

LDCM Ground System Update

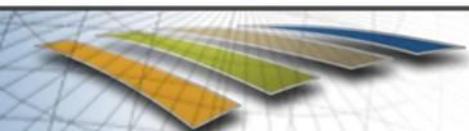
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U.S. Geological Survey – Project Scientist, LDCM Ground System

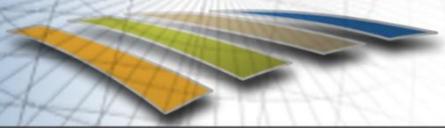
December 13, 2012

L A N D S A T

Data Continuity Mission



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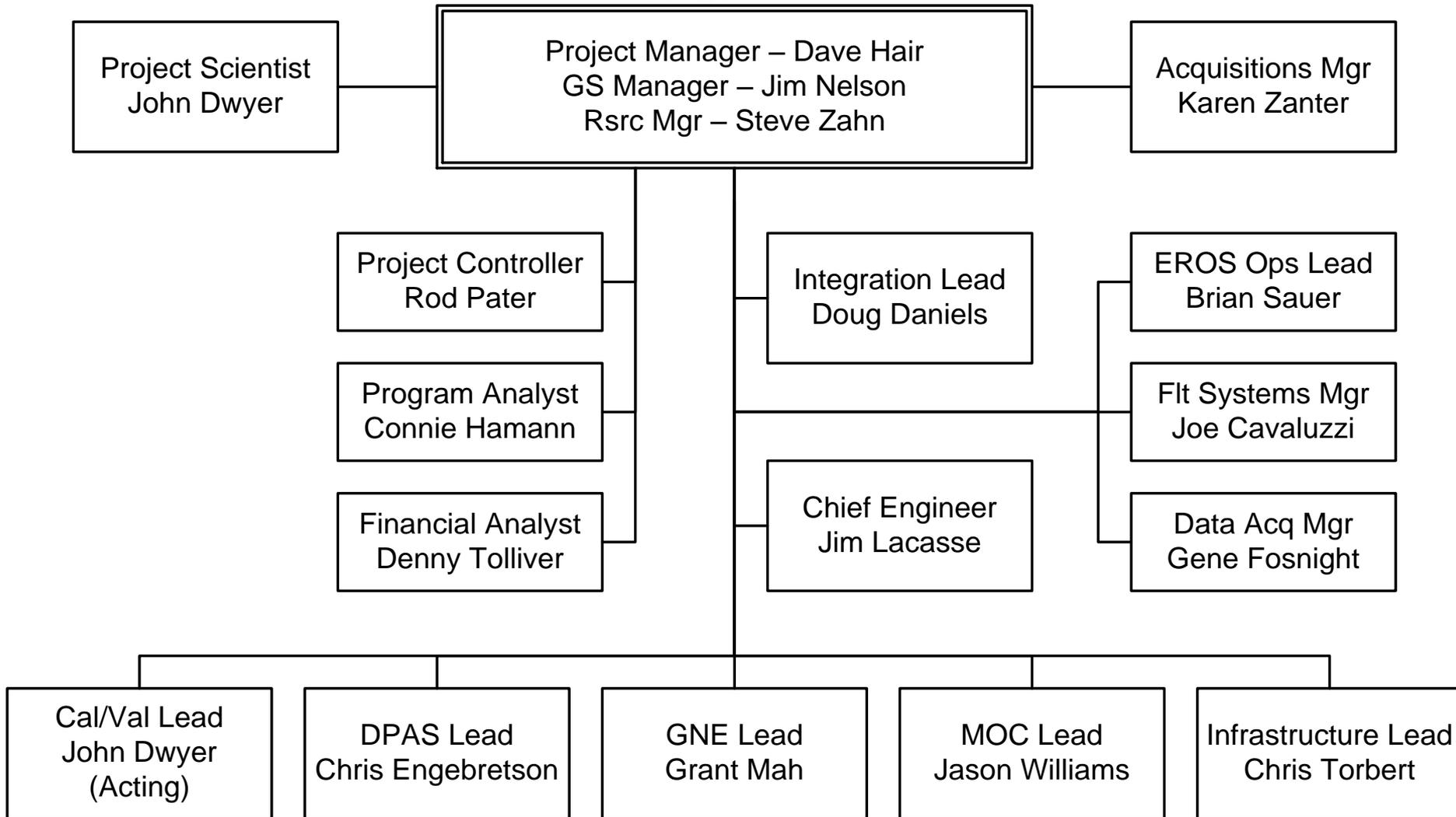
Agenda

