Future Multi-Mission Satellite Operations Centers Based on an Open System Architecture and Compatible Framework

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DoD Open Systems Architecture

DoD Open Systems Architecture,

Contract Guidebook for Program Managers. May 2013

“**Background:** An open architecture is defined as a technical architecture that adopts open standards supporting a modular, loosely coupled and highly cohesive system structure that includes publishing of key interfaces within the system and full design disclosure. The key enabler for open architecture is the adoption of an open business model which requires doing business in a transparent way that leverages the collaborative innovation of numerous participants across the enterprise permitting shared risk, maximized asset reuse and reduced total ownership costs. The combination of open architecture and an open business model permits the acquisition of Open Systems Architectures that yield modular, interoperable systems allowing components to be added, modified, replaced, removed and/or supported by different vendors throughout the life cycle in order to drive opportunities for enhanced competition and innovation.”

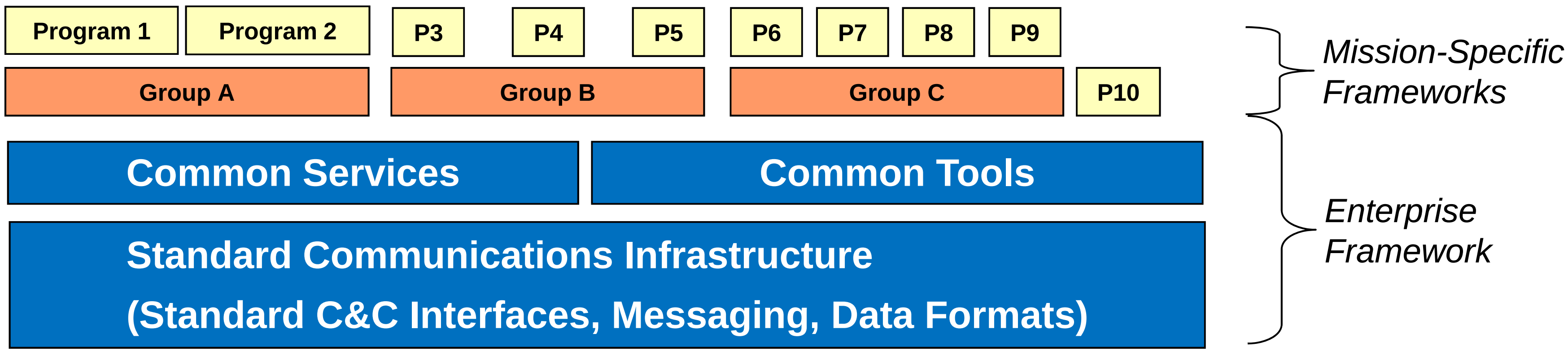
Achievement of open architecture principles requires an affirmative answer to a fundamental question:

> *Can one or more qualified third parties add, modify, replace, remove, or provide support for a component of a system, based on open standards and published interfaces for the component of the system?*

What is Framework?

"**Framework:** *An implementation of the foundation portion of the overall system architecture. It is a structured set of software components and standards, and possibly hardware, upon which to build additional functionality."*

- NASA



The term "Compatible Framework" was coined to combine the NASA GMSEC framework foundations with the information assurance features added by the DOD used in conjunction with mature virtual processing infrastructures that are the foundation of Cloud Computing "Infrastructure as a Service" (ISP) concepts used in modern data centers.

