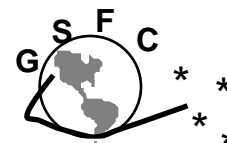




MISSION OPERATIONS
AND DATA SYSTEMS DIRECTORATE



New Software Technologies in Tracking and Data Acquisition

Presented At:

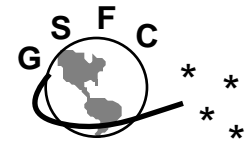
Ground Systems Architectures Workshop '97
The Aerospace Corporation, El Segundo, CA

By:

Keiji Tasaki, Networks Division
keiji.tasaki@gsfc.nasa.gov
NASA Goddard Space Flight Center

February 27, 1997

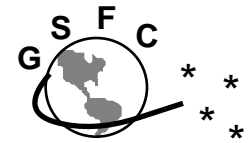
New Software Technologies In Tracking and Data Acquisition



AGENDA

- Tracking and Data Acquisition Overview
- Flight Dynamics
- Ground Network Tracking Stations
- White Sands Complex
- Mission Operations Centers
- Network Control Center
- Ground System Architecture Trends at
Goddard Space Flight Center (GSFC)

New Software Technologies In Tracking and Data Acquisition



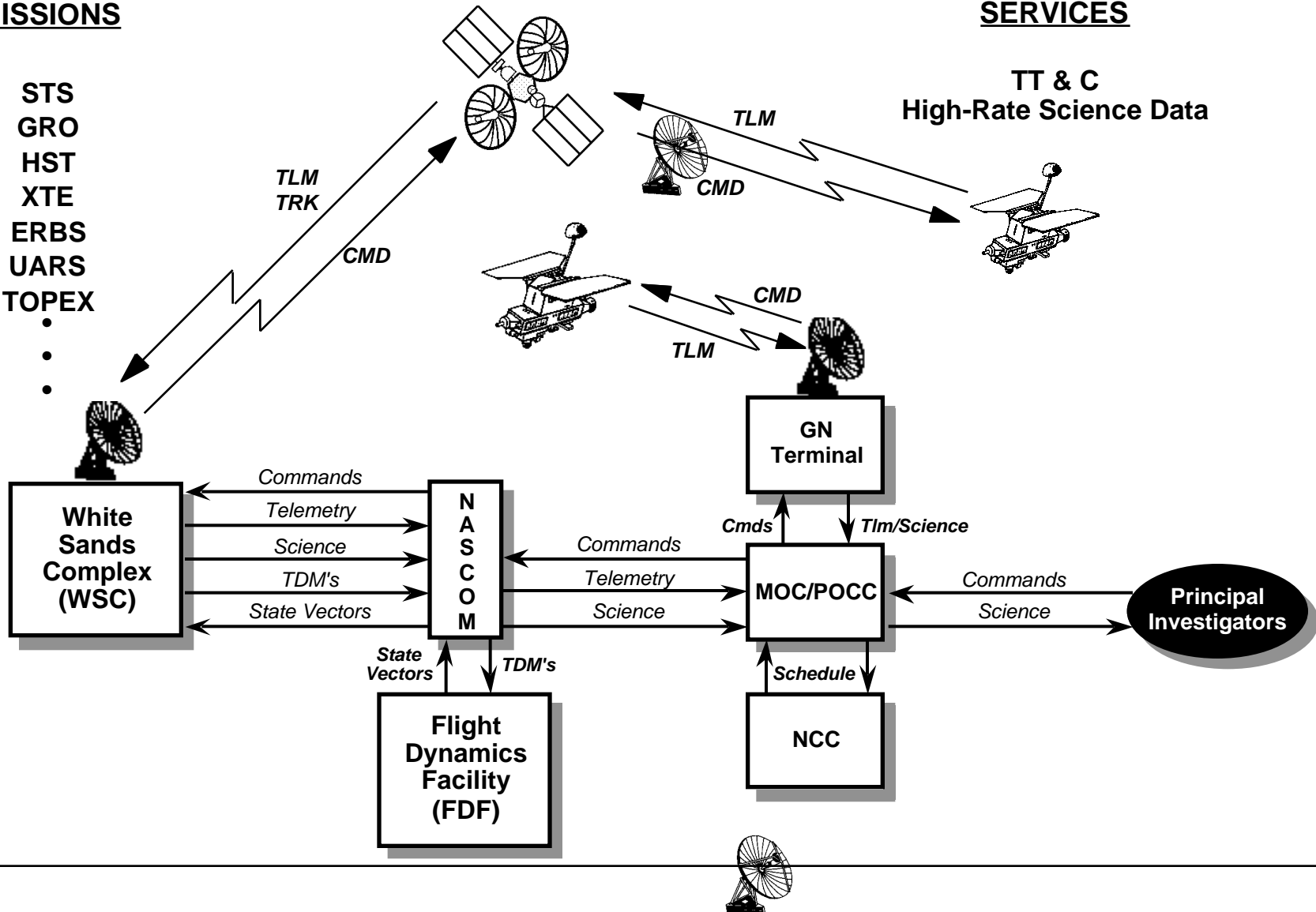
Tracking And Data Acquisition Overview

MISSIONS

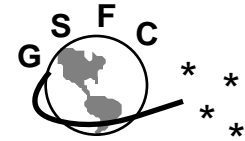
- STS
- GRO
- HST
- XTE
