Ground System Architectures Workshop

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A Modular, Data Driven System Architecture for GSFC Ground Systems

GSFC's Mission Services Evolution Center (GMSEC)

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Introduction

- **The GSFC Mission Services Evolution Center (GMSEC) was established in 2001 to coordinate ground and flight data systems development and services at NASA's Goddard Space Flight Center (GSFC)**

- **GMSEC system architecture represents a new way to build the next generation systems to be used for a variety of missions for years to come**

- **The old approach was to find or build the best products available and integrate them into a reusable system to meet everyone's needs, but..**
  - ❑ Requirements, product offerings, and companies may change tomorrow
  - ❑ There is too much variation in mission needs to assume one size fits all
  - ❑ It is often difficult to infuse new technologies into a large, configured system

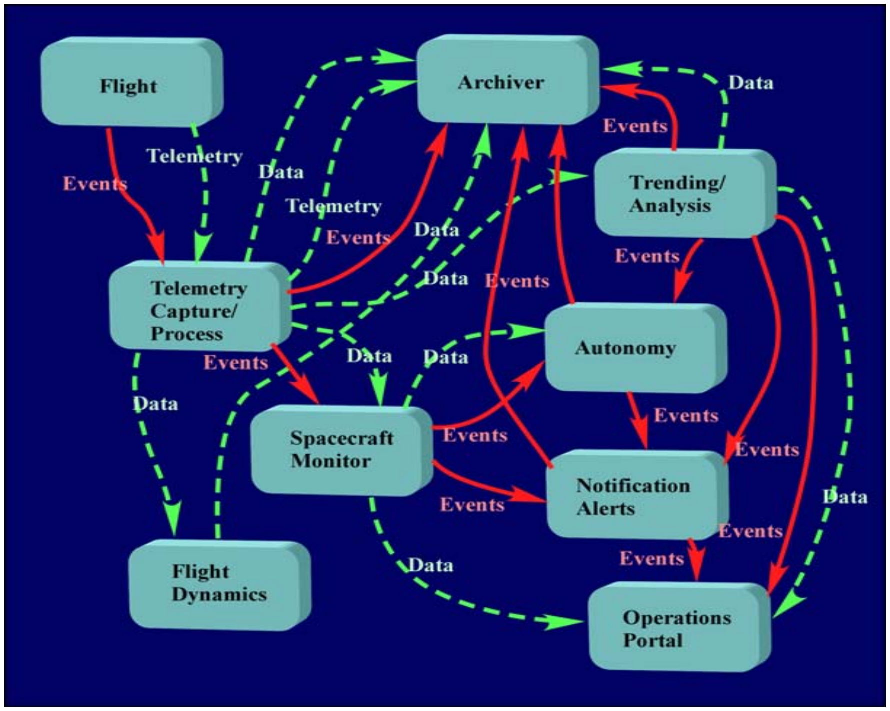
- **The new approach assumes that needs, products, and technology will change**

GMSEC System Concept

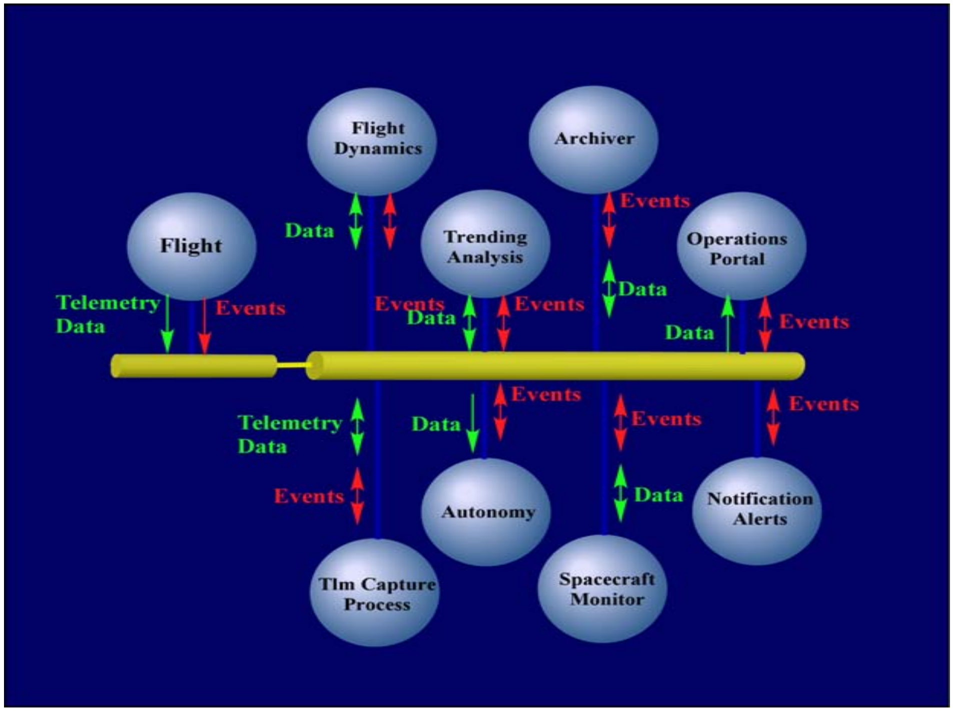
- Standardized Interfaces (not components)
  - ❑ COTS or in-house tools should have the same key interface definitions (or functionally similar)
  - ❑ Use Meta-Languages where appropriate {XML, WSDL}
  - ❑ Goal is to allow for plug-and-play modules that can be integrated quickly
- Middleware
  - ❑ Provides message-based communications services on a GMSEC "software bus"
    - ❑ Publish / subscribe, point-to-point, file transfer
  - ❑ Makes it much easier to add new tools, reduce integration effort
- User Choices
  - ❑ We are not limiting tool selection to one that fits all
  - ❑ Want to give users a choice of T&C systems, flight dynamic systems, etc.
- GMSEC "Owns" the Architecture and Interfaces

