

SpaceOps2004

Multiple Views of Ground Data Systems

Based on Mars Reconnaissance Orbiter's GDS

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JPL

Topics

- What is MRO GDS?
- Challenges in developing MRO GDS
- Why multiple views?
- Multiple Views
- Issues Related to Views Selected

What is MRO GDS?

- Mars Reconnaissance Orbiter (MRO) GDS is the integrated set of ground software, hardware, facilities and networks that support mission operations
- GDS support all phases of the mission including development, test, and operations
- MRO GDS is based on JPL's multi-mission GDS, and incorporates inheritance from the Mars 2001 Odyssey project

Challenges in developing MRO GDS

- Multi-mission system, adopted for every mission
- Large, over 4 millions lines of source code
- Adaptation is non trivial from both complexity and size point of view
- Size of adaptation is 30 work years of effort, procurement is over a million dollars
- System is highly distributed, includes partners from several institutions, companies and countries

Why multiple views?

- Large number of people from different disciplines contribute to the work and need to understand the GDS development effort
 - System engineers
 - Operations Engineers
 - Network Engineers
 - Software Engineers
 - Communication Engineers
 - Managers
 - Scientists

Multiple Views

- **Geographic Site View**
 - Communicates the scope of MRO GDS to all users and defines the global communication needs
- **Operational Processes versus Tools view**
 - Communicates the areas of changes to mission operations engineers
- **Decompositions into Configurations Items**
 - Became the blueprint for development and configuration control engineers
- **Architectures by Mission Phases View**
 - Defines the chronology of the system construction, and depicts the significant test bed effort addressing the need of operations and test engineers
- **Software Architecture View**
 - Defines the interconnection of software components; this is useful for the software and test engineers
- **Network Architecture View**
 - Presents a summary for the network and hardware engineers

GDS Architectural Views

Geographic
Overview

Operational
Processes
and
Tools

Software and
Hardware
Configuration
Items View

Architectures
by
Mission Phase:
Pre-Launch,
Launch,
Post Launch

Software
Architecture
and Interfaces

Network
Architecture

GDS Architectural Views

Geographic
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Operational
Processes
and
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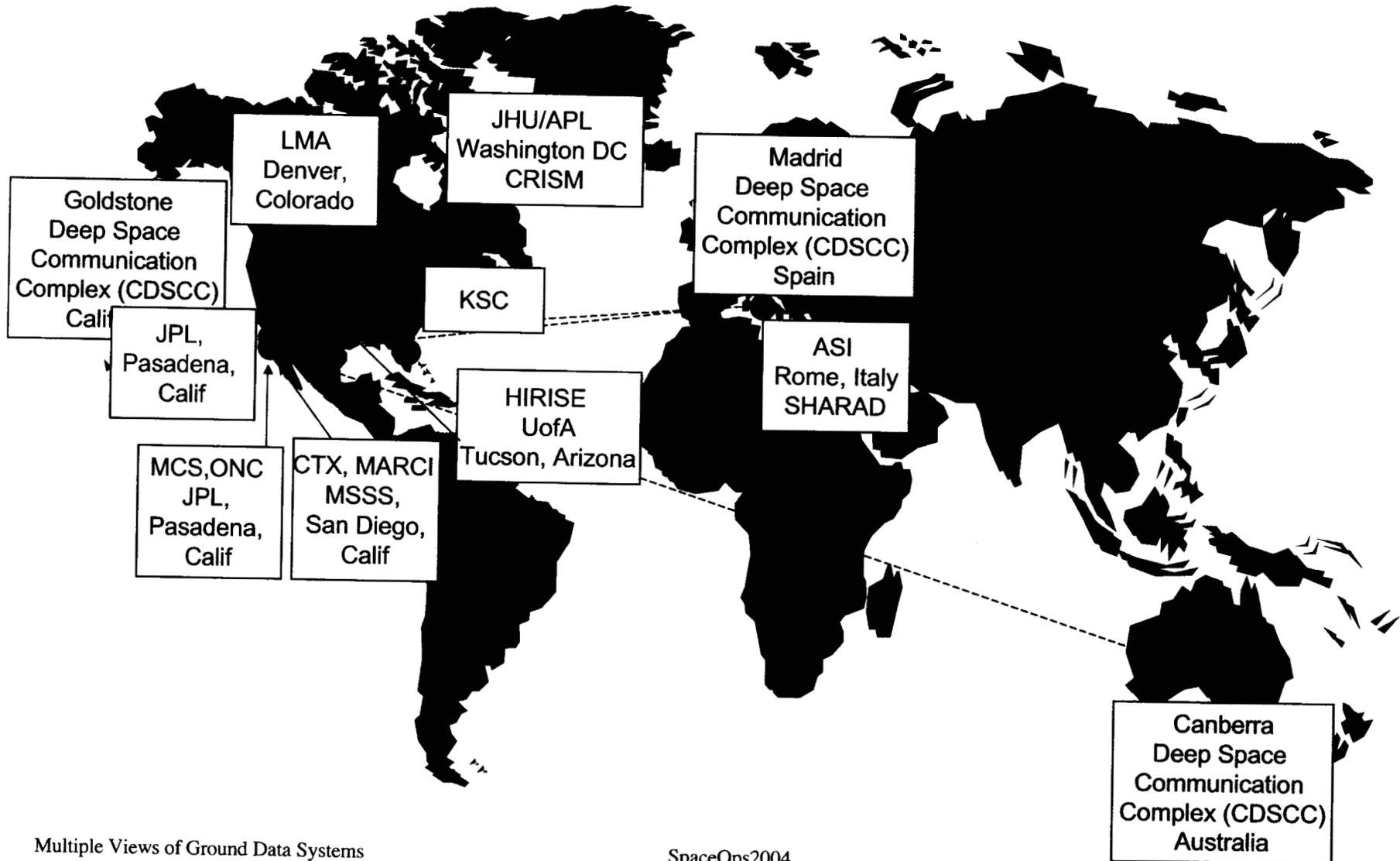
Software and
Hardware
Configuration
Items View