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- ◆ USGS and GS/Ops Organization
- ◆ GS Operational Architecture
- ◆ GS Development Approach
- ◆ GS Development Progress
- ◆ GS Operations Milestones
- ◆ GS Schedule
- ◆ Mission Operations Progress

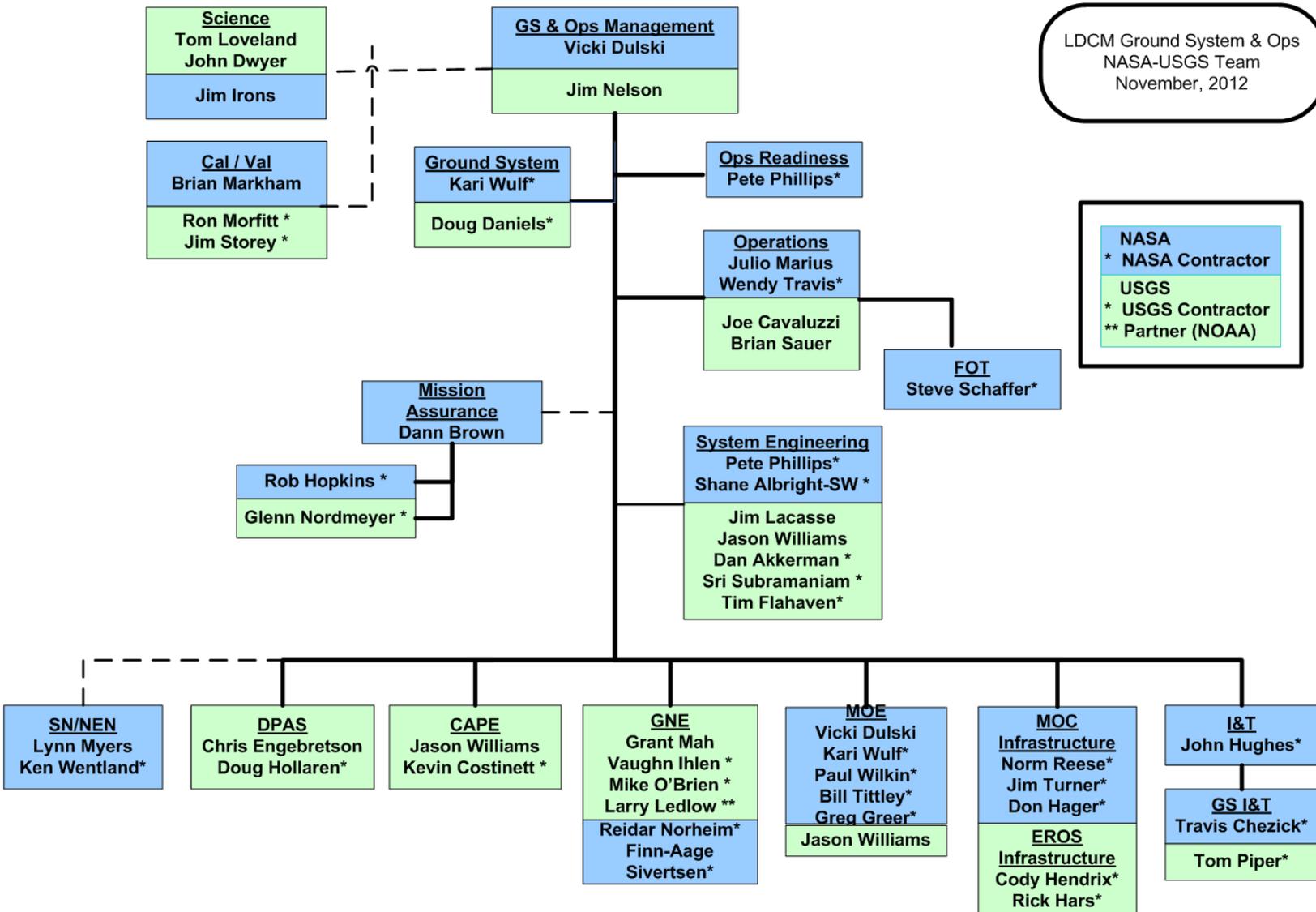
USGS LDCM Project Organization

