Interplanetary Network Directorate
Deep Space Mission Systems

DSMS Services and Capabilities

Presented by

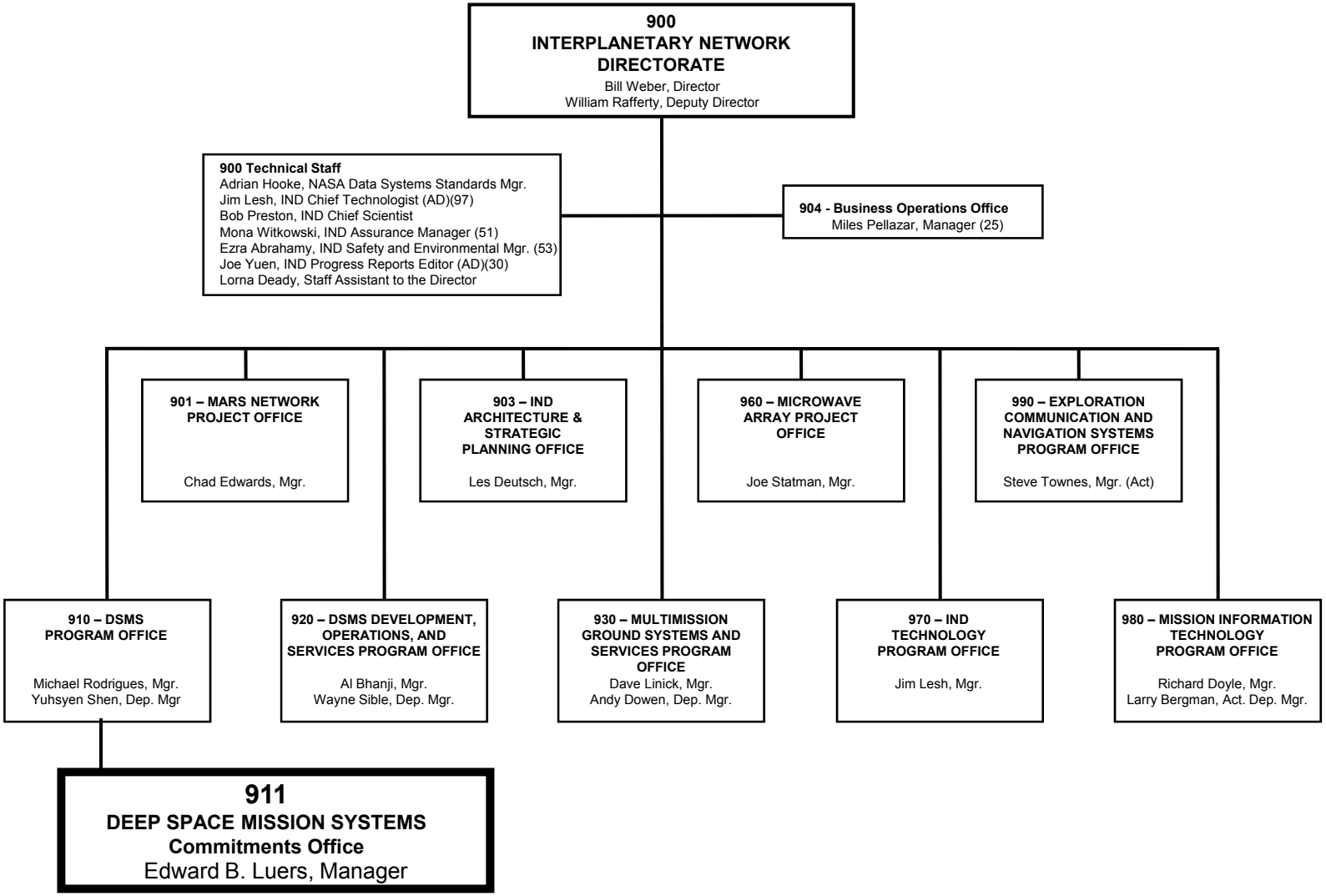
Edward B. Luers

May 2006

Agenda

- Organization Chart
- IND DSMS Support Facilities
- Standard Services
- Support Capabilities
  - Telemetry, Command, and Tracking

