Web as Inspiration and Platform for Mission Operations Software

Dr. Michael Wallick
Jet Propulsion Laboratory
California Institute of Technology
Web as Inspiration and Platform for Mission Operations Software
Mission Operations Software
Mission Operations Software
OPS Lab
Operations Planning Software Laboratory
OPS Lab Customers

- Flight Projects: MER, Phoenix, MSL
- Technology Projects:
  - MaROS
  - USGS/VAlerts
  - ESMD Human-Systems Interaction
    - ATHLETE
    - Centaur (JSC)
    - Chariot (JSC)
  - MGSS In-Situ Project
  - CliffBot
  - Aerobot
  - AISR Tactical Rover-based Martian Geologic Mapping
  - White Sands Missile Range Test and Evaluation Command and Control
  - DARPA National Cyber Range
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We have provided support for assets on land, air, sea, space, and cyberspace.
OPS Lab Product Line (1/2)

**Maestro**
Science data analysis and tactical planning for Mars
Designed for long latency
Runs on off-the-shelf hardware, laptops
Co-winner, 2004 NASA Software of the Year

**Virtuoso**
Real-time monitoring and control of Lunar and Earth robotic systems
Designed for short latency
Utilizes specialized, immersive hardware
OPS Lab Product Line (2/2)

**Orchestrator**

Telemetry processing and data product production

Handles both long and short latency scenarios

Supports Maestro and Virtuoso

**Ensemble**

Open architecture for the development, integration, and deployment of mission operations software

The framework for Maestro, Virtuoso, Orchestrator, and many other tools

Highly successful collaboration with Ames and JSC
Operations Interface Devices
Maestro: A Closer Look
How to Find a Plan
How to Find a Plan
How to Find a Plan
How to Find a Plan

Planning Perspective
Limited Search Area
How to Find a Plan

Planning Perspective
Limited Search Area
Filter by Plan Types
How to Find a Plan

Planning Perspective
Limited Search Area
Filter by Plan Types
Filter by Time Range
How to Find a Plan

Planning Perspective
Limited Search Area
Filter by Plan Types
Filter by Time Range
Freeform Search
How to Find a Plan

Planning Perspective
Limited Search Area
Filter by Plan Types
Filter by Time Range
Freeform Search
Plan Information
How to Find a Data Product
How to Find a Data Product
How to Find a Data Product

Time Range

Sol 1000 to 1010
How to Find a Data Product
How to Find a Data Product

Time Range
Instrument Pulldown
Advanced Tools
How to Find a Data Product
How to Find a Data Product