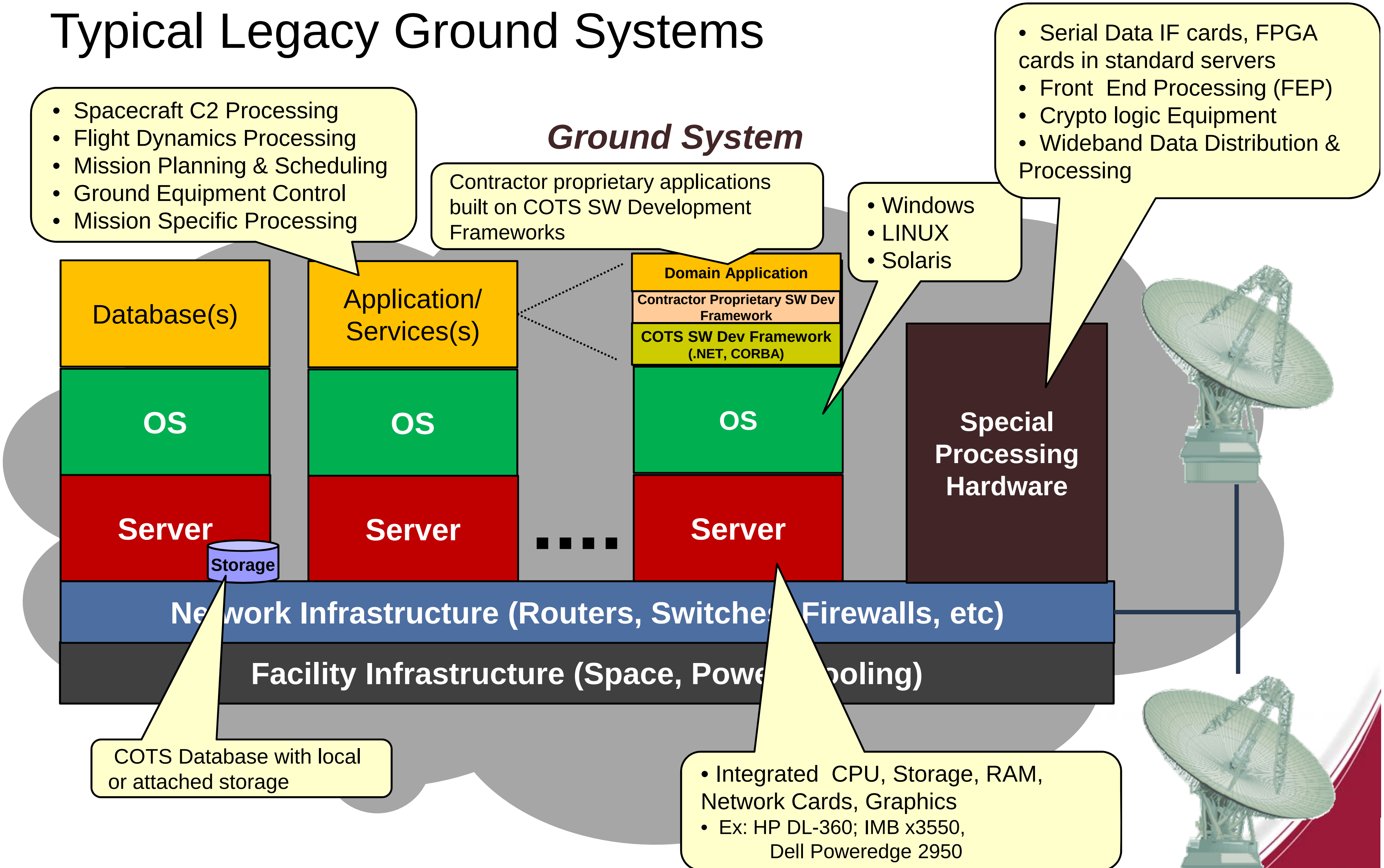
Objectives of Compatible Framework

Supporting creation of Open Architectures

- A framework for integration of legacy and future ground systems that if properly implemented could:
  - *Integrate existing stovepipes into a cohesive enterprise*
  - *Make available satellite data from various disparate legacy sources to authorized users*
  - *Be the foundation for creating an "open system" that future sensors and systems can build upon or into*
  - *Easily provide enterprise situational awareness*
  - *Easily integrate existing sensors and systems with little to no modification of the original system*
  - *Create architectures/systems that protect against cyber attacks*
  - *Enable the development of common tools and services that can be shared across the enterprise*

Enabling evolution from proprietary stove pipes is a key goal of the compatible framework approach!

