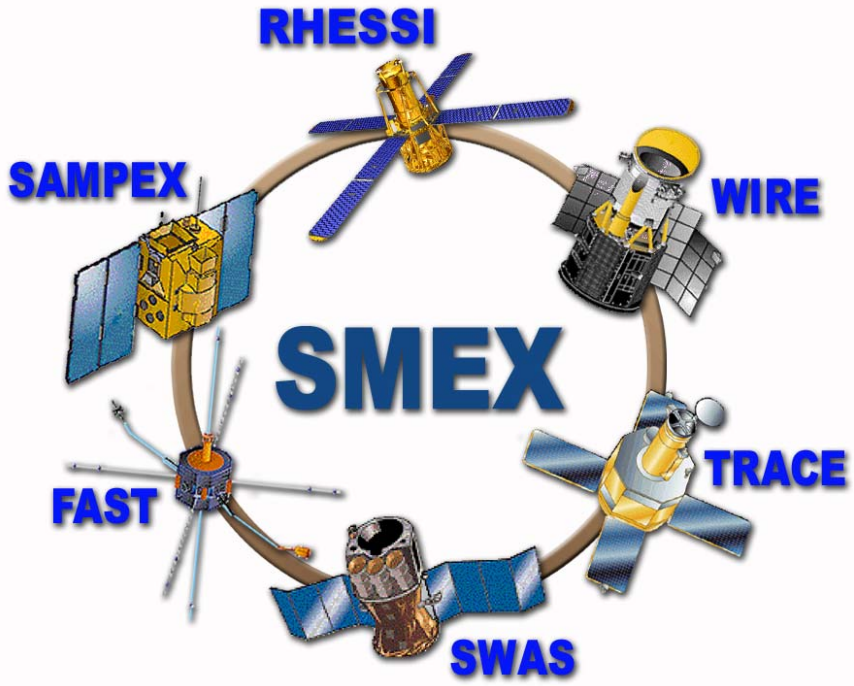
Implementation of a Middleware Based Ground System

March 2, 2005, GSAW2005 Conference



Presented By

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Emergent Space Technologies, Inc.

Teammates

NASA – GMSEC

NASA – SSMO

Honeywell Technology Solutions, Inc.

L-3 Storm Control Systems

NASA's Small Explorers

- **SMEX Program**
  - Provide frequent flight opportunities
  - Inexpensive and well-focused science missions
  - Cost cap at $120 million
  - First program to use "Faster, Better, Cheaper"

- **SMEX Satellite Characteristics**
  - Weigh between 180 and 250 kg
  - Consume between 50 and 200 watts