Architectures
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Mission Phase:
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Geographic Site Overview



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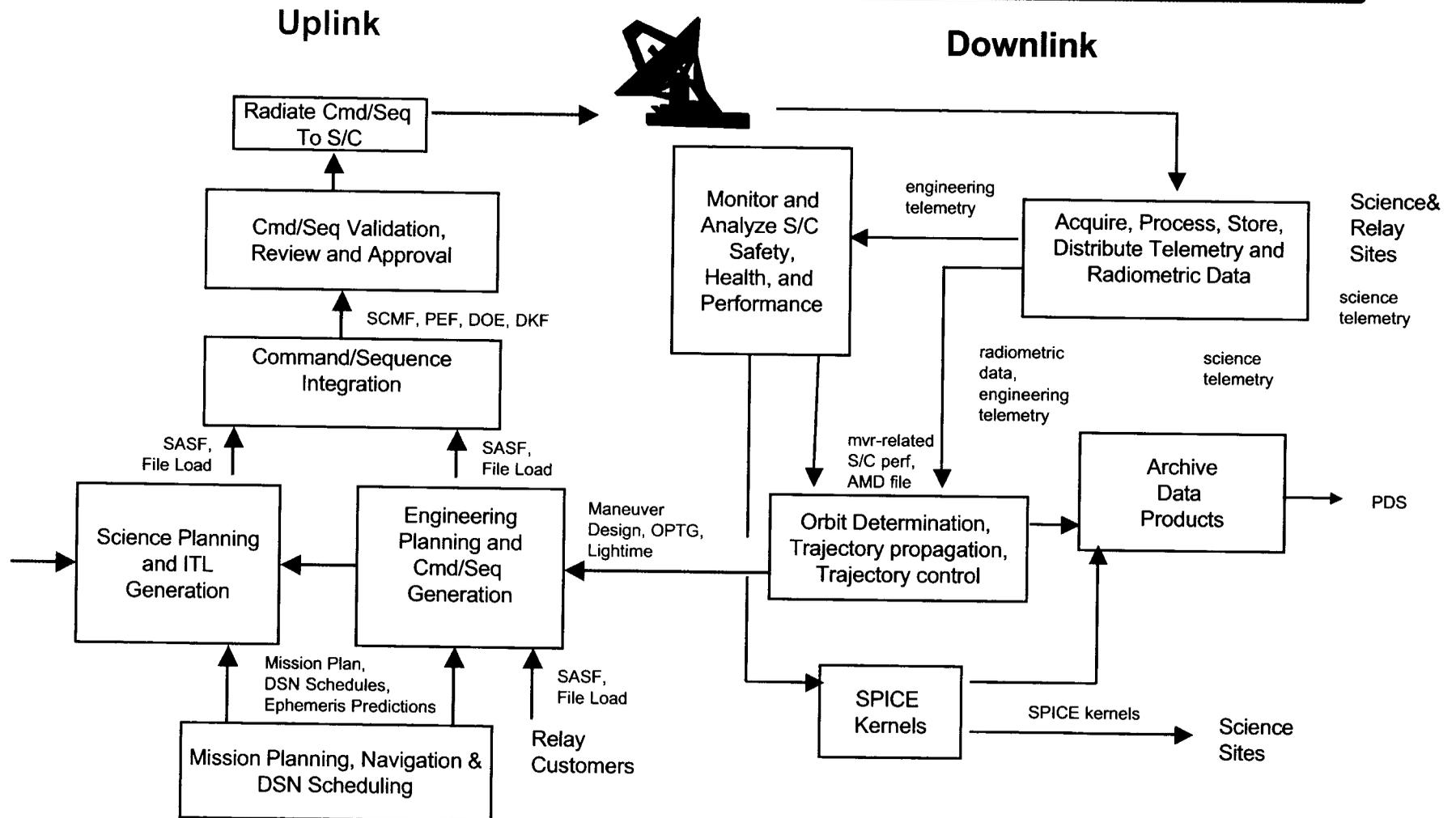