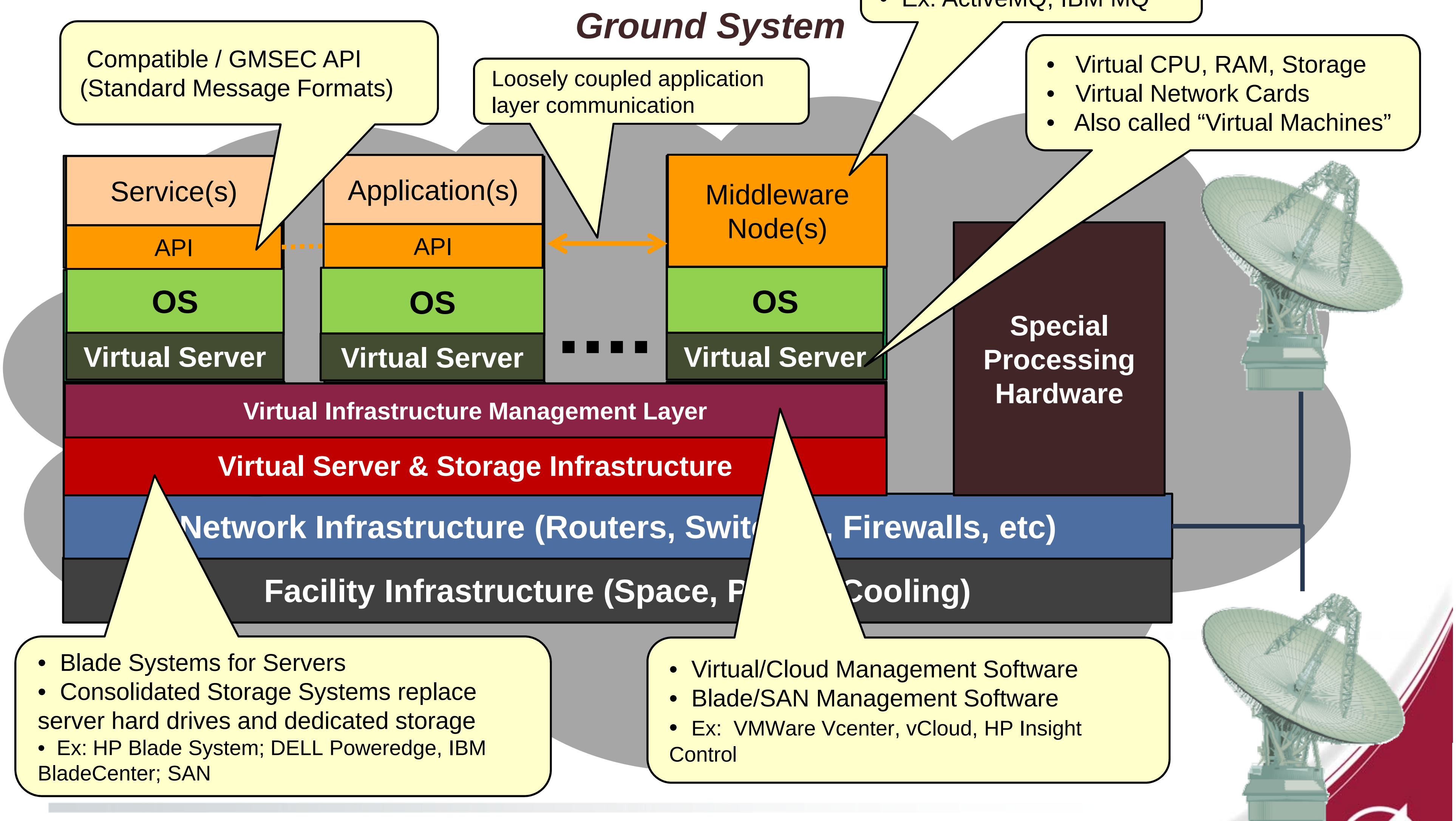
Typical Legacy Ground Systems



Circa 1990's through 2010+

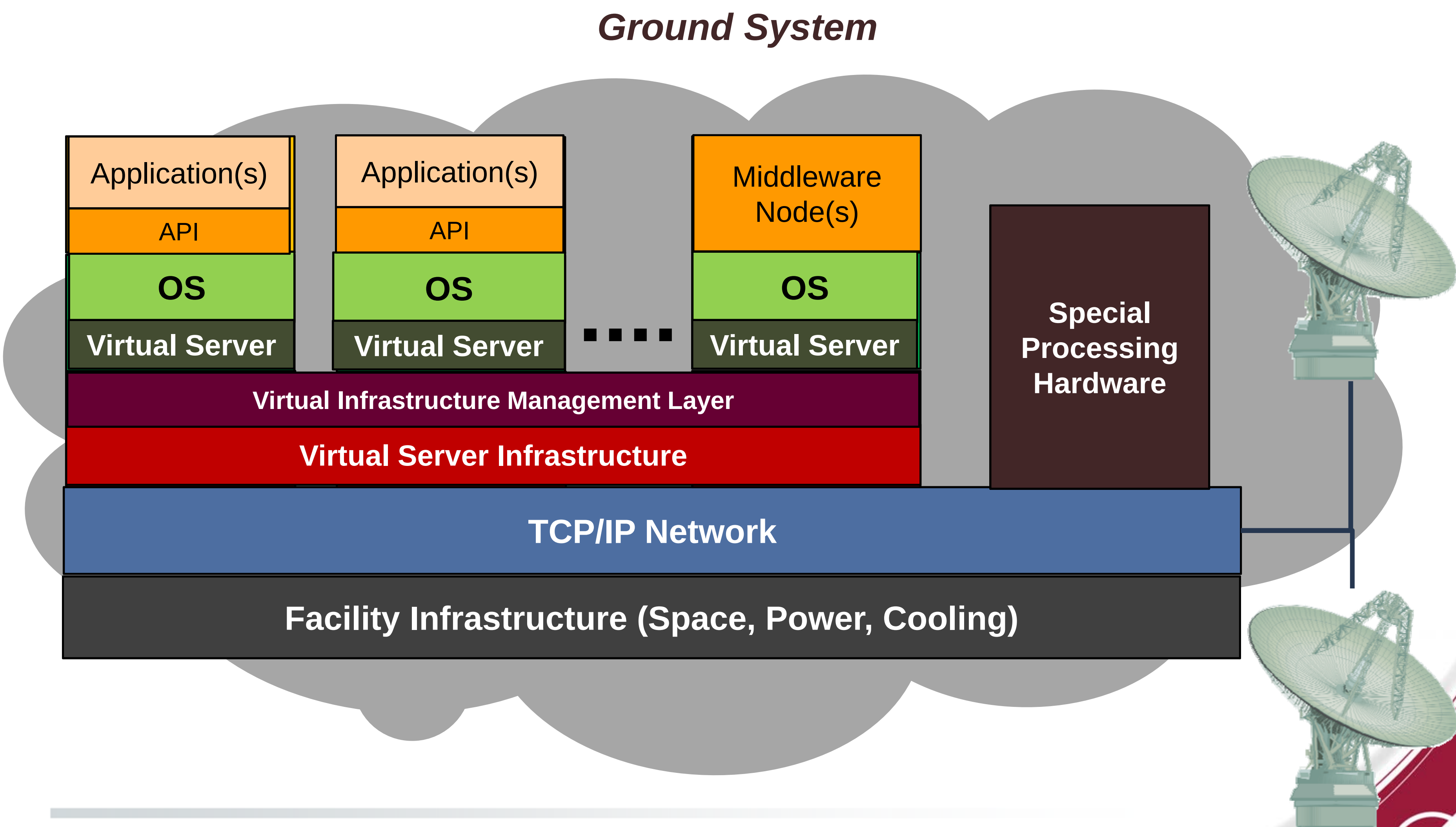
Transitioning to an Open Architecture

Leveraging a Compatible Framework



Many Ground Systems are already implementing portions of the Virtual Server Infrastructure in Major Upgrades

