InControl-NextGeneration: An Ops Concept Driven Architecture for Satellite Command and Control

Ground Systems Architecture Workshop
March 13-15, 2002

David Allen
Senior Software Architect
L-3 Storm Control Systems, Inc.
(703) 713-6200
dallen@storm.com
www.storm.com
Primary Ground System Cost Elements

- **Acquisition Cost**
  - *Initial system procurement cost – includes:*
    - Hardware platforms
    - Software licenses
    - Non-recurring Engineering (NRE) and customization/development

- **Operations Cost**
  - *The cost to actually fly the satellite or satellite fleet – includes:*
    - Operations staff (number of operators, shifts, etc.)
    - General support infrastructure

- **Maintenance and Evolution Cost**
  - *The cost to keep the system operating – includes:*
    - Ability to add satellites - existing missions & new missions
    - Support for new operational requirements
    - Evolution and support for new COTS software releases
Strategies to Minimize Risk and Cost (1)

• Effective Use of COTS Products (*Acquisition*)
  – Excessive custom development is expensive and high risk
  – Goal is to balance the use of existing products with the need to support unique requirements
    • Minimize software license cost and development risk/schedule

• “Design for Change” (*Acquisition and Maintenance*)
  – Based on COTS technology - but, “no two satellites are the same”
  – System must easily adapt to support mission unique requirements
  – Ability to support additional satellites and new mission requirements while minimizing schedule and cost risk

• Strong Emphasis on the User/Operator (*Operations*)
  – Implementation of a “user centric” system design
  – Analysis of user activities to ensure the system is intuitive and easy to use
  – Integrated, system wide, common user interface design
  – Reduced training costs
Strategies to Minimize Risk and Cost (2)

• **Effective Control System Automation** *(Operations)*
  – Automation improves operational efficiency, reduces errors, improves reaction time, and improves operator morale

• **“Fleet” Monitor and Control** *(Operations)*
  – More mission control centers are moving to a multi-satellite capability
  – Ability to control “more with less” without reducing or risking reliability/efficiency

• **“Scaleable Architecture”** *(Acquisition and Maintenance)*
  – Easily add hardware and positions to an existing system
  – Satisfy systems of varying size and complexity using a single architecture
Ops Concept – Focus on the User

- Application of a “user centric” design
  - *Provide a system that is intuitive and easy to use*
  - *Analysis of user requirements prior to the development of system requirements*
  - *Input from operators who have dealt with multiple missions*

- Ensure everyone is always looking at the system from the user’s perspective

- Create a standardized user interface
  - *Provide operators with all the information they need in an organized and effective manner*
  - *Results in reduced training costs*
  - *Simplifies the integration of legacy and mission specific applications*
Fleet Monitor and Control

- Fleet capability must be built directly into the system architecture
  - Running multiple instances of a system is not a fleet ready solution
  - Design must start with how to present an abundance of information to the user in an organized fashion
  - Significant emphasis on user/operator requirements
“Design for Change”

• No two satellites are the same
  – Ground system products must be capable of adapting easily, quickly and without introducing mission risk

• System extension points must be designed into the system
  – Use of CORBA IDL provides a standardized way to define system interfaces
  – User interface framework allows mission specific displays to integrate with core user interfaces

• Important to follow a repeatable process
  – UML provides a standard design language
  – Design patterns allow others to understand the implementation
Scaleable Architecture

• Client/Server architecture
  – Separation of client and server is well-defined
  – Any client can connect to N missions on M hosts
  – Allows multiple views into the same server

• Component-based architecture
  – Server applications are components which can be loaded and unloaded in container processes to support any configuration
  – Standard IDL interface allows any application to become a service and support common component functions

• CORBA
  – Hides the underlying communication mechanisms
  – Allows service to be distributed in infinite ways without requiring code changes or environment variables
  – Configurable to allow tradeoffs between performance and reliability
Summary

- **L-3 Storm’s InControl-NG architecture minimizes control system costs at all major cost points:**
  - **Acquisition**
    - Efficient use of COTS products minimizes unique software development costs and risk
    - Scaleable and fleet capable architecture reduces hardware costs and software licenses fees
    - InControl-NG’s “Design for Change” architecture minimizes NRE and customization effort required to support mission unique requirements
  - **Operations**
    - Integrated graphical user interface simplifies operational use and training costs
    - Automation minimizes operations staff requirements and reduces overall mission risk
  - **Maintenance and Evolution**
    - “Design for Change” makes it easier to evolve the system to meet new requirements and support new satellites/missions
    - Scaleable architecture makes it easy to support new satellites and emerging mission requirements