Intelsat’s experience in Harmonizing ground systems

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Satellite Control Systems
Intelsat
Fleet Operated by Intelsat

Intelsat Owned (52) 3rd Party (22)

Boeing 601, M, & HP
7 3

Boeing 702
3 8

Boeing Spinners
4

S/S Loral
25 10

Orbital Star 2
8

EADS Astrium Eurostar
1 1

Lockheed Martin 7000 series
2

Thales Spacebus 3000B
1

AMOS
1
# Ground Control Systems in use at Intelsat

<table>
<thead>
<tr>
<th>Ground Control System</th>
<th>Satellite Owner</th>
<th>3rd Party</th>
<th>Intelsat</th>
<th>Total</th>
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<tbody>
<tr>
<td>Eclipse</td>
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<tr>
<td>EPOCH</td>
<td></td>
<td>17</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>GNS</td>
<td></td>
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<td>39</td>
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<tr>
<td>IAI</td>
<td></td>
<td>1</td>
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<tr>
<td>ISIS</td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>TCR</td>
<td></td>
<td>2</td>
<td>7</td>
<td>9</td>
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<tr>
<td>TCR (PDP Emulator)</td>
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<tr>
<td><strong>Total</strong></td>
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<td>22</td>
<td>52</td>
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</table>
ESOC/LSOC configuration:

- **ESOC:**
  - East Coast Satellite Operations Center located in Washington, DC
  - 4 controllers operate 49 satellites

- **LSOC:**
  - Long Beach (CA) Satellite Operations Center
  - 3 controllers operate 25 satellites

- Polycom Video Conferencing system between the two SOC
Satellite Operations Concept

Fully Redundant Satellite Operations Network
Business continuity and disaster recovery

Primary Site

Back-up Site(s)

24/7 TTC

Baseband RF

Long Beach Satellite Operations Center (LSOC)

Full East-West Connectivity:
Redundant DS3 lines (with path diversity)

East Coast Satellite Operations Center (ESOC)
What is Harmonization of Ground Systems

• BusinessDictionary.com:
  – Adjustment of differences and inconsistencies among different measurements, methods, procedures, schedules, specifications, or systems to make them uniform or mutually compatible.

• In music:
  – To blend notes nicely with melody

• Harmonization of business processes:
  – Simplify and standardize business processes/procedures

• My definition for harmonization of ground systems:
  – Simplify and standardize hardware, software, and processes of ground control systems to improve the efficiency of satellite operations
Harmonization of Ground Systems at Intelsat

• Intelsat is harmonizing COTS and custom ground systems
  – To improve situational awareness
  – To improve operational efficiencies
  – To improve maintainability of ground systems

• Leveraging existing tools to simplify operations and training

• Leveraging strategic technologies to improve operational efficiencies
  – Ranked by InformationWeek 500 as one of the top 500 innovators

• Consolidating servers and storage; various ground systems supported on same physical hardware
Harmonization – situational awareness

Events and Alarms System

- All events and alarms available in a single application, on a single GUI
- Software applications developed to ingest events and alarms from Epoch, TCR, and ISIS
- Supports events and alarms for Intelsat and several 3rd party s/c including DIRECTV, Sirius XM, WorldSpace, ICO, Hughes
Harmonization – operations

Telemetry viewer (ITM display)

• Historical (archived) telemetry available in various formats --- GNS, Epoch, IAI, ISIS, and SDM

• Software bridges developed to receive telemetry from Epoch, IAI, ISIS, and SDM

• Both real time and historical telemetry can be viewed using ITM display

• Supports telemetry displays for Intelsat and several 3rd party s/c including DIRECTV, Sirius XM, WorldSpace, ICO, and Hughes
Harmonization – operations

Ranging

• Ranging for many s/c operated on COTS systems is being performed using the GNS
• Simplifies operations by automating range scheduling, antenna movement, providing track and range data to FDS, and so on.

Flight Dynamics

• 5 different flight dynamics systems are in use
  – GNS_FDS, Telesat_FDS, STA, GMV, and OASYS
• Interfaces developed between GNS_FDS and Epoch to retrieve telemetry and deliver orbital products
• Similar interfaces between GNS_FDS and TCR under development
Harmonization of infrastructure – Storage

Tier-1 Storage: NetApp

- All mission critical data consolidated on unified Tier-1 storage and synchronized between the SOCs
- All GNS databases, file servers, application binaries, scripts, etc. installed in one location on NetApp
  - Duration of software installation reduced from days to minutes
  - Improved maintainability; reduced errors during deployment

Tier-2 Storage: Winchester Systems SAN

- All telemetry archives consolidated on Winchester Systems SAN
- Improved maintainability, reduced downtime
- Easy to grow/shrink disk storage
Harmonization of infrastructure – Servers

Virtualized compute capacity: CPU and memory

- Most COTS and custom components run on virtualized servers
- GNS, Epoch, other custom PC applications
- Older systems (TCR, ISIS, AMOS, LEASAT) run on physical (non-virtualized) hardware
Harmonization of Infrastructure – Remote access

Mobile and Remote Computing:

- Customers use VNC to access most ground control systems
- Same solution no matter where they are located or which system (client) they use
- Telecommuting, on-call and emergency support made easy
Harmonization – Further work under evaluation

- A unified timeline and daily activity planner for all s/c operated by Intelsat
- Harmonization of applications in use to manage the TTC ground network elements
- Web based user interfaces
Summary

• Intelsat is harmonizing COTS and custom ground systems
  – To improve situational awareness
  – To improve operational efficiencies
  – To improve maintainability of ground systems

• Developing software bridges between ground control systems to improve the efficiency of satellite operations

• Leveraging strategic technologies to harmonize the infrastructure for various ground systems
List of Acronyms

EAS = Events and Alarms System
EPOCH = {ISI's proprietary software name}
ESOC = East Coast Satellite Operations Center
GCS = Ground Control System
GNS = Ground Network System
IAI = Israel Aerospace Industries
IPS = Integrated Product Suite
ISI = Integral Systems, Inc.
ISIS = Integrated Satellite Interface System
ITM = Integrated Telemetry Management
LSOC = Long Beach Satellite Operations Center
OCC = Operational Control Center
SCC = Satellite Control Center
TCR = Telemetry, Command, & Range
TT&C = Telemetry, Track & Command