National Aeronautics and Space Administration

Goddard Mission Services Evolution Center "GMSEC"

GSAW Demo

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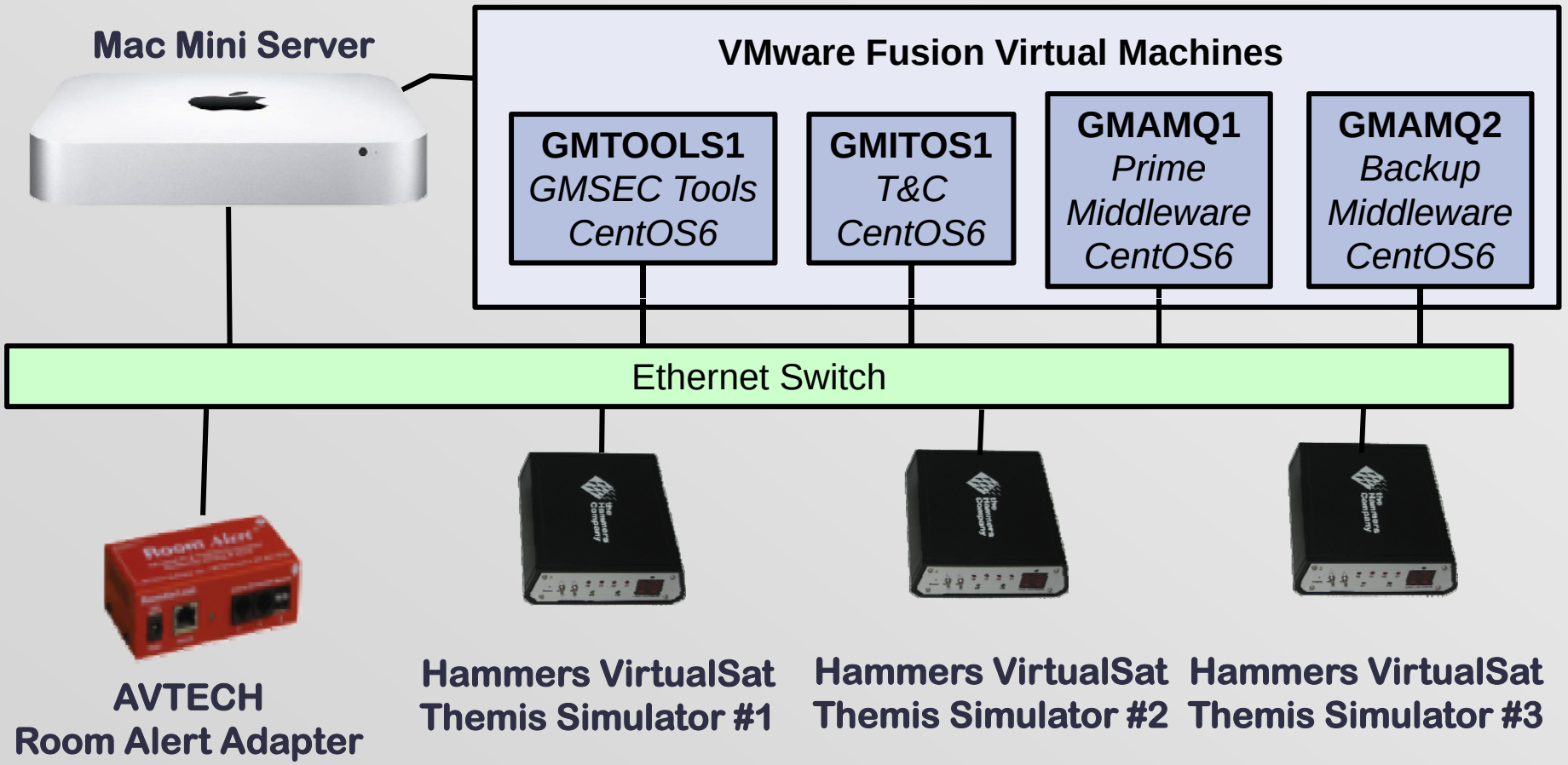
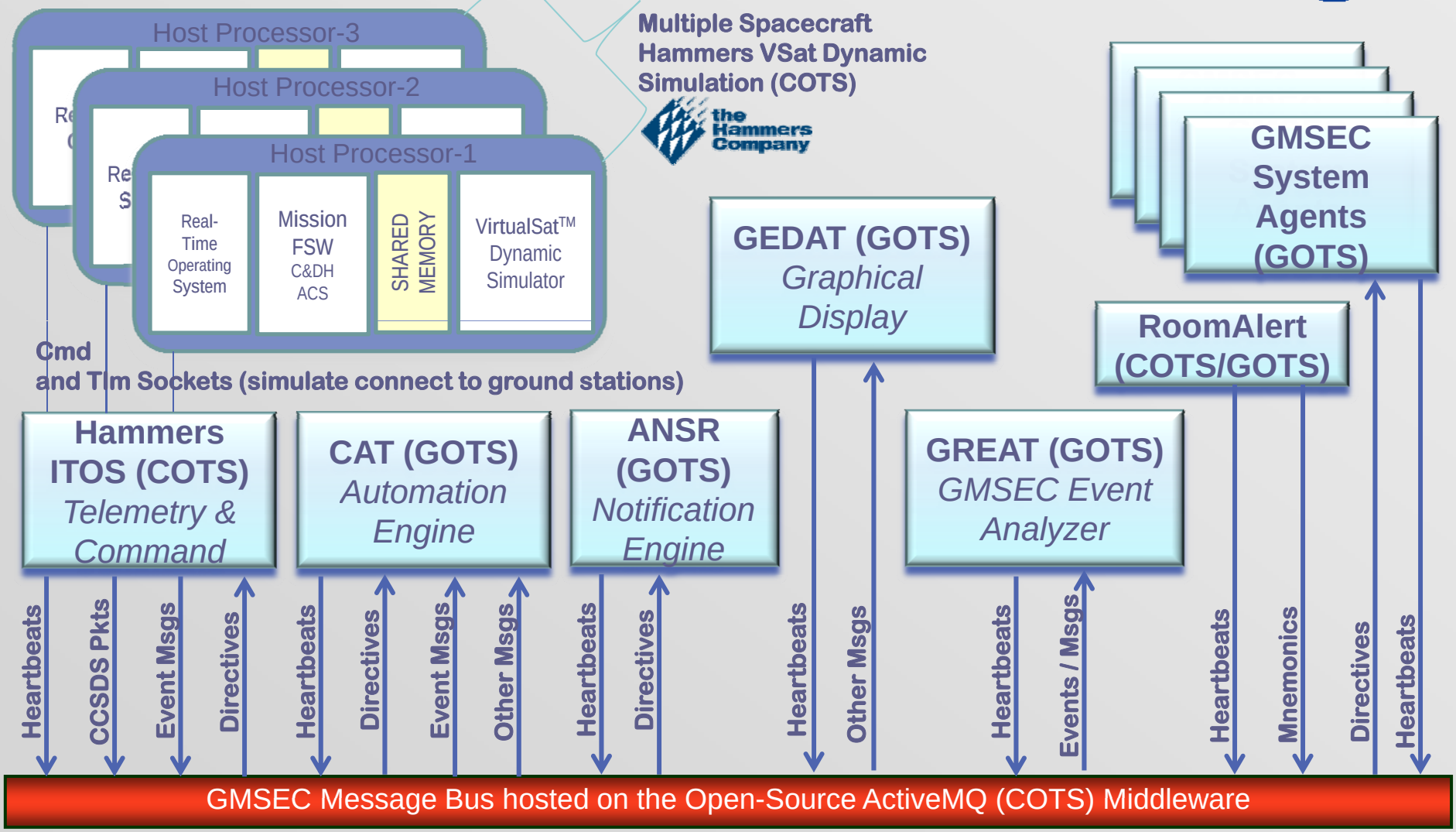
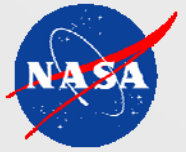
GSAW GMSEC Demo Physical Architecture



