

Multiple Views of Ground Data System
Based on Mars Reconnaissance Orbiter GDS

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Abstract

This paper presents one JPL systems engineer's approach to describe a complex ground data system (GDS) using multiple, concurrent architectural views.

The Mars Reconnaissance Orbiter (MRO) Ground Data System is the integrated set of ground software, hardware, facilities and networks that support mission operation. GDS supports all phases of the mission including development, test, and operations. MRO GDS is based upon the JPL Mission Management Office/Interplanetary Network Directorate Multi-Mission GDS, and incorporates significant inheritance from Mars 2001 Odyssey project.

Multiple architecture views are standard tools of building architects, and gaining acceptance in software architecture. Refer to "Architectural Blueprint – The 4+1 View Model of Software Architecture" by Philippe Kruchten, IEEE Software 12 (6), November 1995, pp. 42-50. As he points out, multiple views allow a presenter to address separately the concerns of the various "stakeholders": end-user, developers, system engineers, project managers, etc.. Since the adaptation of multi-mission GDS requires effort from hardware engineers, software engineers, network engineers, standards engineers, and their managers, the multiple view method of presenting the architecture was adopted and revised to address system issues.

Selection of views is based on the need to communicate to specific user groups. Philippe Kruchten selected the views presented in his article based on the needs of software architecture. The presentation of MRO GDS addressed system architecture and hence a different set of views was required. For the views selected, there were no accepted notational standards in the industry. The following describes the selected views:

- a. *Geographic Site View* helped to communicate the scope of MRO GDS to all users, and defined the global communication needs;
- b. *The Layered CCSDS Communication Architecture View* helped end-to-end system engineers and CCSDS standard engineers;
- c. *Architectures by Mission Phases View* defined the chronology of system construction, and depicted the significant test bed effort for management and test engineers;
- d. *The Operations Processes versus Tools View* communicated the area of changes to the mission operation engineers;
- e. *Decomposition into Configuration Items View* became a blueprint for development engineers, and configuration control engineers;
- f. *Network Architecture View* presented a summary for the network engineers and hardware engineers; and
- g. *Software Architecture View* defined the interconnection of software components and interfaces to the software engineers and interface designers.

The multiple GDS views were presented during the MRO Preliminary Design Review and multiple view approach to presenting system architecture gained general acceptance. Mission scientists commented that for the first time they understood GDS. Future missions will use similar approach for architecture design.

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Architectural Views

- Geographic Site Overview
- MOS/GDS Processes and Tools
- Architectures by Mission Phase
- Software Architecture and Interfaces
- Network Architecture

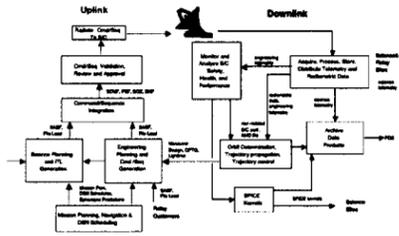
Geographic Site Overview

Geographic Site Overview depicts MRO GDS Locations

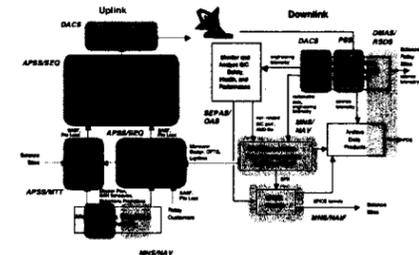
- Yellow: MRO Management and Launch Sites
- Gray: MRO Science Sites
- Blue: Deep Space Communication Complexes



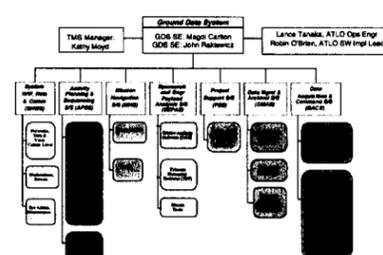
MOS/GDS Nominal Process Flow



Allocation to MOS/GDS Subsystems



GDS Subsystems

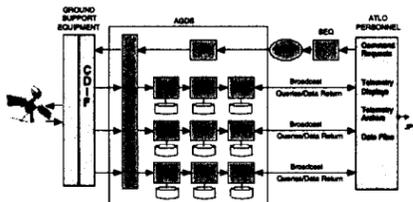


Architectures by Mission Phase:

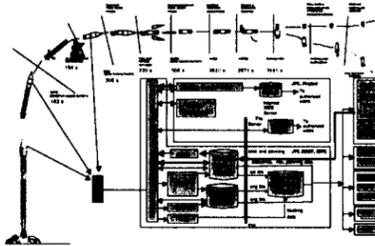
Pre-Launch, Launch, Post Launch

The first diagram is the Assembly, Test, and Launch Operations (ATLO) used during pre-launch. The second diagram is the launch architecture. This is a unique configuration because GDS received telemetry data from the launch vehicle. The third diagram is the full GDS, purple represents multi-mission capabilities and green refers to MRO-specific functions.

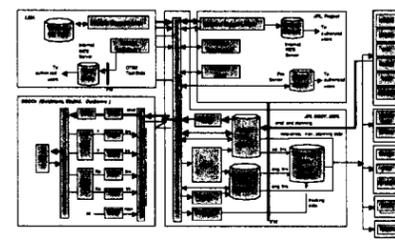
ATLO Architecture



Launch Architecture

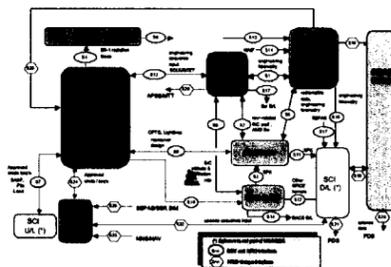


Post-Launch Architecture



Software Architecture and Interfaces

The first diagram shows the major GDS software components and the interface among them. The second diagram is a sample from the interface dictionary. Data flow numbers from the first diagram are mapped to the name of the interface agreements.



ID	From	To	Direction	Frequency	Rate	Notes
1	AGDS	SEPAS	Outgoing	1000 Hz	1000000000	SEPAS Data
2	SEPAS	AGDS	Incoming	1000 Hz	1000000000	SEPAS Data
3	AGDS	DMCS	Outgoing	1000 Hz	1000000000	DMCS Data
4	DMCS	AGDS	Incoming	1000 Hz	1000000000	DMCS Data
5	AGDS	SEPAS	Outgoing	1000 Hz	1000000000	SEPAS Data
6	SEPAS	AGDS	Incoming	1000 Hz	1000000000	SEPAS Data
7	AGDS	DMCS	Outgoing	1000 Hz	1000000000	DMCS Data
8	DMCS	AGDS	Incoming	1000 Hz	1000000000	DMCS Data
9	AGDS	SEPAS	Outgoing	1000 Hz	1000000000	SEPAS Data
10	SEPAS	AGDS	Incoming	1000 Hz	1000000000	SEPAS Data

