Cloud Computing for Spacecraft Operations

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Session Goals

• To invoke lively discussions about cloud computing for spacecraft operations – including benefits and barriers
• To develop a roadmap for successful migration to a cloud environment in harmonization with the existing systems and processes
• To identify the top ten things to be considered for a successful cloud migration / implementation
# Ground System Architectures Workshop

## Session 12F Cloud Computing for Spacecraft Operations

### Presenters/Panelists

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### Terremark/ISI Demo

Implementation of Epoch ground control system on Terremark Enterprise cloud

Demo by Bill Lowry, Terremark and Mark Walker, ISI
1) Security / ITAR:
   - Store only publicly available data on the cloud
   - Host private data on local servers to eliminate potential security holes
   - ITAR considerations must be made, but cloud providers are working to accommodate
     • Amazon EC2/S3 will provide an “ITAR Region” in Fall 2001
   - Acquirers need to understand security provision that are available
     • Bring up concerns with vendors; they have solutions
2) **Cloud standards are needed and necessary**
   - Customers want to be able to migrate from cloud provider to provider; they do not want to be locked in
   - Tools and standards don’t yet exist to do this
   - Avoid using unique features to make migration simpler

3) **New programming paradigms can optimize use of the cloud**
   - Applications can be run as is in the cloud, but …
   - Ground system software can be redesigned to take advantage of the compute capacity available on the cloud
   - E.g., retrieving long term telemetry may be sequential on servers today, but performance would be more optimal if the retrieval were broken into several parallel retrievals
4) Incremental “Bolt-On” approach to cloud migration
   – Cloud computing is ready to provide external storage today
     • Operational archive data (e.g., archived telemetry and events) can be stored locally for recent data, but for long term storage it can be moved to the cloud
     • Payload and science data makes sense
   – But, some space applications may not be cloud friendly
     • Commanding and command encryption interfaces
     • Graphic intensive applications (e.g., orbit visualization)
5) Cloud business cases and strategies need to be refined
   - Benefits to customers and providers are need to be clarified before migrating, identifying real cost savings
   - Some business cases add up now (e.g., using virtualization for testing and configuration management); others need to be fleshed out
   - Amazon EC2’s rental model offers better performance per dollar than having to purchase and maintain local servers
     - More study is needed to see if this applies across the board
   - Do proof of concept and prototyping actives
6) Ground system suppliers need to revamp licensing schemes to be “cloud friendly” and effective for users
   – Per seat licensing isn’t effective as seats very

7) Cultural changes are required to take advantage of cloud technology
   – Private vs. Public Cloud; private clouds are a good first step
   – Procurement paradigms
   – Training for IT professionals
   – Address change and “fear of the unknown”
   – Organizational reluctance to give up control
   – Stakeholder buy in
8) Cloud capabilities improve upgrades and maintenance
   - New versions/releases can be tested alongside current versions
   - Operators can switch over when system is tested

9) Responsive 24 x 7 support required from cloud providers
   - Responsiveness equivalent to network communication service providers can ease acceptance of “out of the building computing”
Key Points

- 10) Hold more workshops!
Q1: I expect spacecraft ground systems to migrate to cloud computing platforms.
Q2: Cloud computing plays a major role in the future spacecraft ground system command and control and spacecraft operations.
Q3: Industry will overcome barriers to the use of cloud hosted ground system software.
Q4: Cloud computing plays a major role in remote access for spacecraft ground system data.
Q5: Requirements for remote access to spacecraft data will increase in the future.
Your Organization is...
Q6: Taking steps towards virtualization / virtual servers (rather than dedicated hardware).
Q7: Attempting to harmonize ground systems / reducing the number of ground systems.
Q8: Contemplating cloud-based systems

A, B, C: Command and control via the cloud makes us nervous, but remote data access is OK.
• Considering the cloud migration top 10 can:
  – Help develop a successful cloud migration strategy and roadmap that takes advantage of cloud computing can offer while avoiding pitfalls
  – Determines which functionality it makes sense to migrate now
• Survey results indicate attendees think cloud computing plays a role in the future spacecraft ground system command & control and spacecraft operations – but commanding is still scary
• More discussions are needed to address the “fear of uncertainty” associated with cloud computing
• We look forward to continuing discussions at GSAW2012