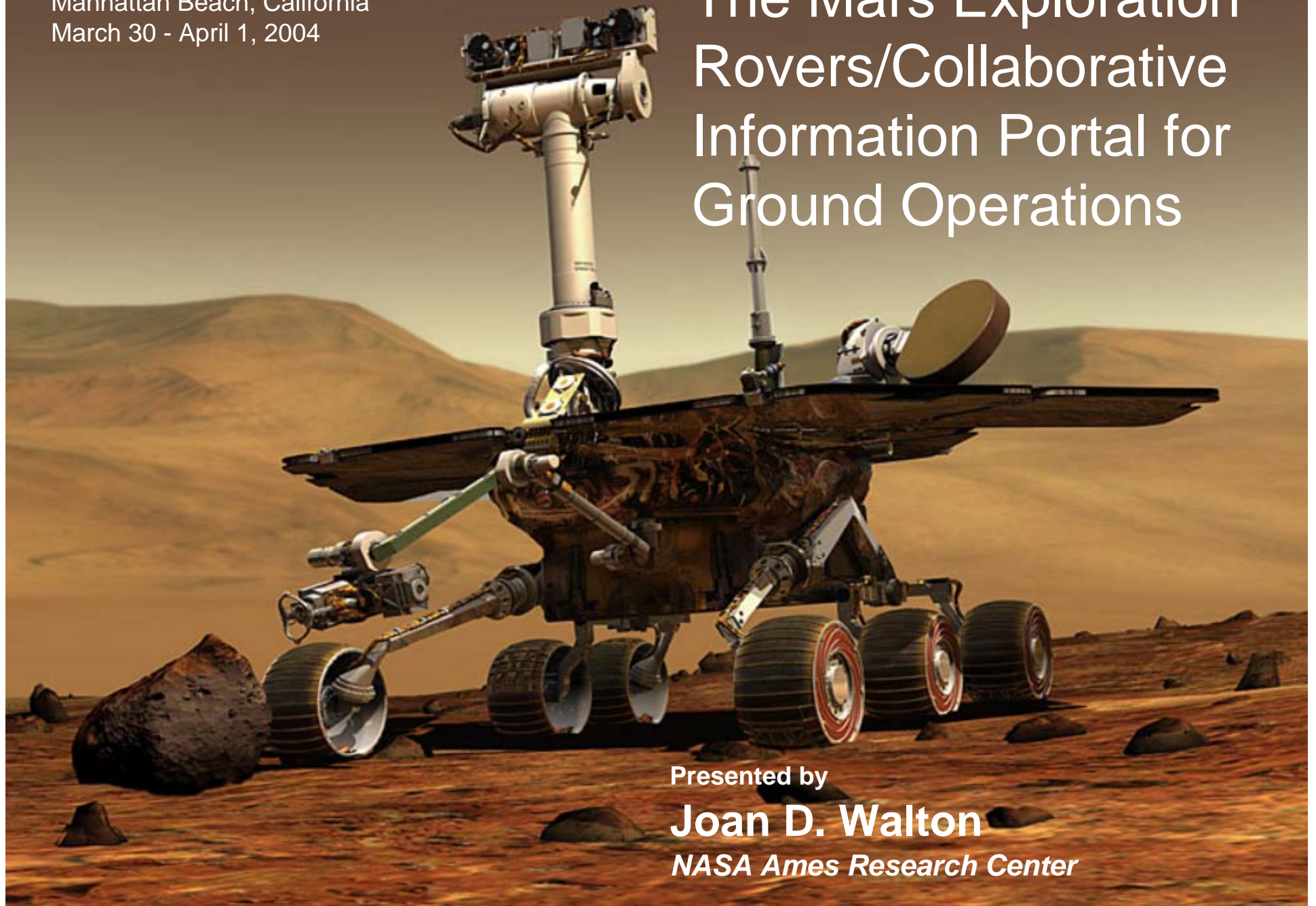


Ground System Architectures Workshops
Manhattan Beach, California
March 30 - April 1, 2004

The Mars Exploration Rovers/Collaborative Information Portal for Ground Operations



Presented by

Joan D. Walton

NASA Ames Research Center



Overview

I will present the lessons we learned from developing and deploying the **Collaborative Information Portal** for NASA's current Mars Exploration Rovers mission.