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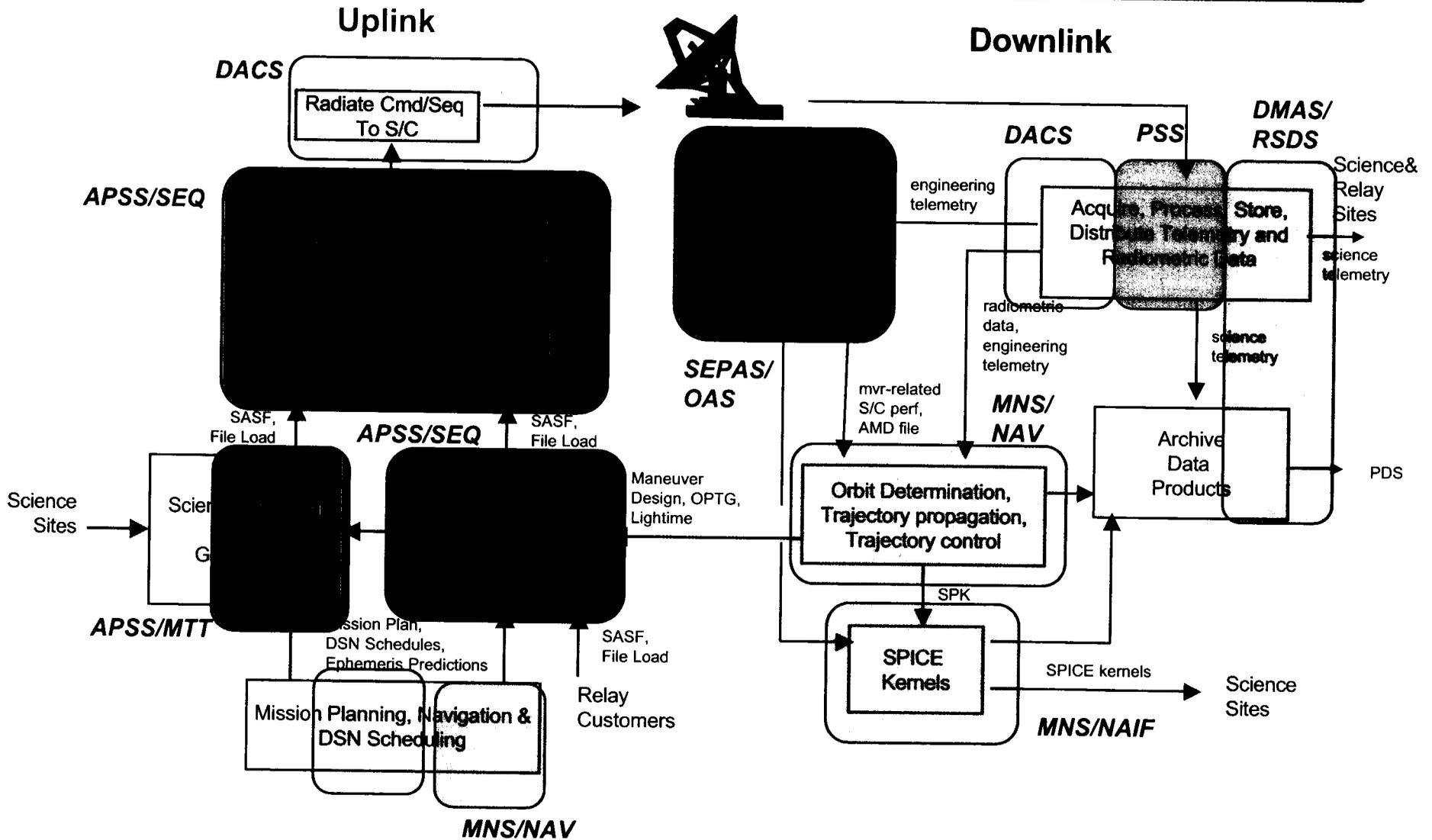
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Network
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MOS/GDS Nominal Process Flow