Scaling to an Enterprise Ground Architecture



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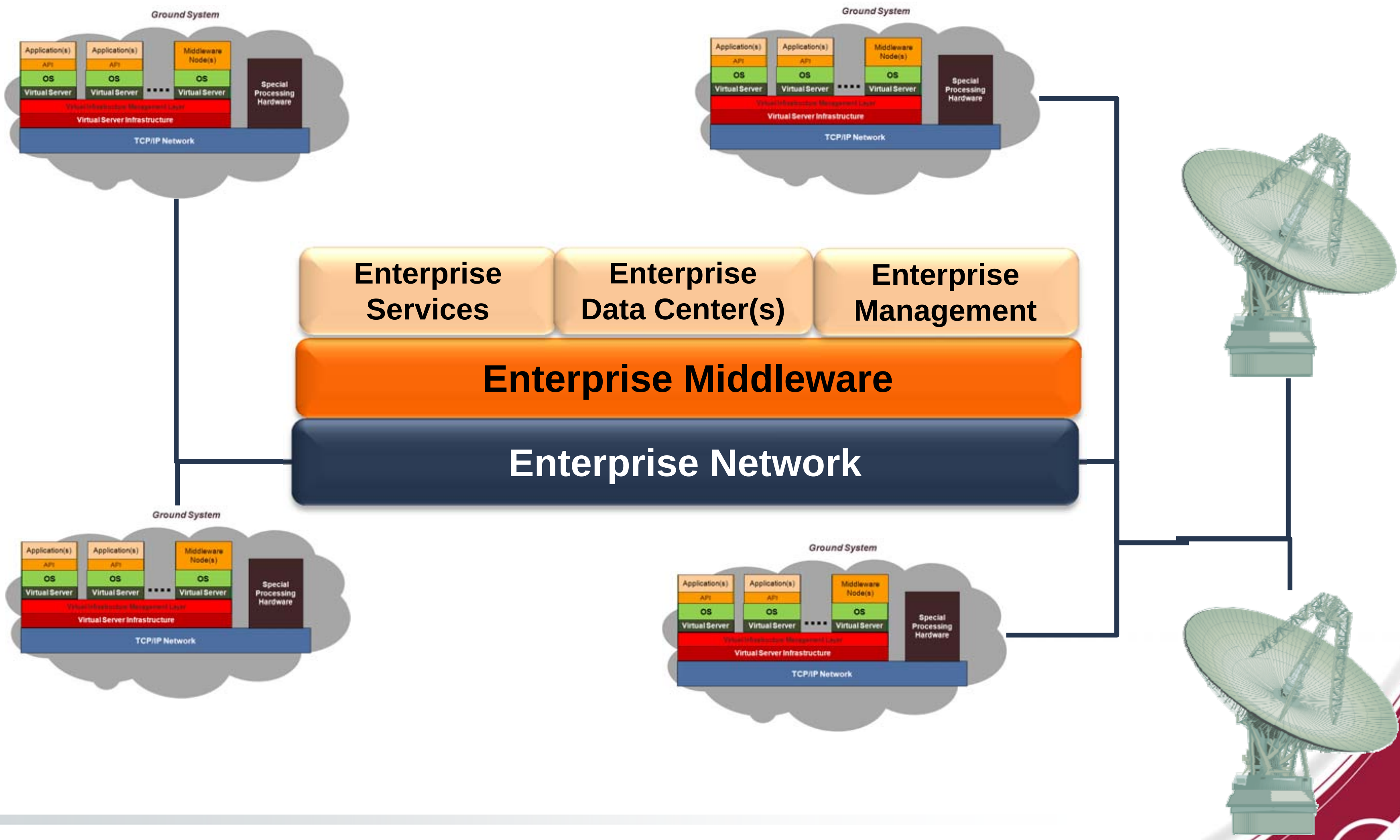
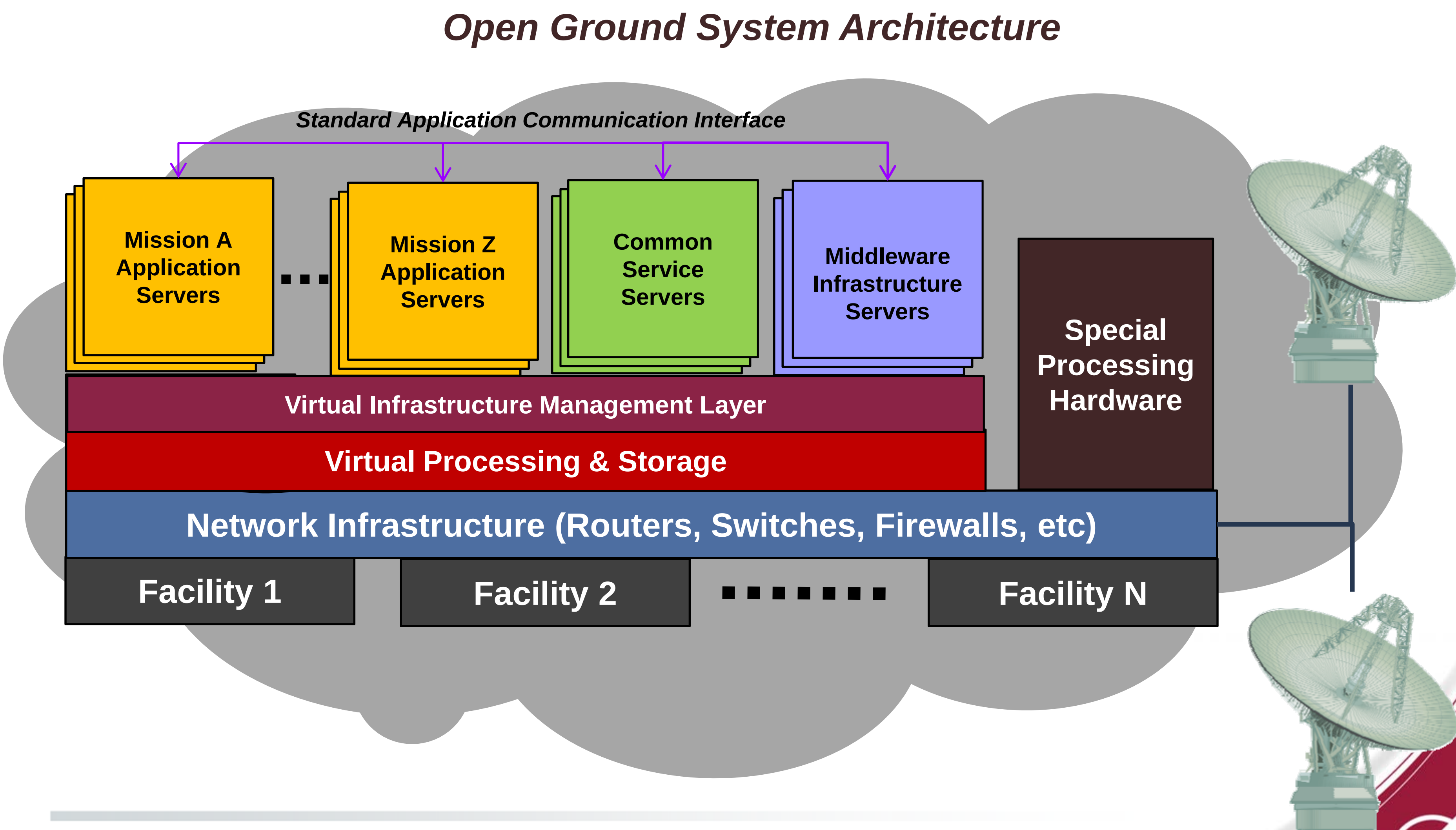


