Gus Razo & Tammy Fujii

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Jet Propulsion Laboratory
California Institute of Technology

MODERNIZATION OF THE CASSINI GROUND SYSTEM

Outline

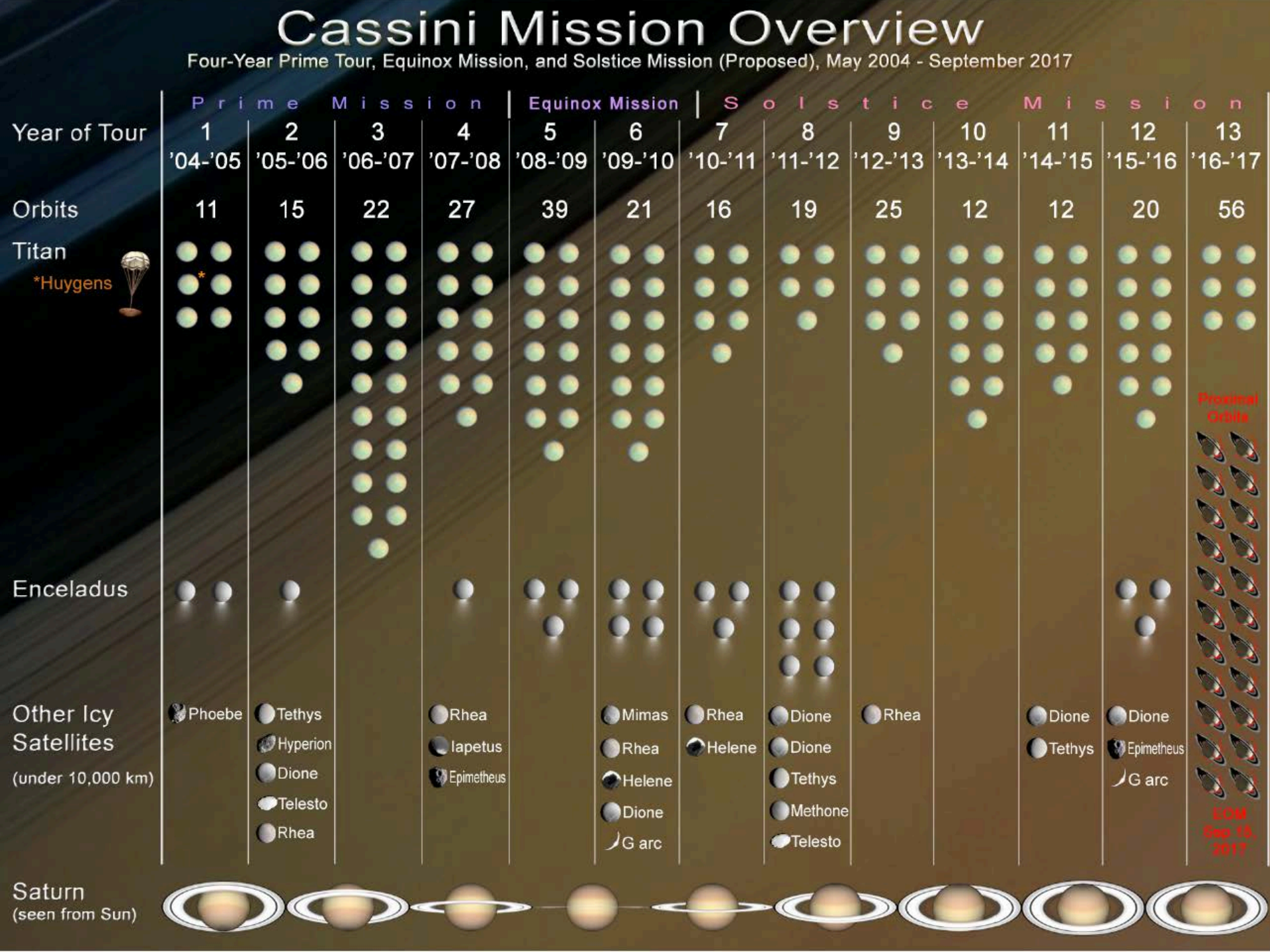
- Definition of Modernization
- Cassini Mission Overview
- Cassini Ground System
- Methodology
- Advantages and Challenges
- Significant Modernization Events
- Lessons learned
- Questions