IND Organization Chart



911 Organization Chart

911
DEEP SPACE MISSION SYSTEMS
Commitments Office

Edward B. Luers, Manager

Staff

Roger Bartoo, Staff Engineer(317)
David Morris, Staff Engineer
V. Rose Nadjarian, Secretary
Ronald A. Slusser, Staff Engineer
E. Diane von Delden, Secretary
Ellen M. Walsh, Program Resource Admin.(252J)
Eve M. Zimmerle, Secretary

Future Missions Planning

Warren L. Martin, Manager

Andrew Kwok
Katherine I. Moyd (Add'l Duty)

Telecommunication & Mission Systems Managers (TMS)

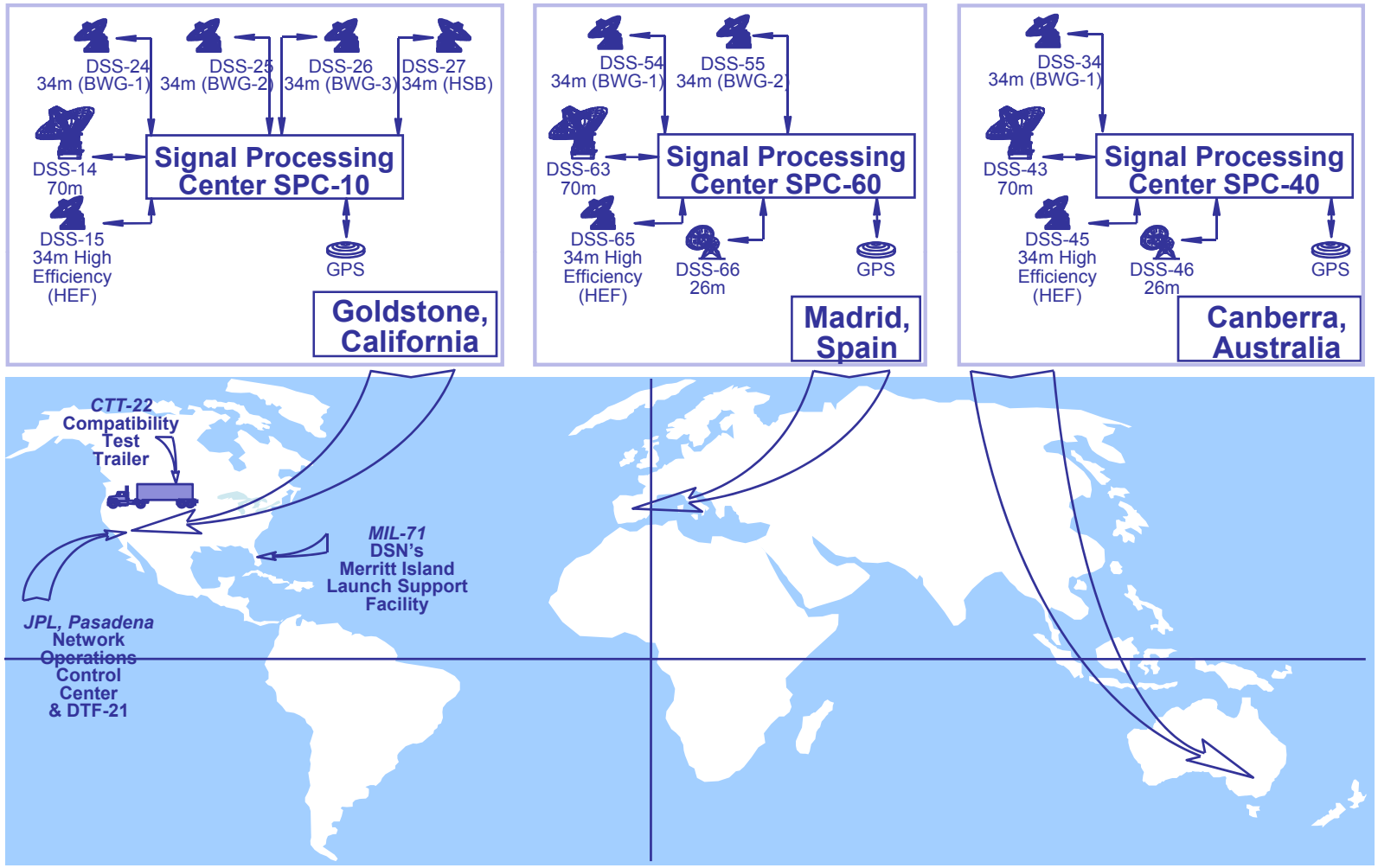
Richard D. Benson	NEW HORIZONS, STEREO A/B, JWST
Eugene S. Burke	ACE, ACRIMSAT, GOES, HST, IMAGE, JASON, LANDSAT-5, MARS GLOBAL SURVEYOR, NOAA, TDRSS, WMAP, CHANDRA
Daniel F. Finnerty	DAWN, MESSENGER, MSL, SIM
Dwight P. Holmes	INTEGRAL, MARS EXPRESS, ROSETTA, VENUS EXPRESS
Katherine I. Moyd	KEPLER, MRO
Peter T. Poon	ATOT, EVN and GLOBAL VLBI, GROUND BASED RADIO ASTRONOMY (GBRA), GOLDSTONE APPLE VALLEY RADIO TELESCOPE, GODR, GRAVITY PROBE-B, GSSR, ODYSSEY, RADIOASTRON- SVLBI, REFERENCE FRAME CALIB., SPACE GEODESY, ULYSSES, VOYAGER INTERSTELLAR MISSION
Stefan Waldherr, Jr.	RADARSAT-S/X BAND, SPITZER, ST-5, ASTRO-E2, CLUSTER-II, GEOTAIL, HAYABUSA, LUNAR-A, POLAR, SELENE, SOHO, WIND, LRO
Byron G. Yetter,	OPPORTUNITY ROVER, PHOENIX, SPIRIT ROVER, CASSINI, JUNO