Interface Standards and Middleware Simplifies Architecture

Traditional Design
Socket Connections

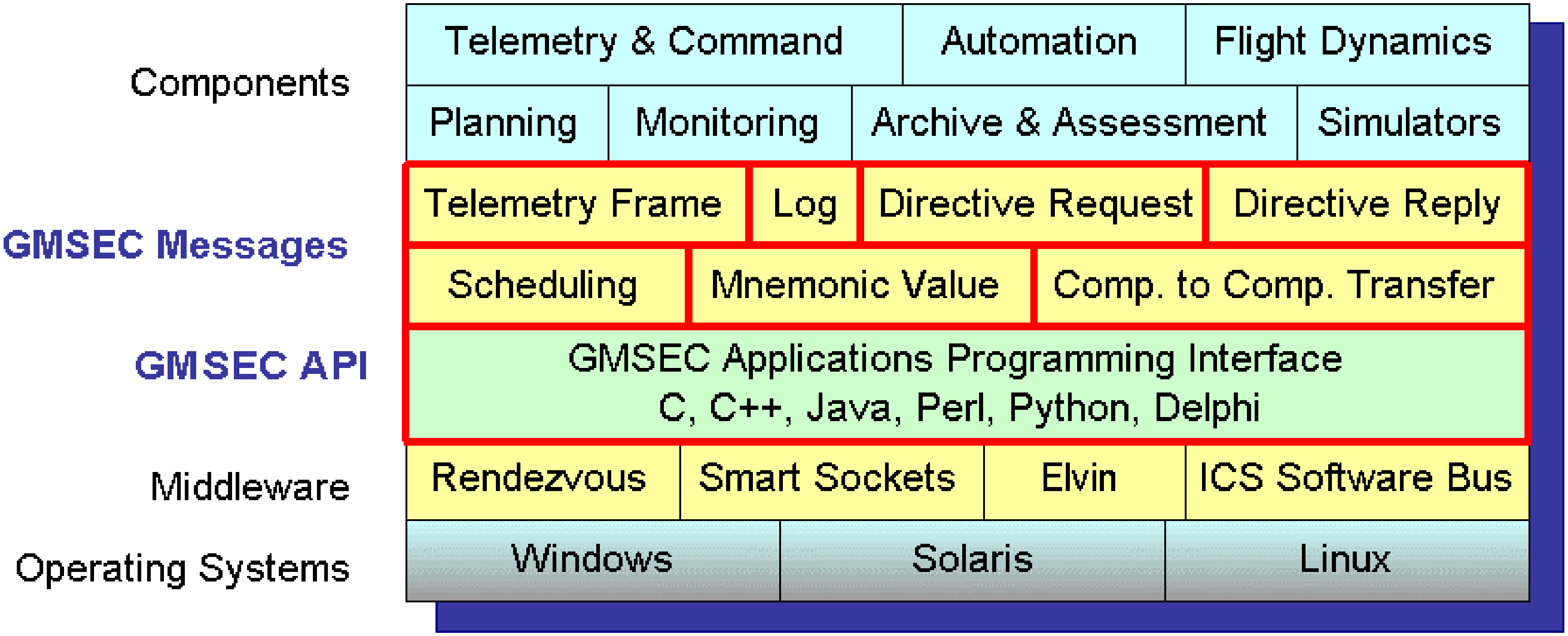


GMSEC Design
Middleware Connections



Middleware simplifies interfaces by reducing knowledge of components about other components

