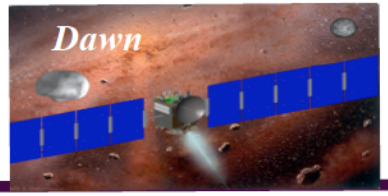
National Aeronautics and
Space Administration



AIAA SOSTC
Ops Workshop

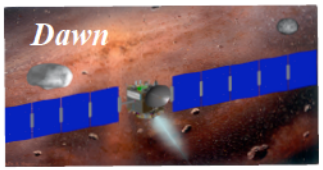
Meeting the Dawn Mission GDS Challenges Through Automation

Lydia Dubon

April 16, 2008

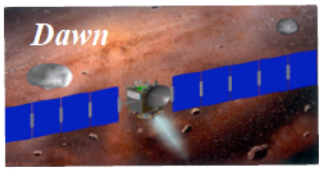
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Agenda



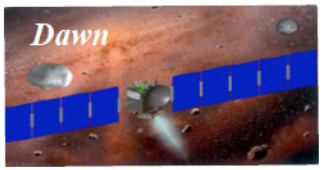
- Mission Overview
- Dawn Ground and Flight Software Interoperability Challenge
- Dawn Ground Data System Automation Highlights
  - Mission Information Control Flow
  - Command & Telemetry Database Translation
  - Flight Parameter Table Management
- Lessons Learned
- Conclusion

Dawn Mission Overview



- Funded by the NASA Discovery Program. It is the ninth Discovery project.
- **Principal Investigator:** Dr. Christopher T. Russell (UCLA)
- **Implementing Organizations**: JPL, Orbital Sciences Corporation (OSC), Deutsches Zentrum Für Luft-und Raumfart (DLR) & Max-Planck - Institut für Sonnensystemforschung (MPS), Agenzia Spaziale Italiana (ASI)
- **Instruments:** Framing Camera (DLR/MPS), Mapping Spectrometer (ASI), Gamma Ray and Neutron Detector (LANL), Gravity Science (JPL)
- **Science:** To significantly increase our understanding of the conditions and processes acting at the solar system's earliest epoch, by examining the geophysical properties of complementary bodies, Vesta and Ceres, using imaging, spectroscopy, and gravity measurements.
- **Milestones**: Launch September 27, 2007 (Delta 2925H); EOM - July 1, 2015
- **First to**: rendezvous with a main belt asteroid, and first mission to orbit two target bodies
- **Key distinction**: use of solar electric propulsion, implemented on Dawn as an ion propulsion system (IPS)

Dawn Mission Overview

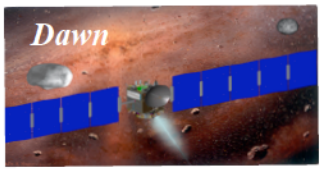


At each body, Dawn will:

- Compile a global color map
- Compile a topographic map
- Map the elemental composition
- Map the mineralogical composition
- Map the gravity field
- Search for moons

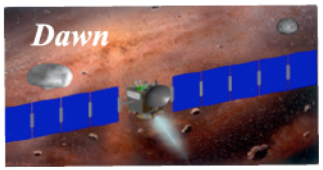
** Courtesy of Dawn Chief Engineer, Marc Rayman*