IND DSMS Support Facilities

- Deep Space Communications Complexes (DSCC)
  - Located near Madrid, Goldstone, Canberra
  - 24 by 7 operation
- Network Operations Control Center (NOCC)
  - 24 by 7 operation
  - Provides network control, schedule, and predictions for network support
- Spaceflight Operations Facility at JPL
  - Deep Space Operation Center (DSOC)
  - 24 by 7 operation
- Navigation Computing Facility (NCF) at JPL
  - 8 by 5 operation

IND DSMS Support Facilities (Cont'd)

Deep Space Network Resources



IND DSMS Support Facilities (Cont'd)

- **Development Test Facility (DTF-21)**
  - Replicates a DSN station
  - Performs RF compatibility testing of S/C engineering and flight hardware
- **Compatibility Test Trailer (CTT-22)**
  - Mobile throughout North America
  - Demonstrates end-to-end telemetry, command, and radio metric compatibility by providing the local (spacecraft assembly facility or launch site) connection between the S/C and Project Mission Operations Center
- **Merritt Island Launch Area (MIL-71) at KSC**
  - Replicates a DSN station
  - Provides an "air-link" connection to the S/C during testing at the Cape
  - Provides final RF and end-to-end system compatibility "verification" tests between DSN and S/C
- **Remote Operations Support Area (ROSA)**
  - Located at the ITT facility
  - Network technical advisors support area during mission critical phases

IND DSMS Support Facilities (Cont'd)

- Deep Space Network (DSN)
  - DEEP SPACE COMMUNICATIONS COMPLEX (DSCC) SIGNAL PROCESSING CENTERS (SPCs)
    - SPC-40 Canberra, Australia
    - SPC-10 Goldstone, California
    - SPC-60 Madrid, Spain
  - DEEP SPACE STATION (DSS) TYPES AT EACH COMPLEX/SPC
    - 70M
    - 34M High Efficiency (HEF)
    - 34M Beam Wave Guide (BWG)
    - 26M
- Advanced Multimission Mission Operations Systems (AMMOS) - JPL
  - Provides a suite of mission operations services to customers including; mission planning, sequence development, spacecraft monitoring, navigation, mission control, data archiving, and science product generation

