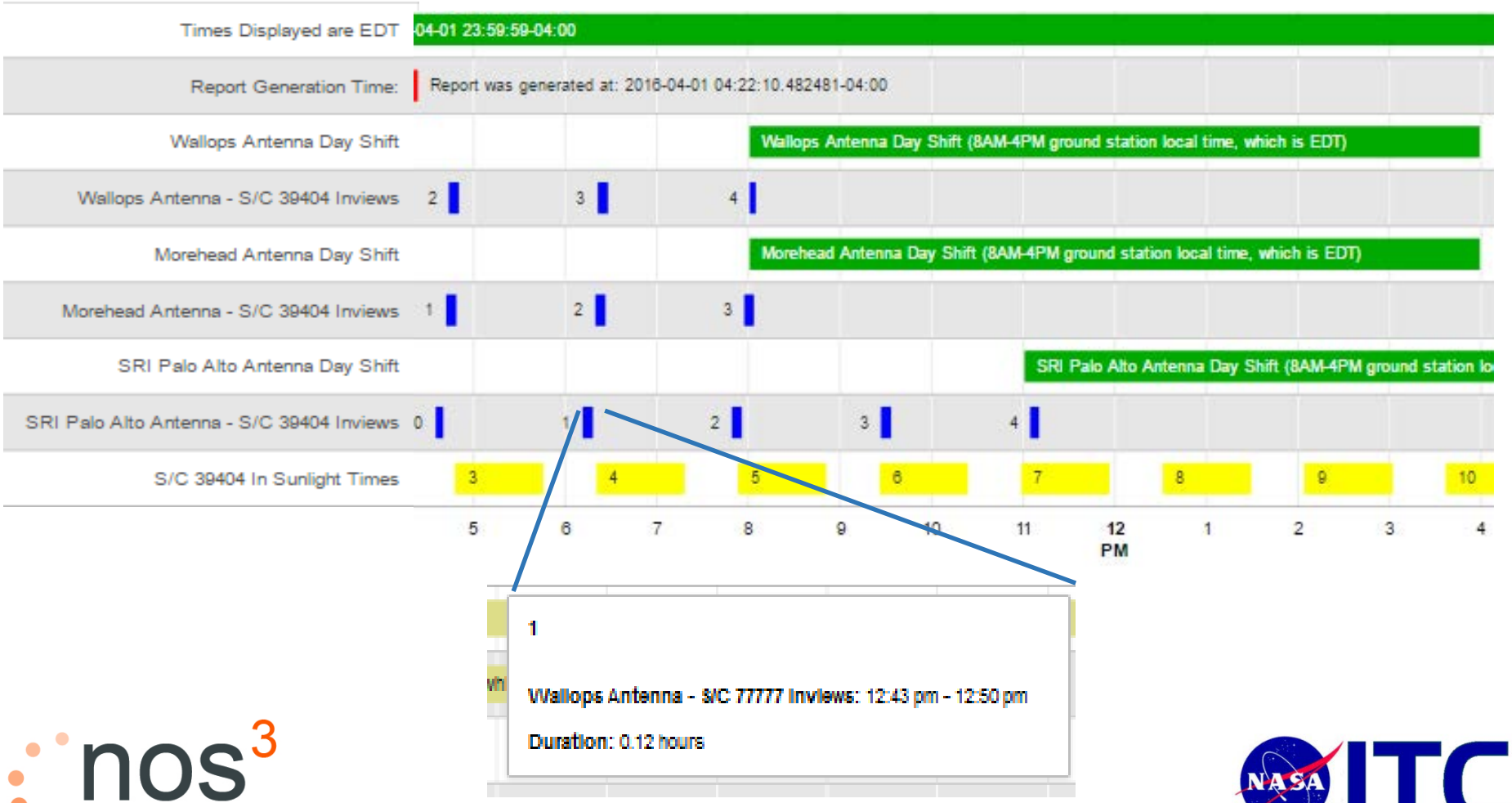
Orbit, Inview, and Power Prediction

- 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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Backup Slides

NOS³ Utilization Example for STF1