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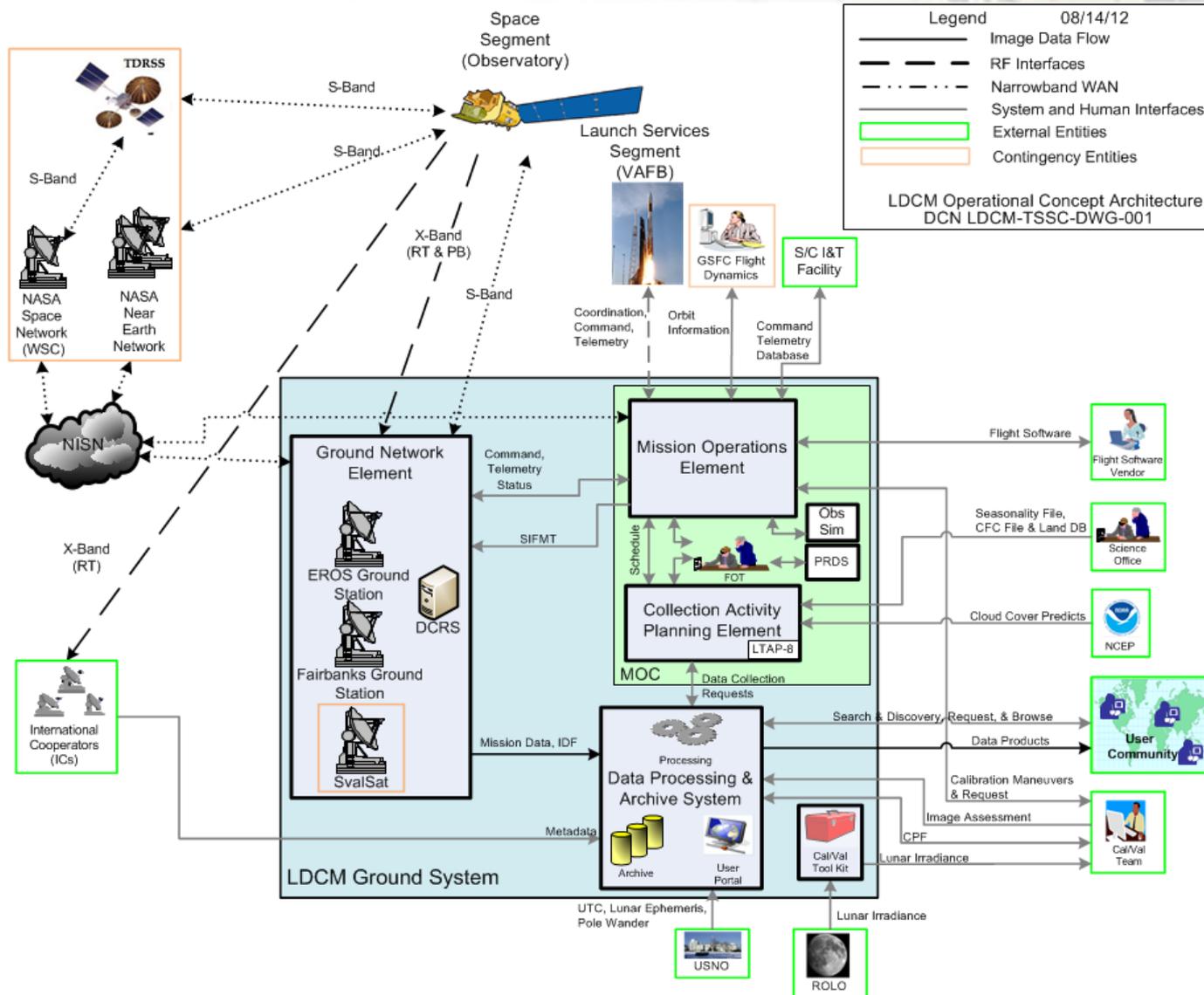
NASA – USGS Integrated Team

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GS Operational Architecture

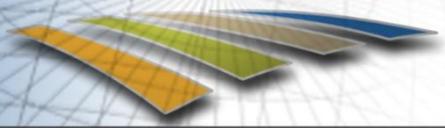
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Ground System Development Approach