GSAW GMSEC Demo Logical Architecture



Lessons Learned/Observations

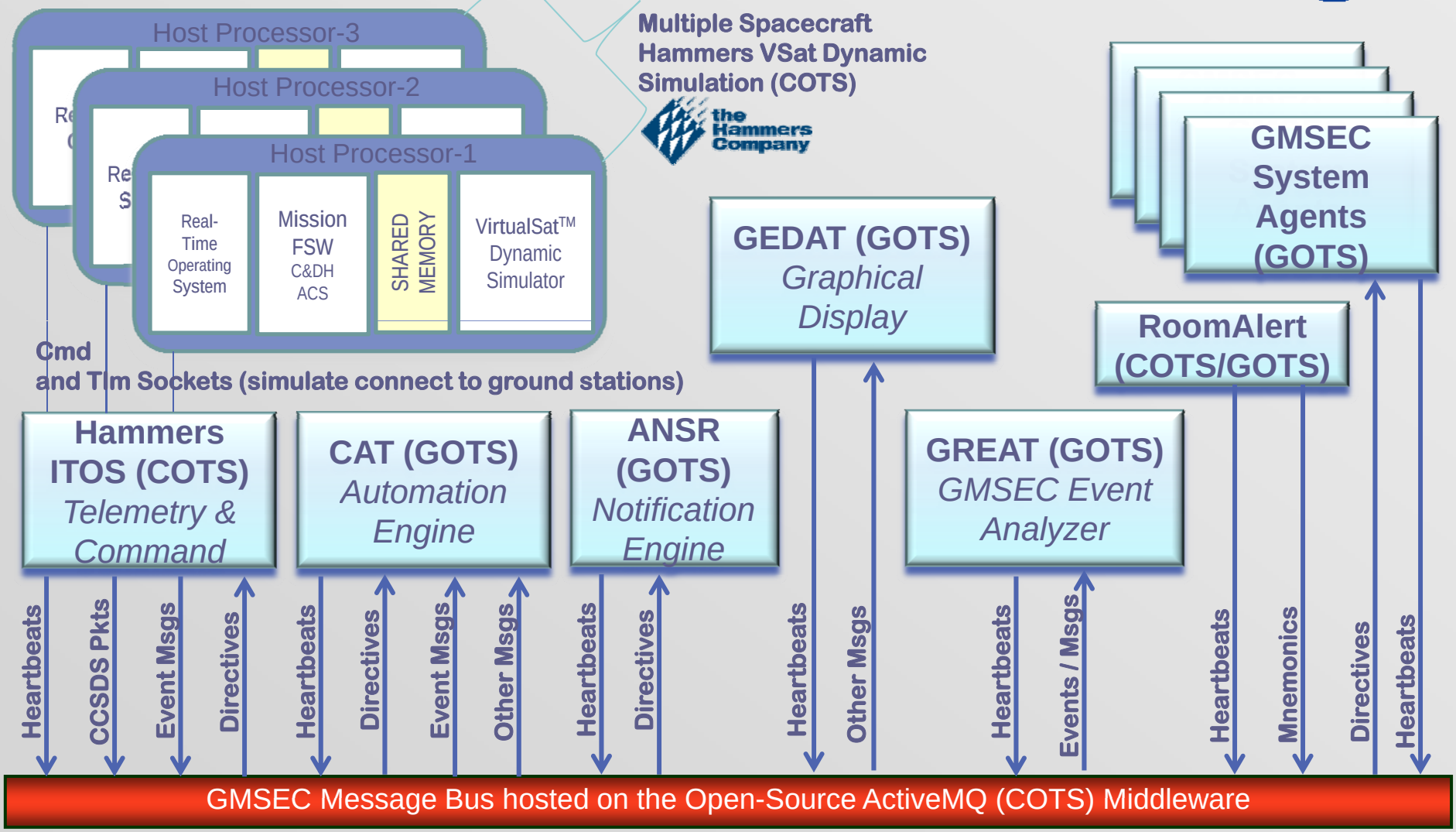


- Total Demo System Development Time <80 hours
  - GMSEC API and Components, Active MQ Server, Active MQ Client Installations: ~ 1 Staff Day
  - ITOS Installation/Simulator Integration: ~2 Staff Days
  - GMSEC Component Configuration: ~ 2 Staff Days
  - Scenario Configuration/Testing: ~ 2 Staff Days
  - Total Debug Time: ~ 2 Staff Days