Standard Services

- COMMAND
- TELEMETRY
- MISSION DATA MANAGEMENT
- TRACKING AND NAVIGATION
- EXPERIMENT DATA PRODUCTS
- FLIGHT ENGINEERING
- SEQUENCE ENGINEERING
- SCIENCE OBSERVATION PLANNING
- GROUND COMMUNICATION AND INFORMATION
- RADIO SCIENCE
- VLBI
- RADIO ASTRONOMY
- RADAR SCIENCE
- SERVICE MANAGEMENT

For further information go to the Services Catalog located at the following URL under "Document Applicable to All Proposals": http://deepspace.jpl.nasa.gov/advmis

Support Capabilities

DSMS Antenna Information

Antenna Dia (m)	Type	Location	DSS No	S-Band Uplink	EIRP (dBW)	S-Band Downlink	S GAIN / G (Note 2) @ 45 deg (dB)	X-Band Uplink	EIRP (dBW)	X-Band Downlink	X GAIN / G (Note 2) @ 45 deg (dB)	K-Band Uplink	EIRP (dBW)	K-Band Downlink	K GAIN / G (Note 2) @ 45 deg (dB)
26	E.O.[1,4]	Canberra, Australia	46	2025 - 2120[7]	94.4	2200 - 2300	52.5 / 31.9	-	-		-	-	-	-	-
26	E.O.[1,4]	Madrid, Spain	66	2025 - 2120[7]	94.4	2200 - 2300	52.5 / 31.8	-	-	-	-	-	-	-	-
34	BWG-1[1,3]	Goldstone, CA USA	24	2025 - 2120[9]	99.1	2200 - 2300	56.8 / 41.3	7145 - 7190[7] 7190 - 7235[7,1]	109.9	8400 - 8500	68.3 / 52.8	-	-	4/27/09[5,15]	77.3/54.3[13,15]
34	BWG-1[1,3]	Canberra, Australia	34	2025 - 2120[9]	99.1	2200 - 2300	56.8 / 40.8	7145 - 7190[7] 7190 - 7235[7,1]	109.9	8400 - 8500	68.3 / 53.7	-	-	31800 - 32300[6] 5/3/10[5,15]	79.0/65.6[6,13] 77.3/54.3[13,15]
34	BWG-1[1,3]	Madrid, Spain	54	2025 - 2120[9]	99.1	2200 - 2300	56.8 / 41.0	7145 - 7190[7] 7190 - 7235[7,1]	109.9	8400 - 8500	68.3 / 53.7	-	-	6/1/08[5,6] 8/3/10[5,15]	79.0/64.4[6,13] 77.3/54.3[13,15]
34	BWG-2[1,3]	Goldstone, CA USA	25	-	-	-	-	7145 - 7190[7] 7190 - 7235[7,1]	110.0	8400 - 8500	68.4 / 53.7	34200 - 34700[11]	108.5	31800 - 32300	79.0 / 64.1
34	BWG-2[1,3]	Madrid, Spain	55	-	-	-	-	7145 - 7190[7] 7190 - 7235[7,1]	110.0	8400 - 8500	68.3/55.3	-	-	31800 - 32300[6]	79.1/65.4[6,13]
34	BWG-3[1,3]	Goldstone, CA USA	26	-	-	-	-	7145 - 7190[7] 7190 - 7235[7,1]	109.9	8400 - 8500	68.3 / 55.5	-	-	31800 - 32300[6]	79.1/65.7[6,13]
34	HEF[1,3]	Goldstone, CA USA	15	-	-	2200 - 2300	56.0 / 40.2	7145 - 7190[7]	110.1	8400 - 8500[12]	68.3 / 54.0	-	-	-	-
34	HEF[1,3]	Canberra, Australia	45	-	-	2200 - 2300	56.0 / 40.2	7145 - 7190[7]	110.1	8400 - 8500[12]	68.3 / 54.0	-	-	-	-
34	HEF[1,3]	Madrid, Spain	65	-	-	2200 - 2300	56.0 / 39.6	7145 - 7190[7]	110.1	8400 - 8500[12]	68.3 / 54.0	-	-	-	-
34	HSB[1]	Goldstone, CA USA	27	2025 - 2120[8]	77.1	2200 - 2300	54.8/ 34.7	-	-	-	-	-	-	-	-
70	D.S.[3]	Goldstone, CA USA	14	2110 - 2120[9,15]	105.8/118.2[8]	2270 - 2300	63.5 / 51.0	7145 - 7190[7]	116.1	8400 - 8500	74.5 / 62.9	-	-	-	-
70	D.S.[3]	Canberra, Australia	43	2110 - 2120[9,15]	105.8/118.2[8]	2270 - 2300	63.5 / 50.9	7145 - 7190[7]	116.2	8400 - 8500	74.6 / 62.8	-	-	-	-
70	D.S.[3]	Madrid, Spain	63	2110 - 2120[9,15]	105.8/118.2[8]	2270 - 2300	63.5 / 50.9	7145 - 7190[7]	116.3	8400 - 8500	74.6 / 63.1	-	-	-	-