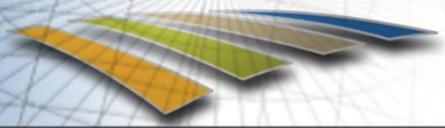
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Element	Capability	Agency / Developer	Approach	Current Software Build	Pending Deliveries
Mission Ops Center	<ul style="list-style-type: none"> •Serves as control center for mission operations performed by the FOT •Hosts the MOE, CAPE, and other operations tools 	NASA / MOMS	Minor mods to HSM MOC, GSFC B3/14	N/A	N/A
Mission Ops Element	<ul style="list-style-type: none"> •Performs command encryption and commanding, RT telemetry monitoring, mission planning and scheduling, monitoring and analysis, flight dynamics, and onboard memory management and mission data accounting 	NASA / The Hammers Co., Inc.	COTS customization	MOE 5.0.4	MOE 5.0.5 (MRT2 Patches if needed), MOE 6.0 (Post launch)
Collection Activity Planning Element	<ul style="list-style-type: none"> •Generates instrument image collection schedules based on science priorities 	USGS / SGT	GOTS customization	CAPE 3.1	CAPE 3.2 (Post launch)
Ground Network Element	<ul style="list-style-type: none"> •Performs S-band communication for S/C commanding and HK telemetry receipt •Receives S/C mission data via X-band •Routes HK telemetry to MOC and mission data to the DPAS 	USGS / SGT, NOAA, KSAT	Modification of existing stations	GNE 5.0 (Includes redesigned DCRS 3.0)	None
Data Processing and Archive System	<ul style="list-style-type: none"> •Performs mission data ingest, product generation, and image assessment •Provides storage and archive services •Provides web interface for data discovery, product selection and ordering, and product distribution 	USGS / SGT	Customization of heritage systems	DPAS 4.1	DPAS 5.0 (Post launch)
NASA institutional services (SN, NEN, NISN, FDF)	<ul style="list-style-type: none"> •Performs S-band communication for S/C commanding and HK telemetry receipt •Provides network connectivity across GS •Supports post-launch FD 	NASA	Existing systems and services acquired through PSLA	N/A	N/A



MOC Progress

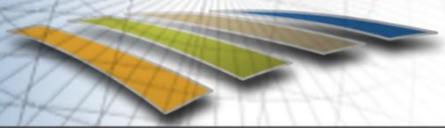
- ◆ Collection Activity Planning Element (CAPE)
 - ◆ Completed CAPE level 4 tests and installed several builds/patches
- ◆ Mission Operations Element (MOE)
 - ◆ Completed MOE level 4 tests and installed several builds/patches
 - ◆ Implemented improvement to trending system to support faster telemetry injection and trend reporting
 - ◆ Received and installed bMOE hardware/software in B32 bMOC
- ◆ Simulators
 - ◆ Spacecraft/Observatory Simulator (SOS) – highest fidelity, delivered in Aug. 2011
 - includes EM units for PIE and SSR
 - Includes OLI and TIRS instrument simulators
 - ◆ Two softbenches – software simulation only
 - ◆ Installed several FSW versions on simulators to stay consistent with spacecraft
- ◆ MOC Infrastructure
 - ◆ Command and Telemetry (C&T) and “Listen line” interfaces to Orbital are fully implemented
 - Observatory I&T listen line telemetry archived in MOC
 - C&T path used during MRTs
 - ◆ Stood up and integrated launch support room (LSR). LSR actively being used for development, CPTs, MRTs, and MOSS
 - ◆ MOC and LSR voice loops activated and used during observatory tests and simulations
 - ◆ Launch site interface planning underway, including pre-launch PPF command & telemetry and ascent telemetry flow to MOC



GNE / RF Progress

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- ◆ Installed Hallway Ground Station (HGS) at spacecraft facility to capture mission data directly from the spacecraft during observatory and mission testing
 - ◆ Use of USGS demodulators provided operational experience with demods and spacecraft
 - ◆ “Mini-DPAS” in HGS allowed Cal/Val Team near real-time analysis of instrument data during testing
- ◆ Data Collection and Routing Subsystem (DCRS)
 - ◆ Re-engineered DCRS to improve functionality, usability for operations and simplify long-term support
 - ◆ DCRS 3.1 completed in November 2012 and installed at all stations (last major release)
 - ◆ Run for record regression tests underway
- ◆ LGS (Sioux Falls, SD)
 - ◆ Operational
- ◆ SvalSat (Svalbard, Norway)
 - ◆ Operational
- ◆ GLC (Fairbanks, Alaska)
 - ◆ Operational
- ◆ Final comprehensive (capstone) performance testing is underway