Modernization

- Modernization is the modification of a system to restore its overall effectiveness by replacing a limited number of critical components.
  - Examples:
    - Small scale (a single hardware component or software application)
    - Large scale (integration of multiple hardware/software components, upgrade of the entire ground system)

Cassini Mission Overview

Four-Year Prime Tour, Equinox Mission, and Solstice Mission (Proposed), May 2004 - September 2017



Cassini Mission Overview

Four-Year Prime Tour, Equinox Mission, and Solstice Mission (Proposed), May 2004 - September 2017

	Prime Mission				Equinox Mission		Solstice Mission						
Year of Tour	1 '04-'05	2 '05-'06	3 '06-'07	4 '07-'08	5 '08-'09	6 '09-'10	7 '10-'11	8 '11-'12	9 '12-'13	10 '13-'14	11 '14-'15	12 '15-'16	13 '16-'17
Orbits	11	15	22	27	39	21	16	19	25	12	12	20	56
Titan													
Enceladus													
Other Icy Satellites (under 10,000 km)	Phoebe	Tethys, Hyperion, Dione, Telesto, Rhea		Rhea, Iapetus, Epimetheus		Mimas, Rhea, Helene, Dione, G arc	Rhea, Helene	Dione, Dione, Tethys, Methone, Telesto	Rhea		Dione, Tethys	Dione, Epimetheus, G arc	

*Huygens

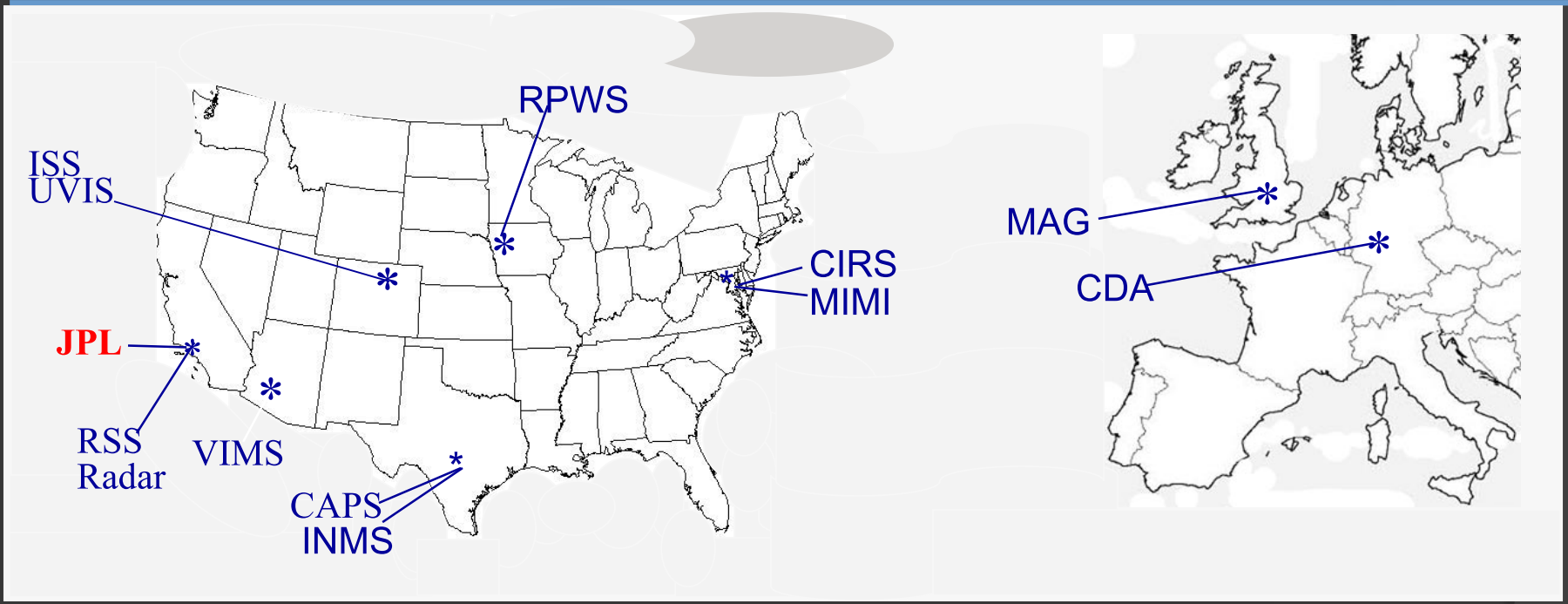
FRNS
LDOM
Virtualization
DOM View
JAVA DOM
AFS to NFS
AceLog
Autorad