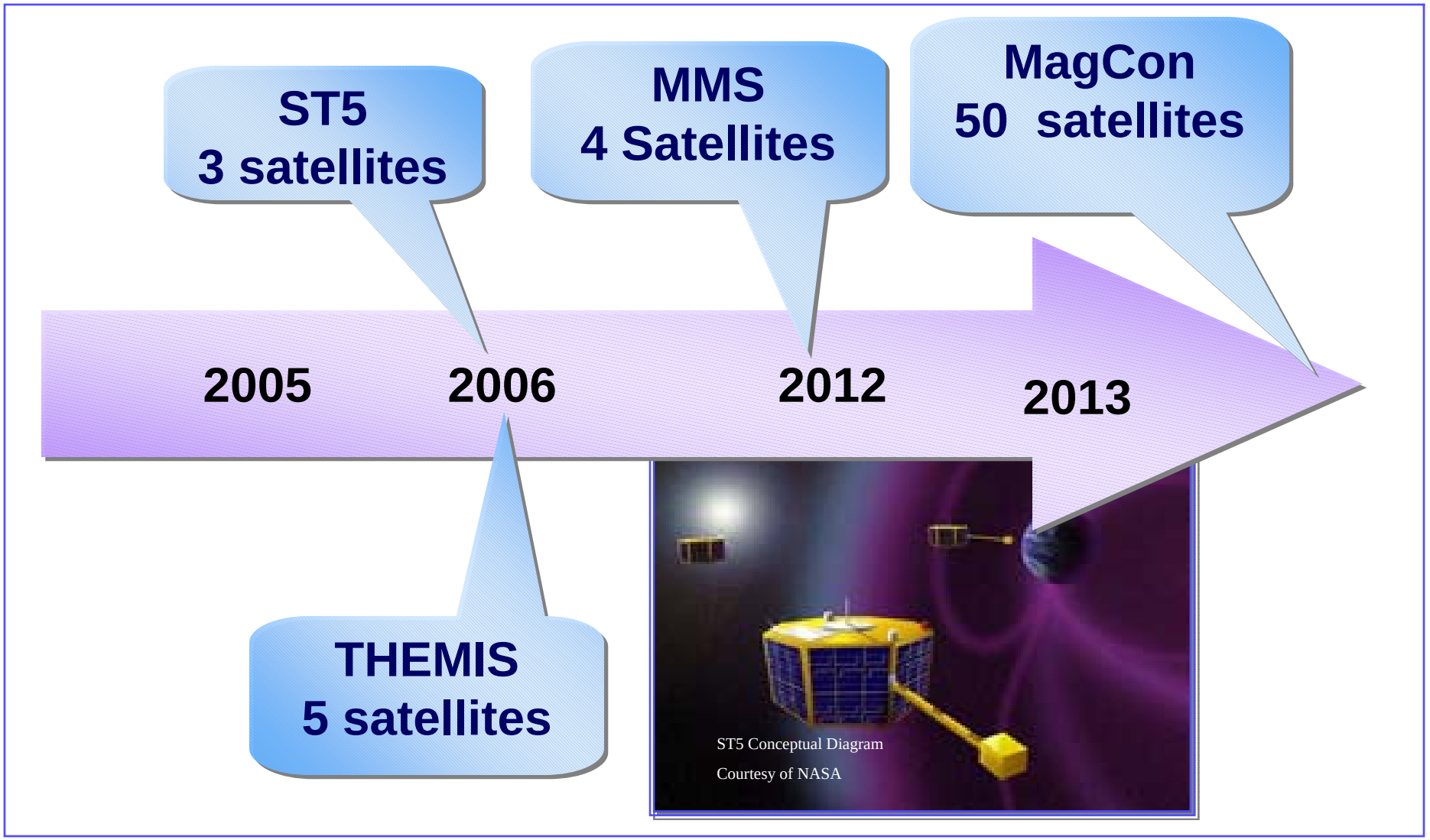
Mission	Operations Center
SAMPEX	**Bowie State University**
FAST	UC, Berkeley
SWAS	**NASA, GSFC**
TRACE	**NASA, GSFC**
WIRE	**Bowie State University**
RHESSI	UC, Berkeley

Why Reengineer?

- **Demonstrate Fleet Operations For Future Missions with Reduced Risk**

- **Continued Value-Added Research from On-Orbit Assets**
  - Aging assets producing useful scientific data
  - Low risk, high payoff orbiting test beds for new ground systems and operations technology development

Timeline for Future Fleet Missions



Current SMEX Missions

Satellite	Launch Date	Service	Mass	Orbit	Passes
SAMPEX	July 3, 1992	3 yrs.	157 kg	550 km x 675 km, 82°	2
FAST	August 21, 1996	1 yr.	191 kg	351 km x 4175 km, 83°	10-12
TRACE	April 1, 1998	1 yr.	250 kg	600 km x 650 km, 97.80°	4-6
SWAS	December 5, 1998	2 yrs.	288 kg	637 km x 653 km, 69.90°	2
WIRE	March 3, 1999	4 mo.	258.7 kg	540 km x 590 km, 97.56°	2
RHESSI	May 5, 2002	3 yrs.	304 kg	587 km x 600 km, 38°	6 - 9

All missions are still active today!

Benefits of Reengineering

- **Infuse New Mission Services Technologies**
- **Demonstrate Potential for Mission Operations Cost Reductions**

