GSAW2003

COTS Breakout Session

COTS or Development: Simulation Tools for Ground System Integration

Tom Tillman, L-3 Communications
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www.L-3space.com tom.tillman@L-3com.com

L3 communications

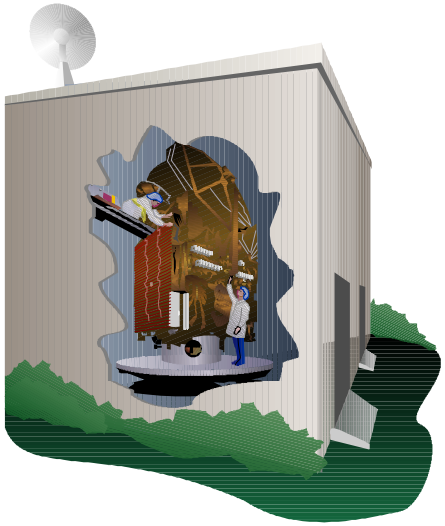
Satellite Test Data for Ground Systems

- **Satellite and Range data for Command and Control Ground System development and integration must be:**
  - **Realistic**
  - **Easily accessible**
  - **Affordable**

- **The satellite factory is the traditional source of test data**
  - **Simulators built by the satellite programs test the functionality and performance of the developed satellite**
  - **Often utilize vehicle hardware-in-the-loop and actual flight software**
  - **High fidelity to verify nominal satellite behavior**
  - **Recorded data**

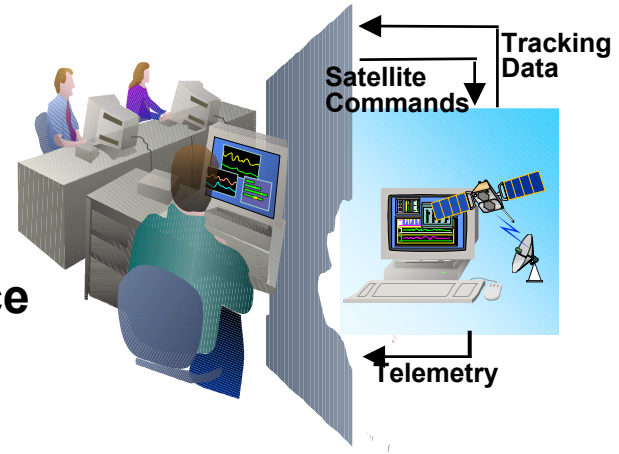
Satellite Factory Simulation – The Problem

- Data often does not meet the needs of the ground system
  - Data for limit and Engineering Unit conversion checks not available
  - Potential anomalies are not available or need to be developed
  - All commands cannot be easily tested
  - Lack of mission scenario flexibility
- Factory simulation data is often difficult to access for ground system developers
  - The satellite development always has first priority
  - Charged for the expense of running the factory simulation for outside users



COTS Satellite Modeling – The Solution

- COTS simulation enables the integrator to vary satellite data
  - Data limits, EU ranges for all desired measurands
  - Quickly change the integration mission scenario
  - Provide real-time and cataloged anomalies
  - Reusable databases within satellite families
- Flexible COTS simulation controls
  - Real-time inputs to the simulator
  - Vehicle commands from the ground system
  - Environment time control
  - State saves and restarts
  - Vehicle models configured via database, vice software
- Ownership of the simulation system



Operations Training Considerations

- Operations training is on-going in the lifetime of a satellite
  - Lasts far beyond the initial launch and deployment
  - Crew rotation
  - Satellite aging
- Simulated data from the satellite factory often used to train operations personnel
  - Same limitations discussed previously, limit data and anomalous conditions are not readily available
- Training scenarios required by ops may require expensive modifications to factory simulation
  - Maintenance issues for factory simulation after satellite is developed and on-orbit

Make vs. Buy, Factory vs. COTS?

- Fidelity of COTS simulation is not as high as the factory engineering simulation
  - The fidelity issue is solved by the requirements for the ground system
  - Data to test ground processing capabilities and limits
  - The ground system is not testing satellite on-board algorithms
- Satellite developers are reluctant to disclose proprietary satellite specifications to other contractors for entry into COTS simulation database
  - Non-disclosure agreements protect a company's proprietary data.
- Licensing and Maintenance costs for COTS simulation will always be cheaper than supporting a team of programmers

Best COTS Simulation Features

- L-3 Communications, and it's legacy companies, have provided simulation for ground systems since the 70s
- This experience, combined with research done by AF customers (CERES, AFRL) has provided a blueprint for COTS simulation products
  - Real-time satellite subsystem models
  - Flexible control for Telemetry data
  - Primary and secondary Command responses
  - Tracking station simulation
  - Develop and exercise libraries of satellite operations mission scenarios
  - Anomalies available for all subsystems and measurands
  - Simulation configurable via database, which can be defined to simulate a variety of satellite architectures executed by the same software

Making COTS Simulation Tools Work

- COTS simulations like SAGES™ are designed for the needs of the command and control ground system
  - Satellite factory simulations are designed to build satellites
- Early and open discussion of requirements between vendor and client is a must
  - Pick vendors that will be part of the team
  - Commitments up front from both sides
- The vendor will not profit if the client is unsuccessful
  - Communication!
  - Risk analysis
  - Life cycle issues
- COTS simulation can meet ground system requirements for hundred thousands of dollars
  - Potential millions spent modifying factory simulations for ground system requirements.

Summary

- The biggest competitor in the COTS satellite simulation market is the satellite programs themselves
  - This has been the case from the early shuttle launches to today
  - Satellite development programs are currently negating requirements for COTS simulation by virtue of factory simulation, even when factory simulation will not meet all of the program training requirements
- More and more of the capabilities for ground systems are being fulfilled by COTS products and support
- Including COTS simulation in that suite of operational tools makes increasing good business sense
  - COTS vendors continue to push open systems standards and interoperability
  - Buying the needed capabilities for integration and training off of the shelf has real world technical and financial advantages for satellite ground systems.