Disaggregation Through Aggregation

Open Interface	Infrastructure as Code	User Experience	Disaggregation	Micro Services
Hardware Stack	Cyber	Message Bus	Enterprise	Vendor Agnostic
Stovepipes	DevSecOps		Virtual Machine	Data Exploitation
Temporal	Loosely Coupled	Resilient	Supply Chain Risk Management	Container
SOA	Situational Awareness	Message Based	Compute Infrastructure	Architecture

Creating a More Resilient Ground Segment through a Single Enterprise Architecture

GSAW 2019

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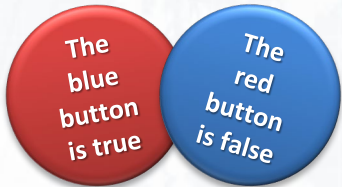
Aggregation/Disaggregation Paradox

The blue button is true

The red button is false

Space Disaggregation

> **STRATCOM chief Hyten: 'I will not support buying big satellites that make juicy targets'**

> **Space Command chief Raymond: 'rather than having a big satellite that you're reliant on, you would have multiple disaggregated satellites that could complicate the targeting calculus'**

Ground Aggregation

- **CCSDS MOIMS MO** - Consultative Committee for Space Data Systems Mission Operations Information Management Services Mission Operation Services
- **NOAA GEARS** - National Oceanic and Atmospheric Administration Ground Enterprise Architecture Services
- **USAF EGS** - United States Air Force Enterprise Ground Services

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Achieving Resilience by 'Aggregating' the Ground

- **Moving multiple ground systems to a shared ground infrastructure**
  - Beyond the obvious cost savings, forcing programs into a shared ground infrastructure makes it easier to proliferate or reconstitute the ground infrastructure and to focus cyber hardening on a single platform
- **Moving Mission functions into a common, platform agnostic, service oriented enterprise architecture**
  - Breaks down the stovepipes that prevented crucial, time sensitive information from getting to the spacecraft operators in time to make mission saving actions and hindered cross mission data exploitation

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Ground System Aggregation Enablers

- **Automated Deployment Technology**
  - Examples: Ansible, Chef, SaltStak
  - Allows ground system technology to be brought up fast, brought up anywhere, and rapid update cycle. Implemented as *Infrastructure as Code* (IaC)
- **Virtual Machine and Container Technology**
  - Examples: VMWare, Kupernetes
  - Allows prepackaged service components to be installed and managed
- **Cloud Computing**
  - Examples: Amazon Web Services, Microsoft Azure, Google
  - Allows redundant, development and even primary operations stacks to be commercially outsourced - a driver for deployment technology
- **Ground Enterprise Frameworks & SOA or Microservices**
  - Examples: MOIMS MO, GEARS, EGS
  - Allows Ground System Services to be shared, individually managed, and commercially competed
- **Open Interface Standards**
  - Examples: CCSDS, C2MS, XTCE
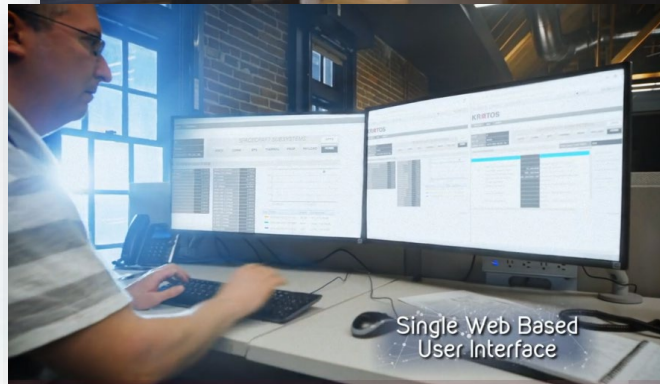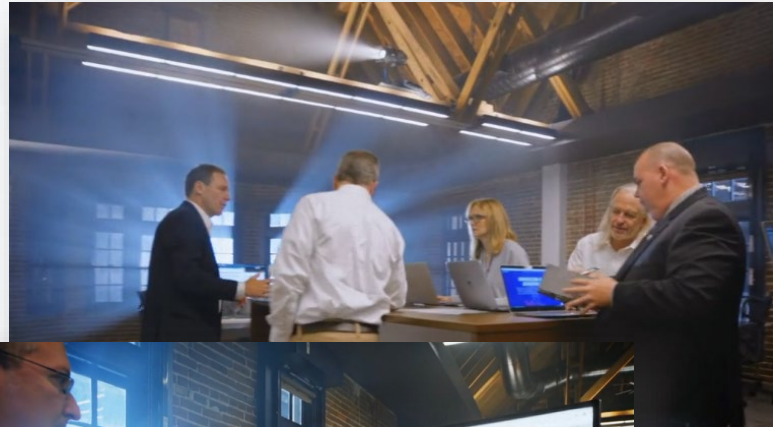 - Allows community input, refinement, and testing