Speaker

- Joan Walton
 - Computer Scientist, NASA Ames Research Center
 - CIP project manager

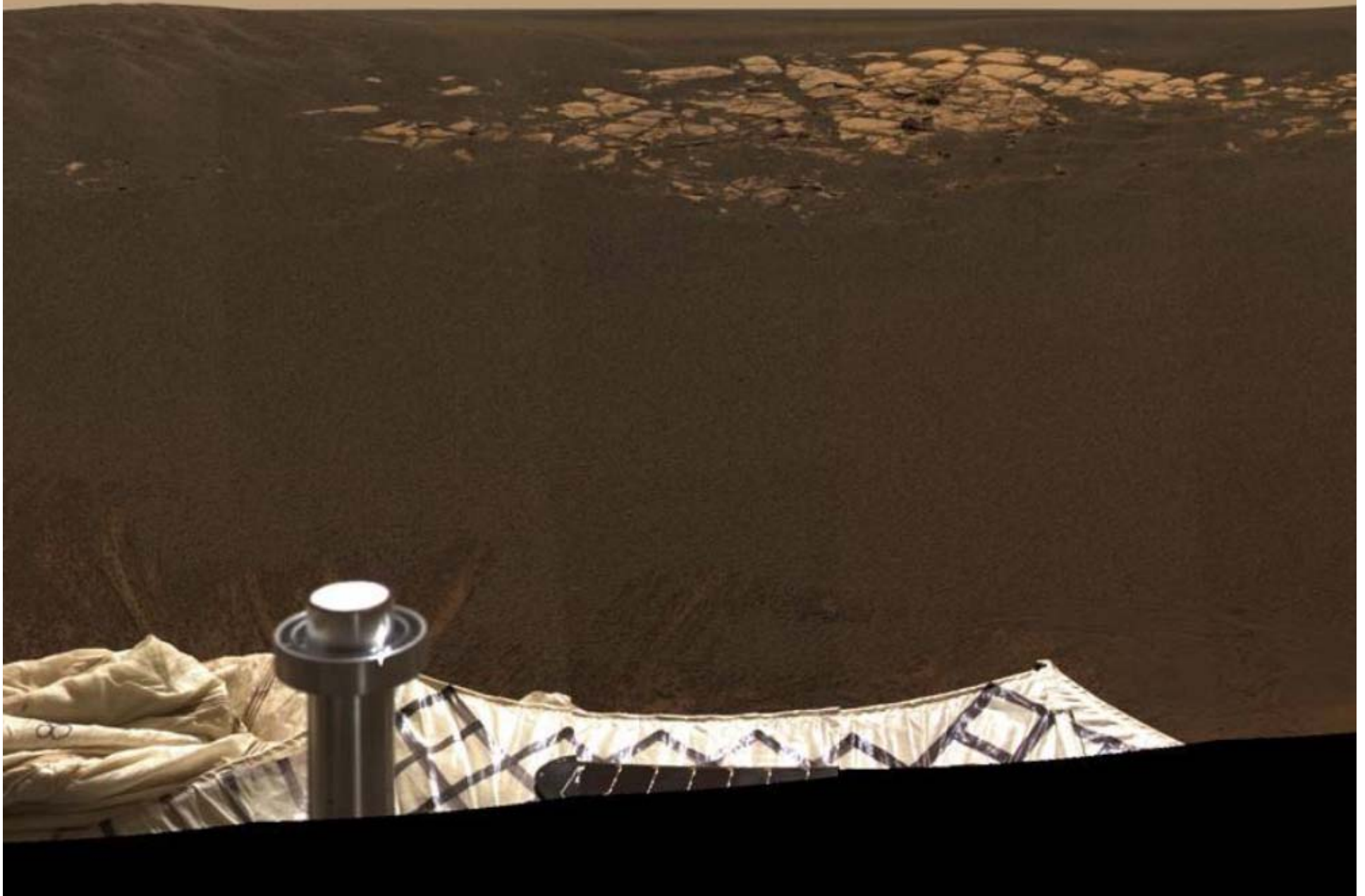
- Development Team:
 - John Schreiner
 - Louise Chan
 - Sanjay Desai
 - Matthew D'Ortenzio
 - Robert Filman
 - Dennis Heher
 - Kim Hubbard
 - Sandra Johan
 - Leslie Keely
 - Vish Magapu
 - Ronald Mak
 - Quit Nguyen
 - Tarang Patel
 - Elias Sinderson