Proximal Orbits

EOM Sep 15, 2017

Saturn (seen from Sun)

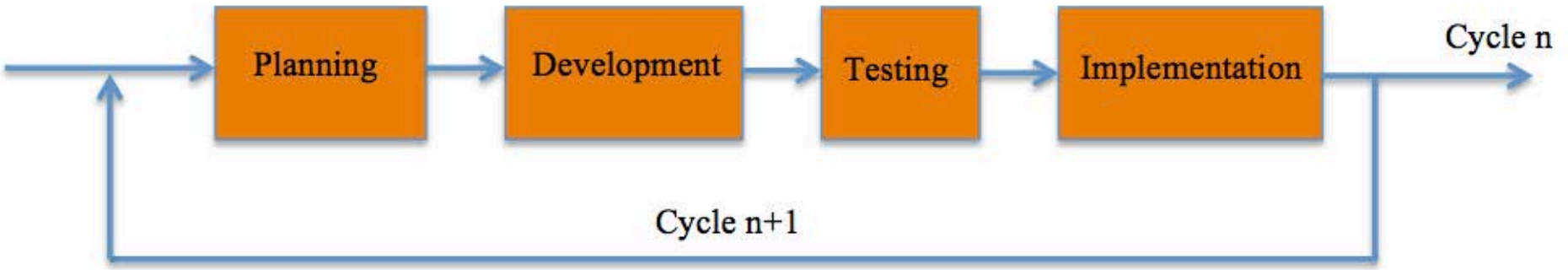
The Reach of the Cassini Ground System



- Operations
- Test
- Development
- Web

Methodology For Modernization

- Agile Method (series of iterations)
  - Planning
  - Development
  - Testing
  - Implementation



Advantages and Challenges of the Agile Method

- Advantages
  - Streamline processes
  - Create knowledge
- Challenges
  - Avoid increasing risk
  - Account for all dependencies
  - Overcome resistance to change
  - Coordinate team involvement

Significant Modernization Events

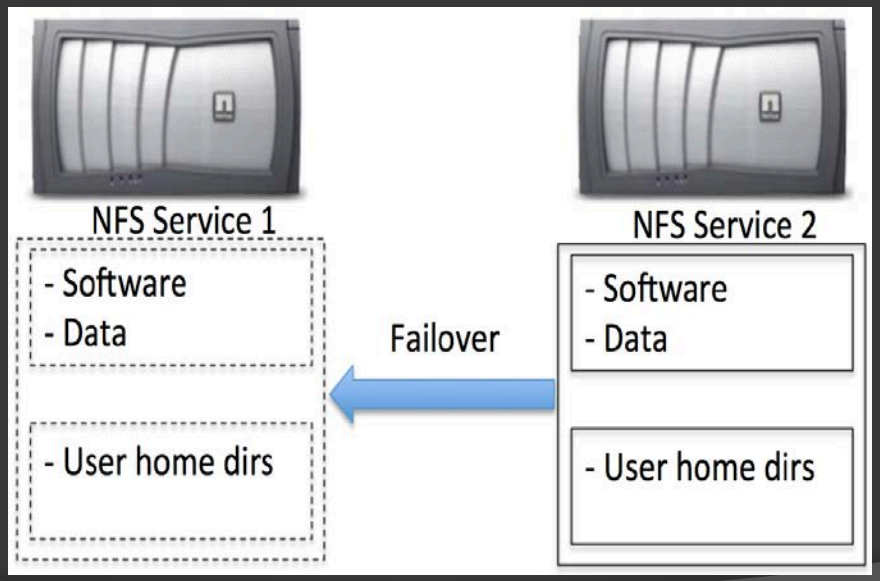
Event/Technology	AFS to NFS	Home directories and software storage system	File repository system upgrade	Logical Domain Virtualization
Why	AFS Cost Reduction of AFS support	Local disk constant failure Significant system administration Cumbersome disk backup	End of C++ version support. Move to NFS Cassini distributed system	Discontinuation of individual workstations Needs to reduce maintenance
Pros	NFS widely used Reduced cost Convenient backup	One home directory per user Fast software deployment Centralization of data	Savings Enhanced performance	Less workstations to maintain Savings Virtual consoles Flexibility
Cons	Not meant for distributed systems Security	One change can affect multiple users/teams Configuration for data exchange is difficult	Different behavior on the Java version Need to add RMI services	Training system admins Virtual disks difficult to maintain
Challenges	Required significant changes on established software and processes Timeouts on mounting and unmounting	Accommodate exemptions Ensure high availability	Adaptation of the Java version to reduce impact to operations	Understand how virtualization fits the ground system Address printer setup for users