On October 8, 2018 Kratos commanded an on-orbit Millennium Space Systems ALTAIR™ spacecraft at the Space Management Battle Lab (SMBL) using:
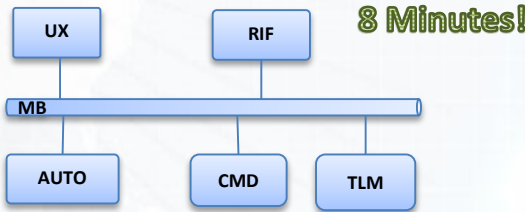
- Vendor agnostic automated deployment
- EGS message formats

Single Web Based User Interface

Demonstrates the Pathway Towards Increased Resilience Through a Single Enterprise Architecture

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Scout Automated Deployment

- **Vendor Agnostic Cloud Computing**
  - Two independent vendors demonstrating supply-chain risk-managed, enterprise computing infrastructure at the Space Management Battle Lab
  - The Scout demo repeatedly deployed enterprise services to both hardware stacks

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Scout Enterprise Ground Services

Webic Server
- User Experience (UX)
- Bridge

Web Browser
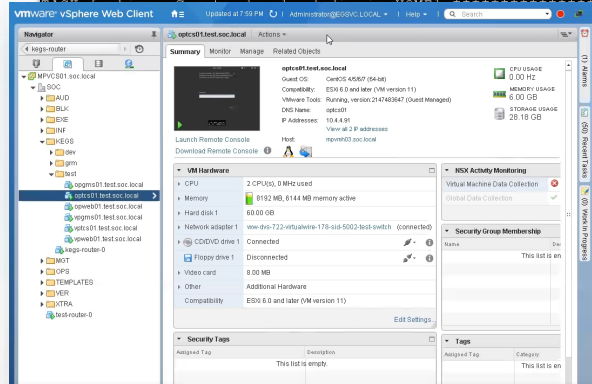
Vendor Agnostic Compute Infrastructure

