DAEP Status

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June 19th, 2012

AGENDA

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- Project Elements Implementation Approach
- Accomplishments
- Summary

DAEP Overview

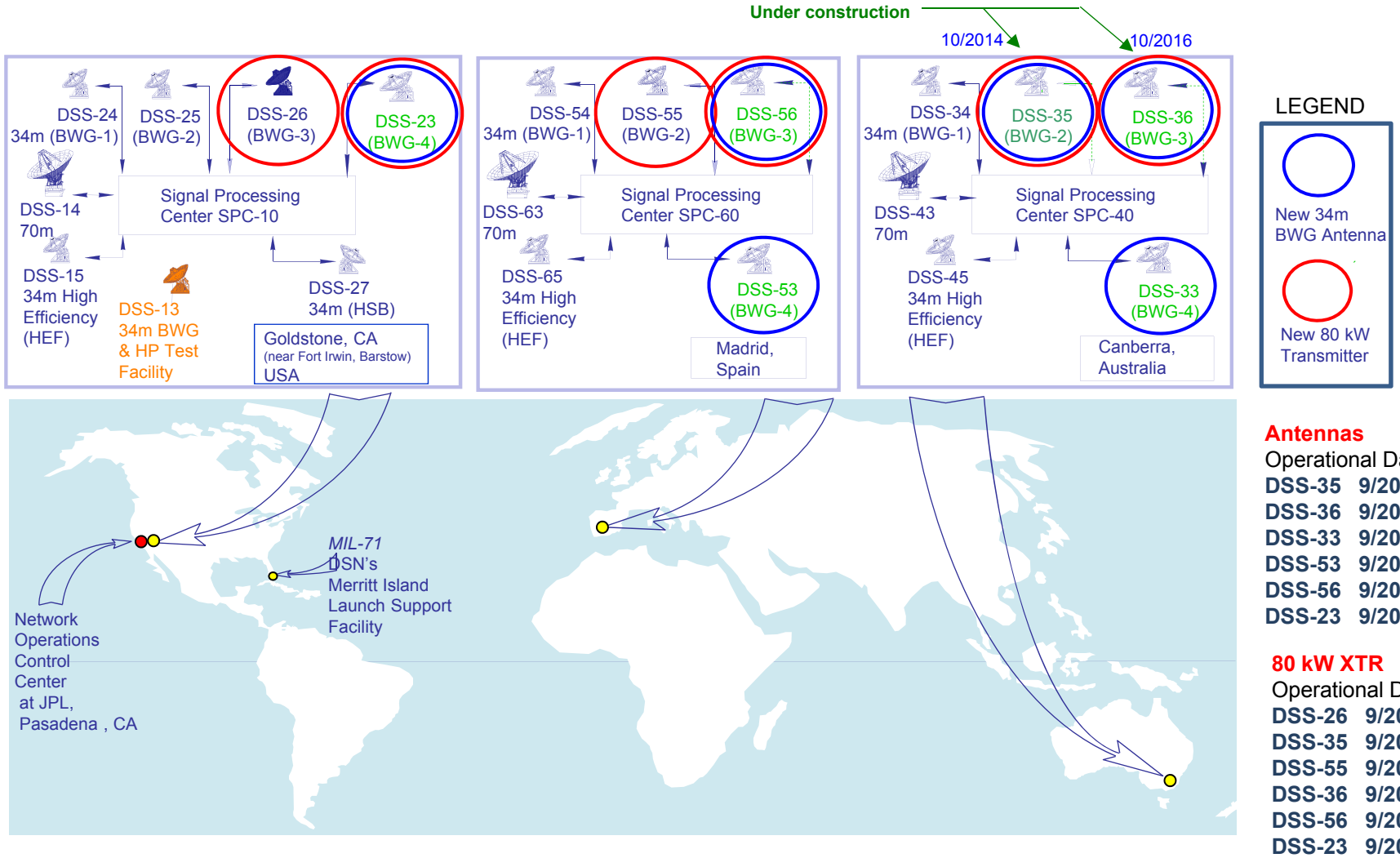
Background

- **The DSN's prime responsibility is telecommunications for NASA missions, but its also supports many international spacecraft as well as scientific investigations through radio astronomy, radio science, and radar activities**

- **The scope of the DSN Aperture Enhancement Project (DAEP) is to implement an equivalent capability to the 70m antenna at each of the DSN complexes.**
  - DAEP will add six new 34m BWG antennas to the DSN by 2025 (three at Canberra (CDSCC), two in Madrid (MDSCC) and one in Goldstone (GDSCC))
  - DAEP will add six new 80 kW transmitters to the DSN by 2025, two at each DSN complex to provide 70m 20 kW equivalent EIRP in a 34m BWG antenna.

- **DAEP will start with deployment of antennas at CDSCC**
  - Current analysis shows that many of the missions tracked will be in the southern declination starting in 2015 and there will be significant asset contention at Canberra during the latter half of this decade.
  - CDSCC is the sole Southern Hemisphere DSN complex, there is no hemispheric back up for Ka-band supports and also no hemispheric back up for 70m antenna.