Presentation Agenda

- Mission Overview
- Collaborative Information Portal (CIP)
 - Functions
 - User Interface
 - Architecture
- Lessons Learned

Mission Overview



Mars Exploration Rovers Mission

- Twin robot geologists search for evidence of water.

- **Launched:** June 10 & July 7, 2003
- **Landed:** January 3 & 24, 2004
- **Duration:** 90+ days
(extended mission could run through September 2004 and beyond)

- **Mission Center:**
Jet Propulsion Laboratory
Pasadena, CA



Daily Process

- Daily process for each rover team
 - Receive downlink of data from a rover
 - Process and analyze results
 - Plan tomorrow's activities
 - Construct rover command sequence
 - Send uplink of command sequence to rover



Mission Needs

- Time management
- Data management
- Personnel management



Collaborative Information Portal



Key Issues

- ❑ Scheduling and schedule reminders
- ❑ Tracking the status of daily predicted outputs
- ❑ Finding, displaying and retrieving data products
- ❑ Collaboration
- ❑ Announcements
- ❑ Personalization

User Interface

The screenshot shows a software interface with several key components:

- Broadcast Messages:** A table at the top left showing mission messages.

Mission	Sender	Message	Sent (UTC)
MER	diblaney	I think I forgot-but	12:14:17, 02/20/04
MER	diblaney	Mini-TES products have been reduced	12:13:17, 02/20/04
- Clocks:** A section below messages showing active clocks.

SOL 51	18:07	LST-A
SOL 31	06:06	LST-B
- Event Countdown Timer:** A table on the right showing upcoming events.

Time Left	Task Summary	Start	Stop
00:52 left	Tactical End-of-Sol Engr. Assessm...	06:00	10:06
01:54 left	SOWG Meeting	09:05	11:08
01:54 until	End-of-Sol Science Discussion	11:08	11:39
01:54 until	Sci Product EPO Caption Interview	11:08	12:10
- Navigation and Conversion Tools:** A row of tabs and buttons including 'Overview', 'Time Converter', 'Schedules', 'Browse Files', 'Find Files', 'New Files', and 'Observations'. Below these are buttons for 'GO TO NOW', 'SHOW/HIDE SCHEDULES', 'PRINT GANTT CHART', and 'GET INFO'.
- Schedule Viewer:** A Gantt chart at the bottom showing a timeline from 23-Feb-0 to 24-Feb-04. Activities are represented by colored bars: Engineering Leads Tagup (red), Engineering Skeleton Activity Plan Up (blue), DL/UL Handover Meeting (green), SOWG Meeting (green), End-of-Sol Science Discussion (green), Sci Product EPO Caption Interview (pink), Activity Refinement/Sequence Assign (blue), and Activity Carving (blue).

User Interface

The screenshot shows a software interface for viewing MER-A data products. The interface includes a menu bar (CIP (Ikeely) File Help), a tabbed view (Data Products, Reports, Plans, OSS, Summary), and a file browser. The file browser displays a list of 14 files with columns for thumbnail, site/pos, size, and filename. A detailed view of a selected image is shown in a separate window, displaying the image and its metadata.