New Mission Services Technologies

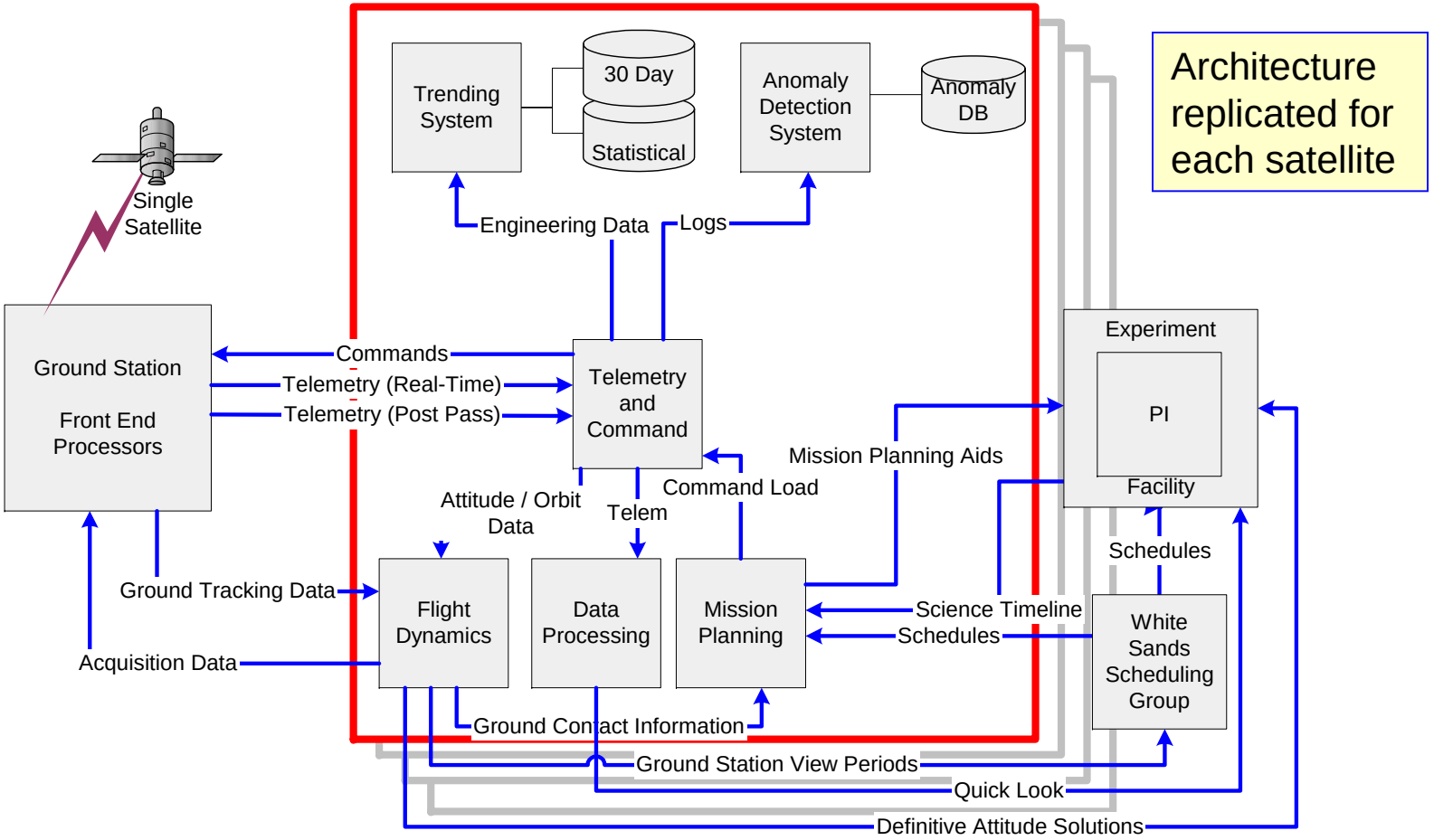
GSFC Mission Services Evolution Center (GMSEC)

- Provides message-based communication services using commercial middleware
- Makes it much easier to add new tools, reduce integration efforts
- Standardized application interfaces to the middleware
- Standardized ground system messages
  - Telemetry and commanding,
  - Logs and archives
  - Products (flight dynamics, scheduling, etc…)

Demonstrate Mission Cost Reductions

- **Consolidation of Hardware and Software to Support Heterogeneous Fleets**
- **Extend Automation Capabilities to Provide Lights-Out Operations Beyond Current Capabilities**
- **Distributed Operations Between NASA and Universities**

