Comprehensive Open-architecture Solution for Mission Operations Systems

Facilitated by

interstel technologies

COSMOS

Comprehensive Open-architecture Solution for Mission Operations Systems

Facilitated by

XLR8UH
Company Team

Claudia Kamiyama
Business Manager

• Administration experience
• Project manager for research projects
• MA in Educational Psychology

Interns

Lindsay Root
Marketing & Sales
UHM MBA Candidate

Lauren Kurashige
Legal
UHM JD/MBA Candidate

Eric Pilger
VP, Technology
• Lead Software Engineer of HSFL and COSMOS
• 25 years experience in planetary science instrument development
• MA in Astronomy

Miguel Nunes
VP, Engineering
• Aerospace Engineer
• Lead Test Bed Engineer for HSFL and COSMOS (simulation and testing)
• PhD candidate in Mechanical Engineering

Dr. Trevor Sorensen
CEO
• Aerospace Engineer
• 40 years experience in space field (NASA, DoD, commercial)
• Expert in mission operations
• Computer game designer
CEO’s Experience
CEO’s Experience
CEO’s Experience

29 Mission Operations

Trevor C. Sorensen, University of Hawaii
with support from members of the AIAA Space Operations and Support Technical Committee∗

29.1 Mission Planning and Operations Development
29.2 Mission Execution
Mission Operations Processes
29.3 Mission Termination and Post-Mission Activities
29.4 Operations Process Improvement and Best Practices
Process Improvement; Best Practices
29.5 The Future of Mission Operations

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It is possible to design and build the best possible spacecraft and even launch it into space, but it is useless unless there is a way for it to accomplish its mission. This is the role of mission operations. Contrary to a popular misconception, mission operations is not limited to what happens in the Mission Control Room or even in the Mission Operations Center (MOC). That is really only the tip of the iceberg. Mission operations includes what happens on the spacecraft or launch vehicle, at ground stations, in engineering offices and science labs, to accomplish the goals of the mission, from design and development through mission execution. It is an integrated system of people, hardware, software, and activities that have to work together to ensure the successful execution of the mission. All organizations that fly space missions, from government agencies to industry and academia, perform mission operations activities. They nonetheless have different requirements for mission operations and often have their own philosophies and methodologies for developing and implementing mission operations. What is presented in this chapter are the methods that have worked for the author and have worked for others from all types of missions - manned, robotic, Earth orbit, deep space, small, large, single and multiple satellites.

Mission operations can be categorized into four basic functions: spacecraft or launch vehicle operations, payload operations, ground operations, and mission management. Mission operations also vary by the phase of the mission life cycle and are divided into two fundamentally different modes separated by the launch: Mission operations design, development, and testing occurs during the study (Phase A), design (Phases B and C), and the assembly, integration and testing (Phase D) phases of the mission. Mission operations execution occurs during the flight phase (Phase E) and termination phase (Phase F).

The following definitions of the four basic mission operations functions are based on those by Kehr [2007]:

Spacecraft/Launch Operations cover the preparation and implementation of all activities to operate a spacecraft (manned or unmanned) to the launch vehicle under normal, non-normal and emergency conditions. This includes the specification, design, production and qualification of all means (tools, procedures and trained personnel) to perform the task of spacecraft/launch operations. It also involves designing compatibility into the spacecraft segment. The main challenges in this area are the cost-efficient combination of tools, degree of automation (for both spacecraft and ground segments), and staffing to provide secure and reliable operations. A very prominent role is played by the mission database containing all pertinent spacecraft and ground operations data parameters to be maintained throughout the mission. It is initially created by the spacecraft designers and handed over to the operations personnel during Phase C/D to be augmented by the specific ground operations parameters.

Payload operations cover the preparation and implementation of all activities related to the payload, which is generally the primary reason for the mission. Details of typical spacecraft payload are covered in Chap. 15.18 and not repeated here. Payload operations differ from spacecraft operations in that unique mission-specific expertise may be required to make decisions with regard to loading the payload and retrieving and interpreting its data. That being said, for small spacecraft and relatively simple payloads, the payload operations are often included as another subsystem within spacecraft operations. In this case, the spacecraft operations team may retrieve and distribute the payload data to clients directly, without the intervention of a dedicated payload operations team. Large spacecraft, on the other hand, often have complex and independent payloads, such as...