- ERBS
- UARS
- TOPEX
-
-
-

SERVICES

TT & C
High-Rate Science Data



New Software Technologies In Tracking and Data Acquisition



FLIGHT DYNAMICS FACILITY

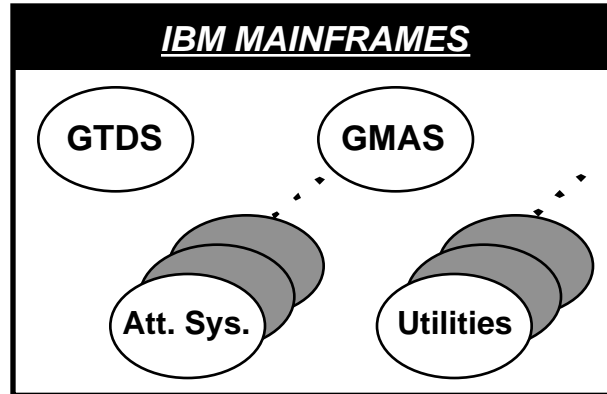
FUNCTIONS

- Orbit Determination
- Attitude Determination
- Maneuver Planning
- Acquisition Data Prod
- Sensor Calibration

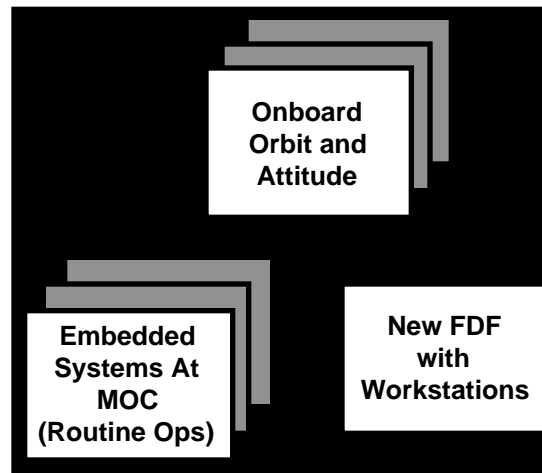
DRIVERS FOR CHANGE

- Reduce Cost
 - O.S.
 - Application Maintenance
 - Facility
- Eliminate Complexity

BEFORE *(Before 1995)*



AFTER *(Current)*

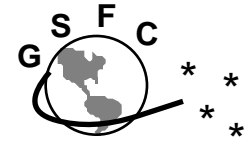


SOFTWARE CHARACTERISTICS

- Centralized
- ~ 100% Custom S/W
- ~ 100% Fortran
- Mission - General

SYSTEM FEATURES

- High Utilization of Off-The-Shelf Products
 - STK
 - CPOD5
 - NAVIGATOR
 - Others
- Distributed
- Workstation - Based
- Mission - Specific



Ground Network Tracking Stations

FUNCTIONS

- STS Launch Support
- STS Orbit Support
- ELV Launch Support
- Calibration Support
- Tracking & Telemetry

BEFORE

(Before 1995)