Previous SMEX MOC Architecture

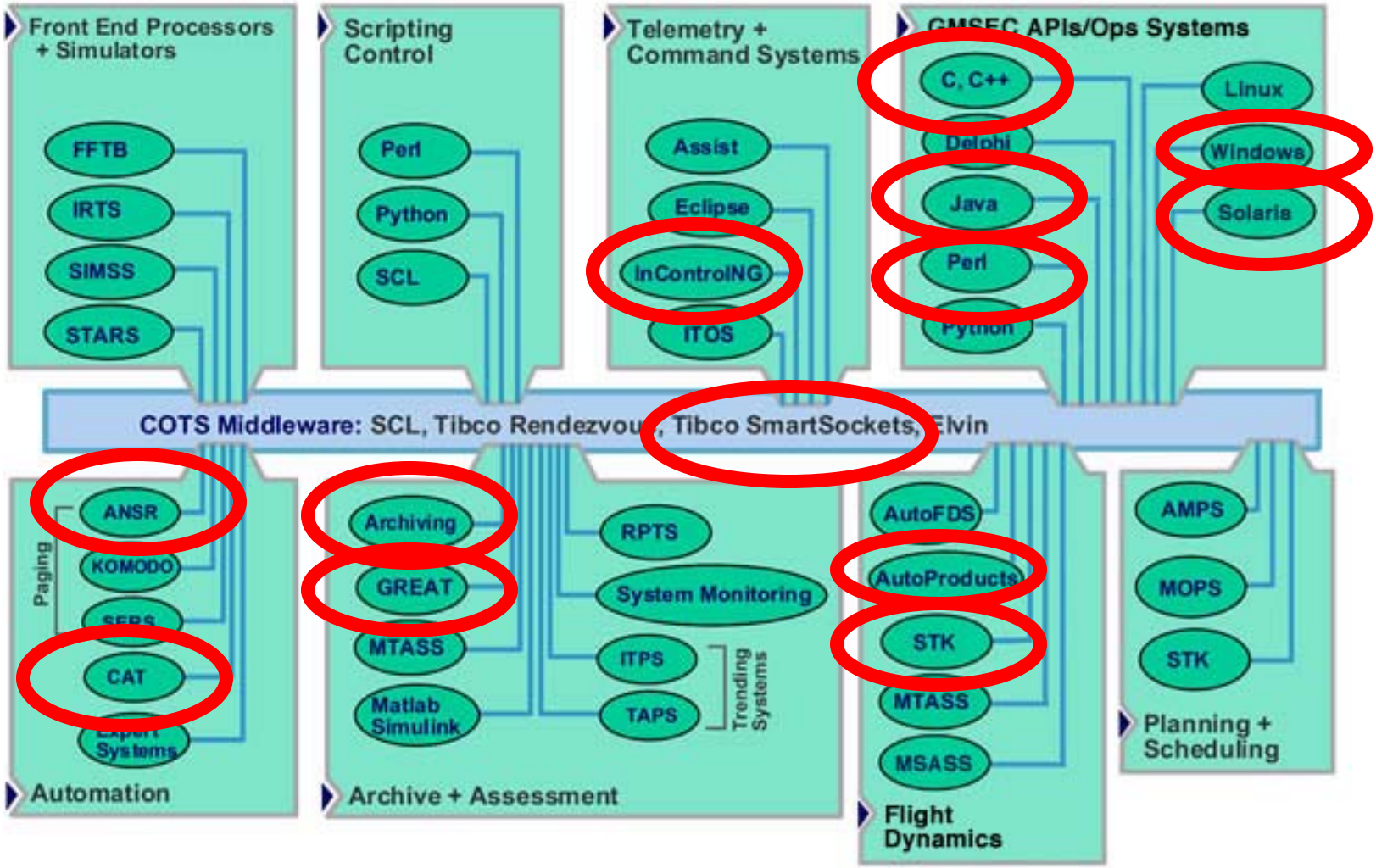


Existing System Built for a Single Mission

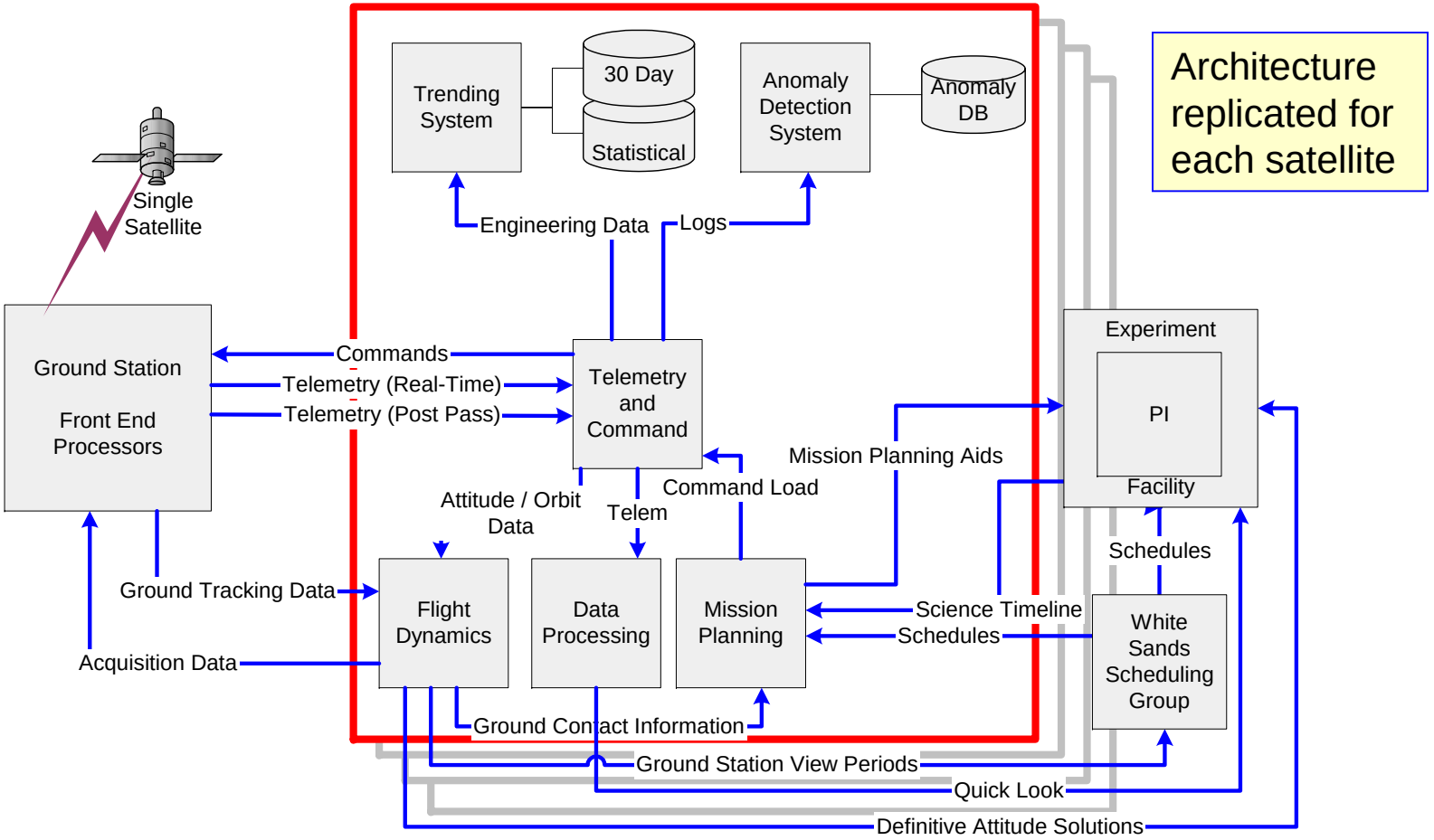
Reengineering Approach

- **Adopt GMSEC standards**
  - Architecture
  - Message definitions
  - Components
- **Select Fleet-Capable Components**
  - Telemetry and Command
- **Provide GMSEC Adapters for Legacy Applications**

