GSAW2003 Breakout Group
“Architecture Granularity - A COTS Vendor’s Perspective”

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Agenda

- Company Background
- Discussion Statements
- Examples of Architecture Granularity
  - COTS vs. Custom Code
- Summary
Background

• Integral Systems provides satellite ground systems
  – Founded in 1982, 350 employees
  – Headquartered in MD; Offices in CO, OH, & Toulouse
  – Three subsidiaries

• We produce COTS software packages

• We act as system integrators for turnkey systems
  – Bundling 3rd party hardware and software

• Prime Contractor for CCS-C
Customer Base and Experience

<table>
<thead>
<tr>
<th>Commercial</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>NewSkies</td>
<td>NOAA</td>
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<tr>
<td>Skynet</td>
<td>NASA</td>
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<tr>
<td>Americom</td>
<td>USAF</td>
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<tr>
<td>EchoStar</td>
<td>USN</td>
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<tr>
<td>Optus</td>
<td>APL</td>
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<tr>
<td>Sirius</td>
<td>NASA</td>
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<td>EuropeStar</td>
<td>USAF</td>
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<tr>
<td>Shin</td>
<td>NSPO</td>
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<tr>
<td>MeaSat</td>
<td>JPL</td>
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<tr>
<td>B-SAT</td>
<td>NSPO</td>
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<tr>
<td>N-STAR</td>
<td>NRO</td>
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<tr>
<td>PanAmSat</td>
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<table>
<thead>
<tr>
<th>Manufacturers</th>
<th>Missions</th>
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<tbody>
<tr>
<td>Boeing</td>
<td>Communications</td>
</tr>
<tr>
<td>Orbital</td>
<td>GEO</td>
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<tr>
<td>Matra</td>
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<tr>
<td>Lockheed</td>
<td>Science</td>
</tr>
<tr>
<td>TRW</td>
<td>LEO</td>
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<tr>
<td>Aerospatiale</td>
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<tr>
<td>SS/L</td>
<td>Remote Sensing</td>
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<tr>
<td>DLR</td>
<td>Deep Space</td>
</tr>
<tr>
<td>Alcatel</td>
<td></td>
</tr>
<tr>
<td>Product</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>EPOCH T&amp;C</td>
<td>COTS T&amp;C Processing</td>
</tr>
<tr>
<td>OASYS</td>
<td>Spacecraft Mission &amp; Orbital Analysis</td>
</tr>
<tr>
<td>ABE/AM</td>
<td>Analysis of Archived Satellite Telemetry Data</td>
</tr>
<tr>
<td>Skylight</td>
<td>Remote Sensing, Direct Broadcasting Terminal</td>
</tr>
<tr>
<td>EPOCH DB</td>
<td>RDBMS to define satellite T&amp;C at the bit level</td>
</tr>
<tr>
<td>MonicsNet/CSM</td>
<td>RF Signal Monitoring Products</td>
</tr>
<tr>
<td>Compass</td>
<td>Ground System NMS</td>
</tr>
<tr>
<td>Telemetrix</td>
<td>Ground System FEP Equipment</td>
</tr>
</tbody>
</table>
Relevant Discussion Statements

- **Component-based architecture**
  - Organized in terms of components with well-defined interfaces
  - Facilitates a level of abstraction away from implementation specifics, yet can easily be mapped to implementation

- **Architecture as a basis for system implementation**
  - Granularity refined to enable the mapping of architectural components directly into COTS components, custom components and hardware
Architecture Granularity

• Architecture should focus on components
  – Describe the functions
  – Describe the data flows between components
• Architecture should provide multiple views
  – Logical, physical, COE, hardware, software
COTS components are treated as “Black Box”

- Define functions & I/O interfaces, but not internal design
- Details of COTS components are proprietary
- Architecture information is generally limited to that in our COTS User’s Guides and Manuals --- General Data Flow is Defined
- Application Program Interface (API) defines external access in LLD

Custom components should be defined in greater detail with additional sub-components, dataflows, processes and design elements
**Typical ISI COTS Architecture**

- **Epoch Architecture**
  - One/more servers and one/more user client workstations interconnected via LAN/WAN
  - Each server can control one/more satellites
  - Each client can connect to any/all servers
  - Spacecraft defined via database
Open interfaces using industry standards allows integration with other COTS products

- SS API, ONC RPC, TCP/IP, COE, JTA

**Typical ISI COTS Architecture**

Cont.
Project Specific Example from CCS-C

A Simplified View of the Architecture

Slide 11
T&C Processing Component

Purpose

- Telemetry processing
  - Decommutation
  - Limit checking
  - EU conversion
  - COTS supported derived parameters
- Command processing
- Ground equipment monitor and control
- Contact data distribution via API
- Archive data playback
- Event generation and logging
## Sample Data Dictionary