Allocation to MOS/GDS Subsystems



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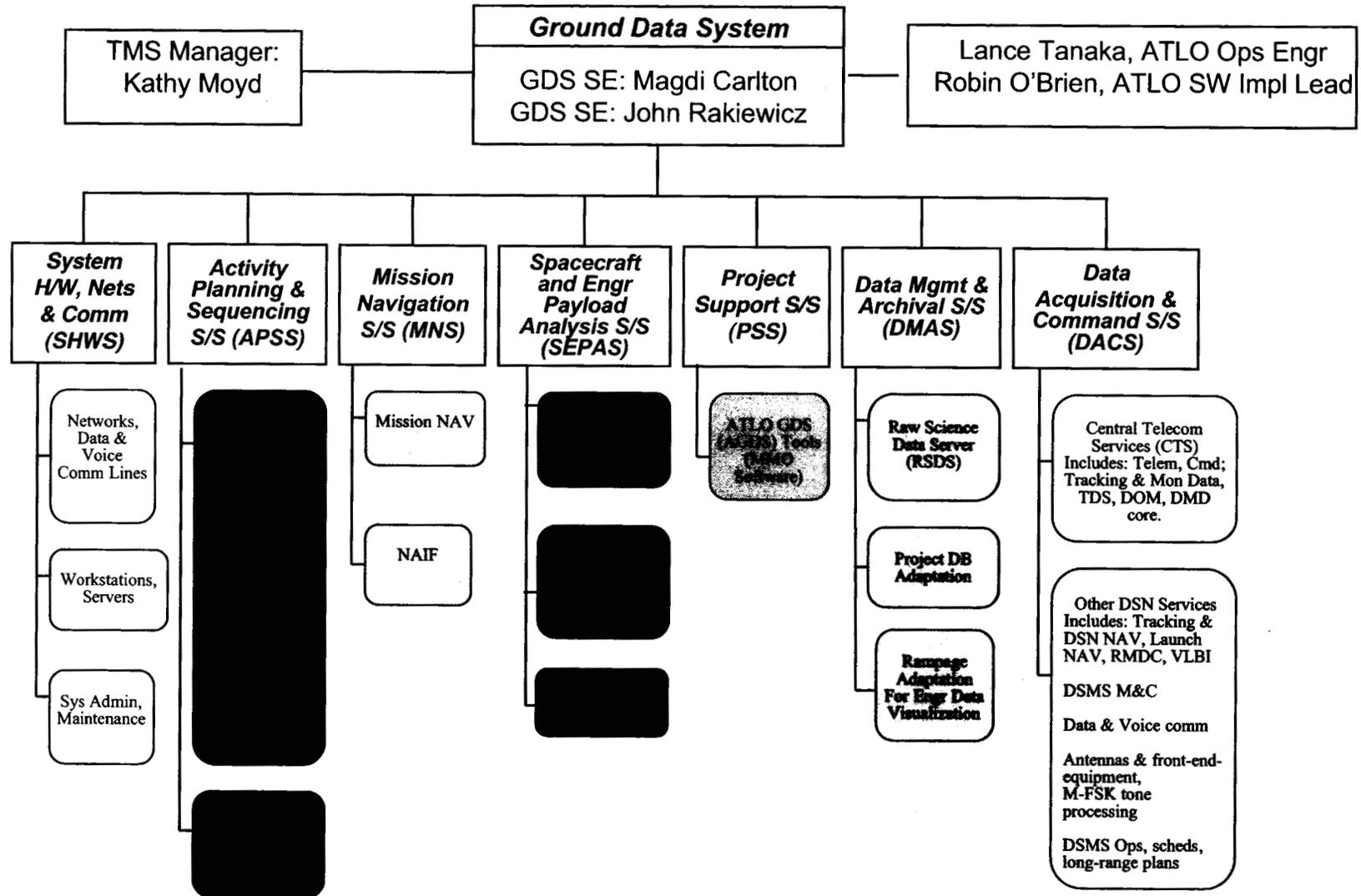
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GDS Subsystems



