

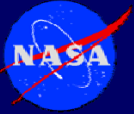
Building a Multi-Mission Operations Center for Space Science

Ground Systems Architecture Workshop, March 1-4, 2010

Robert Antonucci

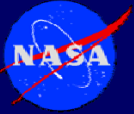
Director of Internet Technologies





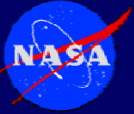
Why Build a Multi-Mission MOC?

- NASA Goddard's Space Science Mission Operations (SSMO) runs 18 missions
 - 12 missions are in extended life
 - 6 missions are over 10 years old
- Older systems are increasingly difficult to
 - Sustain
 - Secure
 - Maintain licenses



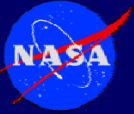
An MMOC Must Be...

- Evolving – accommodates technology refresh
- Secure – meets constantly growing security requirements
- Integrated – shares staff and resources among missions
- Flexible – allows for disparate mission requirements



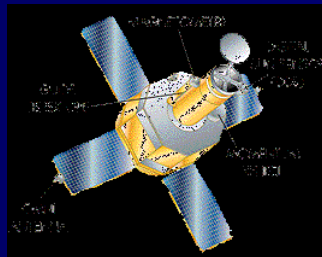
How Will MMOC Do This

- Modularity
 - Break up monolithic systems
 - Reduces dependencies and complexities
- Strategic Sharing
 - “Share where possible, support disparity where necessary”
 - Perform benefit analysis
- Agility
 - Low cost, low risk to making changes
 - Create infrastructure to support this



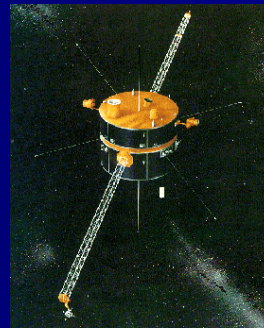
Current MMOC Missions

TRACE



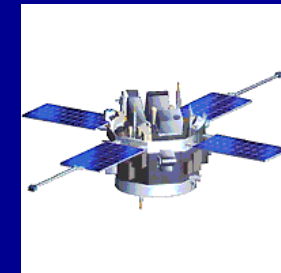
- Map magnetic structure of Sun's Corona
- LEO orbit
- Three-axis stabilized
- Launched 1998

WIND



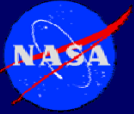
- Study solar wind and interplanetary plasma
- Halo orbit at Earth-Sun L1
- Spin stabilized
- Launched 1994

ACE



- Monitor space weather and accelerated particles
- Halo orbit at Earth-Sun L1
- Three-axis stabilized
- Launched 1997

- Additional missions being considered



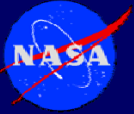
Some Missions Are Similar Some Are Different

■ WIND and ACE

- L1 Orbit
- Communicate through JPL Deep Space Network
- One multi-hour contact each day

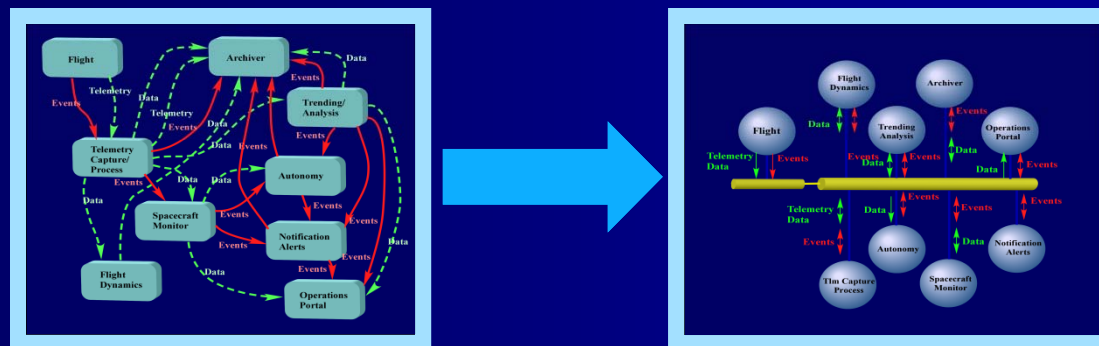
■ TRACE

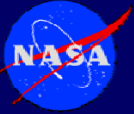
- LEO Orbit
- Communicates through Near Earth Network
- Multiple 12 minute contacts each day