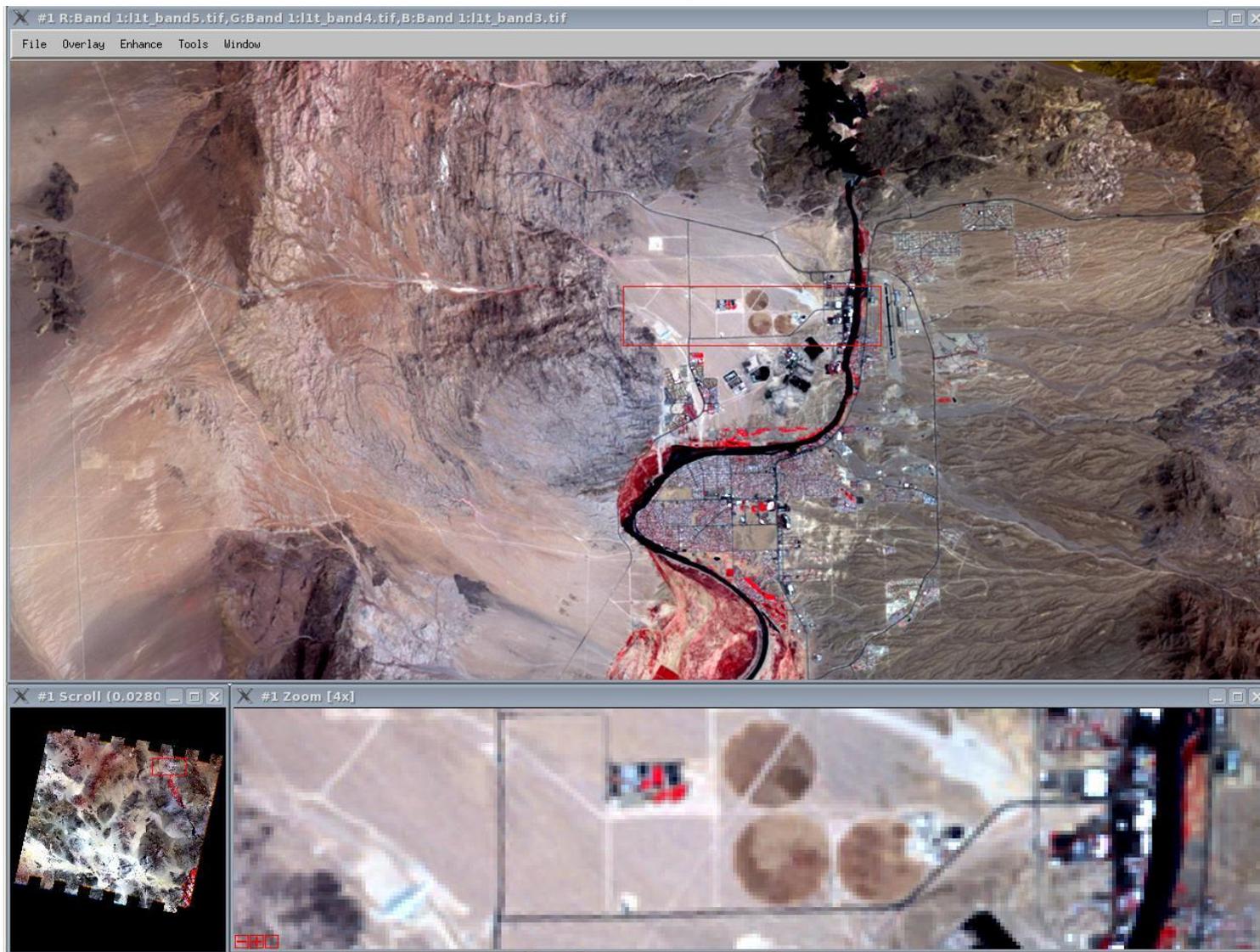
DPAS Progress

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- ◆ The DPAS was delivered in four separate builds:
 - ◆ **Build 1 (March 2011):** Primary scope was to archive and safeguard LDCM mission data and generate Level 0Ra data and metadata with the Ingest Subsystem (IS)
 - ◆ **Build 2 (September 2011):** Provided a preliminary Level 1 processing capability through the Image Assessment Subsystem (IAS); also provided the L0Ra Subsetter and the initial release of the MMO Database Subsystem (MDS)
 - ◆ **Build 3 (May 2012):** Provided a full Level 1 product generation capability with the Level 1 Product Generation Subsystem (LPGS); verified interface and performance requirements
 - ◆ **Build 4 (November 2012):** Primary scope was low-priority image processing algorithms, miscellaneous enhancements, automation, and support for the most recent OLI/TIRS/spacecraft data formats and processing algorithms
- ◆ The DPAS team is currently working on sustaining engineering enhancements to functional capabilities

First L1T Out of DPAS

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Ground and Operations Test Approach

