Jason-1 Telemetry, Command and Communications Subsystem (JTCCS)

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This Command and Control System is:

- Fully Operational
- Modular
- Plug and play
- Portable
- Distributable
- Open Architecture
- Easy to Use
- Very Easy to Learn (Low Cost Training)
- Ready for Lights Out Operation
- Very Low Cost

- Designed for a Twenty Year Lifetime
- Designed to Support Multiple Spacecraft
- Developed With a New Management Methodology
## Impacts of Lifecycle Architecting Decisions

The Correct Application and Synthesis of Experiences In

- The Managers’ Role as Systems Architect and Teacher
- Understanding Cognitive Dynamics
- The Importance of Verbal and Written Communications
- The Importance of Task Oriented Organizations
- The Selection and Tailoring of Software Standards
- Understanding Inferential and Traditional Architectures
- Selecting The Proper Development Methodology and Technique
- Selecting The Correct Control Points For Production
- Project Management in High Quality Low Cost Systems
- The Impact of Leadership in software Intensive Projects
- Estimating Software Development Cost Correctly
The Jason-1 Mission

- Follow-on to Topex-Poseidon
- Provide Higher Accuracy Radar Altimetry Measurements of Global Ocean Circulation (2.5 cm)
- Discover the Relationship Between the Oceans and Atmosphere, Improve Global Climate Predictions, and Monitor Events Such as El Niño Conditions and Ocean Eddies
- Provide Near Real-Time Data Service for Operational Activities Such as Marine Forecasting of Ocean Circulation and Weather (3 Hour Delay)
Jason-1 Project Elements

• Poseidon 2 altimeter
• DORIS receiver
• Microwave radiometer
• Turbo Rogue Space Receiver
• Laser Retroreflector Array

• JPL Project Ops Control Center, with JTCCS at its heart
• Toulouse, France, Ops Control Center

• Delta II from Vandenberg AFB
Jason-1 Project Operations Control Center (POCC) Tasks

- **JTCCS** - Performs All Real-Time Command and Telemetry Processing During the Routine Phase of the Mission
- **Jason Sequencing Subsystem (JSEQ)** - Generates the Sequence of Events for the Mission as Well as All Command Loads Sent to the Satellite for Execution
- **Jason Science Data Subsystem (JSDS)** - Generates the Science Data Products from the Raw Data Received from the Satellite
- **Physical Oceanography Distributed Active Archive Center (PODAAC)** - Archives and Distributes the Science Products to the US Science Community
The JTCCS Subsystem

Telemetry, Command and Communication Subsystem (JTCCS)

- NASA Earth Terminals
- CNES Simulator
- CNES Earth Terminal
- FTP Server
- Communication Process
- Telemetry Process
- Command Process
- Earth Terminal Simulator
- ET Control and Monitor Process
- Science Data Subsystem (SDS)
- Sequencing Subsystem (JSEQ)
- CNES

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JTCCS Functional Tasks

- Control and Monitor Earth Terminals
- Receive, Store, Process and Display Real-time and Recorded Telemetry Data.
  - HKTMR - Onboard Housekeeping Recorded Telemetry Data
  - HKTMP - Real-time Housekeeping Telemetry Data (During Passes)
  - PLTM1 - Payload Telemetry Data One
  - PLTM2 - Payload Telemetry Data Two
- Command and Monitor Satellite Status
- Translate and Transmit Commands
- Decommutate and Distribute Telemetry Data
- Manage and Archive Data Files
Management Approach

- Small Highly Experienced Technical Team
- Very Close Team Work With Customer and Operational Users
- Incremental Delivery of Software (Early Show and Tell)
- Use of Technical Writers as Systems Engineers
- Selection and Tailoring of a Mature Software Development Standard (JPL-D-4000)
- Meticulous Articulation of Requirements and Design
- On Going Reviews
JTCCS Server Platforms

- Windows XP/2000 on a PC Laptop
- Windows XP/2000/NT 4.0 on a PC Workstation
- Linux/UNIX on a Sun/HP Workstation (Not Implemented for JTCCS)
JTCCS Client Platforms