SMEX Component Selection

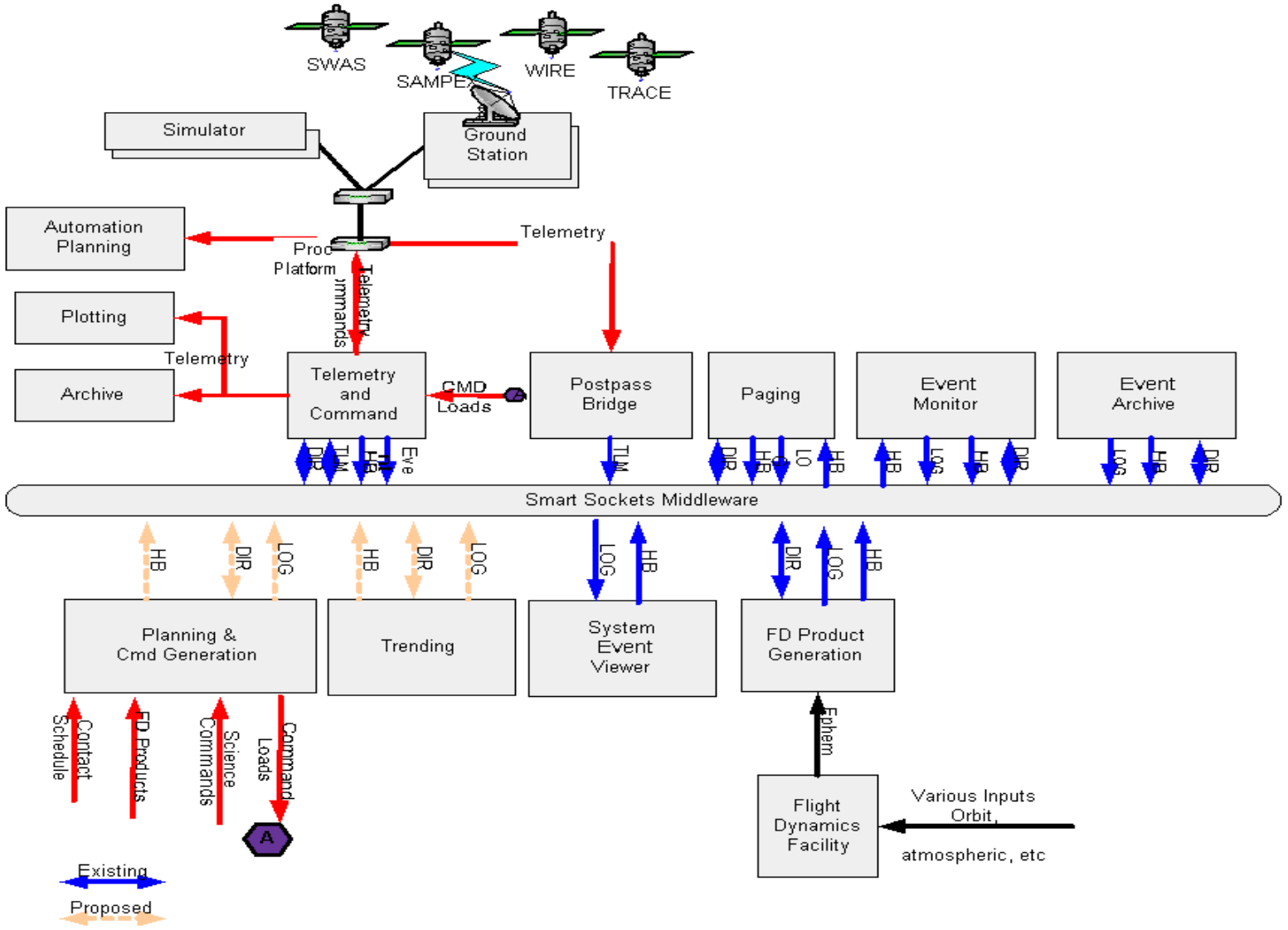


Flashback

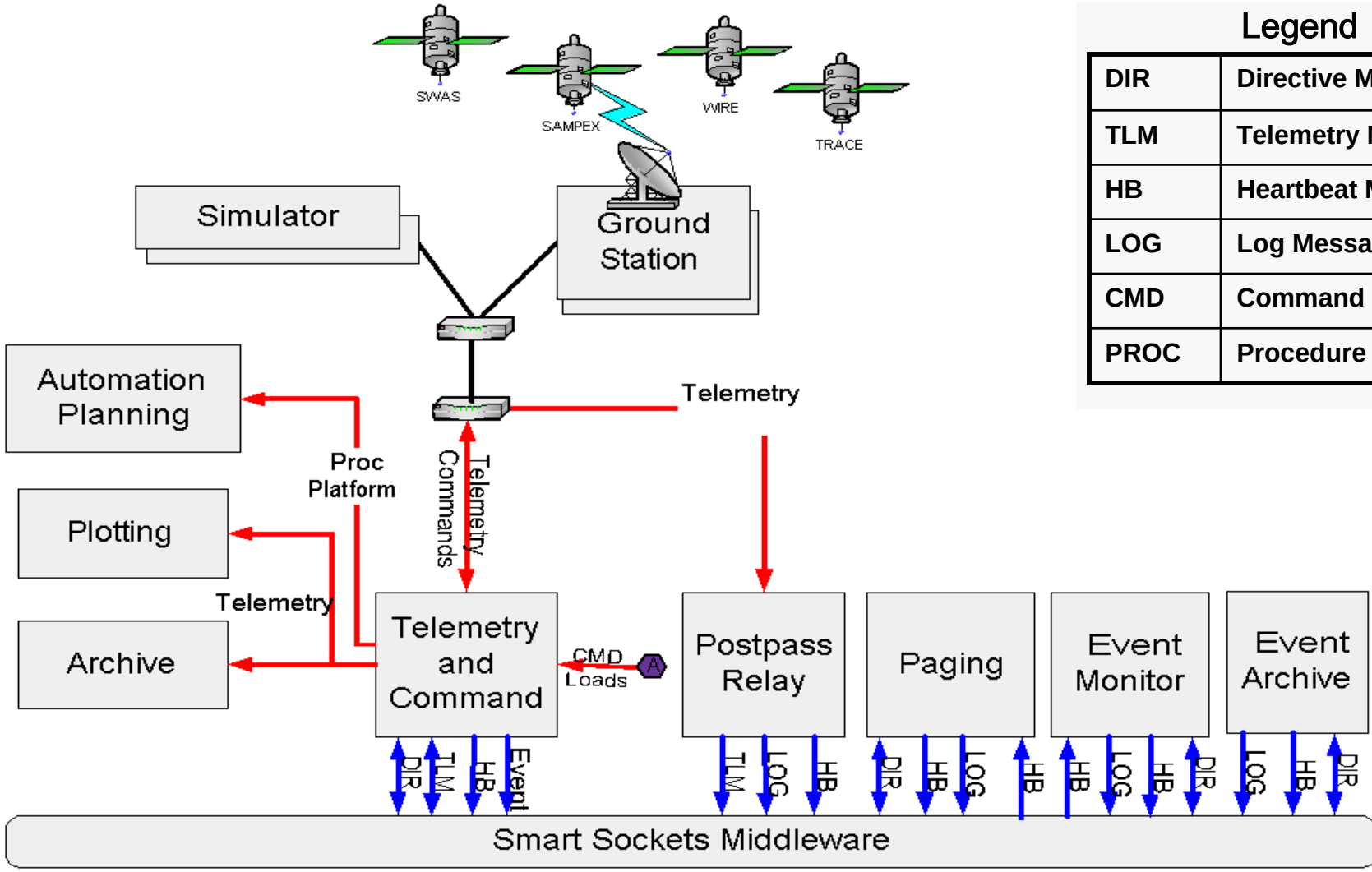


Existing System Built for a Single Mission

Fleet Architecture At A Glance



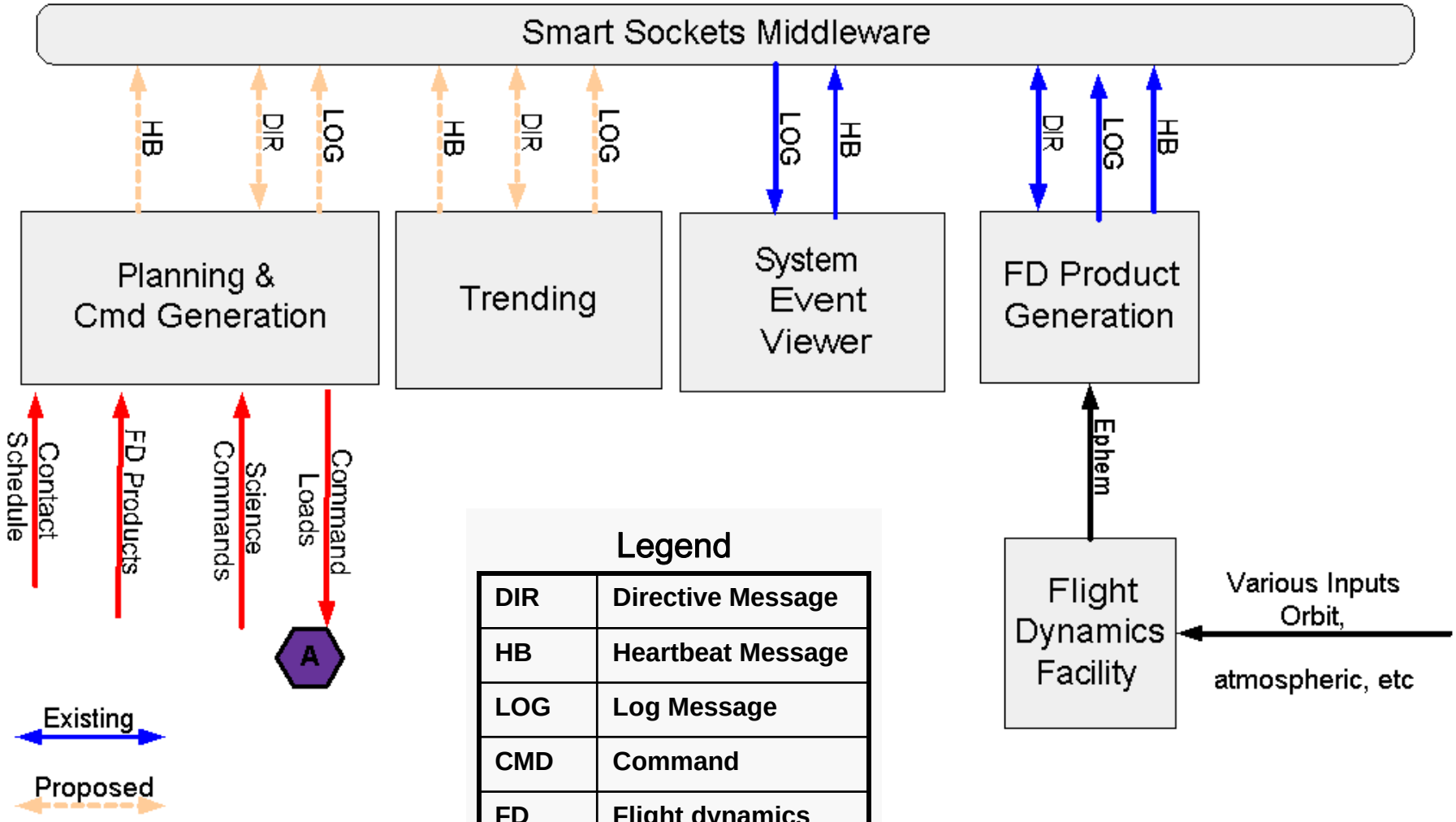
Real-time Architecture



Legend

DIR	**Directive Message**
TLM	**Telemetry Message**
HB	**Heartbeat Message**
LOG	**Log Message**
CMD	**Command**
PROC	**Procedure**

Offline Architecture



Legend

DIR	**Directive Message**
HB	**Heartbeat Message**
LOG	**Log Message**
CMD	**Command**
FD	**Flight dynamics**

Lessons Learned

- **Middleware Supports System Flexibility**
- **GMSEC Component Integration Reduced To:**
  - Configure connection properties
  - Configure message fields
  - Operations logic (e.g. call trees, limit rule sets)