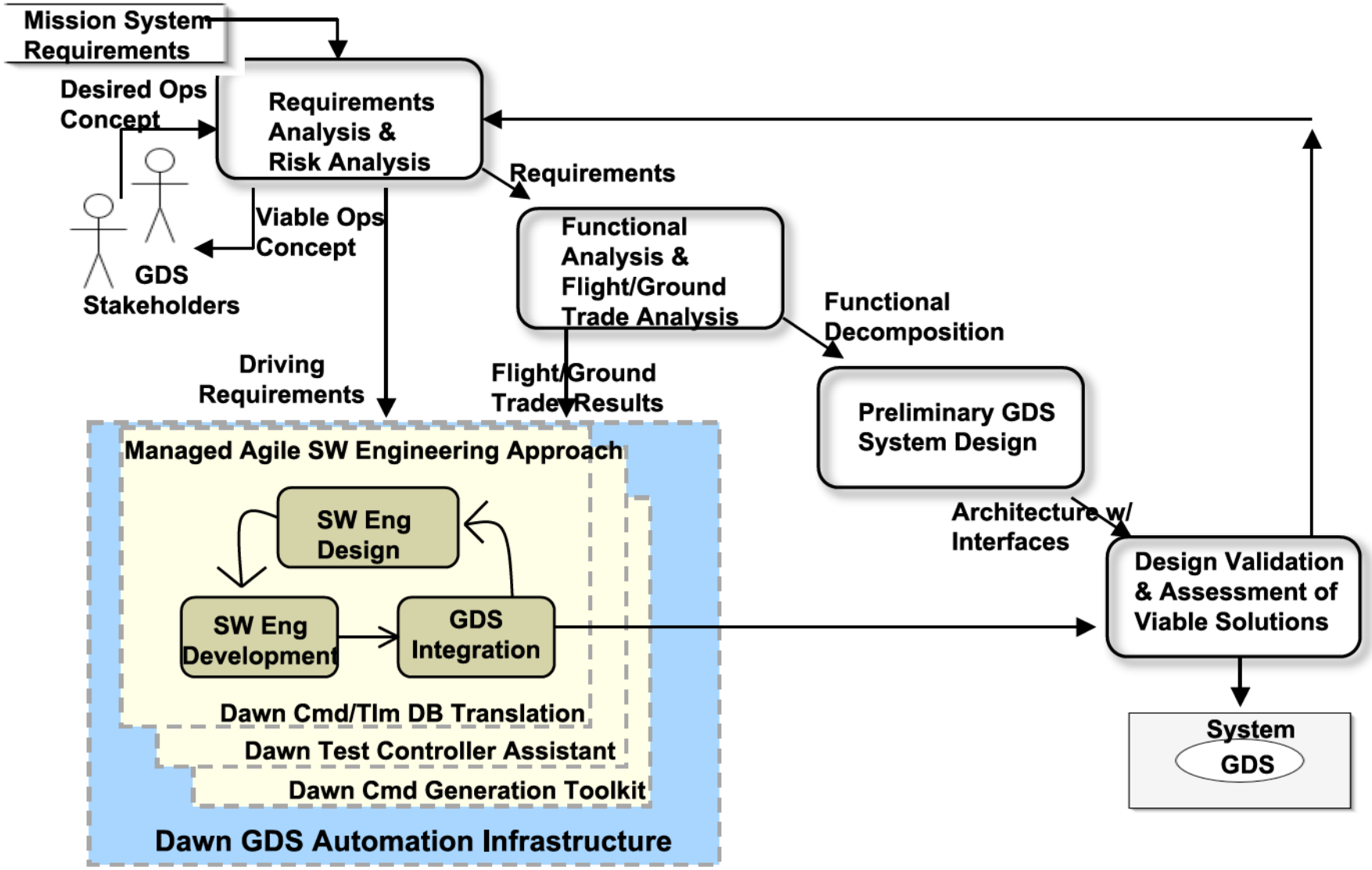
Dawn Ground and Flight Interoperability Challenge



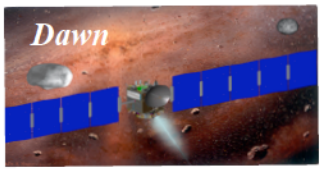
- Ground Data System (GDS) staffing began August 2003 with a focus on the Design Review (PDR) milestone December 2003.
- Soon after, the need to integrate the GDS with FSW in an OSC spacecraft simulator environment by April 2004 was brought to the table.
- An interface did not exist between JPL's ground system AMMOS (Advanced Multi-Mission Operations System) and OSC's flight system. OSC was to use its ground system for flight system I&T. However, AMMOS had been identified as and is the ground system in use for flight operations.
  - An interface did not exist at the time between the JPL and OSC ground systems. Thus the need to automate database translation was required to meet key project milestones.
- In addition, Dawn's ATLO and MOS V&V concurrent activities were geographically distributed: Orbital (Dulles, VA), Naval Research Lab (Washington DC), JPL (Pasadena, CA), and UCLA (Los Angeles, CA).
  - The distributed nature of the development phase in conjunction with limited resources due to budget constraints, was also a driver for GDS automation.

