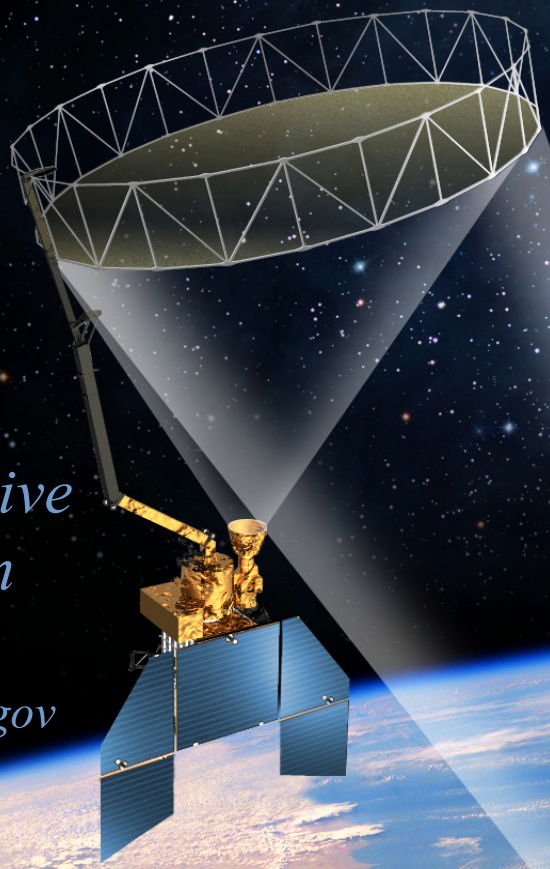


Automating the SMAP Ground Data System to Support Lights-Out Operations

SpaceOps 2014

Soil Moisture Active and Passive (SMAP) Mission

http://smap.jpl.nasa.gov

Antonio Sanders
Jet Propulsion Laboratory

05/07/2014

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Introduction to SMAP

- Soil Moisture Active/Passive (SMAP) is a first tier mission in NASA's Earth Science Decadal Survey
- SMAP will provide global mapping of soil moisture and its freeze/thaw states
  - Enhances the understanding of processes that link the terrestrial water, energy, and carbon cycles
  - Enhances weather and forecast capabilities
- NASA's Jet Propulsion Laboratory selected as lead center for the development and operation of SMAP
  - SMAP represents a new area of JPL focus towards low cost Earth science missions

SMAP Ground Data System

- The SMAP Ground Data System (GDS) is the integrated set of ground hardware, software, facilities, and networks required to support mission operations
- The SMAP GDS is consistent with prior JPL missions and allows SMAP to inherit GDS architecture, design, and implementation
- Key functions performed by the GDS include:
  - Sequence and command generation and uplink
  - Real-time and playback telemetry processing
  - Navigation
  - Ephemeris generation and distribution
  - Data management and accountability
  - Time correlation
  - Station Scheduling

Automation Challenges

- Automation of the GDS must meet the following challenges in order to achieve lights-out operations for SMAP:
  - Reliable performance of the GDS functions
    - Including automated commanding of the SMAP spacecraft
  - Reliable operations by small ops team
    - Simple automation configuration and maintenance
  - Reliable monitoring of automation health and status
    - Closed loop monitoring is required