GDS Architectural Views

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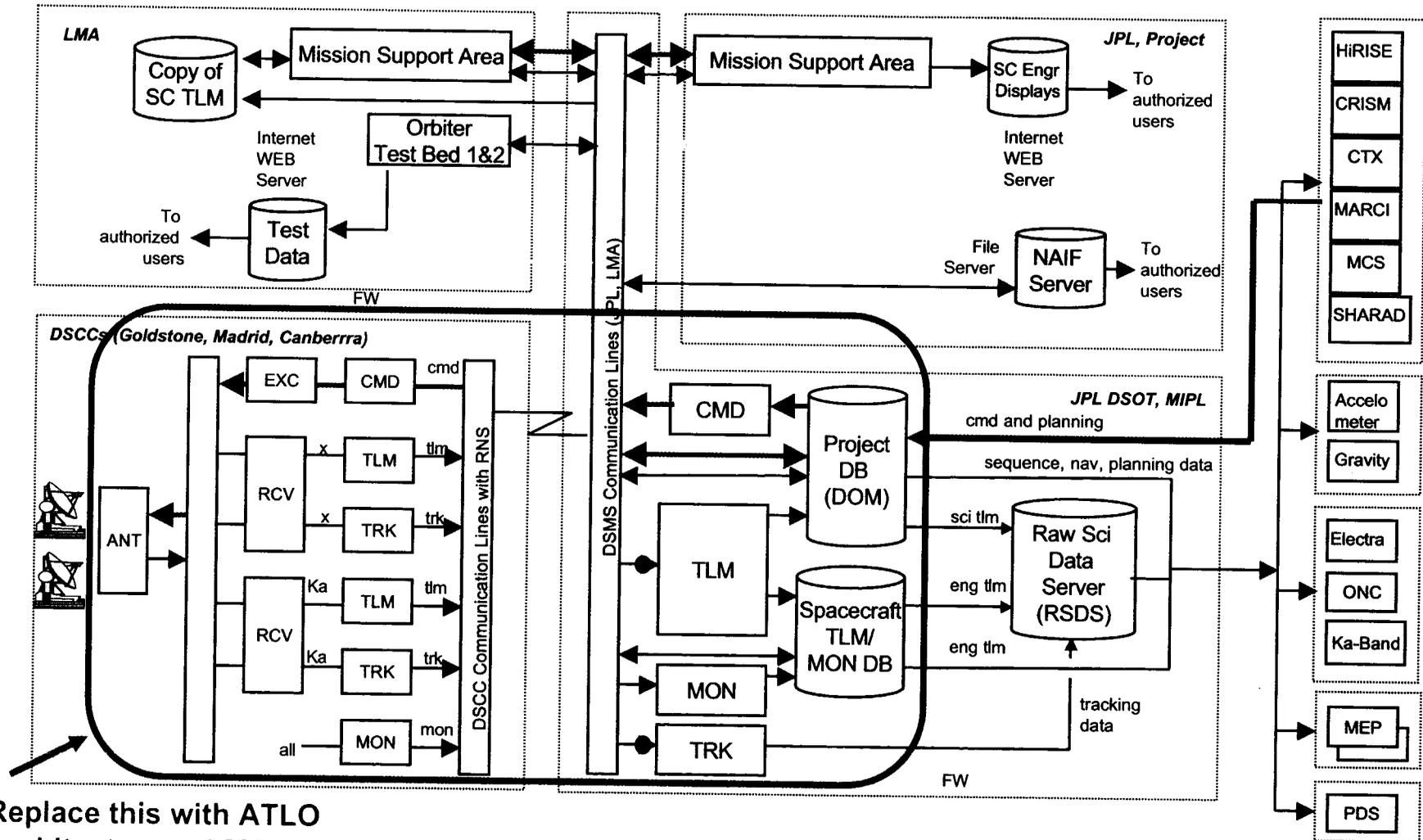
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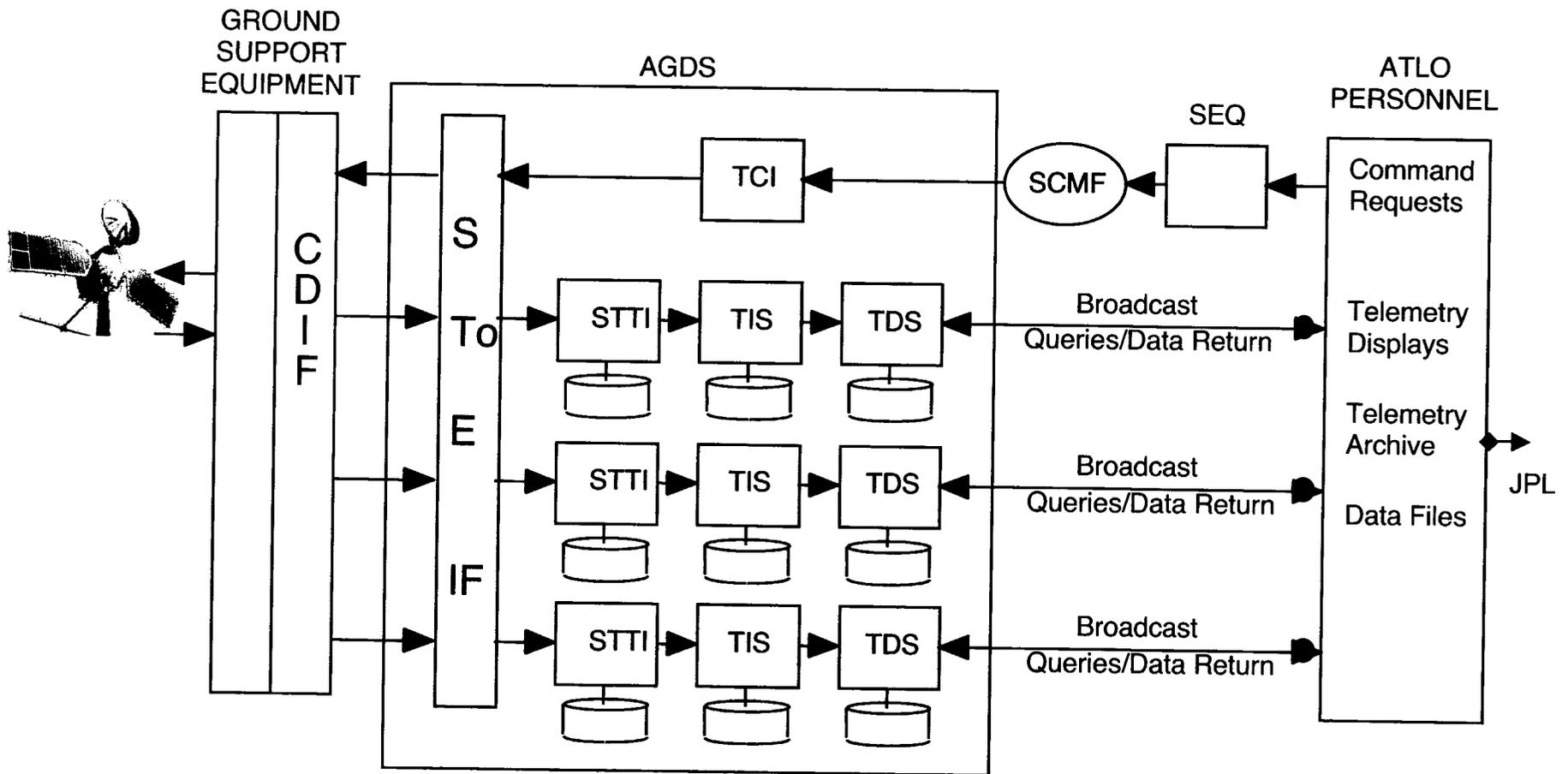
Network
Architecture

ATLO Architecture at LMA (1)