File counts important to users

Complicated file system structure

Configuration, download, and viewing

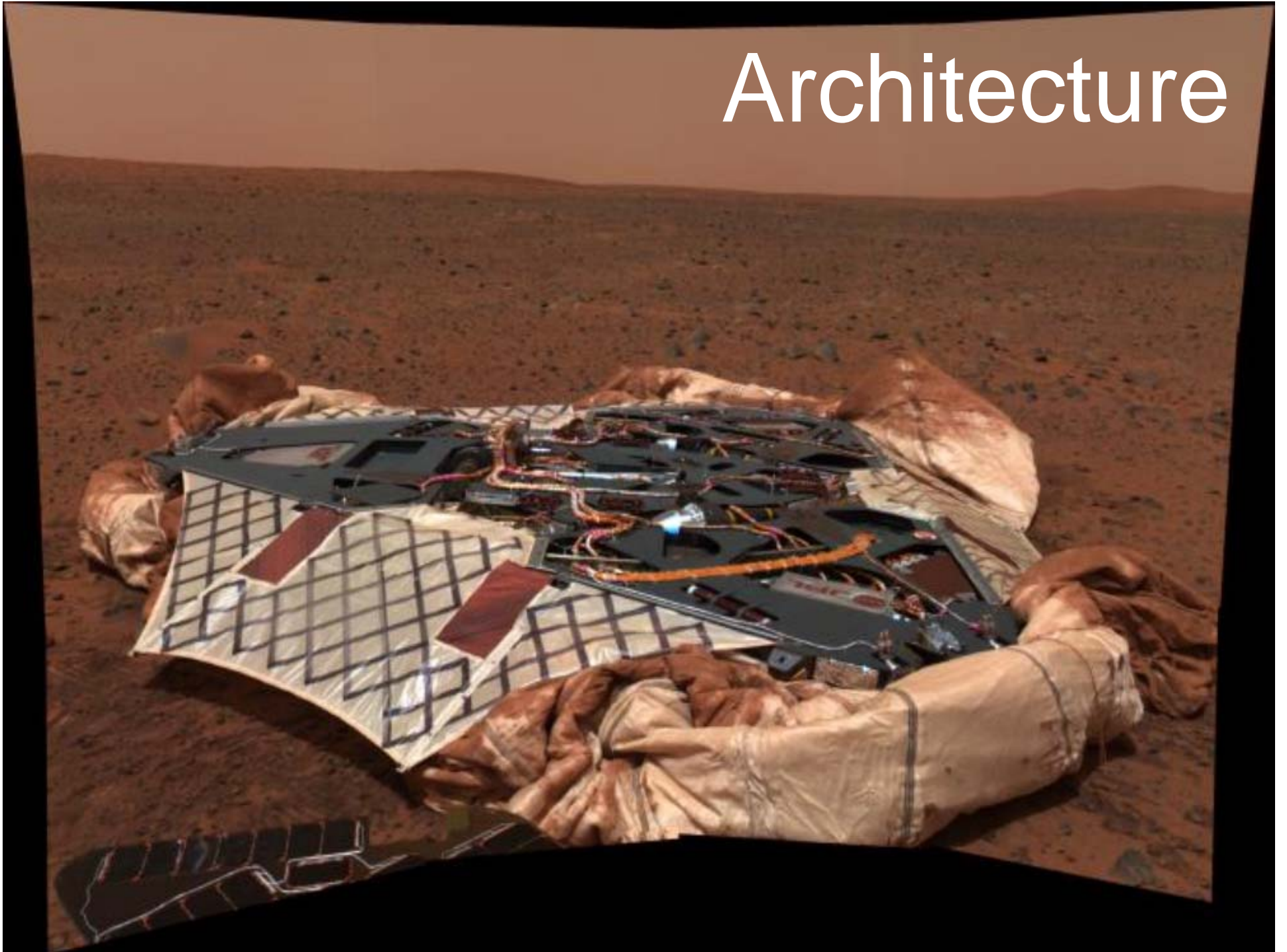
File path important to users

Image metadata

thumbnail	site/pos	size	filename
	10/00	2138064	2N130811934EFF1000P1901L0M1.IMG
	10/00	2138064	2N130812005EFF1000P1901L0M1.IMG
	10/00		
	10/00		
	10/00		

MER-A: /global/ifs/2/mera/ops/ops/surface/tactical/sol/050/opgs/edr/ncam/2N130812149E1
View Info Comments x:1700 y:0696 L R 37%