<table>
<thead>
<tr>
<th>Label</th>
<th>Data Description</th>
<th>Mechanism</th>
<th>Media</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCCU-TCTP-1 accfile</td>
<td>Epoch User Access File</td>
<td>File</td>
<td>FTP</td>
<td>CM Driven</td>
</tr>
<tr>
<td>TCCU-TCTP-2 ConnectStream</td>
<td>Connect to stream request</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>User Driven</td>
</tr>
<tr>
<td>TCTP-TCCU-1 ConnectStatus</td>
<td>Status of connect stream request</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>User Driven</td>
</tr>
<tr>
<td>TCCU-TCTP-3 ReqGlobals</td>
<td>Request information on global variables</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>User Driven</td>
</tr>
<tr>
<td>TCTP-TCCU-2 GlobalInfo</td>
<td>Information on requested globals</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>Periodic</td>
</tr>
<tr>
<td>TCCU-TCTP-4 SetGlobals</td>
<td>Set a value of a global</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>User Driven</td>
</tr>
<tr>
<td>TCCU-TCTP-5 RequestCmdSt</td>
<td>Request command status queue</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>User Driven</td>
</tr>
<tr>
<td>TCTP-TCCU-3 CmdStatus</td>
<td>Command status queue</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>Periodic</td>
</tr>
<tr>
<td>TCCU-TCTP-6 CmdControl</td>
<td>Add/Delete of a command in the command queue</td>
<td>EPOCH API</td>
<td>Electronic</td>
<td>User Driven</td>
</tr>
</tbody>
</table>
Summary

• Architecture granularity should be at component level for COTS
  – Internal design is proprietary and not published
  – I/O Defined w/API to provide modularity

• Custom components should provide at least 1 additional level of detail/decomposition

• Primary purpose of architecture is for communication of functionality and requirements linkage, not necessarily for maintenance
  – The vehicle for the latter is detailed as-built design
Backup Slides
COTS Products

- The ISI line of COTS is designed for widespread use, and are stand-alone products with key “true COTS” features including:
  - Generic designs intended for the entire market
  - Product evolution driven by industry mission needs
  - Ability to be installed, configured, and sustained by the customers, without on-site developer support
  - Open interfaces using industry standards allows integration with other COTS products
- SS API, ONC RPC, TCP/IP, COE, JTA
Open API

• Provide an open data service for two-way communications
  – Let external programs share data, commands, telemetry, etc. with core functions
  – Allows system to be reconfigured for mission-unique requirements without impacting the core architecture
Project Specific Examples

**AFSCN Resource Management Segment**
- WGS Factory (BSS WGS IDD)
- AEHF TTSE (SI-3242, SI-3125)
- AEHF MOPS (SI-3242, SI-3125)
- WGS SATSIM (BSS WGS IDD)
- WGS Platform Apps (BSS WGS IDD)
- WGS/DCS (BSS WGS IDD)
- WGS/FDB (BSS WGS IDD)
- SIM Commands
- RTS Cntrl
- Orbit Vectors
- COV
- User Data
- Covariance

**AFSCN Command Range Segment**
- SV Commands
- NTS Control
- OAA Interfaces
- MILSTAR Interfaces
- AEHF Interfaces
- WGS Interfaces
- DSCS Interfaces
- OAA Interfaces
- AFSCN Interfaces
- Milstar Interfaces
- ABF Interfaces
- WGS Interfaces

**NOTES:**
1) SOC-41 provides only remote command/control through SOC-42
2) Mission trainer provides positional training
3) SOC trainer provides crew training as well as positional training
4) AIA Secure Copy (Secure Copy / Dirty Word Checker) used to copy data to floppy.

**AFSC N 1/sec**
- 24 Hr/NTO, Site Schedule List
- Directives
- WP, SA,
- DEFT, LSETs, CPUNCH
- 24 Hr/NTO, Site Schedule List
- DEFT, RFI, CPUNCH

**SIM Command Data**
- RTS Cntrl
- Orbit Vectors
- Orbit Vector, PL Table
- Upload Status
- User Data
- Coverage

**SIM Telemetry**
- RTS Status
- Orbit Vectors
- COV
- Orbit Vector, PL Table
- Upload Status
- User Data
- Coverage

**SIM Telemetry**
- RTS Status
- Orbit Vectors
- COV
- Orbit Vector, PL Table
- Upload Status
- User Data
- Coverage

**AIA Secure Copy Toolkit**
- ONLY used to copy data to floppy.