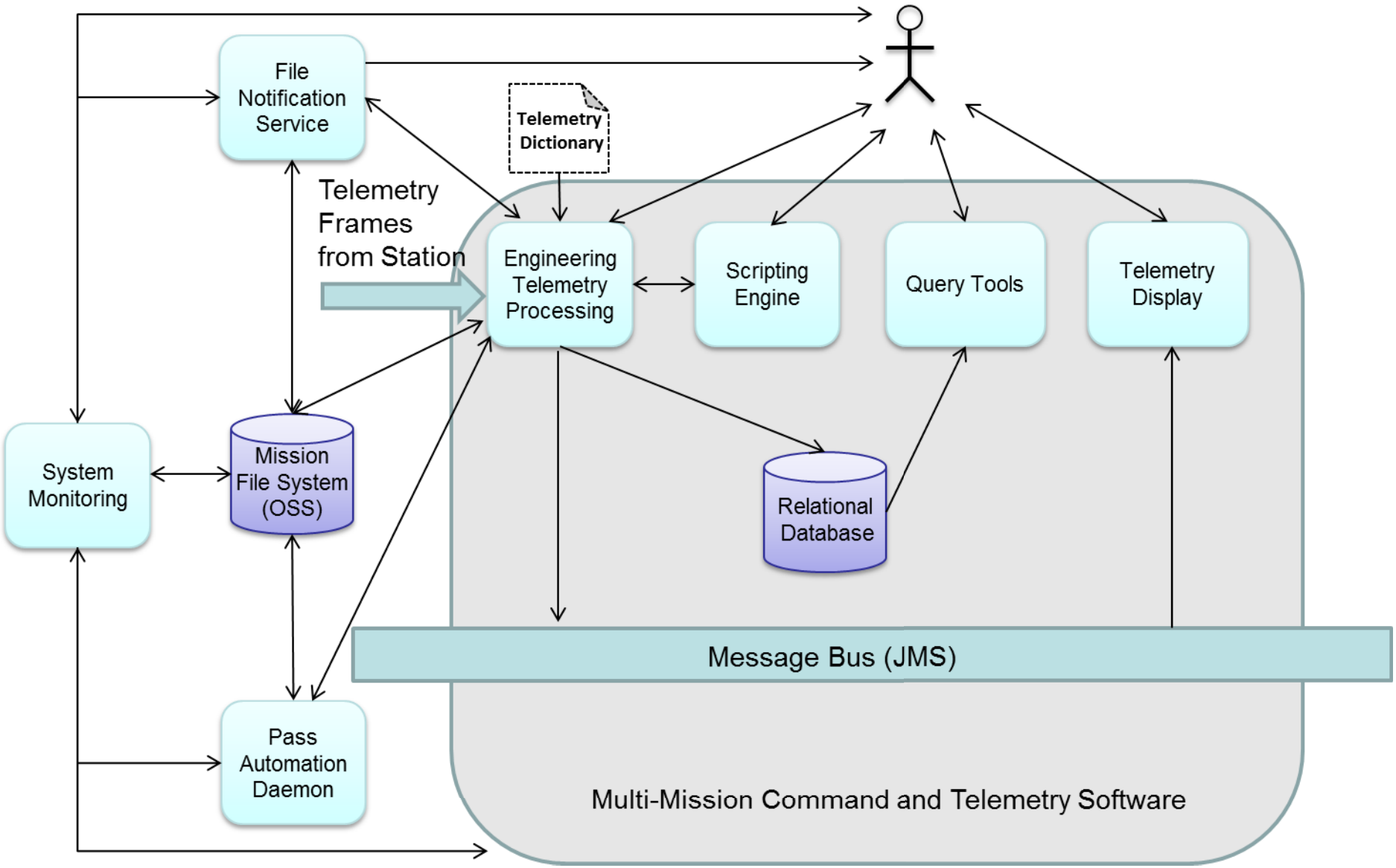
Automation Approach

- Identification and Implementation of Automation Patterns
  - File-Based Automation
  - Pass-Based Automation
  - Time-Based Automation
- Automation design inheritance from prior JPL Earth science missions
  - Jason-1 and WISE
- Leveraging of multi-mission and open-source software
  - Automation software provides thin layer around proven software capabilities
- Use of system monitoring