Overall Approach & Strategy to Meet Interoperability Challenge



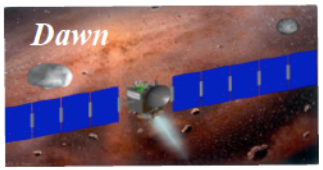


Dawn GDS Automation Infrastructure



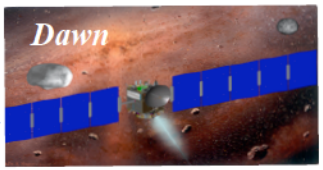
- In order to address GSW/FSW interoperability, Dawn GDS automation was implemented at two levels:
  - Automation of distributed data processing flow
    - Mission information control scripts utilize the Message Reactor capability provided by AMMOS's Distributed Object Manager (DOM).
    - The DOM ground subsystem provides missions with Java-based client software that interfaces with a multi-mission J2EE server, and uses Java Remote Method Invocation (RMI) for external, un-trusted client access.
    - DOM multi-mission servers provide the project data repositories
  - Automation of command, telemetry, and flight parameter database translation
    - Python scripts that implement the JPL/OSC database ICD, and interface with DOM Message Reactor service
    - Java-based flight table processing and web-posting from real-time downlink stream. Operates 24x7 lights-out, and ingests tables from all available sources: Test beds and spacecraft (includes both ATLO and ops)

Performance Requirements met through Automation



- The following performance requirements were met through automation. These were driven by the need to iterate through GSW/FSW I&T as the flight/ground interface evolved:
  - Translate and process command and telemetry databases within one hour of receipt from Orbital (Orbital publish of databases to DOM)
  - Uniformly deploy AMMOS equivalent command and telemetry configuration files to all venues (ATLO and two test beds at Orbital; 1 test bed at JPL; 1 MSA at JPL; 1 MSA at Orbital; Thermal Vac at NRL; and Science Operations Center at UCLA) within 5 minutes of database translation
  - Test/validate Virtual Machine Language command C structures within 24 hours of command database translation
  - Process flight tables from telemetry using new table schema within 24 hours of flight parameter database translation
  - Notify all database stakeholders within 5 minutes of new databases posted to DOM by Orbital

Automation of Cmd & Tlm DB Translation



OSC Flight Software

VML Flight C-strucs

JPL
NRL
OSC
UCLA

4 (tlm)

3

Distributed Object Manager (AMMOS)

C Strucs
VML CDL
ITAR CDL
CDL

Decomm Maps
Tlm Defs
Channel Tables
Channel Conversions
Alarms Event Msgs

JPL VMLCDL tool

2

OSC Cmd/Tlm Databases

Flight Tables

1

AMMOS Cmd/Tlm DB Products

OSC Database Translator

OSC Reformatted DB Files

Translated Output per OSC/JPL ICD

MySQL

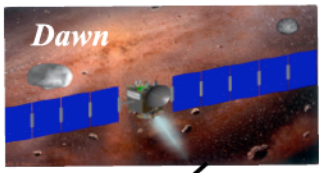
JPL Dawn Database Translation Tools (J. Wright)

XML

http://www

Event Driven Information Control Flow

Automation of Flight Table Processing



- Ingests flight tables from real-time downlink stream (extracts from packet data)
- Checks format against DB definition
- Generates XML and Bin representation and stages for on-line viewing and editing

Flight System Test Bed 1

Flight System Test Bed 2

OSC

Flight Table Manager
Lights out 24x7 JPL

LOGS

XML

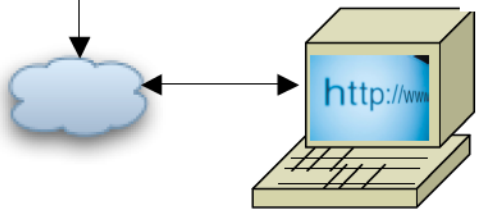
BIN

Deep Space Ops Center

Dawn Flight Tlm Servers

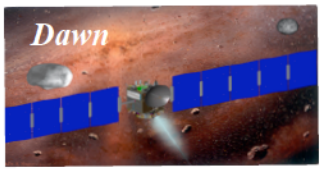
Flight System Test Bed 3

JPL



Dawn JPL Authenticated Users

Summary



- The Dawn GDS Automation effort was driven early on in the Dawn project life-cycle by the need to provide a proof of concept that the JPL ground system could be successfully integrated with the Orbital flight system within the allocated budget and schedule.
- Key to GSW/FSW integration in a heterogeneous ground system environment is a automated command and telemetry dictionary management software. The automation infrastructure must be able to support tactical database turnaround times.
- The Dawn GDS Automation infrastructure has been key in attaining consistent GDS installation and configuration in a distributed operational environment; and in providing JPL partners a venue for automated collaboration.

Key contributing Dawn GDS Team members: Jesse Wright (software architect), Eric Tauer (Information Management System Engineer), Magdy Bareh (Flight/Ground I&T expert), Dipak Achhnani (GDS I&T), and Kyran Owen-Mankovich (GDS Deployment Engineer).