



Monitor and Control of the Deep-Space Network via Secure Web

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Enterprise Information System
Section 394

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Jet Propulsion Laboratory

- NASA lead center for robotic space exploration
- Operating division of **Caltech**
 - ◆ 6500 employees, \$1.1 B annual budget, "downsizing"
- Current missions
 - ◆ Voyagers 1 and 2 beyond the solar system
 - ◆ Galileo in orbital operations at Jupiter
 - ◆ Pathfinder, Global Surveyor en route to Mars
- Upcoming missions
 - ◆ **Cassini (Saturn/Titan)** launch 1997-10-06/11-04
 - ◆ Numerous smaller missions to **Mars**, other destinations
 - ◆ New Millennium

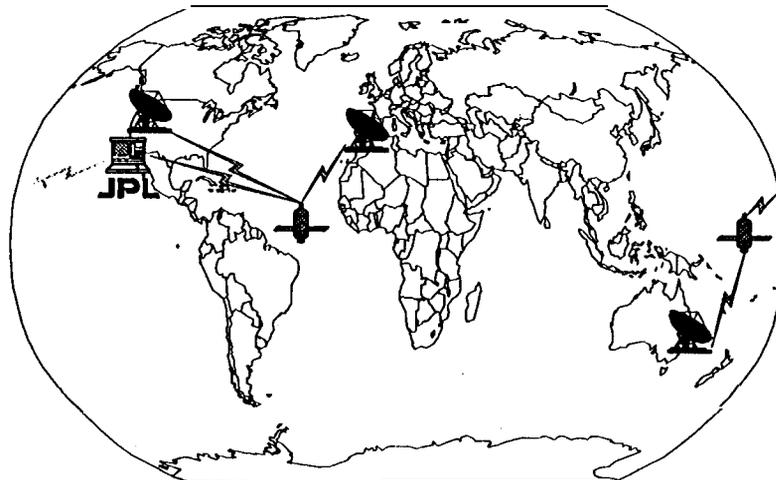
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NASA/JPL Deep Space Network

- Est. Jan '58 to track Explorer 1
 - ◆ First U.S. orbiting satellite
- Since Dec '58
 - ◆ separately managed and operated NASA facility
 - ◆ communications for all deep space missions
- Major operations centers:
 - ◆ Deep Space Communications Complexes
 - Goldstone, California, USA (117° W)
 - Canberra, Australia (140° E)
 - Madrid, Spain (3° W)
 - ◆ Network Operations Control Center
 - Pasadena, California, USA

1-24-97 nt-3

NASA/JPL Deep Space Network



1-24-97 nt-4

Deep Space Communications

- Assets

- ◆ Large (up to 70m diameter) steerable antennas
- ◆ Ultra-low-noise, high-gain (40 dB) microwave amplifiers
- ◆ Very-high-power (400 kW) microwave transmitters
- ◆ Global terrestrial communications
- ◆ High-precision frequency and timing references

- Capabilities:

- ◆ High-precision navigation at solar system distances
- ◆ Advanced coding and signal processing capabilities
- ◆ Detailed modeling of radio propagation characteristics
- ◆ Advanced Spacecraft/Mission Design

1-24-97 nt-5

Network Control Project (NCP)

- DSN Operations Reengineering

- ◆ Reduced Budgets, Increasing Requirements
- ◆ First substantial step toward full lights-out automation
- ◆ Approach: location-independent distributed operations

- Major objectives:

- ◆ Operations cost reduction of **\$8M/year** by FY99
- ◆ 60% increase in customer tracking hours by FY97
- ◆ Increasing usage by NASA, Europe, Japan, Russia

- Upgrades become operational in three phases:

- ◆ 1997-05, 1998-02, 1998-09

1-24-97 nt-6

Network Control Project Components

- Network Monitor and Control (NMC)
 - ◆ Consolidated "Operator Console"
- Network Planning and Preparation (NPP)
 - ◆ Network Information Service (NIS)
- Data Management Service (DMS)
 - ◆ Distributed File management (based ON DCE DFS)
 - ◆ Distributed Catalog (DCE front end to X.500/Oracle)
- Common Services (CS)
 - ◆ Global Monitor and Control Services based on DCE RPC
- Interfaces to JPL Enterprise Information System
- Subsystem Upgrades for Automation