- Manual Control of Station Equipment

SOFTWARE CHARACTERISTICS

- N/A

DRIVERS FOR CHANGE

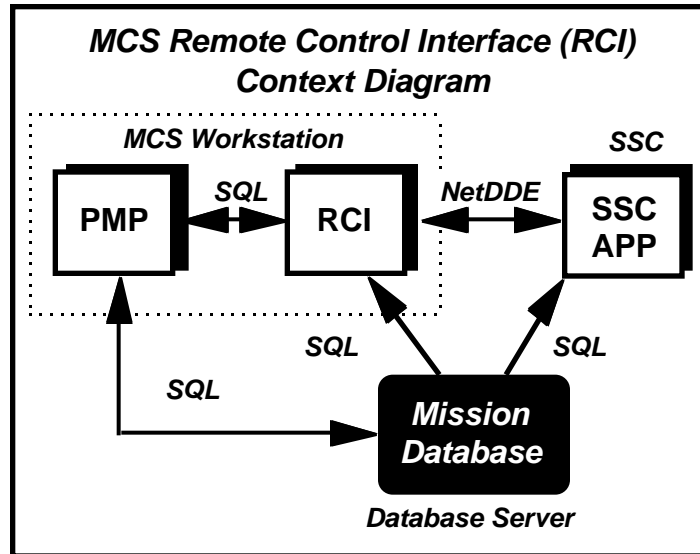
- Modernize Equipment
- Consolidate Monitoring and Equipment Configuration Activities
- Simplify Station Ops
- Reduce Station Ops Cost
- Reduce the Number of Equipment Racks

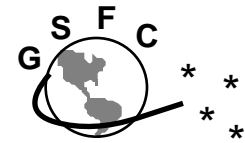
AFTER

(1995 & Beyond)

SYSTEM FEATURES

- Workstation - Based
- Automation and Remote Control
- COTS
 - ORACLE
 - IN TOUCH
 - WINDOW MAKER
 - WINDOWS VIEWER
 - TATE Integrated Systems TIS-4000





White Sands Complex

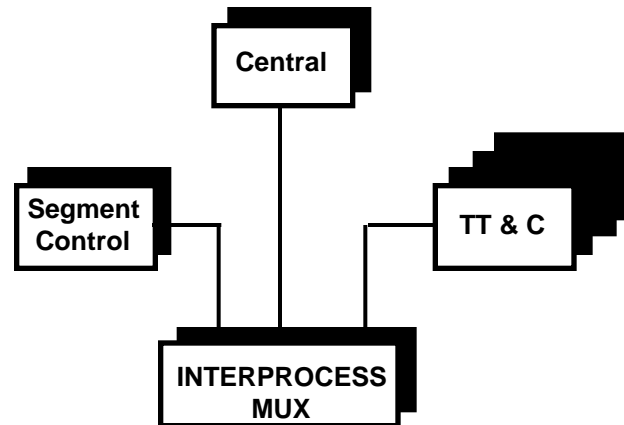
FUNCTIONS

- T&DA For TDRSS-Supported Mission
- Automatic Control of RF and Digital Equipment
- TDRS TT&C

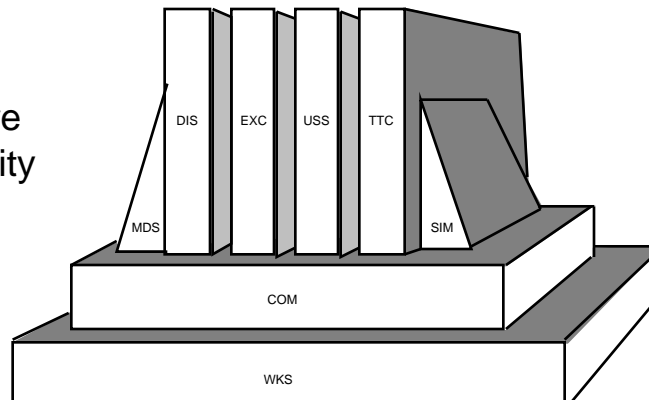
DRIVERS FOR CHANGE

- Reduce Complexity
- Improve Maintainability
- Eliminate Single-Point-of-Failure
- Improve Reliability, Maintainability and Availability

BEFORE (1980's)



AFTER (1990's)



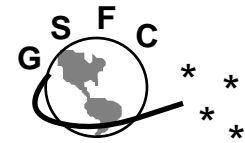
SOFTWARE CHARACTERISTICS

- JOVIAL, FORTRAN
- Centralized Control

SYSTEM FEATURES

- Over 500 KSLOC of ADA
 - 8 CSCI's
 - 3000 ADA Packages
- COTS Packages
- Internal Reuse of Common Software