GMSEC Software Integration Layers



Components

Telemetry & Command | Automation | Flight Dynamics

Planning | Monitoring | Archive & Assessment | Simulators

GMSEC Messages

Telemetry Frame | Log | Directive Request | Directive Reply

Scheduling | Mnemonic Value | Comp. to Comp. Transfer

GMSEC API

GMSEC Applications Programming Interface
C, C++, Java, Perl, Python, Delphi

Middleware

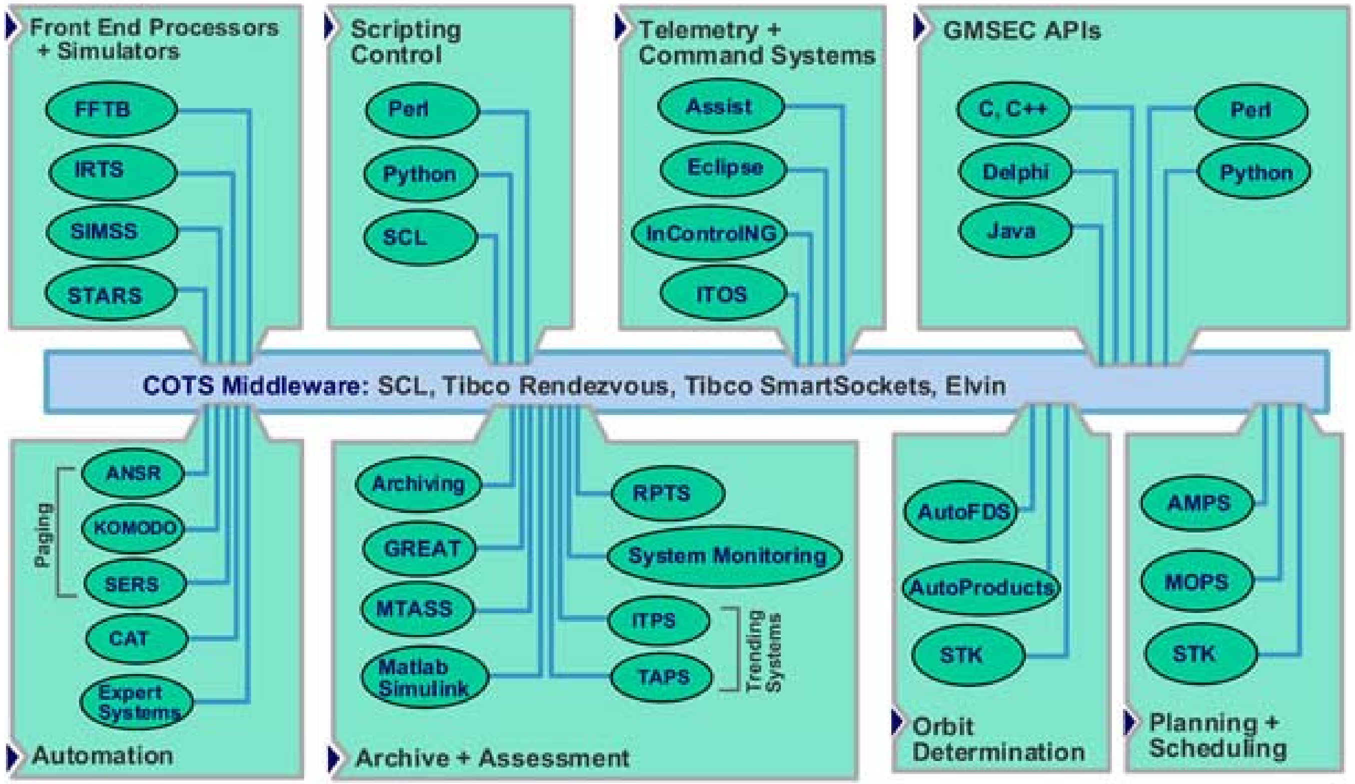
Rendezvous | Smart Sockets | Elvin | ICS Software Bus