Notes:

1. These stations can be used for Earth Orbiting (Category A) missions.
2. Performance values based on 45 deg. elevation, vacuum condition & Diplexed (if possible) single band mode.
3. These stations are used for Deep Space (Category B) missions.
4. These 26M stations will be closed in the future (FY08).
5. Planned Operational Date.
6. 31800-32300 MHz.
7. Transmit power range: 200 W to 20 KW (23 to 43 dBW).
8. Transmit power range: 50 W to 200 W (17 to 23 dBW).
9. Transmit power range: 200 W to 20 KW (23 to 43 dBW).
10. Transmit power range: 20 KW to 400 KW (43 to 56 dBW).
11. Transmit power range: 50 W to 800 W (17 to 29 dBW).
12. 8200 - 8600 MHz for VLBI Service.
13. Estimated values.
14. Near-Earth spectrum
15. 25500-27000 MHz

Support Capabilities

Telemetry Characteristics

- **Concatenated Decoding (Convolutional And Reed-Solomon)**
  - Error free (BER ≤ $1x10^{-6}$) channel performance, requires E_b/N_0 = 2.6 dB
- **Decoding Capability**
  - Convolutional decoding: Rate (r) 1/2, Constraint Length (k) 7
  - Standard CCSDS Reed-Solomon 255/223 Block Code
  - Turbo codes: 1/3 and 1/6
  - Low Density Parity Check (LDPC) - Future
- **Telemetry Data Rates**
  - 10 bits/sec to 6 Mbits/sec - Today
  - 10 bits/sec to 150 Mbits/sec - Future
- **Telemetry Time-tag Accuracy**
  - Earth received data time-tag - ±10 microsecond (negotiable)

Support Capabilities

Command Characteristics

- **Command Modulation Characteristics**
  - **Subcarrier Phase Shift Keying (PSK)**
    - **Commands on Subcarrier - 999 to 16003 Hz Sine wave (CCSDS standards 8 or 16 kHz)**
      - **Modulation type - NRZ-L, -M, -S or Biphase-L, -M, -S (NRZ-L or M recommended)**
      - **Data Rates from 1bps through 4kbps**
  - **Direct Carrier**
    - **Commands directly on residual carrier**
      - **Modulation type – Biphase-L or M**
      - **Data Rates from 8kbps to 64kbps**

Support Capabilities

Tracking Characteristics

- **Doppler Data**
  - Raw phase count (1 and 10 samples per second)
  - Doppler observables
- **Ranging Data**
  - Sequential Ranging (square-wave) at 26/34/70M stations
  - Tone Ranging (sine-wave) at the 26M stations
  - Pseudo-Noise (PN) and Regenerative Ranging - Future