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Test Phase	Ground Readiness Tests (GRTs)	Network Readiness Tests (NRTs)	Mission Readiness Tests (MRTs)	Mission Ops Simulations (MOSs)
Test Responsibility	Ground Readiness Manager	Network Ops Manager	GS/Ops Test Lead	Mission Simulation Manager
Test Conductors	GRTT, FOT	FOT, LGN/NEN/SN Operators	FOT, S/C team, Inst. teams	FOT, FST
Test Types	Integrated Ground System Testing, (MOC/GNE/DPAS Integrated)	RF Compat test, LGN/SN/NEN to MOC tests	Spacecraft - Ground System E-T-E Type Tests	MOC tests with hi-fidelity simulator
Purpose	Integrated Functional Ground System L3 Verification	Verify space-to-ground RF interface and certify MOC and ground network operations	L2 Verification and Operations Validation	MRT Test-as-you-fly Exceptions, Operations Validation, Training



Operations Milestones (1/5)

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Ground / Operations Reviews

Date	Description	RFA/ADV Status
9/07	<i>Ground System SRR</i>	<i>All Closed</i>
9/09	<i>Ground System PDR</i>	<i>All Closed</i>
9/10	<i>Ground System CDR</i>	<i>All Closed</i>
7/10	<i>General Ops Con Peer Review</i>	<i>All Closed</i>
8/10	<i>Planning & Scheduling Peer Review</i>	<i>All Closed</i>
10/10	<i>Mission Operations Review</i>	<i>All Closed</i>
8/11	<i>Pre-MRT Table-top Readiness Review</i>	<i>None issued</i>
11/11, 3/12	<i>Internal Ops Peer Reviews</i>	<i>All Closed</i>
4/12	<i>Ascent Peer Review</i>	<i>All Closed</i>
11/29-30	Pre-FOR Operations Peer Review	
1/3-4	FOR/ORR	

Launch Readiness Date: February 11, 2013

Operations Milestones (2/5)

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GRT#* *	Date	Description	Configuration
GRT 1	7-9/10	<i>TLM/CMD (S-band)</i>	1) MOC with LSIMSS 2) MOC to EROS station CTP across NISN interface
GRT 2	11-12/10	<i>Planning, Scheduling and Mission Data Management (MDM)</i>	1) MOC with LSIMSS 2/3) MOC with remote access to Orbital hotbench and integrated X-band demodulator. 4) MOC with LGS
GRT 3	3/11	<i>Maneuvers and Special Events</i>	MOC with softbench
GRT 5a	5/12	<i>Observatory Health & Safety from BMOC</i>	MOC, bMOC, GNE
GRT 5b	1/13	Failover and BMOC Operations	MOC, BMOC, GNE
NCT-S	6/11	<i>Repeat GRT-1 and GRT-2 topics as needed for Svalbard and GLC</i>	MOC , GLC, SvalSat
NCT-G	11/11		
GRT 6a	8/11, 4/12	<i>MOC & Station Capstone/Clean-up</i>	MOC with softbench (instruments modeled), and MOC with GNE
GRT 6b	7-9/12	<i>MOC & Station Capstone/Clean-up</i>	MOC with full S/OS and GNE
GRT 4a	5/11	<i>Safeguard Mission Data</i>	DPAS, GNE/DCRS
GRT 4b	11/11	<i>DPAS Level 1 Processing</i>	DPAS, GNE/DCRS.
AVT	5/12	<i>Algorithms and Cal/Val Toolkit</i>	DPAS and CVTK
GRT 4c	8/12	<i>DPAS Performance Capstone</i>	DPAS, MOC, GNE/DCRS
GRT 4d	12/12	Ground System Capstone	DPAS, GNE, MOC



Operations Milestones (3/5)

Network Readiness Tests (NRTs)

Date	Description	Configuration
9/11	<i>RF Compatibility and Calibration Testing</i>	<i>S/C, CTV, TDRS 171, WSGT SNG, MOC</i>
7/12	<i>SN Schedule Testing</i>	<i>MOC, WSGT, STGT</i>
7-8/12	<i>SN RF End-to-End</i>	<i>MOC, WSC, RFSOC</i>
8/11	<i>SN Connectivity</i>	<i>MOC, WSC</i>
2/12	<i>NEN Schedule Testing</i>	<i>MOC, WOTIS</i>
10-12/12	NEN Connectivity/Configuration Testing	MOC, WFF, MGS
11-12/12	NEN RF Long Loop	MOC, WFF, MGS
12/12-2/13	Mission Sims and Rehearsals	MOC, WSC, FDF, NEN
9/12-2/13	SN Ops Readiness Tests	MOC, WSGT, STGT
12/12-2/13	NEN Ops Readiness Tests	MOC, WFF, MGS

Operations Milestones (4/5)

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Mission Readiness Tests (MRTs)