Operating Systems

Windows | Solaris | Linux

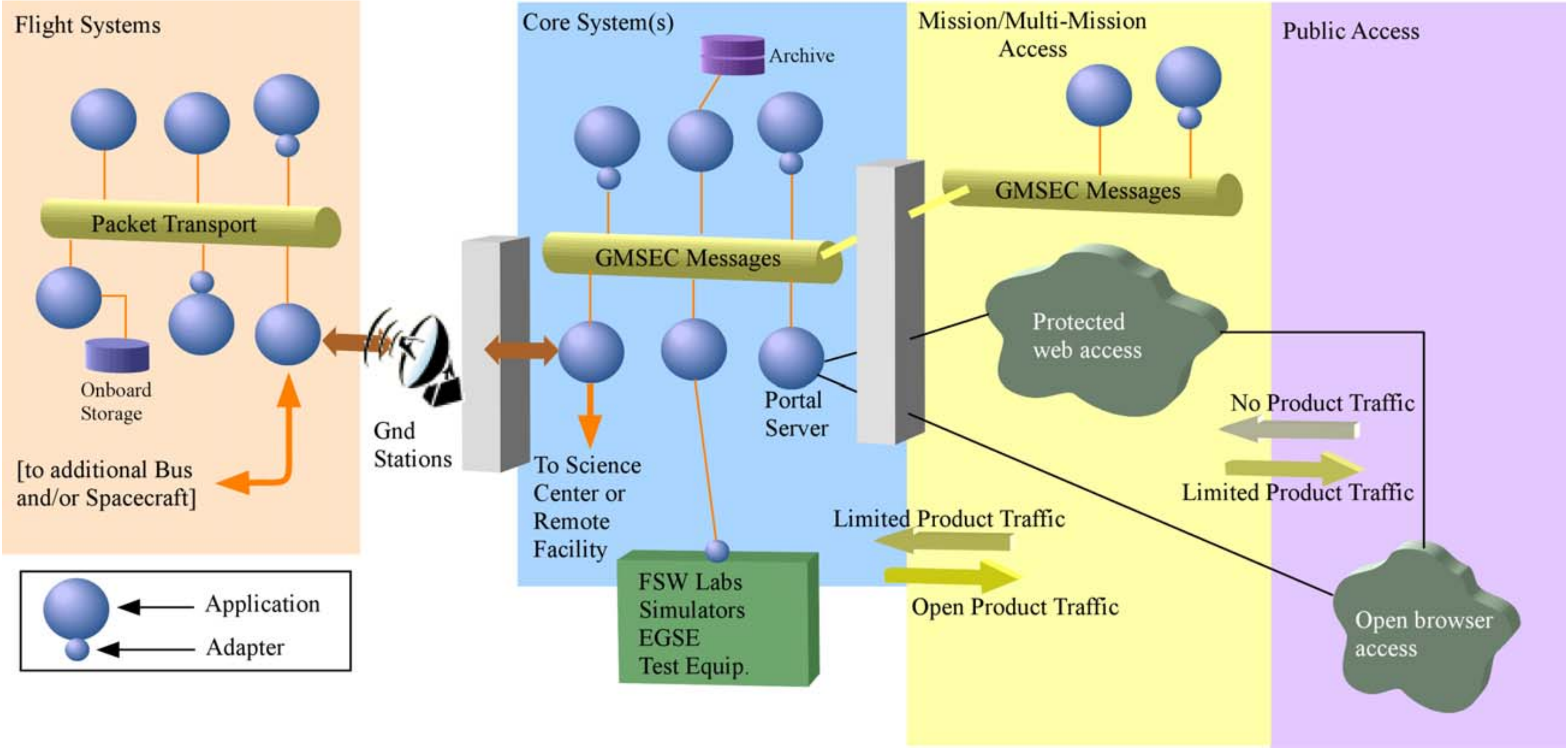
A layered architecture allows GMSEC to control the interfaces, while vendors continue to provide their specialty components