1-24-97 nt-7

NCP Data Management Service

- Central distributed repository for operational support data
 - ◆ not spacecraft science and engineering data
 - + subsystem and spacecraft tables, support data, logs
 - ◆ documentation, discrepancy reports, and other reports
- Provides cataloging of data products
- Generates standard and periodic reports
 - ◆ including data stream accounting
- Maintains equipment availability table
- Provides analysis tools

1.24-97 nt-8

Example DMS Scenario

- NPP Subsystem (Pasadena)
 - ◆ generates tracking predictions file for Canberra **DSCC** and stores in DFS (usually several days before the pass)
 - ◆ updates X,500 based support data catalog
- Replication:
 - ◆ DFS updates replica of file in Canberra
 - +X.500 updates replicated Directory Server Agents
- At Canberra:
 - ◆ NMC queries catalog
 - + Required data retrieved from (local) DFS server

1-24-97 nl-9

NCP Common Services

- General messaging framework for DSN operations
 - ◆ Based on legacy messaging idioms
- Monitor and Control Services -
 - ◆ based on DCE RPC
 - ◆ Resource Assignment Service
 - ◆ Monitor Data Service (any node to any node)
 - ◆ Directive/Response Service (closed-loop control)
 - ◆ Event Message Service (alarms, etc)

1-24-97 nl-10

JPL Enterprise Information System

- Provides institutional information infrastructure
 - ◆ Network, security, directory, RPC, file
 - ◆ Time synchronization, data access, messaging
 - ◆ Systems management services
- Goals:
 - ◆ Provide framework for **laboratory-wide** interoperability
 - ◆ Exploit economies of scale in information technology
 - ◆ Coordinate evolution of information technology foundation
- Defines DCE cell architecture
 - ◆ Operate unified core services (eg, security, directory, file)

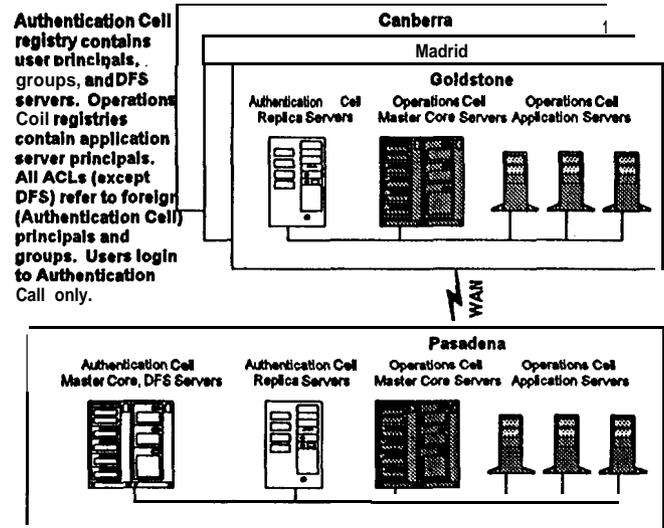
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JPL Cell Architecture Issues

- Multi-Cell Architecture benefits:
 - ◆ Robustness for **disconnected autonomous operations**
 - **preventive measures** during critical mission events
 - security threats, WAN outages
 - ◆ Defined interfaces between multiple organizations
 - Change control contained inside cell boundaries
- But: Single enterprise registry has major benefits
 - ◆ single" sign-on; single point of **admin** for (fluid) roles
- JPL is trying a hybrid approach
 - ◆ Central registry in authorization cell
 - ◆ Multiple operational cells with authorization replicas
 - ◆ Compromise between opposing constraints