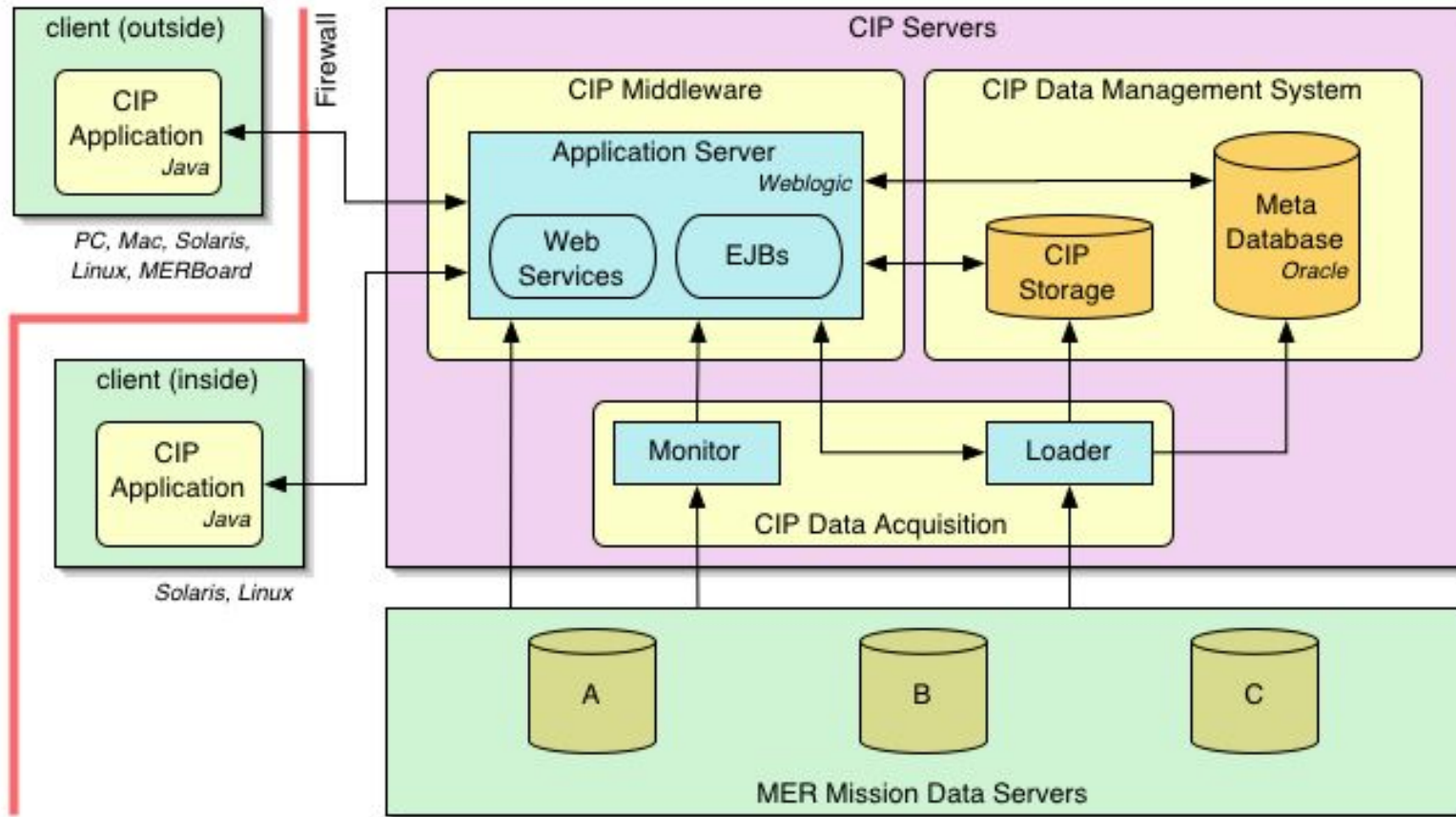
Architecture



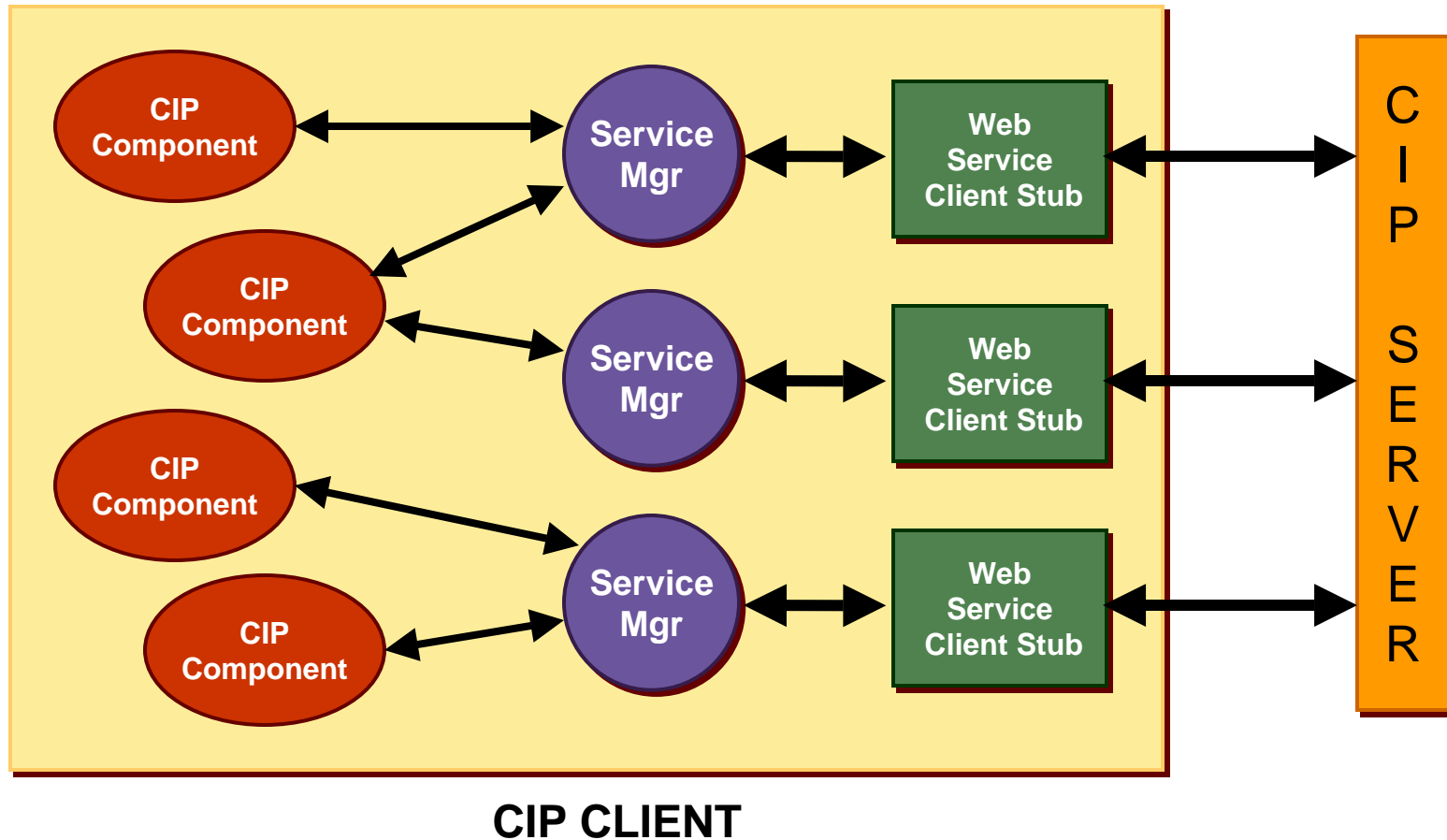
Three Tier Architecture

- Client
 - Java application (Swing)
- Middleware Server
 - Web services, Enterprise JavaBeans, Java Message Service
- Data Tier (Management & Acquisition)
 - Database (Oracle)
 - File monitor (Java application)
 - Data loader (Java application)