- **Use of Small Independent Components for New Functions**
  - e.g. External systems and automation components
  - Bits of automation sprinkled throughout
- **Potential for Further Integration**
  - Ground stations to MOC
  - MOC to experiment facilities
  - Scheduling facilities to MOC

SMEX Direction in 2005

- **Automation**
  - Routine operations
  - Dynamic pass scheduling
  - Command load generation
- **Demonstrate Two Week Pass Automation**
  - Operators monitor and provide load verification only
  - Ability to add automation components as needed
- **Explore Integration of Other Missions and Facilities**
  - Integrate SMEX and Non-SMEX missions into the fleet
  - Evolve ground systems and ops concepts to support fleets

Additional Information

Internet

http://gmsec.gsfc.nasa.gov

E-mail

gmsec@nasa.gov

Acronyms

ANSR	**Alert Notification System Router**
CAT	**Criteria Action Table**
CMS	**Command Management System**
DPS	**Data Processing System**
FAST	**Fast Auroral Snapshot Explorer**
GMSEC	**GSFC Mission Services Evolution Center**
LISA	**Laser Interferometer Space Antenna**
PI	**Principal Investigator**
MC	**Magnetospheric Constellation**
MMS	**Magnetospheric Multiscale Mission**
RHESSI	**Reuvan Ramaty High Energy Solar Spectroscopic Imager**
SAMPEX	**Solar Anomalous and Magnetospheric Particle Explorer**
SMEX	**Small Explorer**
ST5	**Space Technology 5**
SWAS	**Submillimeter Wave Astronomy Satellite**
T&C	**Telemetry and Command**
TRACE	**Transition Region and Coronal Explorer**
WIRE	**Wide-Field Infrared Explorer**