Range Interface Service
- Bridge

MILLENNIUM SPACE SYSTEMS
A Boeing Company

modem

SSC

Message Bus (MB) {GMSEC – C2MS}
C2MS
Command & Control Message Specification

TAO-DSI
- Bridge
- Automation

EPOCH
- Bridge — Command Processing
- Bridge — Telemetry Processing
- XTCE
  XML Telemetry & Command Exchange
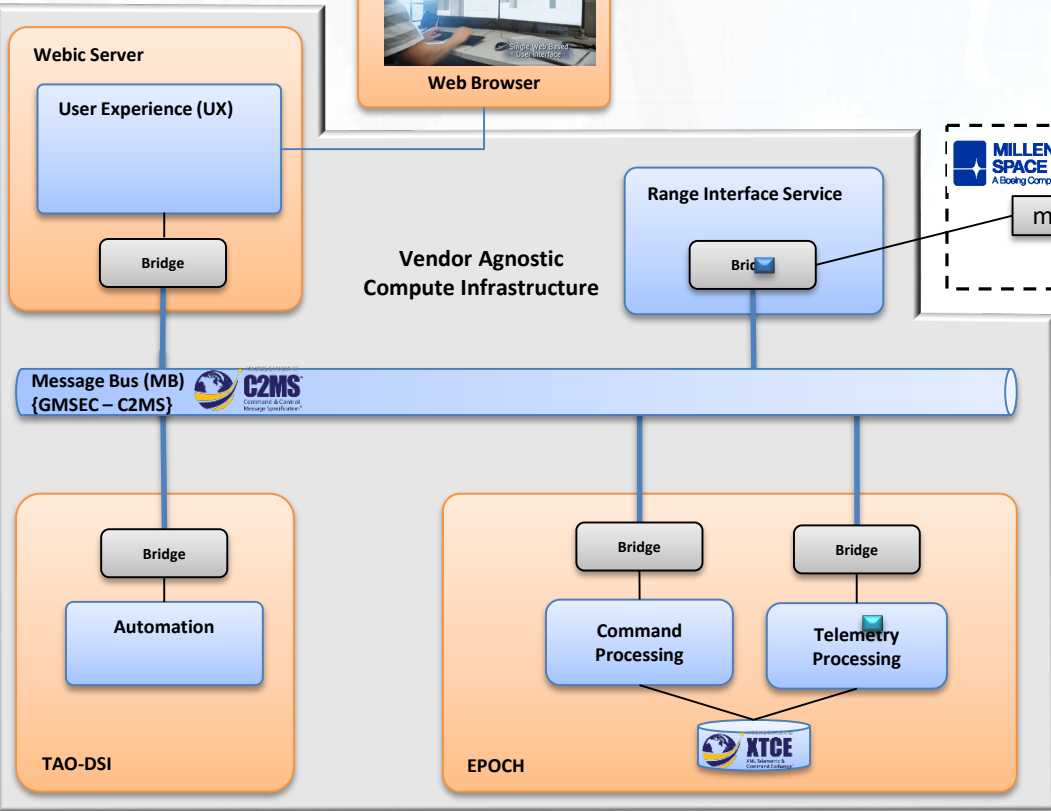
Legend
- 🟥 RF
- 🟪 CCSDS Packet
- 🟦 Raw Tlm Frame
- 🟦 Mnemonic Msg
- 🟪 CCSDS Packet

— Message I/F
— IP I/F

- EGS Service
- COTS
- Bridge

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Accomplishment	Relevance
Rapidly deployed Telemetry, Command, Automation, and UX service implementations to two different cyber secure hardware stacks	Proved the feasibility of mobile, vendor agnostic infrastructure
All enterprise services integrated into a GMSEC/C2MS service bus architecture	Consistent with loosely coupled, message based serviced oriented architecture precepts
Matched EGS service categories (Telemetry, Commanding, Automation, UX) to Kratos products	Kratos commercial products map well with EGS service categories
Start to finish in three weeks	This is not that hard
Commanded an on orbit spacecraft	The gold standard for ground system legitimacy
100% Web based user interface	No need for thick user clients – run from any browser

EGS Scout touched on all four EGS elements: Infrastructure, Messaging, UX, and Cyber

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The Future of Space Operations

- **Cyber resilience through temporal and mobile existence of the ground segment**
  - Targeting ground infrastructure will be like chasing a shadow
- **Agility and performance through competitive interchangeable enterprise ground services**
  - Big, monolithic, stove piped, paralyzed with custom software are replaced with ground systems continuously adjusting to the dynamics of New Space
  - Service architectures support rapid DevSecOps cycles
- **Ground systems that truly operate in an enterprise environment**
  - Enables data exploitation for situational awareness
  - Enable real response to natural and man-made threats

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Thank You!

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