Modularity: Uses Modular Architecture

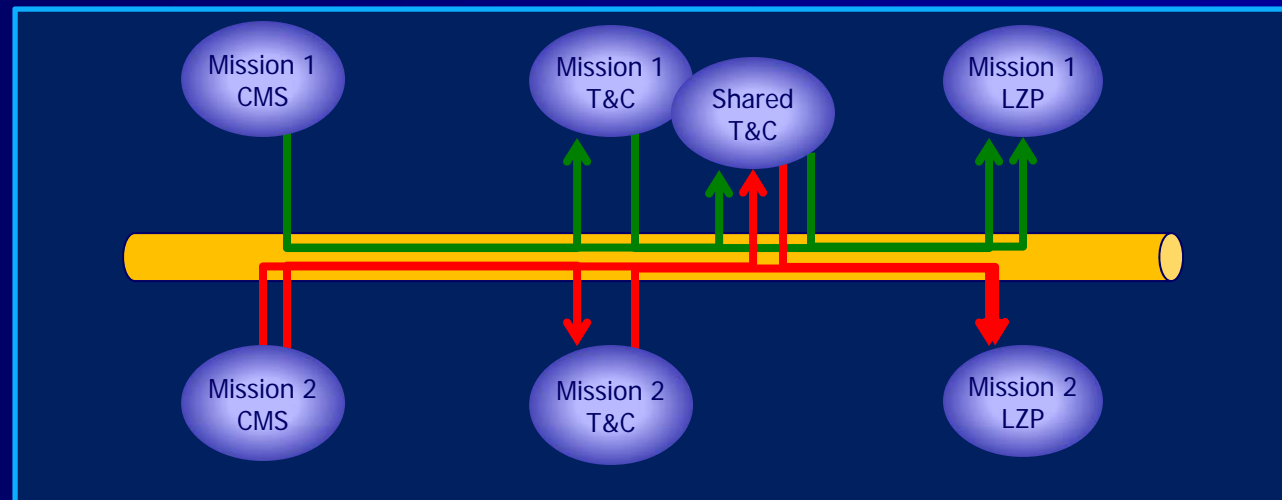
- Goddard Mission Services Evolution Center (GMSEC) Architecture
- Components communicate via message bus
- Standard message definitions for space ops functions

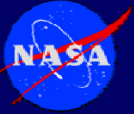




Advantages of GMSEC

- Message bus decouple components
 - Easier to test, update, or replace
- Allows missions to mix shared components with mission-specific components





Modularity: Uniform, Interchangeable Hardware

- Pool of machines all of the same hardware
- Each machine has all mission software installed
- Any machine can quickly replace any other