National Aeronautics and
Space Administration

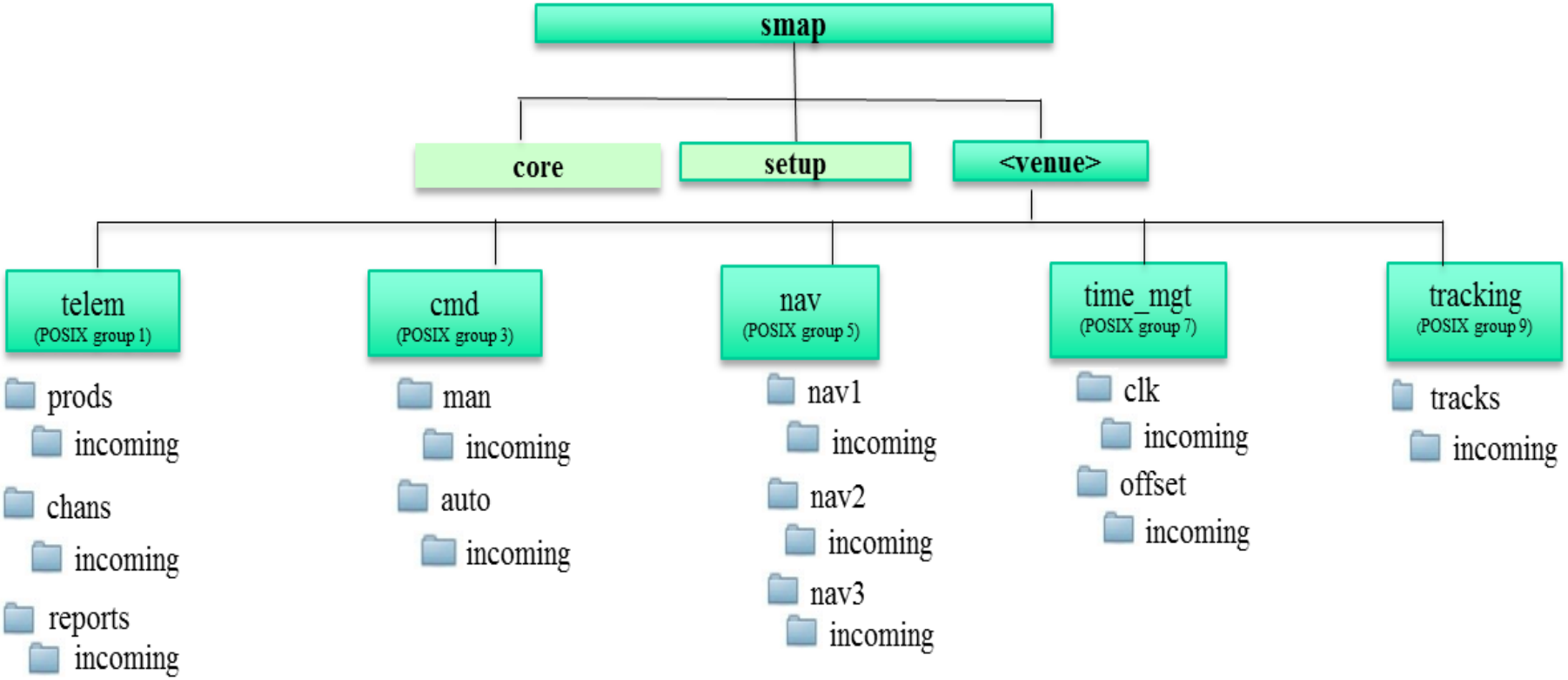
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Automation Architecture



Operations Storage Server

- An NFS-based file system that implements a hierarchical directory structure that provides storage for the data that is exchanged among the various SMAP teams



File Notification Service

- The File Notification Service (FNS) provides file-based automation within the OSS
- FNS can be configured to monitor any number of directories within the OSS
  - invokes user specified processing upon detection of new files stored to the OSS
- FNS provides a set of atomic operations that can be performed upon file detection
- FNS provides notification of file arrival events and success/failure status of the atomic operations
- The FNS provided detect/process/notify construct that allows the implementation of workflow automation within the OSS