New Software Technologies In Tracking and Data Acquisition



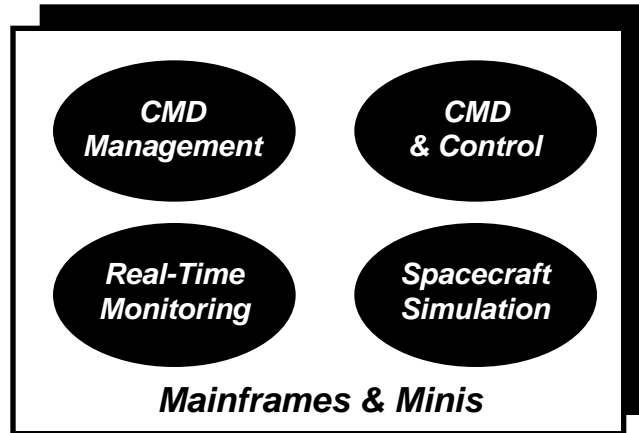
Mission Operations Centers

FUNCTIONS

- Command Management
- Command & Control
- Real-Time Monitoring
- Spacecraft Simulation

BEFORE

(Evolved Over Time)



SOFTWARE CHARACTERISTICS

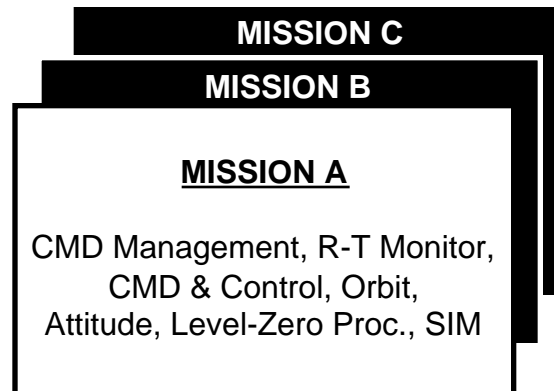
- Centralized
- Mission-General
- FORTRAN, ASSEMBLY
- Custom Code

DRIVERS FOR CHANGE

- Reduce Cost
 - O.S.
 - Vendor-Supplied
- Fulfill Customer Demands (i.e., Deliver Systems to Customers)
- Eliminate Complexity

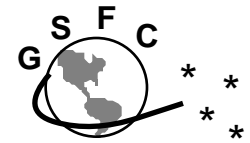
AFTER

(Current)



SYSTEM FEATURES

- High Utilization of Off-The-Shelf Products
 - LABVIEW
 - STK
- Monitoring-By-Exception
- Mission-Specific

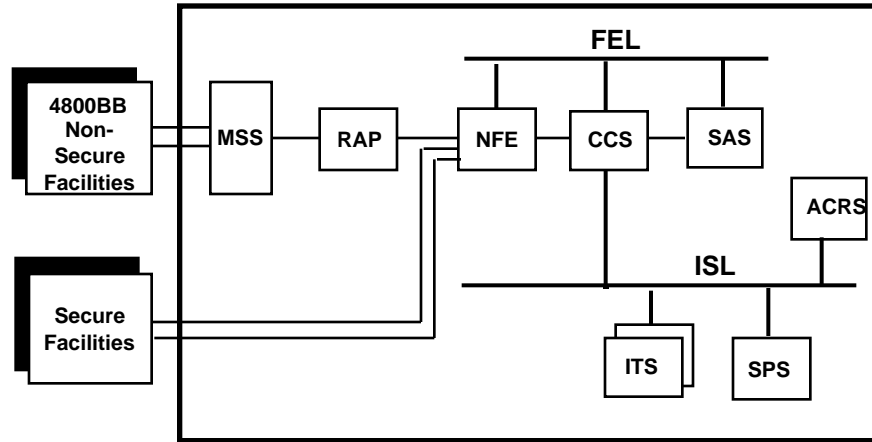


Network Control Center

FUNCTIONS

- Scheduling on TDRSS Resources
- Monitoring and Control of Comm. Activities
- RFI Prediction
- Service Accounting

BEFORE *(Current)*



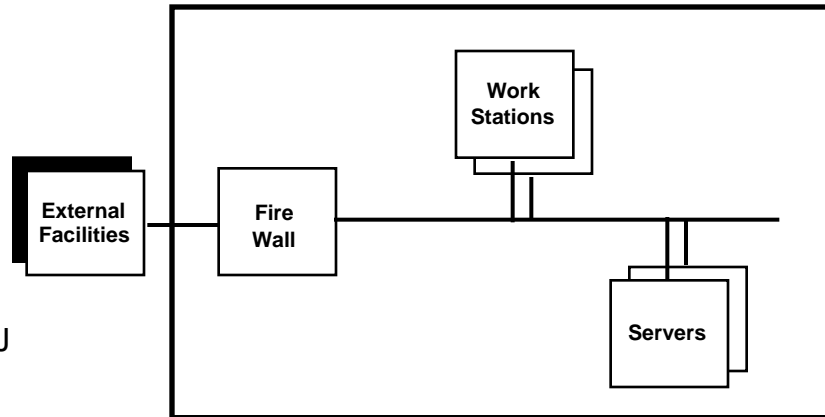
SOFTWARE CHARACTERISTICS

- Distributed, but Highly Coupled
- Mixture of FORTRAN and ASSEMBLY
- Custom Protocol