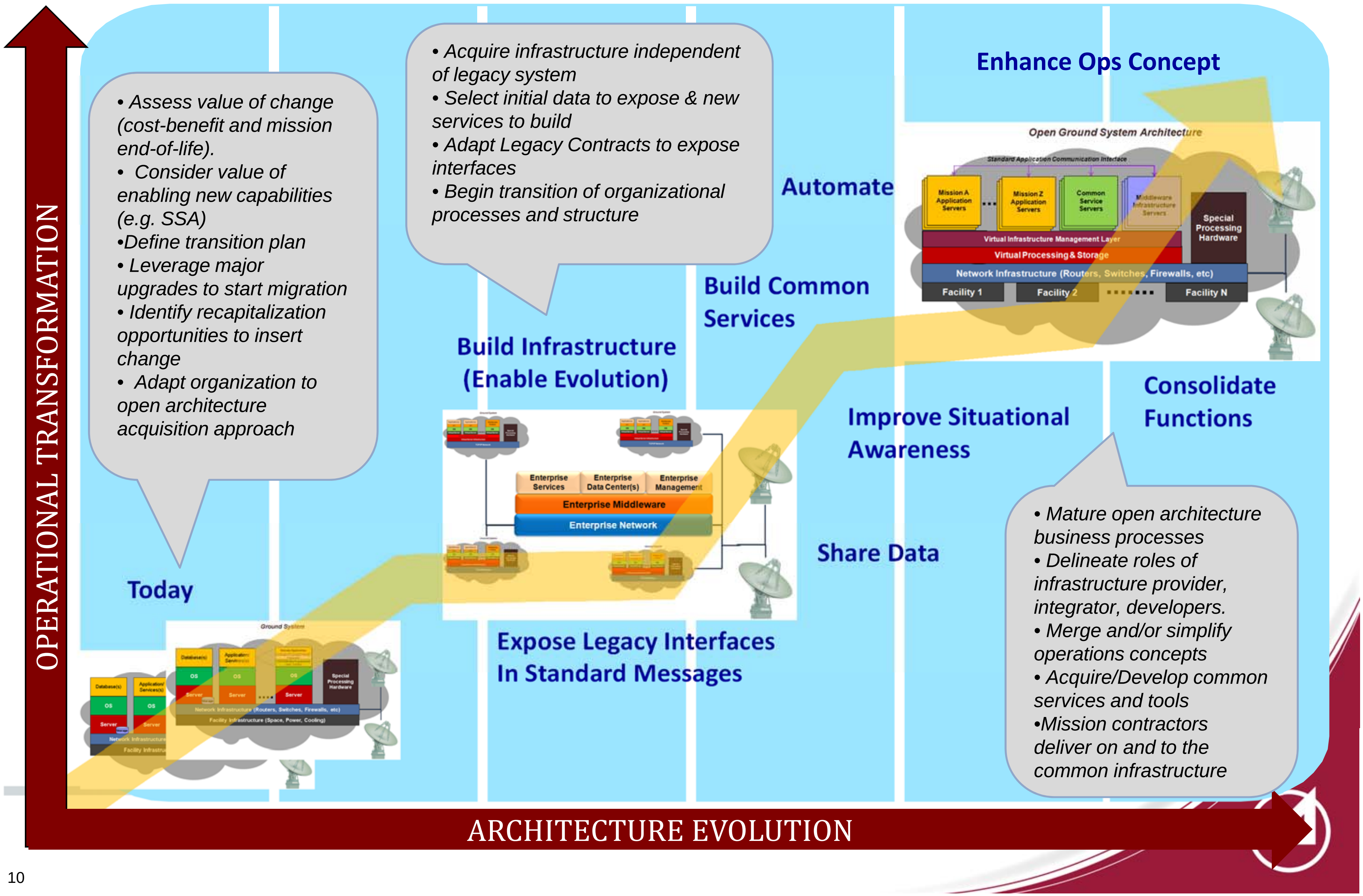
An Open System Architecture End State

Leveraging a Compatible Framework



End State Architecture is Built to Evolve to Support New Missions

Architecture Evolution Enabled by Compatible Framework



System Operational Paradigm Shifts

Legacy to Modern Framework Transformation

Operations Concepts	Legacy Systems (heritage in 1990's)	Modern Frameworks (e.g. Compatible Framework)
Personnel Skills Needed to Support 24hr Ops	• Mission Specific Satellite Operations • C2 Application Software O&M • OS System Administration • Special Purpose HW O&M (FEP, Crypto) • Complex Physical Network Equipment Configuration • Commodity Hardware/LRU O&M • Simple Middleware System Administration (based on system design)	• Mission Specific Satellite Operations • C2 Application Software O&M • OS System Administration • Special Purpose HW O&M (FEP, Crypto) • Complex Physical and Virtual Networking Configuration • Commodity Hardware/LRU O&M • Virtual Environment System Administration • Blade Center System Administration • More complex Middleware System Administration (based on enterprise infrastructure design)
Backup Operations	•Duplicate infrastructure, processing hardware and software in a separate location	• Separate location with minimal special hardware (e.g. Crypto) • Virtual Servers representing all SOC processing capabilities stored in generic IT infrastructure ready to activate
Ground System Situational Awareness	• Physical heath & status of HW –based functions provides situational awareness for ground system • Network Management Software provided by ground system developer monitors HW & SW (e.g. Telemetry Processing Server)	• Multiple-levels of situational awareness 1. Physical Infrastructure (i.e. SAN, Blades, Network) 2. Dynamic Virtual Deployment 3. Middleware traffic 4. Software processes and threads\ • COTS management systems provide status of each level • Other software needed to pull together a complete system view.

Transformation in System O&M Characteristics

Legacy to Modern Framework Transformation

Operations Concepts	Legacy Systems (heritage in 1990's)	Modern Frameworks (e.g. Compatible Framework)
Ground System Maintenance	• 1:1 relationship between hardware and SW functions (e.g. LRU) • Maintenance of HW & SW tied together	• Hardware maintenance separate from SW maintenance, except for special processing hardware • Multiple levels of maintenance that are loosely coupled (i.e. Physical, Virtual , Network, Middleware, VMs, SW Applications)