* Although the payload is usually contained within the spacecraft bus, sometimes it might be separate, such as a separate probe or interceptor vehicle.
CEO's Experience
PROBLEM ?
Problem

Too many satellites…
and lots more coming
Problem

How do we efficiently monitor & control hordes of satellites?
Problem

Ops systems for multiple satellites are TOO COMPLICATED...
...and hard to adapt to new missions!
Problem

A good COTS solution is missing!
“Adaptability is a definite problem for every mission I have worked on.”

Paul Douglas, NOAA Satellite Operations Facility

“System needs flexibility and configurability.”

Chris Jones, Iridium Operations Director

“Need to integrate everything into one system/tool that shows the status of everything in the system including spacecraft, ground stations, etc. .”

Dave LaVallee, Project Leader, Applied Physics Laboratory

“COTS don't quite do what we need; they are not flexible.”

Chris Jones, Iridium Operations Director

“At Space X we could not find a COTS solution for our mission operations and had to develop our own.”

Dr. Marco Villa, former Director of Mission Operations, SpaceX
Problem

Is there a solution?

After all, it’s only ROCKET SCIENCE!

“It's time we face reality, my friends... We're not exactly rocket scientists.”
Yes, there is a solution - it’s…..

Developed by real rocket scientists!
The **only** operations software toolkit that is comprehensive with nodal architecture
COSMOS Mission Ops Functions (Tools)

- Mission planning & scheduling (MPST)
- R/T command & control (MOST)
- Ground segment C&C (GSCT)
- System executive management (CEO)
- Flight dynamics (FDT)
- Data system management (DMT)
- Test bed & simulators (TBCT)
- Analysis tools
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### Competition

<table>
<thead>
<tr>
<th>Company</th>
<th>Product</th>
<th>Nationality</th>
<th>Cost</th>
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<tbody>
<tr>
<td>L3</td>
<td>InControl</td>
<td>US</td>
<td>$$$</td>
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<tr>
<td>Orbit Logic</td>
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<tr>
<td>GMV</td>
<td>HiFly</td>
<td>European</td>
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<td>Harris</td>
<td>OS/COMET</td>
<td>US</td>
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<td>SCOS-2000</td>
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<tr>
<td>Kratos</td>
<td>Kratos C2</td>
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<td>$$$</td>
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<td><strong>Interstel Tech.</strong></td>
<td><strong>COSMOS</strong></td>
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- Mission planning & scheduling
- R/T command & control
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- System executive management
- Flight dynamics
- Data system management
- Test bed & simulators
- Analysis tools
How Do We Compare?

Desirable Features

How do we efficiently monitor & control hordes of satellites?

Users want ease of use and overall executive tool
How Do We Compare?

**Desirable Features**

Ops systems for multiple satellites are **TOO COMPLICATED**…
…and hard to adapt to new missions!

Customers want something easily adaptable.
How Do We Compare?

**Desirable Features**

- Open Source
- Plug and Play
- Remote Virtual Ops
- Scalable
- Error Handling
- Automation
How Do We Compare?

Desirable Features
Market

Satellites + UASs + Ground Stations

$24 B
Ground Equipment, Flight Software, Ground Software, Services, Ops

2020 Estimate

$2.4 B
Addressable Market
Revenue Models

Freemium Model

License Product to Reseller

Gov. Contracts (annual licensing)

Commercial (annual licensing)

Expansion Areas

Service
- Mission Ops
- Data on demand

Hardware
- Portable Ground Stations
- Embedded in avionics

FREE! + $
Go to Market Strategy

Seek strategic partnerships

Win contracts to develop COSMOS & gain customers

Get customers to try COSMOS demos

FREE!

Keep

Develop COSMOS community for developers/users

Product improvement and new features

Grow

Targeted collaborations

Provide ops services

Tiered product offerings
# Development Plan

**To COSMOS v2.0 Launch**

<table>
<thead>
<tr>
<th>Milestones</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
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<tr>
<td>COSMOS Development</td>
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<td>MOST Development</td>
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<td>OTB/Simulators Development</td>
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<td>CEO Development</td>
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<td>Other Tools</td>
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<td>Obtain VC Funding</td>
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<td>Commercial Operations</td>
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First flight use

First flight use
Financial Projection

Revenue

- Reseller Sales
- Remote Sensing Sales
- Ground Stations
- License sales
- Large Commercial
- Government Contracts

SELL!
Financial Projection

Net Profit

Investment Needed

Version 1.0 - $50,000
Version 2.0 - $1 million
is expanding!

MAHALO!