T&C



**T&C system
procs**

Attitude

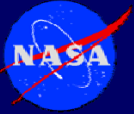


**attitude system
star chart**

Paging

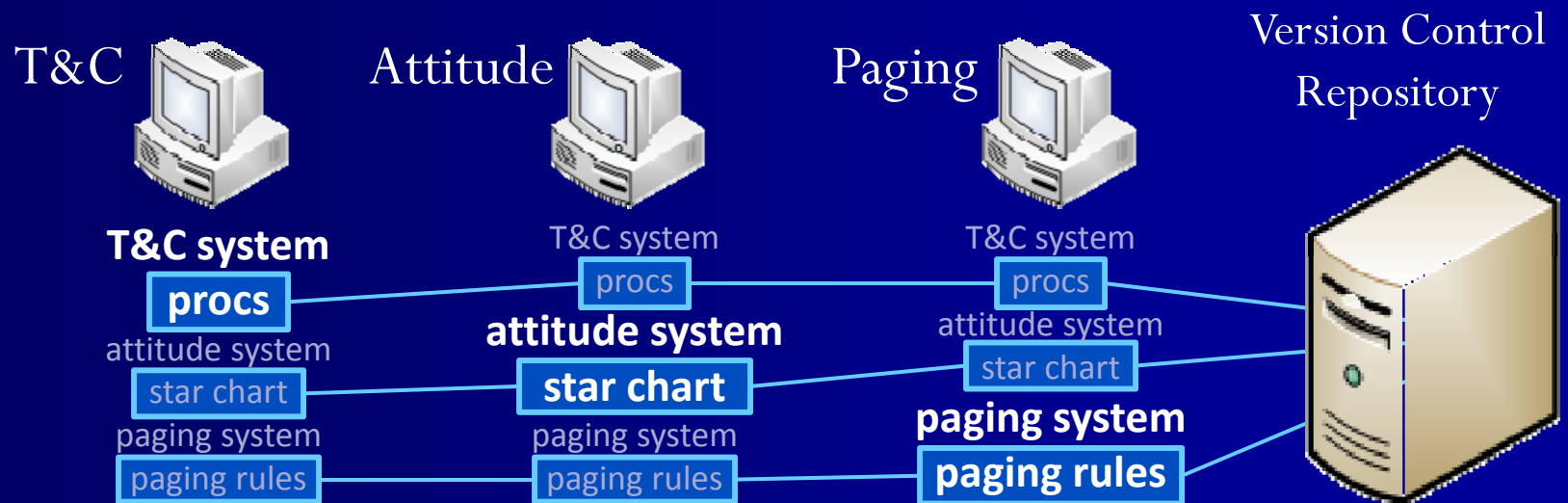


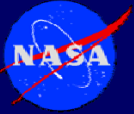
**paging system
paging rules**



Modularity: Uniform, Interchangeable Hardware

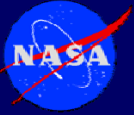
- Pool of machines all of the same hardware
- Each machine has all mission software installed
- Any machine can quickly replace any other





Strategic Sharing: Software Sharing

- “Share where possible, Support disparity where necessary”
- Benefit evaluations were done



Software Used in MMOC

Front End

MU-SLE

One tool shared by all missions

T&C Automation

ITOS
ITOS

CAT

Paging

ANSR

Planning

T.CMS
GMAN
W.CMS

Flight Dynamics

FDF

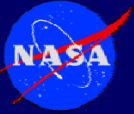
Each mission using its own tool

Attitude

MSASS
MTASS

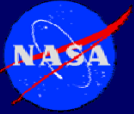
Science Processing

A.LZP
W.LZP
DPS



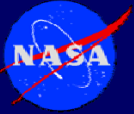
Strategic Sharing: Adopted Common Processes

- Authoring common processes is not easy
 - All missions had existing processes
 - All missions liked existing processes
- Required a collaborative effort
 - Large time commitment from missions
 - Facilitation from CM manager
 - Commitment from management
- Common Processes included:
 - Configuration Management
 - Security
 - Data Storage and Recovery



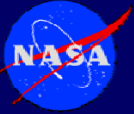
Advantages to Common Processes

- Necessary for cross-training of staff
- Economy of scale for tools to support process
 - Hardware and software to perform automated data backups
 - CM tools were explicitly configured by tool developers to support the CM process



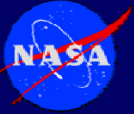
Agility: Managed Change

- Must support multiple, simultaneous system changes
- Often, no single person understands the full scope of all changes being made
- Use change request process that
 - Is automated
 - Requires work/scope estimates
 - Requires varying degrees of authorization
 - Provides audit trail
- Use revision control system



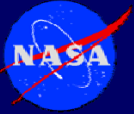
Agility: Low Cost to Update System

- With multiple missions, software must be updated more often
- Updates that address one mission's bugs must not create problems for another mission
- Use defined, efficient software update procedures
 - Software delivery process that tracks release changes and bug fixes
 - Acceptance test matrices derived from mission requirements
 - I&T system that mirrors Ops



Current State

- TRACE operational since July 2009
- WIND and ACE are taking live passes
- WIND and ACE Operational Readiness Review planned March 2010
- Other missions being considered



Acknowledgements

- NASA Goddard Space Flight Center, Space Science Mission Operations
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