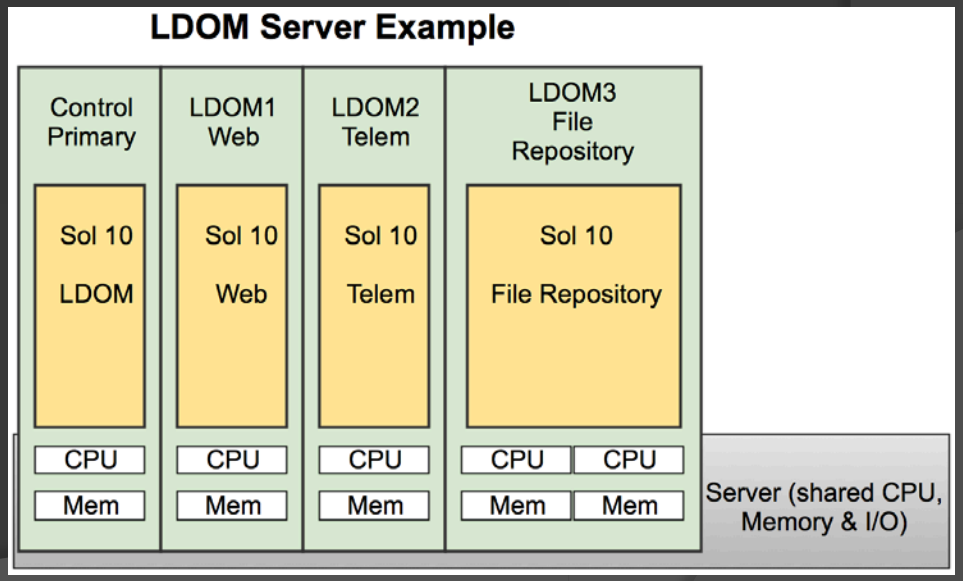
Significant Modernization Events

Event/Technology	ACELOG	Autorad	File Release Notification Services
Why	Manual process Unreliable software Lack of web interface	Reduction of personnel	Need for a accurate service Need to reduce manual input
Pros	One web based tool Auto population of fields LDAP integration	Automation Savings Decrease of shift activities	Accurate notification Automatic field population Re-release capability Quicker searches Single signup
Cons	Migrating old data into the system Add new web services	Risk had to be assessed and mitigated	Redevelopment of the system Users retraining
Challenges	Retraining personnel Transition users and tools to the new system	Significant verification and validation Configuration of the process	Understand the message reactor technology Train users on new user interface