GSMEC Architecture



The GMSEC approach gives users choices for the components in their system

Extensible Architecture



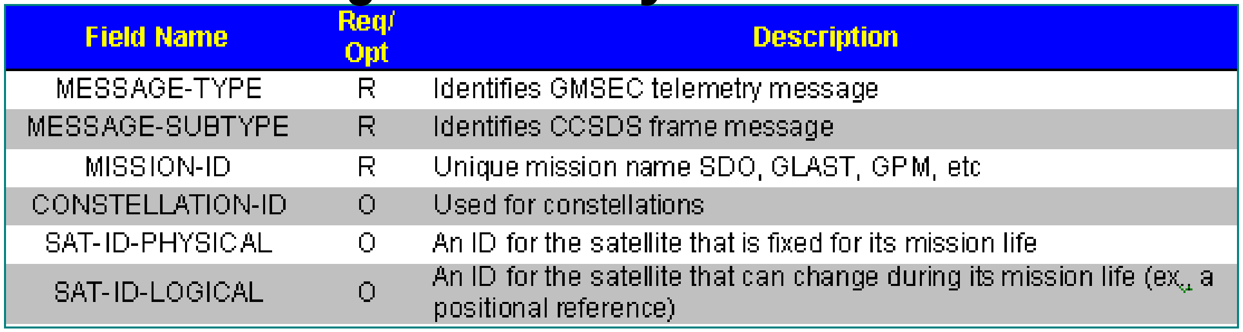
Middleware makes it possible to extend the dataflow from the spacecraft to the experiment facilities and beyond…

Use of Components

- **Granularity**
  - ❑ Matched to COTS vendor product offerings
  - ❑ Do not want to subdivide available products
  - ❑ Granularity affects number of key interface messages
- **Variety**
  - ❑ Traditional components form system core
    - ❑ TLM / CMD system, flight dynamics, planning & scheduling, trending
  - ❑ Message standards allow many new, independent tools
    - ❑ Expert systems, data monitors, etc.
- **Basic Requirements**
  - ❑ Meet standards or be ‘adaptable’
  - ❑ May have own GUI, but also needs external directive control
  - ❑ Issue status via event messages

Messaging and API Standards

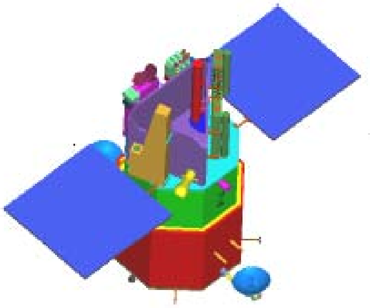
- **Messages are at functional granularity**
  - ❑ Telemetry
  - ❑ Scheduling
  - ❑ Flight Dynamics
  - ❑ Directives



Field Name	Req/ Opt	Description
MESSAGE-TYPE	R	Identifies GMSEC telemetry message
MESSAGE-SUBTYPE	R	Identifies CCSDS frame message
MISSION-ID	R	Unique mission name SDO, GLAST, GPM, etc
CONSTELLATION-ID	O	Used for constellations
SAT-ID-PHYSICAL	O	An ID for the satellite that is fixed for its mission life
SAT-ID-LOGICAL	O	An ID for the satellite that can change during its mission life (ex., a positional reference)

- **Vendor integration techniques**
  - ❑ Native GMSEC support integrated into application
  - ❑ API-to-API bridge
- **Components quickly integrated using the API, messaging ICD, and examples available online**
  - ❑ Development effort done off-site; vendor code not exposed
  - ❑ Able to ‘plug’ components in the lab and immediately work

System Status



- **2002**
  - ❑ Architecture completed
  - ❑ Preliminary message standards
- **2003**
  - ❑ Support for Tibco Smart Sockets & Rendezvous, Elvin, and ICS's SCL messaging system through the GMSEC API
  - ❑ Demonstrations throughout the year showed incremental capability (new components, new messages)
  - ❑ ALPHA / BETA 1.0 release of message standards / API
- **2004**
  - ❑ Mission Hardened Release 1.0 of messaging and API standards early summer
  - ❑ Implementation work is continuing with existing missions. A single-satellite earth-science mission, and a multi-mission operations center. Both planning for operational status CY04.
  - ❑ Working with 5 future NASA missions
  - ❑ New components coming online (trending, automation, paging / alert)

Benefits Seen of the GMSEC Approach

- Reduction in integration time
- New components added or upgraded without impacting existing systems
- Many suggestions are being made for small independent components that simply integrate with the bus to provide immediate benefits
- Missions more willing to adopt GMSEC incrementally
- Some vendors see GMSEC-compliance as a way to finally enter the NASA marketplace
- Other organizations are beginning to talk to use about trading components that use standardized interfaces

Conclusions

- **GMSEC Themes are working at GSFC:**
  - ❑ User Choices
  - ❑ Component based
  - ❑ Message Driven
  - ❑ Middleware communications

- **Missions are resistant to change; GMSEC allows incremental capabilities**

- **Vendors are adopting GMSEC standards, bringing more choices for ground system components**

- **Further efforts required on API and messaging standards. GMSEC standards may be a practical start of a community effort.**

Want Additional Information?

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