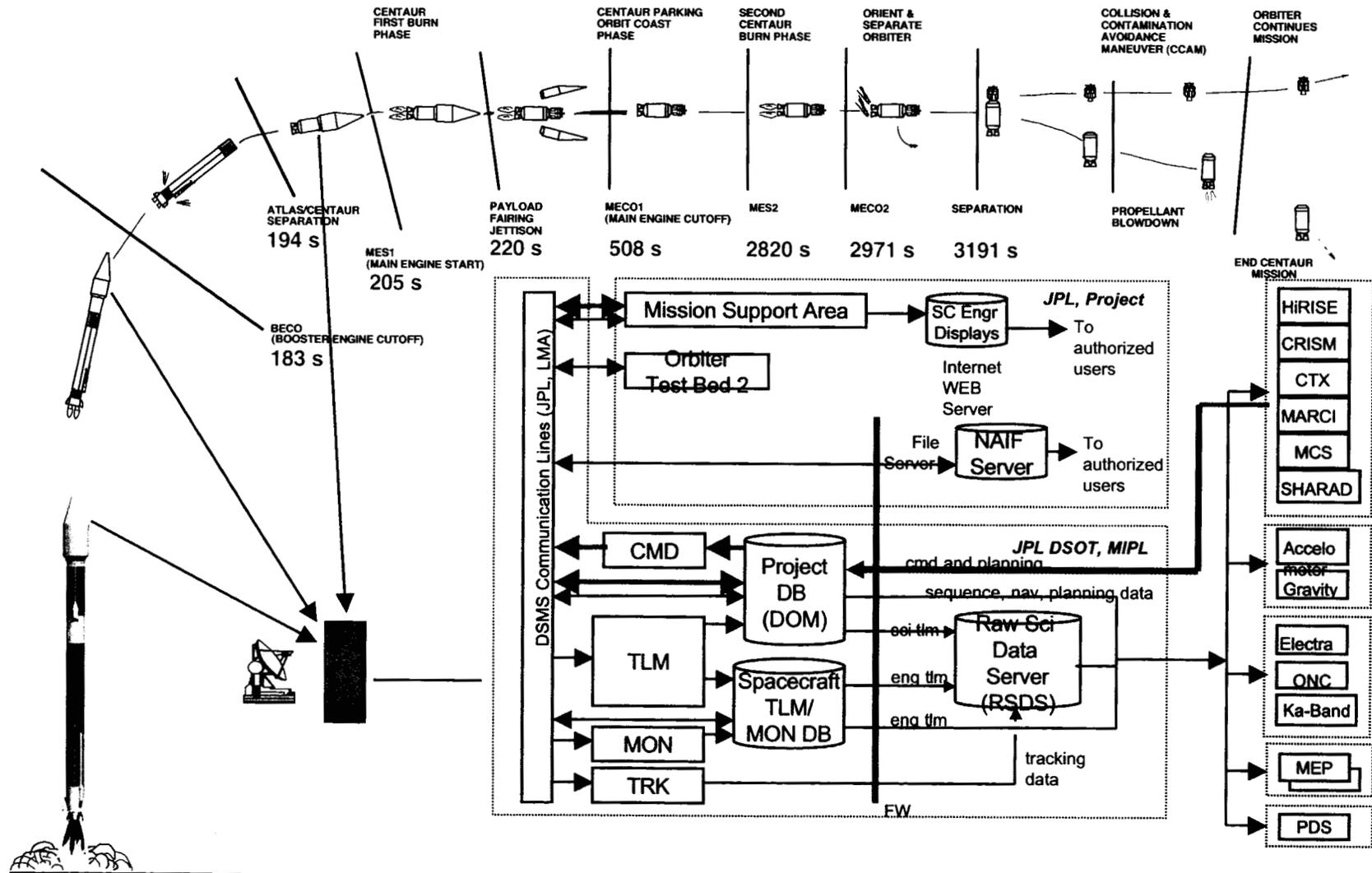


Replace this with ATLO Architecture at LMA

ATLO Architecture at LMA (2)