LDOM Virtualization

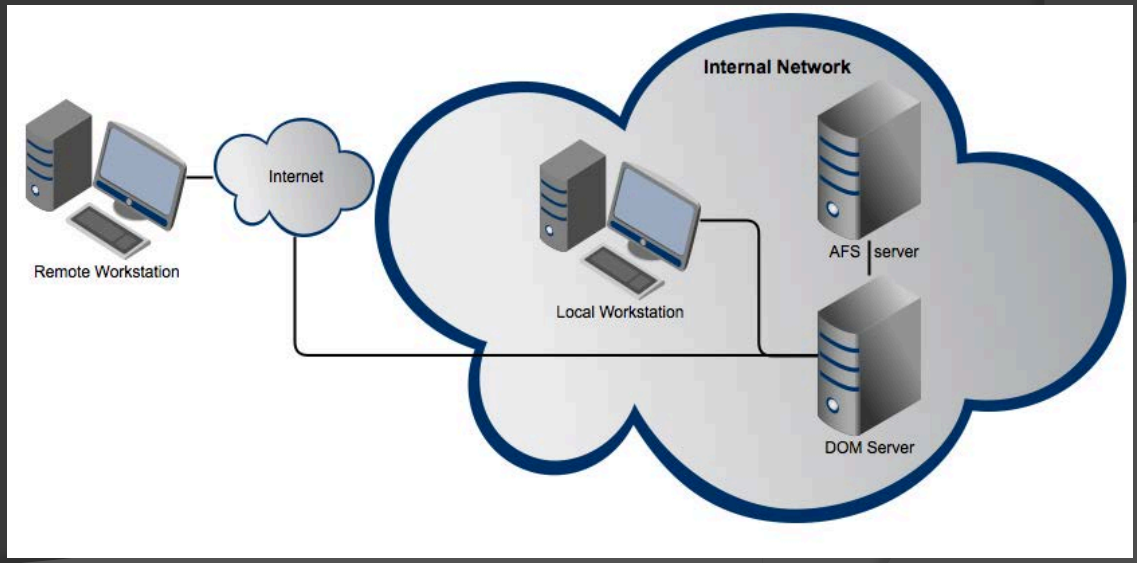
- LDOM
  - Work stations
  - Servers
- NFS high availability configuration





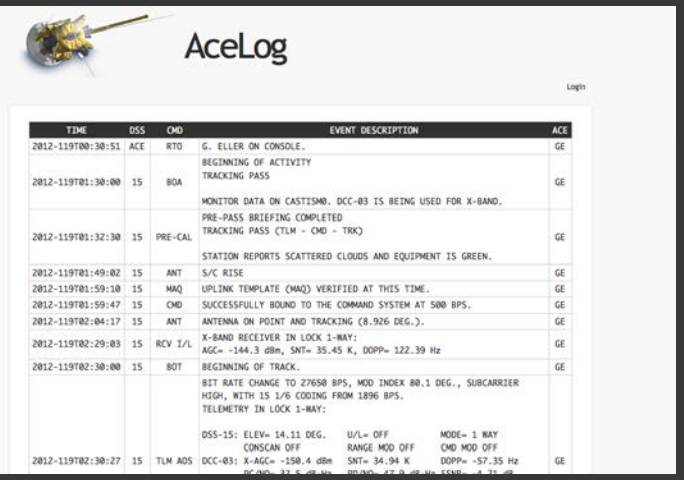
Cassini's DOM Architecture

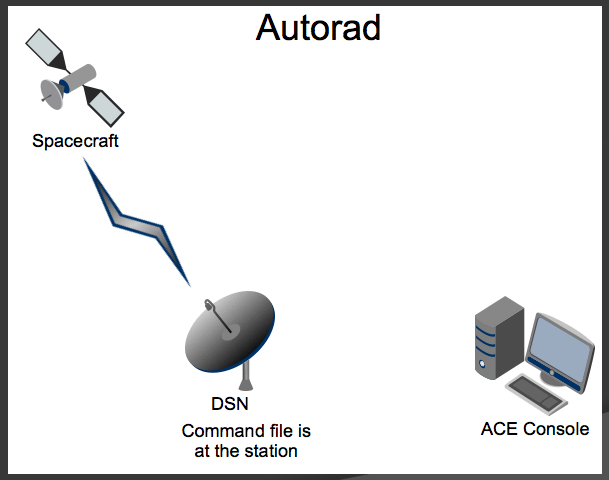
- Cassini file repository system
  - AFS to NFS
  - C++ to JAVA
- Distributed environment
  - AFS
  - RMI services