Pass Automation Daemon

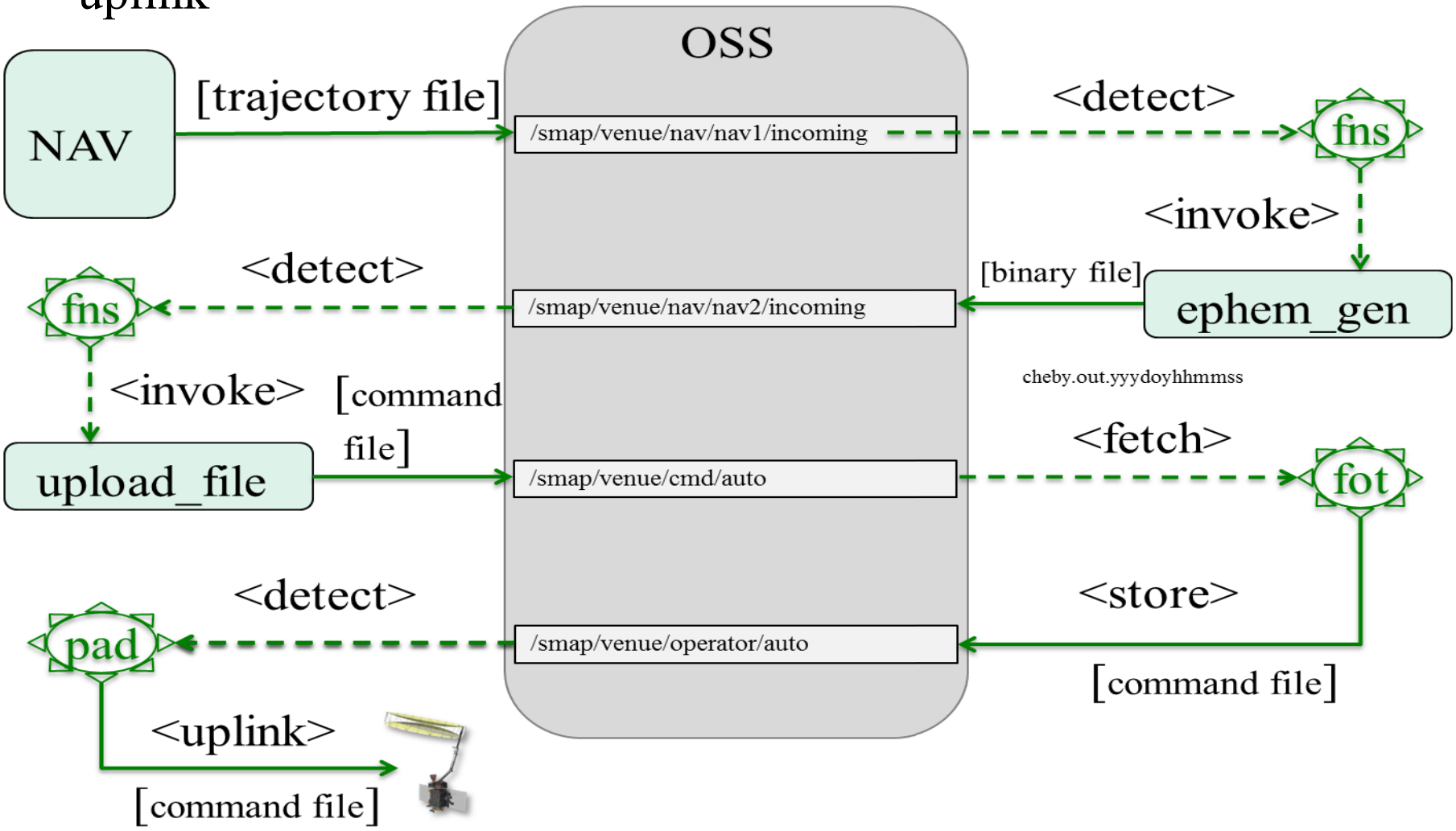
- The Pass Automation Daemon (PAD) provides pass-based automation
- PAD orchestrates all activities associated with unattended tracking passes
- PAD is driven by a pass list which is derived from the tracking pass schedule
- PAD allows the automation of pre-pass, in-pass, and post-pass activities such as:
  - Station connection management
  - Automated uplink
  - Telemetry processing
  - Invocation of custom flight operations scripts
  - Data management
  - Time correlation

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Workflow Automation

- Sample FNS, PAD, and OSS interactions to enable ephemeris uplink



Time-based Automation Scheduler

- The Time-based Automation Scheduler (TAS) provides time-based automation
- TAS provides a flexible means to construct and manage sets of time-based automation activities
- The task scheduling algorithms in TAS are aware of the SMAP ground station tracking pass times
  - Allows scheduling of automation activities outside of tracking pass times
- Automation activities supported by TAS include
  - Data management
  - Report generation
  - Data archival

System Monitoring

- Successful operation of the SMAP mission requires the reliable use of robust GDS automation
  - The automation software must be highly available
  - Automated procedures must be performed in a timely manner
- System monitoring will be used to detect and respond to anomalous system behavior
- A monitoring solution based on the open-source Zabbix and Nagios software will perform the system monitoring function for SMAP
- The system monitoring solution will
  - Monitor GDS automation resources
  - Restart failed processes
  - Provide closed-loop notification to the GDS support team

Summary

- As SMAP GDS development continues towards a November 2014 launch date, upcoming system tests will certify the readiness of the GDS automation for lights-out operations
- Although lights-out operation has been partially demonstrated in the past, SMAP represents the first JPL mission that will utilize a fully lights-out approach for routine operations
- The architecture and approaches used by SMAP will set the baseline for future JPL Earth science missions