A COTS-Based Reference Architecture for Satellite Ground Systems

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Outline

• Architectural Principles
• Why A COTS-Based Architecture?
• Layered Network Approach
• Ground/Space Trades
• Standards
• Conclusions
Architecture Principles

- Framework should maximize the reuse of complete off-the-shelf components
- Flexible framework that allows the mission developer the opportunity to tradeoff features and risk in the design of the overall mission
Why A COTS-Based Architecture?

- Maximize component choices and minimize dependence on any specific supplier
- Spread maintenance cost across multiple organizations
Layered Network Approach
Architecture Layers

Global Services

Local Area Services

Platform Services
Platform Services

Platform Services

Network

Physical network - Ethernet, FDDI, ATM, ....

(Layers 1 & 2)

O/S Services

Platform Hardware Resources

Platform

Platform-Dependent Applications

Network Transparency Middleware

Network Applications

(Layers 5 & 6)

Internet Protocol
(Layer 3)

Data Transport
(TCP, UDP)

(Layer 4)

(Layer 7)

Platform Services

Platform Hardware Resources

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Internet Protocol
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Network Applications

(Layer 7)

Platform-Dependent Applications

Platform Services

O/S Services

Platform Hardware Resources

Physical network - Ethernet, FDDI, ATM, ....

(Layers 1 & 2)
Local Area Cell Architecture

- Gateway Process
- GS Ctl Apps
- Mission Operations Apps
- Payload Apps
- Local Area Services
Global Services Architecture

- Spacecraft Cell
- Gateway Process
- Ground Station Ops Cell
- Gateway Process
- Vehicle Ops Cell
- Gateway Process
- Payload Ops Cell

Wide Area Network Services
Ground/Space Trades
Architecture Addresses Multiple Dimensions of Mission System

- Frequency of Contacts
- Downlink Rate
- Number of Spacecraft
- MB/Day
Ground/Space Trades

- Architecture allows functions to be moved between ground and space
  - Architecture addresses entire mission system as a whole network, not as two separate systems
  - Network transparency allows applications to be anywhere in the network and still interact
  - Trades based on multi-dimensional aspects of the problem
Ground Space/Trades

• System is built to meet mission needs
  – Network approach allows applications to be seen as individual pieces
  – Selection of pieces is based on mission needs
  – Designer can easily trade off cost of a component against risk of not having the functionality
  – Mission only pays for applications that it needs
Standards
Standards

- Establish a core of widely accepted and supported standards (Global standards)
- Supplement with a wider set of system implementation standards (Mission standards)
- Differentiate between integration and development standards
## Standards Categories

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<tr>
<th>Integration</th>
<th>Global</th>
<th>Mission</th>
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<tbody>
<tr>
<td></td>
<td>Used when selecting building blocks</td>
<td>Additional standards needed to integrate a</td>
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<td>given mission</td>
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<td>Development</td>
<td>Applied when developing software to be part</td>
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<td>of a product line</td>
<td>Applied when developing mission unique soft</td>
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Prototypes

• IMACCS
  – Demonstrated feasibility of integrating a ground data system using COTS

• BIOS
  – Demonstrated use of network transparency layer (CORBA) to allow movement of components within an overall architecture
Conclusions

• Architecture is flexible enough to accommodate a wide range of mission requirements
• Network transparency provides for the capability to trade functions easily between ground and space
• Standards facilitate integration without unnecessary constraint
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References


References 1 and 2 are available through Mr. Gary Meyers, NASA/GSFC, Greenbelt, MD 20771.
Sample Logical Architecture Implementation
Sample Implementation Features

- Device Control/Management provides gateway functions between primary control center cell and ground site cells
- Database server replication features provides gateway functions between primary control center cell and backup control center cell
• Each component was specified with a set of COTS products
• COTS products selection was a mix of command & control applications and system/network management tools
• Spacecraft could be easily integrated as a cell using the Device Control/Management functionality