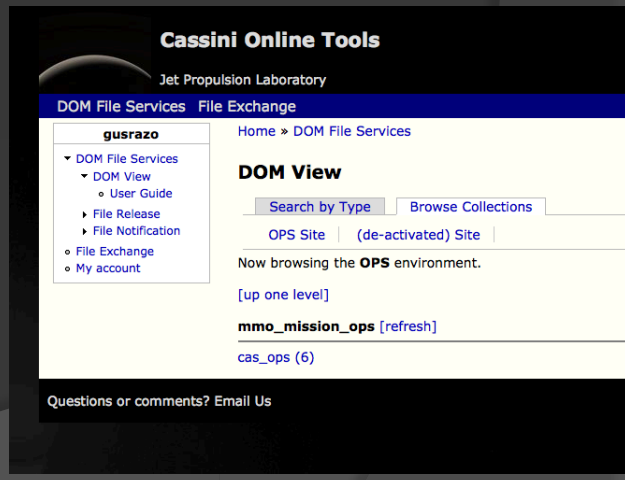


Software Application Adaptations

- File Release Notification Services
- DOM view
- AceLog
- Autorad







Lessons Learned

- Ground system evolution is achieved through incremental changes.
- Enhance security
- Significant changes require comprehensive testing.
- Use test as an opportunity to train operations staff.
- Document processes early and revisit them to avoid knowledge loss.
- Plan downtime into deployment schedule.
- Treat modernization as an opportunity not a challenge.

Questions?

Backup slides

Cassini Instrument Teams

CAPS	Cassini Plasma Spectrometer, *Southwest Research Institute, San Antonio, USA*
CDA	Cosmic Dust Analyzer, *Max Planck-Institut fuer Kernphysik, Heidelberg, Germany*
CIRS	Composite Infrared Spectrometer, *Goddard Space Flight Center, Greenbelt, USA*
ISS	Imaging Science Subsystem, *Space Science Institute, Boulder, USA*
INMS	Ion And Neutral Mass Spectrometer, *University of Michigan, Ann Arbor, USA*
MAG	Dual Technique Magnetometer, *Imperial College, London, UK*
MIMI	Magnetospheric Imaging Instrument, *John Hopkins University, Baltimore, USA*
RADAR	Radar, *Jet Propulsion Laboratory, Pasadena, USA*
RPWS	Radio and Plasma Wave Spectrometer, *University of Iowa, USA*
RSS	Radio Science Subsystem, *Jet Propulsion Laboratory, Pasadena, USA*
UVIS	Ultraviolet Imaging Spectrograph, *University of Colorado, Boulder, USA*
VIMS	Visible And Infrared Mapping Spectrometer, *University of Arizona, Tucson, USA*

Ace log

AceLog

Login

TIME	DSS	CMD	EVENT DESCRIPTION	ACE
2012-119T00:30:51	ACE	RTO	G. ELLER ON CONSOLE.	GE
2012-119T01:30:00	15	BOA	BEGINNING OF ACTIVITY TRACKING PASS MONITOR DATA ON CASTISM0. DCC-03 IS BEING USED FOR X-BAND.	GE
2012-119T01:32:30	15	PRE-CAL	PRE-PASS BRIEFING COMPLETED TRACKING PASS (TLM - CMD - TRK) STATION REPORTS SCATTERED CLOUDS AND EQUIPMENT IS GREEN.	GE
2012-119T01:49:02	15	ANT	S/C RISE	GE
2012-119T01:59:10	15	MAQ	UPLINK TEMPLATE (MAQ) VERIFIED AT THIS TIME.	GE
2012-119T01:59:47	15	CMD	SUCCESSFULLY BOUND TO THE COMMAND SYSTEM AT 500 BPS.	GE
2012-119T02:04:17	15	ANT	ANTENNA ON POINT AND TRACKING (8.926 DEG.).	GE
2012-119T02:29:03	15	RCV I/L	X-BAND RECEIVER IN LOCK 1-WAY: AGC= -144.3 dBm, SNT= 35.45 K, DOPP= 122.39 Hz	GE
2012-119T02:30:00	15	BOT	BEGINNING OF TRACK.	GE
			BIT RATE CHANGE TO 27650 BPS, MOD INDEX 80.1 DEG., SUBCARRIER HIGH, WITH 15 1/6 CODING FROM 1896 BPS. TELEMETRY IN LOCK 1-WAY: DSS-15: ELEV= 14.11 DEG. U/L= OFF MODE= 1 WAY CONSCAN OFF RANGE MOD OFF CMD MOD OFF	