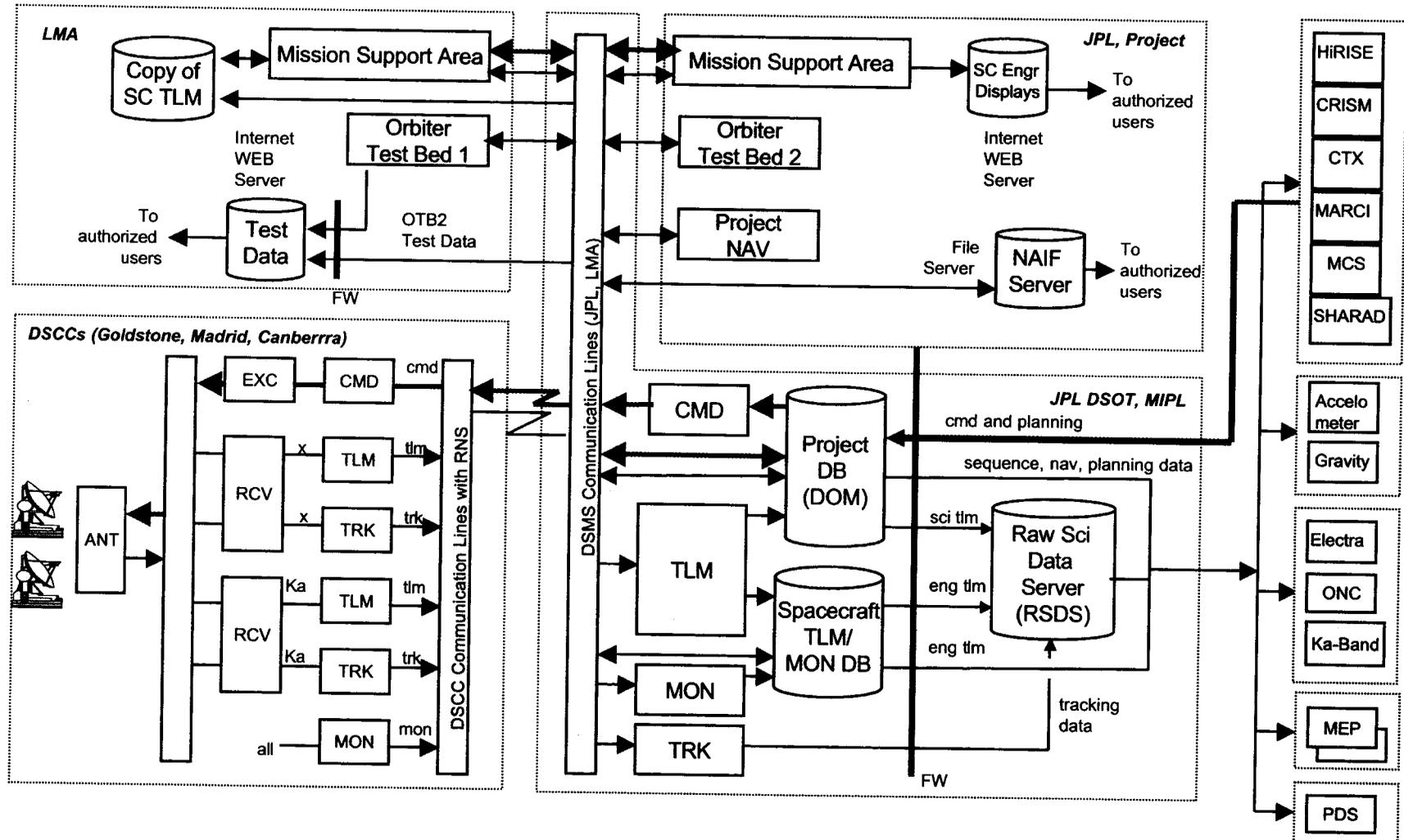


Launch Architecture



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Multiple Views of Ground Data Systems

Post-Launch Architecture



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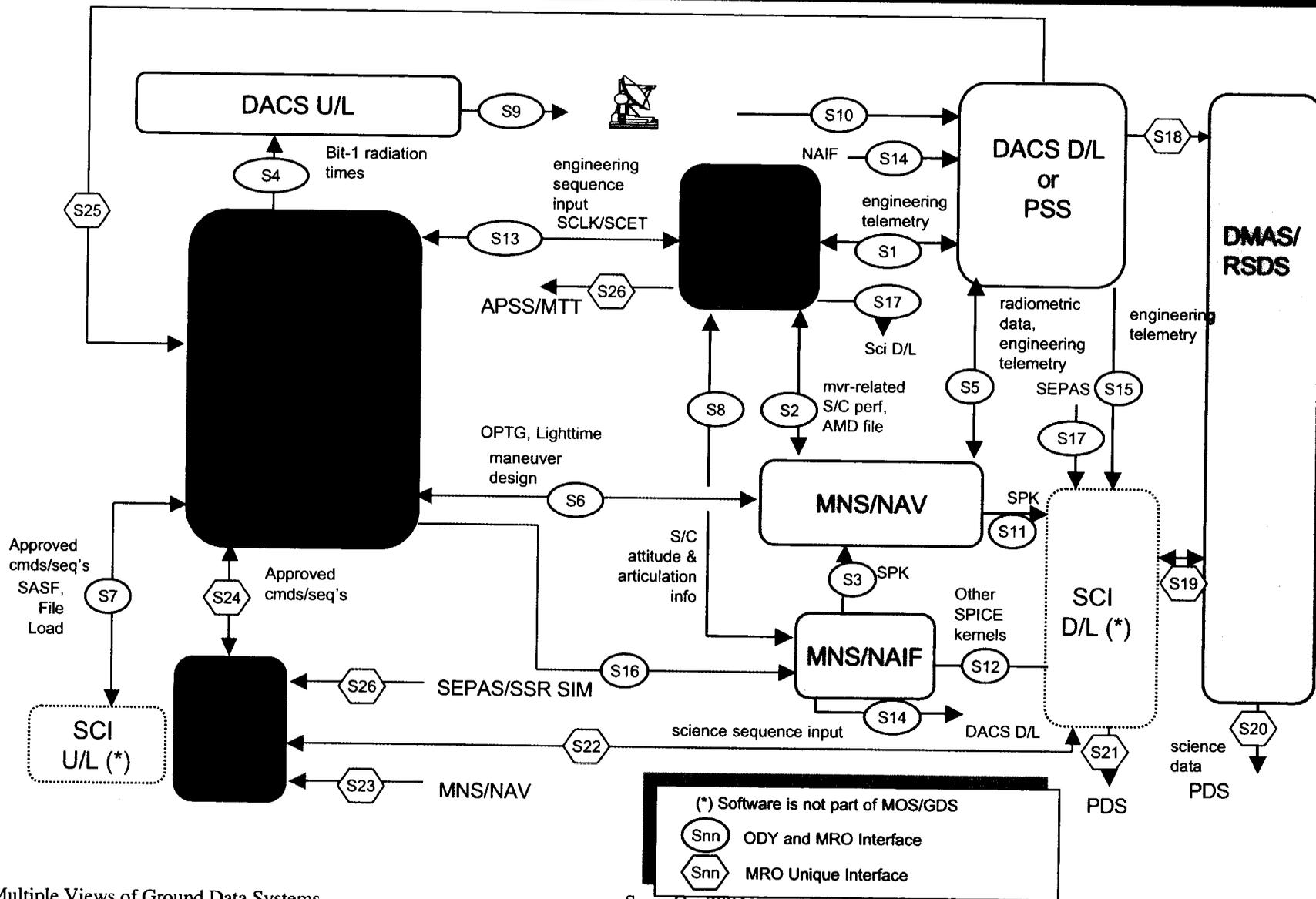
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MRO GDS Software Architecture