1-24-97 nl12

JPL DCE Cell Architecture



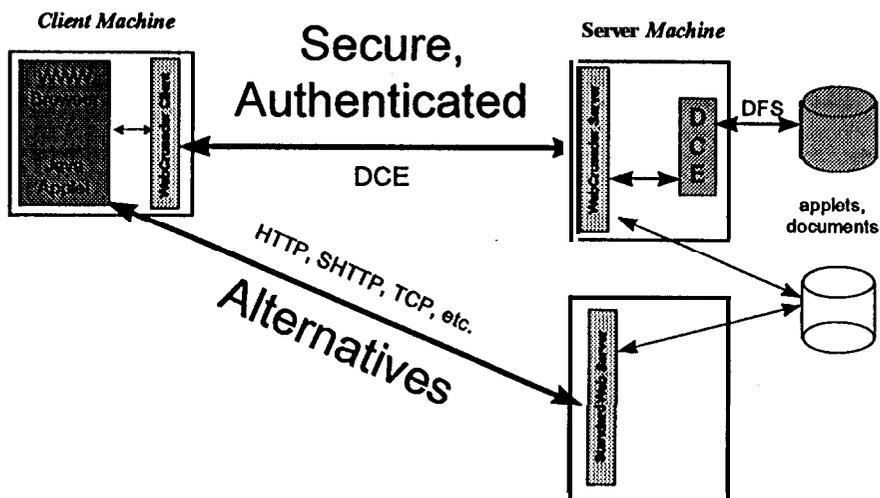
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DCE/Web Integration Demo

- Goal:
 - ◆ Allow external authenticated access to JPL
 - Sensitive resources
 - eg, Monitor/Control of critical mission event
- Approach:
 - ◆ Secure DCE/Web Gateway
 - Seamless integration with JPL authentication
 - ◆ Components:
 - Browser GUI (Java)
 - Object-oriented multi-threaded "Router/Gateway"
 - COTS software (Web Crusader)

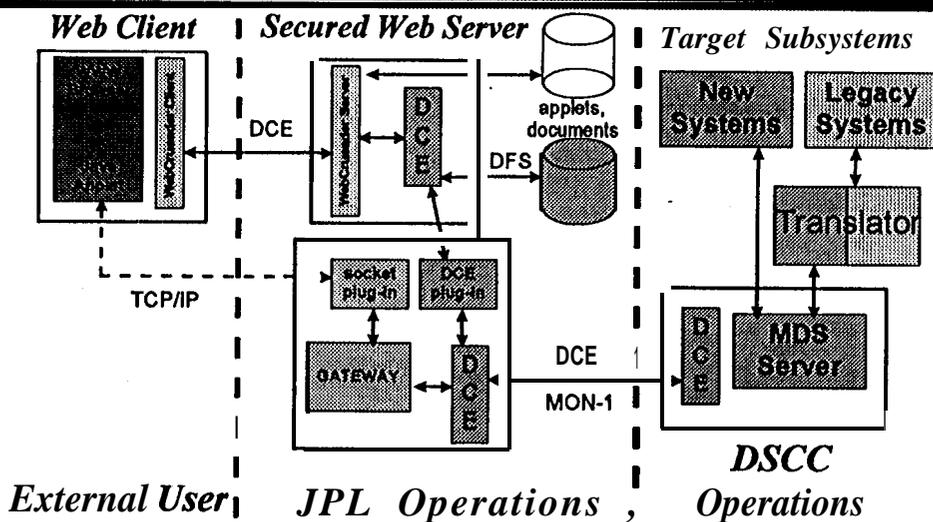
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Secure, Authenticated Web Access



1-24-97 nl-15

Secured Web Access to DSN Monitor/Control



1-24-97 nl-16

Conclus on

- **JPL Enterprise Information System (EIS)**
 - ◆ Single DCE **registry** for authorization/authentication
 - + Multiple DCE cells for operations, development, etc.
 - ◆ Enterprise infrastructure: file, directory, management, etc.
- **Global DSN operations monitor/control**
 - ◆ Infrastructure upgrade based on EIS services
 - ◆ Location-independent semi-automated operations
- **Secure Web access: integrated with EIS**
 - ◆ Demo application: Monitor/Control of critical operations
 - ◆ Information access (reports, logs, etc.)
 - ◆ Many other possibilities...

1-24-97 nt-17