New Software Technologies in Tracking and Data Acquisition

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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

White Sands Complex (WSC)

GN Terminal

MOC/POCC

NCC

Flight Dynamics Facility (FDF)

Commands
Telemetry
Science
TDM's
State Vectors

TLM
TRK
CMD

Commands
Telemetry
Science
TDM's
State Vectors

Schedule

Principal Investigators
New Software Technologies In Tracking and Data Acquisition

FLIGHT DYNAMICS FACILITY

FUNCTIONS

BEFORE
(Before 1995)

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

DRIVERS FOR CHANGE

AFTER
(Current)

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

IBM MAINFRAMES

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

• Mission - General
• Reduce Cost
  - O.S.
  - Application Maintenance
  - Facility
• Eliminate Complexity
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Ground Network Tracking Stations

FUNCTIONS

BEFORE
(Before 1995)

SOFTWARE CHARACTERISTICS

AFTER
(1995 & Beyond)

SYSTEM FEATURES

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

• Manual Control of Station Equipment

• N/A

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

DRIVERS FOR CHANGE

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

MCS Remote Control Interface (RCI) Context Diagram

• Manual Control of Station Equipment

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White Sands Complex

FUNCTIONS

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

SOFTWARE CHARACTERISTICS

- JOVIAL, FORTRAN
- Centralized Control

DRIVERS FOR CHANGE

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

SYSTEM FEATURES

- Over 500 KSLOC of ADA
  - 8 CSCI’s
  - 3000 ADA Packages
- COTS Packages
- Internal Reuse of Common Software
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Mission Operations Centers

FUNCTIONS

BEFORE
(Evolved Over Time)

SOFTWARE
CHARACTERISTICS

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

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

DRIVERS FOR CHANGE

AFTER
(Current)

SYSTEM
FEATURES

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

• High Utilization of Off-The-Shelf Products
  - LABVIEW
  - STK
• Monitoring-By-Exception
• Mission-Specific
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Tracking and Data Acquisition

Network Control Center

FUNCTIONS

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

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

SYSTEM FEATURES

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