SISs by Data Flow Number

Data Flow Number	Odyssey		MRO		SIS ID	Description	Acronym
	Producer	Consumer	Producer	Consumer			
S01	DAE	SOE	DACS D/L	SEPAS/OAS	DSN002	DSN Viewperiod File	VP
					SEQ009	Spacecraft Command Message File	SCMF
					TLM001	Expanded Channelized Data	ECDR
					TLM017	MRO TLM SFDUs	
S01	SOE	DAE	SEPAS/OAS	DACS D/L	MIS001	Spacecraft Clock Coefficient File	
					TLM003	Decommuration Map	
S02	NAE	SOE	MNS/NAV	SEPAS/OAS	NAF001	SPICE Ephemeris Kernel	SPK
					NAV001	Orbit Propagation and Timing Geometry File	OPTG
					NAV003	Light Time File	LTF
					NAV009	Maneuver Profile File	MPF
S02	SOE	NAE	SEPAS/OAS	MNS/NAV	NAV011	Maneuver Performance Data File	MPDF
					NAV013	Maneuver Implementation File	MIF
					NAV016	Small Forces Data File (for ODY)	
S03	NAE	AIE	MNS/NAV	MNS/NAIF	NAV004	Spacecraft Ephemeris File and Planetary Ephemeris File	P-File
					NAV007	Planetary Ephemeris File	
					NAV018	Small Forces File	SFF
S03	AIE	NAE	MNS/NAIF	MNS/NAV	NAF004	SPICE Orientation Kernel (aka C-Matrix Kernel)	CK
					NAF006	SPICE Leapseconds Kernel	LSK
					NAF007	SPICE Spacecraft Clock Kernel	SCLK
					NAV018	Small Forces File?	

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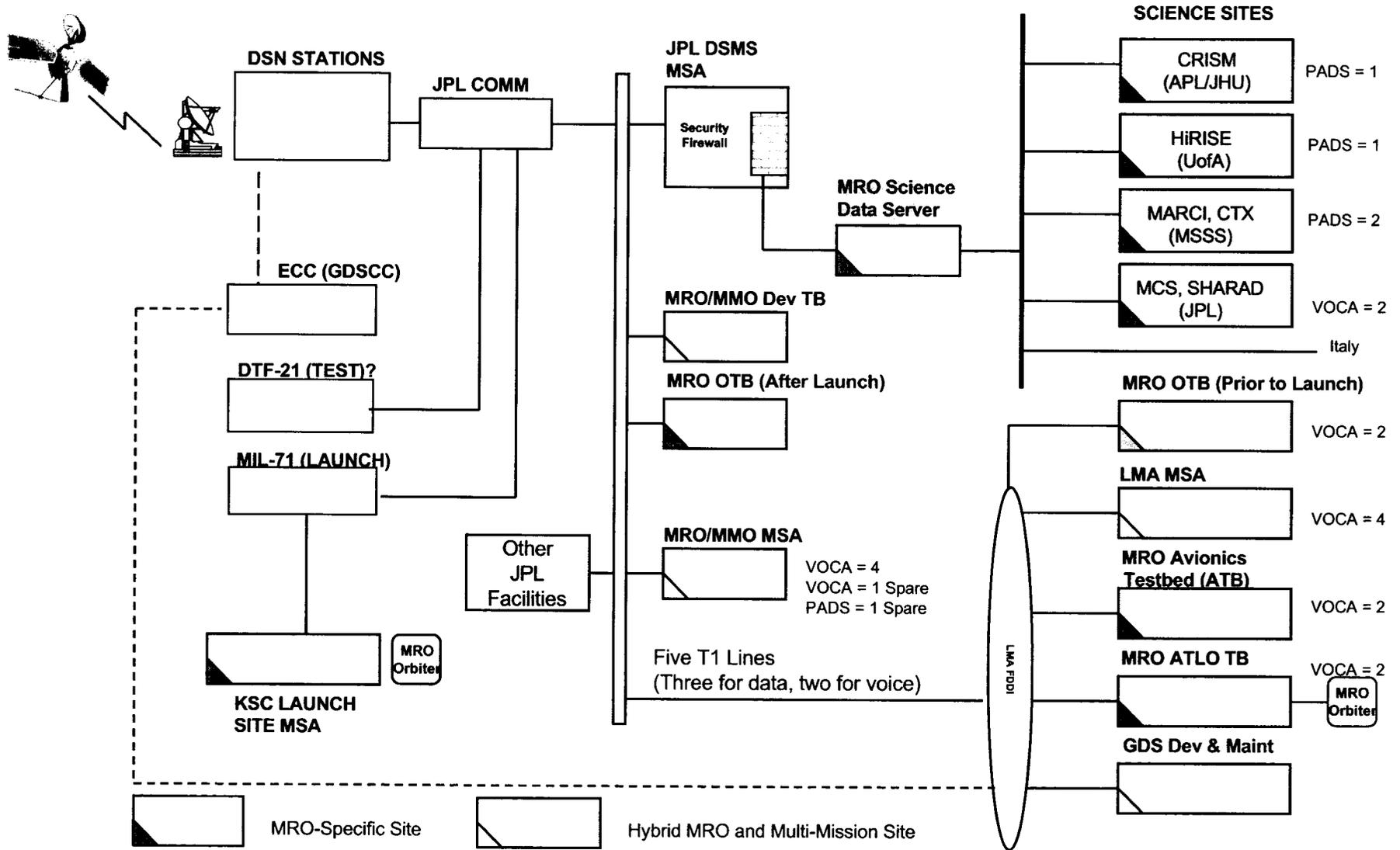
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MRO GDS Network Architecture



Issues Related to Views Selected

- **Communication**
 - These multiple views of MRO GDS were presented during the MRO Preliminary Design Review and mission scientists commented that for the first time they understood GDS
 - The multiple view approach to presenting system architecture has gained general acceptance
 - Future missions at JPL will use a similar approach for architecture design
- **Lack of diagrammatic standards**
 - Kruchten's 4+1 View Model is good for software, needs adaptation for system