Ground System Redundancy & Failover CONOPS	• A set of physical servers provides redundancy (i.e. spare strings of HW) • Failover to physical hardware stings	• HW redundancy separate from SW redundancy • Spare physical servers and storage provide spare capacity in case of HW failures • RAID redundancy for data storage • Logical redundancy of SW functions provided by virtualization high availability and failover concepts • Application level redundancy for infrastructure software (e.g. middleware)
Scaling for Simultaneous, Multiple Satellite Contacts	• Multiple physical servers forming processing threads • Thick Client-server architecture enables sharing of workstations across processing threads.	• On demand activation of logical servers providing processing threads on the fly • Limited only by SW licensing • Any thin client can access a virtual server from anywhere in network

Governance of Compatible Framework Implementations

- Need for Governance
  - *Reduce individual implementation costs*
  - *Maintain openness of framework*
  - *Prevent proprietary one-off implementations*
  - *Share lessons learned and best practices*
  - *Enable the sharing of data between missions (i.e. NSS SATOPS Enterprise)*
- Status
  - *SMC Space Development and Test Director (SDTD) is blazing the trail for DOD application of framework in multi-mission environments*
  - *NASA GSFC Funded to Maintain GMSEC Spec & API supporting SMC*
  - *Joint SATOPS Compatibility Committee (JSCC) Facilitating Creation of Governance Documentation & Practices*
  - *Individual programs can choose to participate*

Summary

- A Open Architecture based on a Compatible Framework is a good tool for evolving legacy systems or building new systems
  - *Creates common infrastructures & services, open interfaces*
  - *Leverages and sustains legacy investments*
  - *Promotes competition and innovation*
  - *Enables lifecycle cost savings & creation of new capabilities at lower cost*
- This approach is mature and is starting to be leveraged by government organizations:
  - *SMC/SDTD MMSOC (transitioning to Operation in 2014)*
- Program offices will need to change system architecting and acquisition approach to take full advantage of this approach
  - *"DOD Open System Architecture Program Managers Guide" gives practical advice and tools for acquisitions*