- Time Range
- Instrument Pulldown
- Advanced Tools
- Quick Search
- Results Appear in Different Tab
How to Find a Target/Place

```plaintext
<table>
<thead>
<tr>
<th>Feature</th>
<th>Site(s)</th>
<th>Image ID</th>
<th>Target Location (WGS84)</th>
<th>Nominal</th>
<th>Creation Time</th>
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<td>Target Location 1201</td>
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- NASA logo on the right side of the image.
# How to Find a Target/Place

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<th>Image ID</th>
<th>Target Location (ECEF)</th>
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<td>2007-03-14T00:00:27Z</td>
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# How to Find a Target/Place

## Select from List

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<th>Soll(s)</th>
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<th>Normal</th>
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</thead>
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<td>(-0.2017, -0.9765, 0.0757)</td>
<td>2007-03-16T00:00:27Z</td>
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<td>(-0.7135, -0.6792, 0.1720)</td>
<td>2007-03-16T00:09:09Z</td>
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<tr>
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</tbody>
</table>
Quick - I need to find ...
Quick - I need to find ...
Quick - I need to find ...
Quick - I need to find ...
Quick - I need to find ...
Quick - I need to find ...

Three Data Types, Three Different Search Interfaces
How do I get ALL DATA from Sol 77?
Web as Inspiration and Platform for Mission Operations Software
Web as Inspiration
Web as Inspiration - My Browser
Web as Inspiration - My Browser

Back/Forward Buttons
Web as Inspiration - My Browser

Back/Forward Buttons
Address Bar

http://www.jpl.nasa.gov/
Web as Inspiration - My Browser

Back/Forward Buttons
Address Bar
Freeform Search
Web as Inspiration - Find Products

Screenshot from http://www.newegg.com
Web as Inspiration - Find Products

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Web as Inspiration - Find Products
Web as Inspiration - Find Products

Control Bar
Breadcrumb Trail
Search Area

Screenshot from http://www.newegg.com
New Science Browser
New Science Browser
New Science Browser

Context-sensitive Control Bar
New Science Browser

Context-sensitive Control Bar
Back/forward Reload Buttons
New Science Browser

Context-sensitive Control Bar
Back/forward Reload Buttons
Breadcrumb Trail
New Science Browser

Context-sensitive Control Bar
Back/forward Reload Buttons
Breadcrumb Trail Shareable Link
New Science Browser

Context-sensitive Control Bar
Back/forward Reload Buttons
Breadcrumb Trail Shareable Link
Detailed Results
New Science Browser

Context-sensitive Control Bar
Back/forward Reload Buttons
Breadcrumb Trail
Shareable Link
Detailed Results
Detail Sheet with Links
I Can Find All Data From Sol 77!
I Can Find All Data From Sol 77!

Click Through Links
Type Directly
What Else can the Web Provide?
Bookmarks

- Images tagged highpriority on sols (1554 to 1563)
- Images flag sequenced is f0006 on sol 601
- Images flag on sols (1 to 328)
- Images navcam tagged highpriority on sol 1555
- Images sequenced is p2111 site is 134
- Crockett's places
- Images sequenced is p2111 site is 134 tagged teamh
- Images navcam on sols (1 to 328)
- Mosaics tagged vista on sols (658 to 1116)
- Inaris's places
- Images
- Mosaics on sols (658 to 1116)
- Images tagged highpriority on sol 1555
- Mosaics on sols (158 to 398)
- Images sequenced is p2957 on sols (297 to 314)
- Images tagged highpriority

Add Bookmark
Flickr.com “most popular” tag set
Tags
Tags

Links in Control Bar
Web as Inspiration -- What’s Happening
Web as Inspiration -- What’s Happening

Real-time Updates from Friends and Co-workers
Web as Inspiration -- What’s Happening

Real-time Updates from Friends and Co-workers
Non-intrusive Notifications
Web as Inspiration -- What’s Happening
Web as Inspiration -- What's Happening

Non-intrusive indicator
Web as Inspiration -- What’s Happening

Non-intrusive indicator
Separate Viewer
Web as Inspiration - Information Portal

News of the day
News of the day
Daily Agenda
Web as Inspiration - Information Portal

News of the day
Daily Agenda
Locations
Web as Inspiration - Information Portal

News of the day
Daily Agenda
Locations

Configurable Information that is Important to Me
<table>
<thead>
<tr>
<th>Search Field</th>
<th>Bookmarks Page</th>
<th>Bookmarks Folder</th>
<th>Bookmarks Page</th>
</tr>
</thead>
</table>

**Michael Wallick's MSLICE Homepage**

Thursday, May 14, 2009  
Time to Next Uplink: 03:42  
Time to Next Downlink: 03:42
Web as Inspiration - Information Portal

Michael Wallick's MSLICE Homepage

Search Field

Personal Information
Quick search for data
Web as Inspiration - Information Portal

Personal Information
Quick search for data
Saved bookmarks and
Current Popular searches
Web as Inspiration - Information Portal

Personal Information
Quick search for data
Saved bookmarks and
Current Popular searches
Current Popular Data
Web as Inspiration - Information Portal

- Personal Information
- Quick search for data
- Saved bookmarks and
- Current Popular searches
- Current Popular Data
- Recent Announcements
Web as Inspiration - Information Portal

- Personal Information
- Quick search for data
- Saved bookmarks and Current Popular searches
- Current Popular Data
- Recent Announcements
- Recent and future downlinks
Initial Findings

- These improvements seem to be timely
  - Tagging was requested during Phoenix ORTs and OPS during development
- Training comes natural
- Must stick to the known model
  - Editable breadcrumbs where very hard to get right
Web as Inspiration and Platform for Mission Operations Software
Web as Platform
Web as Platform - MaROS Case Study

Satellites in Orbit

Landed Assets on the Surface
Web as Platform - MaROS Case Study

Satellites in Orbit

Meanwhile on Earth

Landed Assets on the Surface
MaROS: Mars Relay Operations System

A new system under development to coordinate the interactions between landed and orbiting assets on Mars ...

With a Web Interface Component
Communication Opportunities Include

- **Landers**
  - Orbiters
  - Latencies (x5)
  - Elevation Angle
  - Conflicts
  - Warnings
  - Local Solar Time

- **Orbiter:**
  - Landers
  - Latencies (x5)
  - Deep Space Network Time (x4)
  - Orbit Number
MaROS Web Interface
MaROS Web Interface: Select
MaROS Web Interface: Select
MaROS Web Interface: Select
MaROS Web Interface: Mouse
MaROS Web Interface: Overflight
MaROS Web Interface: Overflight
MaROS: Current Status

- “Phase 1” deployment underway
  - Replace current system of manual transfers and phone calls
  - All data is fetched/set via ReSTful interfaces
  - Web view is read-only
- “Phase 2” development being
  - Waiting on customer acceptance testing
- **Web will allow data to be set**
Mission Operations and Google Wave

Senior Design Project by University of Southern California
Computer Science Students
Google Wave as a Data Analysis Tool
Google Wave as Data Analysis Tool
Google Wave as a Data Analysis Tool

- Students are currently in project design phase
- Next semester begins implementation
- Concurrent “public access” wave
  - Allow members of the public to subscribe and discuss imagery
Conclusions
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- Mission Operations Software (Long Term/Range Missions)
  - Operations software is distributed
  - Runs on commodity hardware
- Web as Inspiration
  - Using web metaphors simplifies “rocket science”
  - It is important not to break the metaphor!
- Web as Platform
  - Simplifies software distribution
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  - Flex, Silverlight, Wave will have exciting consequences for future Mission Operations
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Acknowledgements

- Maestro/MaROS Teams
- Ames Research Center Human Factors Team Members
- Many Interns and USC Students
- Web 2.0 Expo Conference
Thank You

Questions???