DRIVERS FOR CHANGE

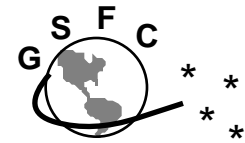
- Reduce Cost
 - O.S.
 - Vendor-Supplied S/W
 - Application Sys. Maint.
- Respond to Changes in Environment
 - Protocol
 - Security
- Accommodate TDRS H, I, J
 - Increase in Resources
 - Ka-Band

AFTER *(1998 & Beyond)*



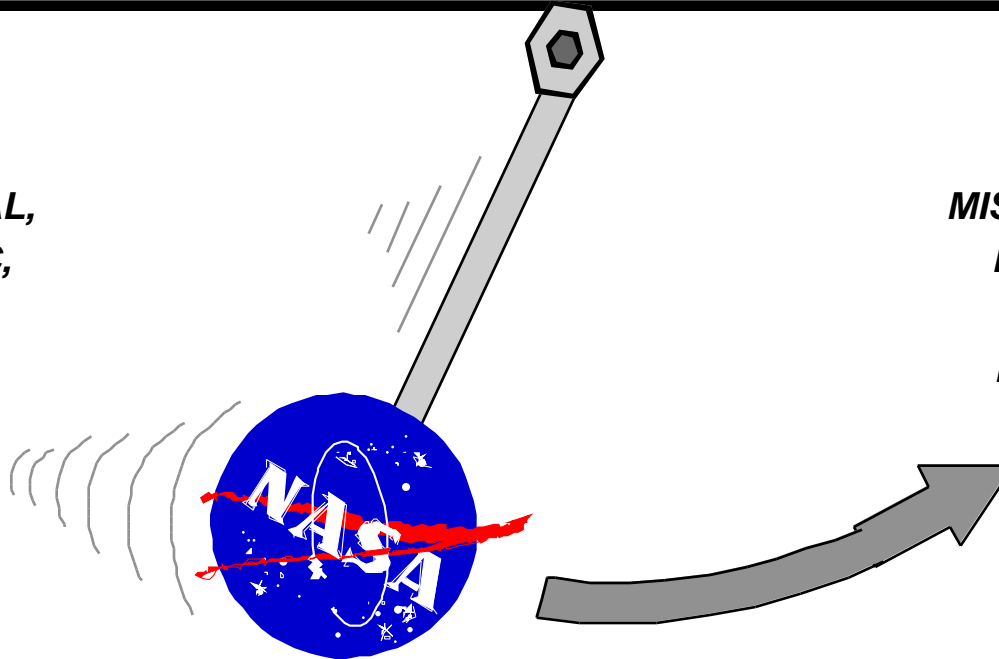
SYSTEM FEATURES

- Uniform H/W Architecture
- Workstation-Based
- Industry Std. Protocol
- High Utilization of Off-The-Shelf Products
 - COBRA
 - BX
 - PERSISTANCE



Ground System Architecture Trends At Goddard Space Flight Center (GSFC)

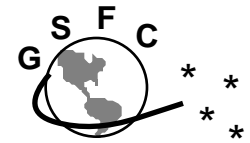
**INSTITUTIONAL,
MONOLITHIC,
CUSTOM,
EXPENSIVE,
STATIC**



**MISSION-SPECIFIC,
DISTRIBUTED,
COTS, GOTS,
HOTS-BASED,
EVOLVING**

- Shifted Organizations to Projectized Teams
- Changed Management Style to Team Empowerment and Team Autonomy

- Driven By Economics
- Driven By NASA Enterprises:
 - Mission to Planet Earth
 - Aeronautics
 - Human Exploration
 - Space Science



A New Paradigm

“SHOW ME THE MONEY!”

**With Enterprise Funding
and
Full-Cost Accounting**

AS OPPOSED TO . . .

“FASTER, BETTER, CHEAPER”