- Windows XP/2000 on a PC Laptop
- Windows XP/2000/NT 4.0 on a PC Workstation
- Linux/UNIX on a Sun/HP Workstation
- Mac OS 10 (UNIX) on a PowerBook G4
- Windows CE on an iPAQ
JTCCS System Elements

- Size: 489,000 Lines of Code (LOC)
- Total cost: $8.7 Million
- Documentation: Fully Documented to JPL Standards
- Software Languages: Java, C++ and TCL
- Operational Modes: Manual, Automatic and Unattended
- Designed to Support Four Generations of Jason Class Satellites Over a Twenty Year Life Cycle
- Wireless and Handheld Personal Digital Assistant Capability
JTCCS Pluggable Architecture

Operating System

Common Services (CS)
- Inter-process communication (IPC)
- Database
- Processes & Threads
- Other Encapsulated Functionality

Other/COTS
- Talarian

Potential Future Plug-ins

Java Native Interface (CSJNI)
- COM
- TCL

Automation
- UI Server
Common Software Service Architecture

Java Native Interface

Common Software Services
- IPC
- Shared Memory
- Timers/Timing
- Threads/Synch
- Processes Ctrl
- File Services
- Global Variables
- Debug
- Database

SmartSockets

Operating System

ODBC
JTCCS Software Architecture

- Jason Communications
- IPC Server
- FTP
- UI Server
- TCL Automation Script Engine
- Databases
- CS
- Network
- ETSim
- Earth Terminal (ET)
- UI Clients
- Handheld Clients
- Future
- Windows, Unix/Linux, Mac OS X
- Windows CE
JTCCS Client/Server Architecture

- **API**
  - **TC** Data Manager
    - Mnemonics
    - State
    - Stream List
  - **CM** Session Manager
  - **Event Log Manager**
  - **Server** / **System State**
  - **Notification Manager**
  - **Automation Engine**
  - **Automation Scripts**

- **IPC** API

- **Server API**

- **UI Server**

- **Screen**

- **Client**

- **COM**

- **TM**
All Functions that can be Performed by an Operator can be Done by TCL (Tool Command Language) Scripts. TCL Scripts Interact With UI Server. Scripts Have Access to All Ground and Satellite Parameters.

Simple Syntax:
```
set result [jtcc tc send "Commandfile"]
if {$result != 0} {… Error Processing…}
```

Scripts can be Modified and Tested Online. There are No Separate “Compilation” or “Build” Steps.
Pass Schedule Tells Automation When to Perform Functions.
For Jason-1, Most Passes are Executed “Hands-Off” (No Operator Intervention). The Script Controls All Data Flows, Commanding, Data Receipt, Alarm Checking, Product Generation, etc.
Errors can Cause Audible Alerts, Emails or Pages/Phone Calls.
JTCCS Key Architectural Features

- Designed to Support Multiple Jason Follow-on Satellites (4 Jason Satellites - 20 Years)
- Common Software Provides Significant Common Functionality Shared Across All Application Modules
- Inter-process Communication Foundation on Proven, Reliable Middleware Technology - Talarian SmartSockets
- Platform Abstraction - “Ready to Run” on Other O/S Platforms (E.G., Windows NT, VMS, Unix)
- Common Debugging Services
- Use of TCP/IP and FTP Protocols for Communications
Event Manager Provides
- Startup/Shut down Process Synchronization
- Transient Process Management - Resource Efficiency
- Generic Event Scheduler and Script Processor for Automation
- Dead/Hung Process Detection and Automatic Restart

FTP Server Manages Retrieval, Storage and Distribution of Remote Files

Command Translator is Shared by JTCCS and the Jason Sequencing Subsystem (JSEQ)

UI Client Completely Portable - Runs on Any Wintel Workstation or Any Java Enabled OS Platform

Decom Able to Perform Real-time (Pass) Monitoring and the Playback of Recorded Data Simultaneously
Benefits We Have Realized With JTCCS

This Command and Control System is:
- Modular
- Low Cost (Very)
- Plug and Play
- Portable
- Distributable
- Open Architecture
- Easy to Use
- Very Easy to Learn (Low Cost Training)
- Capable of Fully Automated Operation