Strategies for Developing Web-based Satellite Operations

Rinsing the SOAP out of your eyes to look at Network-Enabled Operations (NEO)
Don’t bet against IT

- “There is no reason for any individual to have a computer in his home.”
  – Ken Olsen, 1977

“The number of components in an integrated circuit will double every two years.”
  – Gordon Moore, 1965
Don’t bet against IT

- “No one will send spacecraft commands over the Internet.”
  – Name withheld, 2009
Goals

• Our customer’s goals did not require web-based tools, but web technologies make them less expensive to achieve
  - Platform independence (operating system, GUI tools, and language choices) for the local and remote operations console
  - 24x7 remote engineering support for operations
Typical OS maintenance cycle is 10 years, and security updates are critical for a system exposed to the Internet/Grid.
Obstacles to Web-based Operations

- Security of information and the control link
- Latency impact on operations
  - Increased time required for specific operations
  - Variability in time required for specific operations
- Reliability of remote operations
  - Assuring access
  - Assuring once-only operations
- Visibility into system operations
  - Space system state
  - Ground system state
Security: Defense-in-Depth

- RESTful Web Service approach allows reuse of commercial web security practices

Operations Servers

Web Servers

Authentication Gateway

Firewall

SSL/VPN
Careful definition of resources (URL paths) in REST enables configurable security without recoding application.

GET, POST allowed
GET only allowed
Latency

• Scripted operations run locally in real-time with predictable latency.
  – Insure that critical time-related operations are run as local scripts or fault responses rather than across the web

• Analysis work requires more thought time than transit time. These tasks can be conducted locally or remotely:
  – Telemetry observation and analysis
  – Script selection
  – Command selection

Analysis

Verification & Reaction
Reliability of Operations

- Moving operations into scripts rather than individual commands enhances the reliability when the operator loop has to traverse the network. One initiation runs the operation to completion.
- Once-only operations (non-idempotent) must be able to be repeatedly status-checked.
  - Command request
  - Script Initiation

Warning: Do not press the submit button more than once or your card may be charged multiple times
Visibility

- Next-level down visibility into operation plans and results provides confidence to the operator.

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<th>Scheduled Operations</th>
<th>Event-Driven Operations</th>
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<td>Scripts (3rd generation languages)</td>
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<td>Macros (macro assembler)</td>
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Visibility

- Visibility into the space system state, ground system state, and operations history must be provided for troubleshooting.

State of both systems