The Virtualized Multi-Mission Operations Center (vMMOC) and its Cloud Services

Presented by
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Objective of Presentation

• What is Space Science Mission Operations (SSMO)?
• What is the vMMOC?
• Available vMMOC Services
• “Looking Beyond the Horizon”
What is Space Science Mission Operations (SSMO)?
What is Space Science Mission Operations (SSMO)?

- **SSMO** provides project oversight for 19 NASA *space science* missions for which **GSFC** is responsible.

- **SSMO** has a diverse set of missions:
  - heritage/launch date
  - orbit regime
  - spacecraft bus type
  - mission profile
  - communication networks
  - In-house and Out of House Mission Operations Centers (MOCs)
## SSMO Spacecraft in Operations

<table>
<thead>
<tr>
<th>Mission</th>
<th>Launch Year</th>
<th>MOC Location</th>
<th>Science Type</th>
<th># s/c</th>
<th>Orbit Regime</th>
<th>Catalog #</th>
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What is the vMMOC?

What is the virtualized Multi-Mission Operations Center (vMMOC)?

The vMMOC’s Objectives are ...

- Rapid and efficient provisioning and orchestration of spacecraft mission operation environments.

- Break the barrier to mission operations and enhance accessibility
What is the vMMOC?

- Multiple-missions Operated from one center
- Local virtualized infrastructure
- *Access* to a secure public cloud computing infrastructure
- Situational Awareness Dashboard (a SaaS)
- Telemetry as a Service (TaaS)
  - Soon to be *Telemetry, and Tracking as a Service* (TTaaS)
- Navigation as a Service (NaaS)
vMMOC’s High Level Infrastructure

- Restricted Mission Network
- Open Mission Network
- Closed Mission Network
- Internet
- Instrument User Community
- CNE – NASA Network

Exchange

Common Services

ACE
Fermi
LRO
MMS (backup)
OSIRIS-REx (backup)

SDO
SOHO
SWIFT
Wind

Fermi
ACE

LRO

MMS (backup)

OSIRIS-REx (backup)

Common Services
What is the vMMOC?

- **Shared:**
  - Infrastructure
  - Product formats
  - Networking interfaces
  - Workflows & Procedures
  - Security implementations
  - Hardware and software
  - Core staff
  - Lessons-learned
  - Culture
What is the vMMOC?

Private virtualized infrastructure

GSFC - SSMO
- VMware
- Storage
- PMs
- VMs

Public Cloud Computing (secured)

AWS GovCloud
- Instances
- Distributed Object Stores

Data Producers & Consumers

Ground Systems Architectures Workshop (GSAW) - 2017; Los Angeles, CA March 13-16, 2017; Session: Virtualization and Cloud
Situational Awareness Dashboard

Break the barrier to data access
• Provide local and remote users an integrated, situational awareness dashboard of major spacecraft and ground events
  • Secure
  • Tailorable, self-service capability to access all spacecraft timelines
  • Liberate the data
  • Empower each engineer to tailor requests for any SSMO spacecraft
• A web service based on NIST’s Software as a Service (SaaS) model
A timeline view of ACE, Fermi and LRO

[Image of a timeline view of ACE, Fermi and LRO events]
A view of a closeup of MMS1
A view of LRO
Execute General Mission Analysis Tool (GMAT) in the cloud
Telemetry as a Service (TaaS)

Break the barrier to data access
• **Provide local & remote users access to telemetry & tracking**
  • Secure
  • Tailorable, self-service capability to access all SSMO spacecraft telemetry & tracking:
    • Liberate the data
    • Empower each engineer to tailor requests for any SSMO spacecraft
    • Each engineer can perform analysis without interfering with operations workflows
  • A *web service* based on NIST’s Software as a Service (SaaS) model
A view of the portal

<table>
<thead>
<tr>
<th>SPACECRAFT</th>
<th>PACKET</th>
<th>MNEMONIC</th>
<th>MNEMONIC DESCRIPTION</th>
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<td>GNC_TLM_MODE Telemetry (SIANCILLARY GNC_MODE). Current spacecraft ACS mode</td>
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<td>ACRW1SPD</td>
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<tr>
<td>Swift</td>
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<td>ACS_TLM_MODE Telemetry. Current spacecraft ACS mode</td>
</tr>
</tbody>
</table>
A view of a plot of wheel speeds
Navigation as a Service (NaaS)

Break the barrier to data access
Navigate the Spacecraft in Support of Mission Operations

**Navigation Services**
- Maneuver planning
- Maneuver execution
- Maneuver reconstruction
- Orbit estimation & control
- Attitude estimation & control

**Scheduling & Planning in Support of Navigation**
- Maneuvers
- Network Availability
- Antenna Availability
- AOS/LOS
- Shadows
- Interference
- Tracking
“Looking Beyond the Horizon”
How would one simulate hundreds of spacecraft?

• With the coming age of OneWeb, and other massive spacecraft operations proposals, how does one:
  • Design, Model and Simulate Ground and Space Segments?
  • Leverage Cloud Computing & Create Service Models, such as:
    • Spacecraft as a Service (SCaaS)
    • Flight Software as a Service (FSWaaS)
    • Ground Segment as a Service (GSaaS)
    • Auto Provision, Orchestrate & Terminate services at will
Thank you.

Any Questions?