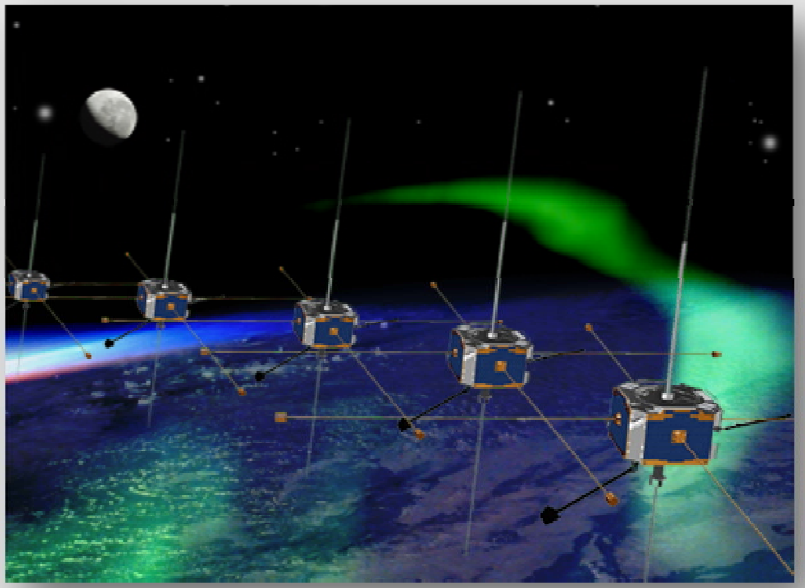
- Longest effort was waiting for the hardware to arrive
- The VM's running all of the software, middleware, and simulators with 8GB memory seem faster than some of the desktops we've used in the past
- Higher-Fidelity Simulators allow for more accurate and advanced use-case generation
- VM's allow for minimal network integration and system administrator needs during development, thus minimizing effort
- VM's allow for easy backup, migration, and configuration throughout the development process
- The use of GMSEC and VMs really enables rapid and continued enhancement of the demo system to show new tools, to demonstrate different operations concepts and scenarios, and to run various performance tests.
  - We are already talking about what to add next!

Backup Charts

GSAW GMSEC Demo Logical Architecture



Constellation Simulation and T&C, by the Hammers Company



- Hammers Company hosted the THEMIS flight software and our VirtualSat™ spacecraft dynamic simulator with RTEMS OS on a commercial Coldfire processor
- Each Processor simulates a spacecraft executing the actual THEMIS flight software currently in orbit
- The constellation fleet is managed by a single ITOS ground system
- Used by the NASA MMS Project for flight Ops team training

VirtualSat™

Spacecraft Dynamics & Real-Time Simulator

- ♦Hardware Closed-Loop Testing
  - •Utilizing COTS circuits, provides HW closed-loop test environment
  - •HW failure modes & SW critical path testing
  - •HW interfaces include Mil Std 1553, SpaceWire, RS 422/424/485, digital and analog IO
- ♦FSW Development in an all Virtual Environment
  - •Attitude Control Systems
  - •Command & Data Handling
- ♦Integration
  - •Drive physical IO for simulated dynamics
  - •Transition FSW from simulated environment to target hardware environment
- ♦Mission Planning & Support
  - •In conjunction with ground system software, verify Ops procedures and train the Ops team

ITOS

Spacecraft Telemetry & Command Control System

- ♦Designed for spacecraft fleet management mission operations
- ♦Comprehensive command & telemetry solution for spacecraft, component, and instrument development
- ♦Supports CCSDS, CFDP, and SLE protocols and more
- ♦Red Hat Enterprise Linux, Mac OS X, FreeBSD, Solaris
- ♦Supports interfaces for Mil-Std 1553, SpaceWire, RS-422/485
  - •Spacecraft simulator for instrument development
  - •Instrument simulator for spacecraft IO development

Demo Scenarios

- Environmental Alert Scenario
  - Temperature conditions in the Satellite Operations Center are beyond limits, detect and alert Operations Team
- Nominal Pass (single spacecraft)
  - Demonstrate using GMSEC to drive automation to set up for a ground station contact and shut down after Loss of Signal (LOS)
- Pass with Anomaly (multiple spacecraft)
  - Demonstrate using GMSEC to drive automation to detect and dynamically respond to an anomaly and alert the Operations Team that an anomaly has occurred
- Co-ordinated Observations (multiple spacecraft)
  - During a real-time pass with one spacecraft, detect a science target of opportunity and via GMSEC automation schedule additional resources in the constellation to come into contact and observe