MRT	Date	Description	Configuration
1	9/11, 2/12	<i>Routine and Periodic Operations</i>	<i>MOC to spacecraft via CTV. Utilizes RF Compat configuration, including SN, NEN, and LGN equipment</i>
2	12/12	<i>Contingency Operations</i>	<i>MOC to Observatory via SCIT rack</i>
3	3/12	<i>Sub-System Activation</i>	<i>MOC to spacecraft via SCIT rack</i>
4	7/12	<i>Maneuver Operations</i>	<i>MOC to spacecraft via SCIT rack</i>
5.1	8/12	<i>Instrument Activation & Ops, part 1</i>	<i>MOC to Observatory via SCIT rack</i>
5.2	10-11/12	<i>Instrument Activation & Ops, part 2 (in TVAC)</i>	<i>MOC to Observatory via SCIT rack</i>
6.1	11/12	<i>36-hour Scheduling Period in the Life (in TVAC)</i>	<i>MOC to Observatory via SCIT rack</i>
6.2	11-12/12	<i>Product validation re-tests: OLI cals, DITL w/ROS</i>	<i>MOC to Observatory via SCIT rack</i>

Operations Milestones (5/5)

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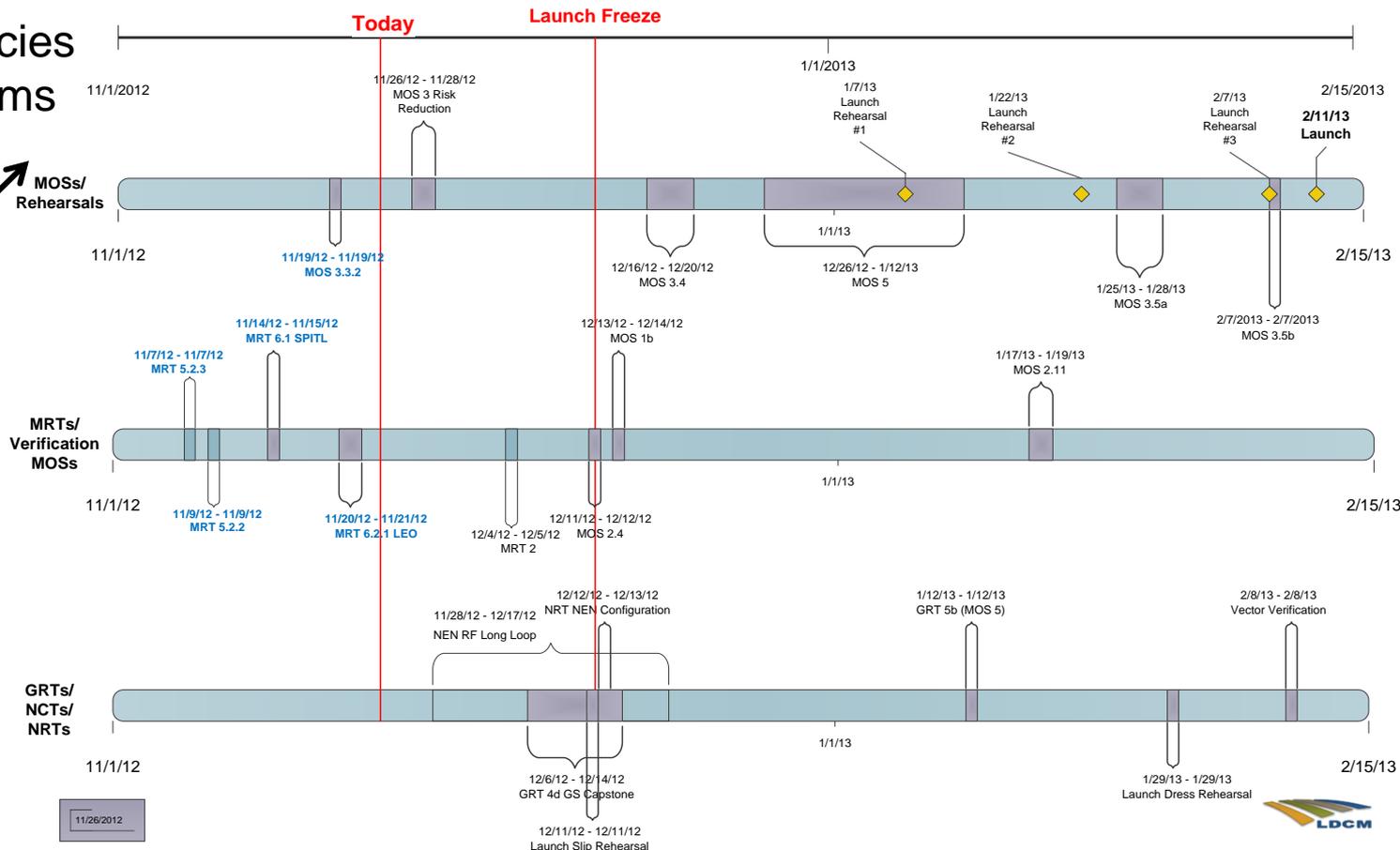
Mission Operations Simulations (MOSs)