Architecture Overview

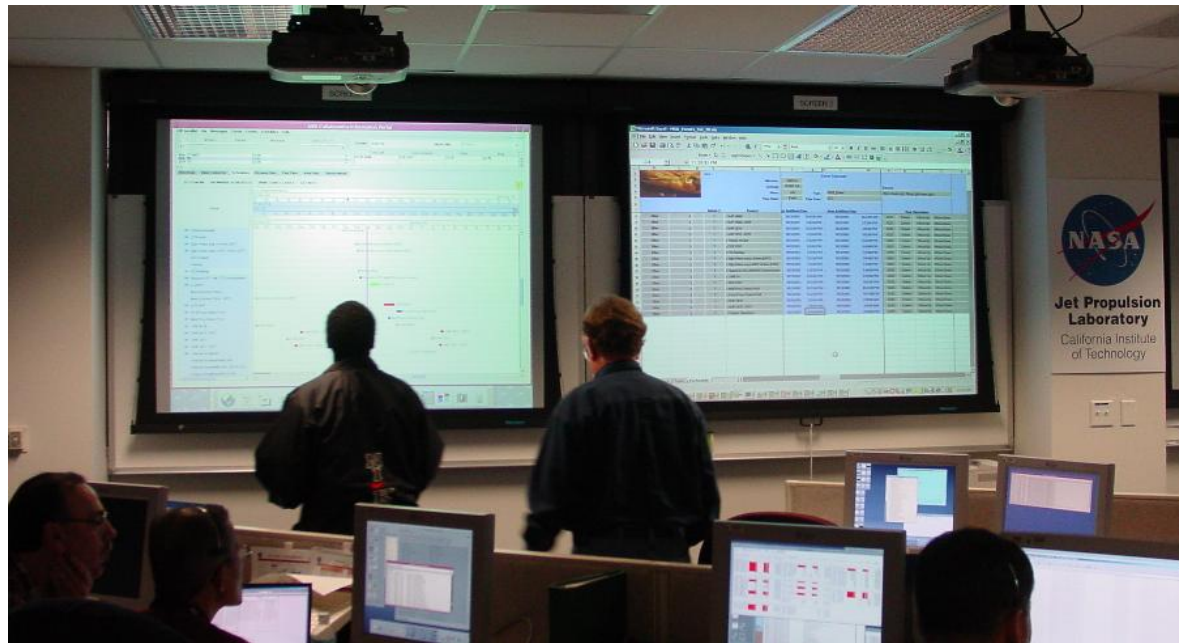


Client Architecture



CIP Middleware Services

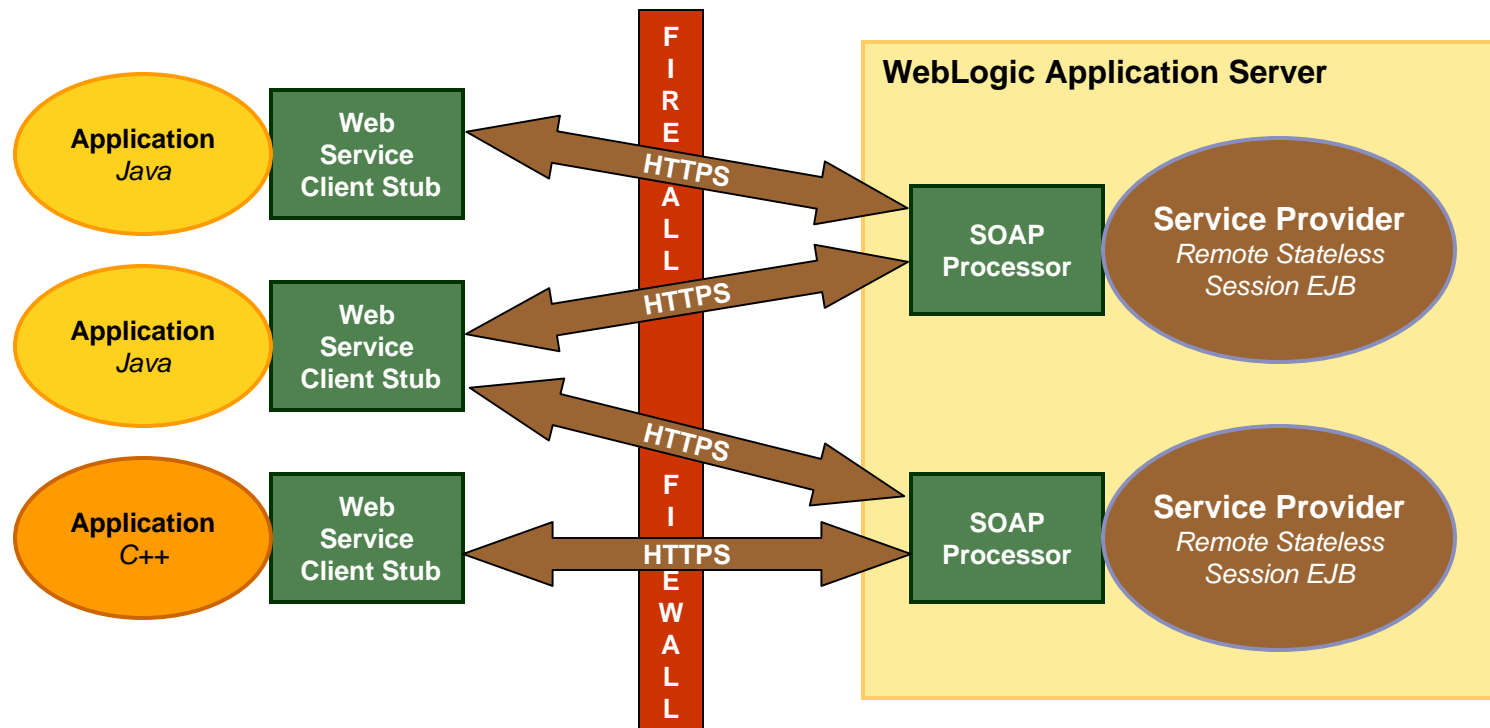
- User management
- Metadata
- Schedules
- Time
- File and directory
- Message



Middleware Technologies

- **Enterprise JavaBeans (EJBs)** to achieve reliability, scalability, security, platform independence, and standards.
- **Web Services** to expose the remote methods of the service provider EJBs.
- **Java Message Service (JMS)** for asynchronous messaging.

Middleware Architecture



- Web Services expose the remote methods of the Service Provider EJBs

- HTTPS encrypts the transmissions and gets them through the firewall

Databases

- Meta-Database
 - Hierarchical, relational view of the mission data based on activity
 - Descriptive information about elements in the hierarchy
 - Pointers to related data products
- Schedule Database
 - Events and personnel schedules
 - Enables querying of schedules and construction of “virtual schedules,” i.e., schedules created from elements of multiple schedules
- Message Archive
 - Holds the broadcast announcements

All CIP databases are implemented in Oracle 9i

Monitor and Loader

□ Monitor

- Monitors the data repositories to find out about new files
- Notifies Loader and Middleware
- Automated
- Event driven, not polled

□ Loader

- When notified of a new file, the Loader parses file metadata and loads it into the database
- Parses schedule files and loads schedule data into the database

Lessons Learned



Lessons Learned

- Specifications change during development
 - Be flexible
- Pre-deployment expectations are often wrong
 - Be highly configurable
- Take advantage of off-the-shelf software
 - Reliability and support are worth the inflexibility



Lessons Learned

- Include quality assurance as part of the development process
 - Plan for training, documentation
- Allow time for plenty of user interface testing and validation
 - Perception of accuracy
 - Security concerns



Lessons Learned

- The Collaborative Information Portal is a key component of the Mars Exploration Rovers mission
 - CIP is the mission's primary time management tool

- Prepare for success!
 - High volume
 - High visibility
 - Scope for nominal and optimal outcomes



Questions?



Useful URLs

- More about CIP
 - <http://ic.arc.nasa.gov/>

- General information on the Mars rovers
 - <http://marsprogram.jpl.nasa.gov/>
 - <http://marsrovers.jpl.nasa.gov/home/index.html>

- Daily press releases and downloaded images
 - <http://www.jpl.nasa.gov/mer2004/index.html>

- Download a Mars clock
 - <http://www.giss.nasa.gov/tools/mars24/>