

# **Multi-Mission Ground Systems: A Commercial Approach**

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# Topics

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- Multi-Mission Ground System
  - COTS or Fiction?
- Commercial Expectations
  - Where's the shelf?
- Architectural Parameters
  - The 3-D View.
- Standards and Components
  - Lessons learned in the commercial world.
- Acquisition Strategies
  - Try before you buy.
- Sustainment Strategies
  - Where's the marching army?

# Multi-Mission Ground System

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- The multi-mission ground system to be discussed today...
  - Supports multiple satellites
  - Supports satellites from multiple manufacturers
  - Supports multiple ground control sites (primary, backup, remote)
  - Supports multiple orbit types (LEO / GEO)
  - Supports different operations concepts
  - Is currently in use throughout the world at some of the largest commercial satellite operations centers in the world
  - Is available as an integrated suite of COTS products from a company in Maryland. (this company will not to be named so I don't look like a shameless marketer)

# Commercial Expectations

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- The commercial world has come to expect satellite ground systems to be:
  - Off the Shelf
  - Inexpensive (compared to government programs)
  - Compatible with all their satellites
  - Deliverable quickly (in many cases less than 6 months)
  - Safe and Reliable
- The commercial world realizes this means...
  - Specifying certain unique requirements may drive up cost and schedule
  - Specifying certain standards may drive up cost and schedule
  - Specifying certain hardware may drive up cost and schedule
  - Customizations to the system should be to accommodate spacecraft peculiarities not operations peculiarities

# Architectural Parameters

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- Successful commercial architectural parameters. “3-D”
  - Decentralization
  - Decoupling
  - Dynamic Reconfiguration

# Decentralization

- All computers are interconnected via LAN/WAN. All software functions can run on any computer.
  - No need to get obsessed with architectural details
    - How do I get redundancy and hot backups?
      - ✍ By running another copy of the software
    - Do I run the archives at the station or the control center?
      - ✍ Either or both, depends on your needs
    - What if the commanding computer goes down?
      - ✍ Have a backup copy running somewhere else take over
- Client functions can run on one client machine or be divided among several client computers
  - Ditto for servers
  - No host computer to get bogged down when you add seats
  - Fine-tune the processing and network load by reallocation
  - Any client cans connect to any server or all servers

# Decoupling

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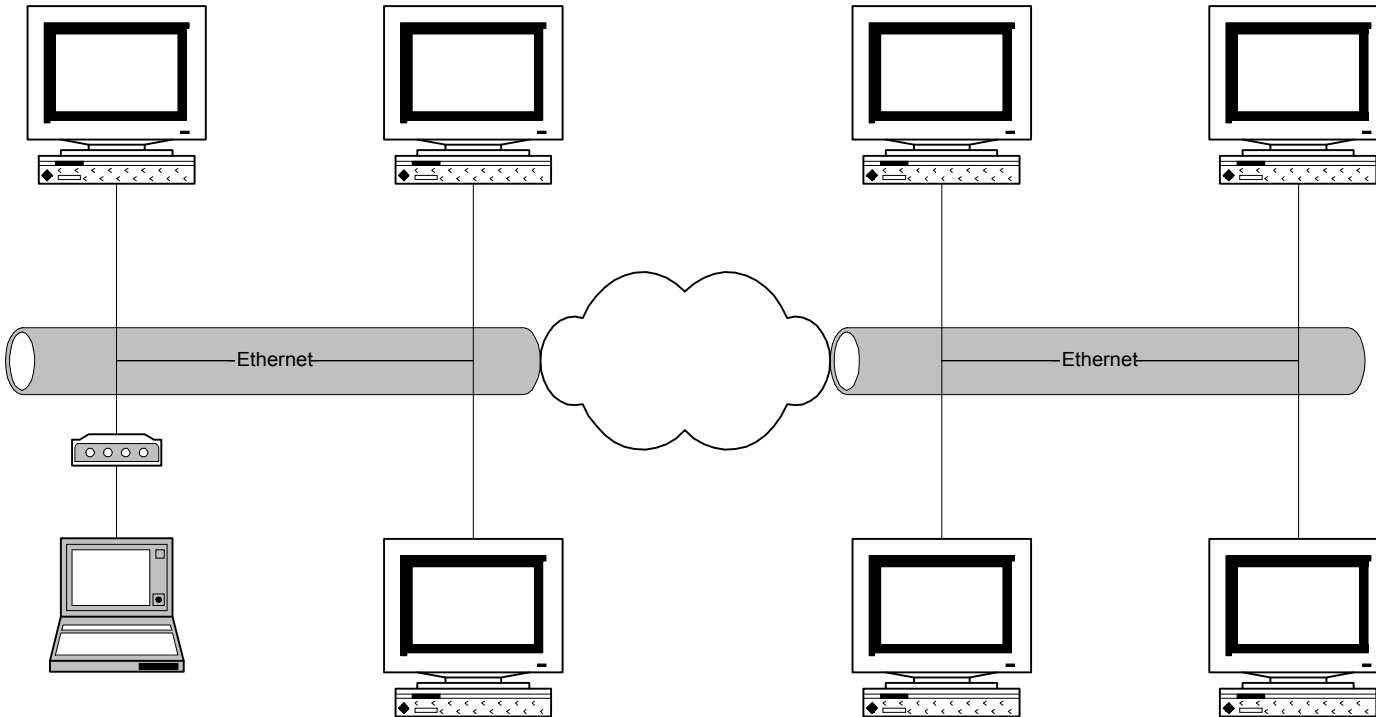
- Build mission specific features via API's outside the core COTS software
  - Maintains the integrity of the core software
  - Preserves the usefulness of the core software for all users
- Isolate hardware dependencies with a common layer for interprocess communications
  - Avoid inadvertently incorporating specific frame syncs, telemetry boxes, etc. in your architecture
- Define the satellite and ground characteristics in a database
  - Make changes and reconfigure without rewriting software

# Dynamic Reconfiguration

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- 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
- Provide a common event mechanism with external triggers
  - Allows core software to launch scripts and external programs in case of an alarm

# Sample Architecture Diagram



**Which computer runs which function? The design should let you reallocate at will!**

# Standards and Components

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- Don't dictate an architectural standard
  - Else industry will pass you by: NASCOM, TPOCC
- Don't dictate a tools standard
  - ELSE industry will pass you by: ADA, FORTRAN
- Industry has lots of components available to choose from, but
  - They don't all play together
  - They don't all work as advertised
  - They don't all exist
- Let the vendor tell you which components he can offer
  - Otherwise you may make the vendor force fit his solution around a few components you have chosen
- COTS software interchangeable components is a myth
  - It works in the hardware world, but is not there yet with software

# Acquisition Strategies

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- Buy COTS and ask for a customer list and references
  - You can make sure the software really exists
  - You can make sure the system's core capabilities can be configured for your satellite(s)
- Don't let blanket support and cost plus contracts
  - This eliminates competition
  - This provides incentive for building a custom system
- Employ the requirements police!
  - Make sure operations peculiarities and personalities don't get specified in the system
    - Otherwise system cost and schedule go up and up and up

# Sustainment Strategies

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- No marching army needed
  - The system is COTS after all
- Stay current with the COTS vendor releases
  - You will get new software features with each release
  - Your maintenance costs will be low
    - The cost for bug fixes will be shared by all users through a software subscription
  - Otherwise your COTS system...
    - Will not stay current with the industry
    - Will necessarily become custom after the COTS vendor drops support for its older versions