MOS	Date	Description	Configuration
1a	9/12	<i>Contingency Operations – EPS, TCS, ACS, PROP</i>	<i>MOC, softbench</i>
1b	12/12	Contingency Operations – COMM, CDH, FSW, Instruments	MOC, softbench, SOS
2.3	5/12	<i>MRT 3 Test-As-You Fly Exceptions</i>	<i>MOC, LSR, S/OS</i>
2.4	12/12	MRT 4 Test-As-You Fly Exceptions	MOC, softbench
2.11	12/12	MRT 5&6 Test-As-You Fly Exceptions	MOC, SOS
3.1	5/12	<i>Launch and Activation 1</i>	<i>MOC, S/OS, LSR</i>
3.2	9/12	<i>Launch and Activation 2</i>	<i>MOC, S/OS, LSR</i>
3.3	11/12	<i>Launch and Activation 3 risk reduction</i>	<i>MOC, S/OS, LSR</i>
3.4	12/12	Launch and Activation 4	MOC, S/OS, LSR
3.5	1/13	Launch and Activation 5	MOC, S/OS, LSR
4.1	6/12	<i>Total WRS-2 in the Life (TWITL)</i>	<i>MOC, S/OS</i>
4.2	9/12	<i>Long Durations Data Flow</i>	<i>GNE, DPAS</i>
5	1/13	TWITL w/Contingencies	MOC, S/OS

Schedule to Launch

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Remaining work is primarily contingencies and launch team sims



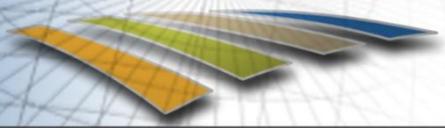
Zoom View

GS Technical Performance Measures

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- Ground System performance is monitored through a set of TPMs
 - To support management of the development process between milestone reviews
 - Design is not static
 - Numbers below were updated following DPAS B4.0 testing

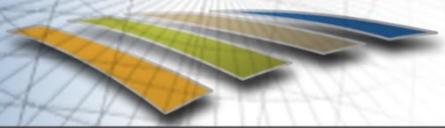
TPM	Requirement	Performance	Margin
LGN Contact Time <i>(with SvalSat)</i>	98 min/day	133 min/day 248 min/day	+36% +153%
Ingest and Processing Throughput	400 scenes/day	1,762 scenes/day	+341%
Distribution Capacity Years 1-2	1250 scenes/day	4,645 scenes/day	+272%
Distribution Capacity Years 3-5	3500 scenes/day	4,645 scenes/day	+33%
End to End Latency	85% in 48 hrs	85% in 12 hrs	+75%
Receiver Implementation Loss	3 dB	1.8 dB	+40%



Mission Operations Progress

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- ◆ Operations Concept
 - ◆ Significant development and testing of day-in-the-life (DITL) ops, including mission data management (MDM) ops con
 - ◆ Addition of routine operations sequences (ROs) to DITL MDM ops con
- ◆ Testing
 - ◆ Ground Readiness Tests (GRTs) and Mission Readiness Tests are nearly completed
 - ◆ Completed RF compat testing and several NRTs with SN and NEN
 - Issue with SN command path. Low risk to LDCM.
 - ◆ Completed several Mission Operations Simulations
- ◆ LEO&A Preps
 - ◆ Kicked off FST WG and developing LEO&A processes
 - ◆ Developed initial versions of the LEO&A timeline, with plans to baseline in Dec. 2012
 - ◆ Exercising timeline and FST processes during LEO&A MOSs
- ◆ Completed all FOT classroom training for spacecraft, instruments, and ground software
- ◆ Matured Flight Ops and Programmatic Mission Transition Plans



Summary and Next Steps

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- ◆ Data Processing and Archive System (DPAS) is ready to go
- ◆ Data Collection and Routing System (DCRS) has been simplified, is more robust, and is now operational
- ◆ User Portal Element (UPE) is completed and operational
- ◆ Ground System freeze begins December 13