DSN 2025 Implementation Plan



Antennas
Operational Dates
DSS-35 9/2014
DSS-36 9/2016
DSS-33 9/2018
DSS-53 9/2020
DSS-56 9/2022
DSS-23 9/2024

80 kW XTR
Operational Dates
DSS-26 9/2015
DSS-35 9/2016
DSS-55 9/2017
DSS-36 9/2020
DSS-56 9/2022
DSS-23 9/2024

DSN Complexes

Madrid, Spain

Goldstone, California

Canberra, Australia

DAEP Phase-I Implementation

Phase I Description

- DAEP Phase-I provides for the implementation of DSS-35 and DSS-36 antennas at CDSCC and one 80kW Uplink system at each DSN complex.
- DAEP Phase-I work has five major Elements:
  - Management (Mgmt, System Engineering, Integ. & Test)
  - Facilities
  - Pedestal/Antenna Structure/Mechanical/Servo
  - RF Electronics (Microwave, Uplink, Downlink, FTS,..)
  - Transmitters (80 kW, 20 kW)

- The RF package will be the X/X/Ka system currently installed in the DSN.
  - X-band uplink and downlink and Ka-band (32 GHz) downlink
  - Design allows for potential addition of:
    - S-band uplink and downlink
    - Ka-band uplink (both Near-Earth and Deep-Space)
    - Ka-band (26 GHz) downlink (Near-Earth)
    - Ka-band (HEDs frequency) uplink and downlink
- Designs of RF Electronics, Transmitters , Servo modified due to obsolescence.

DAEP Key New Developments

- **Antenna Servo**
  - Replacement of current analog DSN design with new commercial digital technology, to include; Digital Servo, Azimuth Encoder, Elevation Encoder, DC brushless motors, and all mechanical changes to accommodate new design.
- **RF Electronics**
  - **Microwave**
    - Repackaging of the X/X/Ka feed/LNA package with reduced cost and volume
      - *Reduces time for cool down, allowing quicker maintenance periods*
  - **Downlink FPGA consolidation**
    - Integrates receiver, ranging, and telemetry functions
    - Reduces per channel cost
    - *FPGA platform facilitates future implementation of new decoding algorithms (e.g. LDPC)*
  - **Uplink FPGA consolidation**
    - Consolidates uplink phase continuous synthesizer, commanding and uplink ranging using FPGA technology.
    - Consolidates multiple exciter assemblies into five Miteq boxes
    - *Improves future uplink capability (higher bandwidth and higher data rates - up to 12 Mbps)*

DAEP Key New Developments

- **80 kW & 20 kW Transmitters**
  - Changes from in-house to commercial (CEC) design
  - Addresses current obsolescence issues in existing JPL design.
  - Moves to digital power supply technology (High Voltage Power Supplies) instead of current motor generators. Both transmitters will have an array of HVPS modules.
  - Higher reliability (multiple HVPS modules provide graceful degradation)
  - New high power microwave components designed at JPL
  - 80 kW transmitter design will be capable of operating a 25 kW or 100 kW klystron.

- **These key new developments will:**
  - Reduce O&M cost (eliminates assemblies and custom hardware)
  - Increase reliability
  - Designs can be used to retrofit obsolete DSN equipment on other DSN antennas
  - Designs could be tailored to benefit similar digital implementation developments at other NASA network's facilities.

DAEP Elements Implementation Approach

Facilities

– Provide site facilities to fully support DSS-35 and DSS-36.

– Provide facility modifications at the Goldstone High Power Test Facility, DSS-26 and DSS-55 to support the new 80 kW transmitter.

– Support facilities for the antenna (roads, power, CSA, water, HVAC, ...) are being constructed under CSIRO subcontracts at CDSCC.

– DSS-35 and 36.
  - Detailed specifications developed by Australian A&E GHD. Reviewed by DSN Facilities Engineering and CDSCC.
  - CDSCC issued RFTs April - May 2012, for DSS-35

– DSS-26.
  - DSN Facilities Engineering will lead a design effort to upgrade existing DSS-26, based on requirements and lessons learned, in FY'13

– DSS-55.
  - MDSCC will issue design contract to local A&E to generate specifications for upgrade, with review by Facilities Engineering, in FY'15.

DAEP Elements Implementation Approach

Pedestal, Antenna Structure, Mechanical, including Servo

- JPL manages a subcontract with General Dynamics SATCOM (GDST) for two antennas (DSS-35, DSS-36) with servos.
  Principal suppliers:
  - Guideline ACT (Canberra, Australia): DSS-35 Pedestal.
  - General Dynamics- Richardson (TX): Servo drives and positioning control.
  - Schwartz-Hautmont (Spain): Antenna steel structure.
  - Cospal Composites (Italy): Reflector panels, subreflector, BWG mirrors.

Antenna panel's checkout

- JPL will upgrade (H/W &S/W) existing DSN Antenna Pointing Control Assembly (APCA) to interface with vendor supplied servo system.

Beam Waveguide Shroud

- JPL Provides engineering and management oversight, inspections and design-interpretative support during the fabrication and construction phases.

- Schedule drivers for vendor antenna beneficial occupancy in July 2013 (DSS-35) and July 2015 (DSS-36) to accommodate JPL Electronics II&T and for operational dates in Sept. 2014 (DSS-35) and Sept. 2016 (DSS-36).

DSS-35 Pedestal Construction

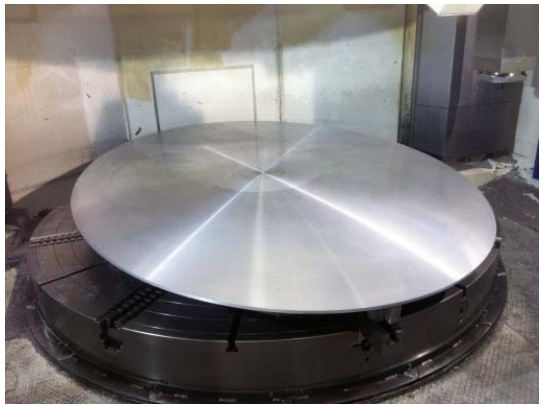







DSS-35

Antenna Panels & Mirrors



Cospal

Antenna Structure








Schwartz - Hautmont

DAEP Elements Implementation Approach

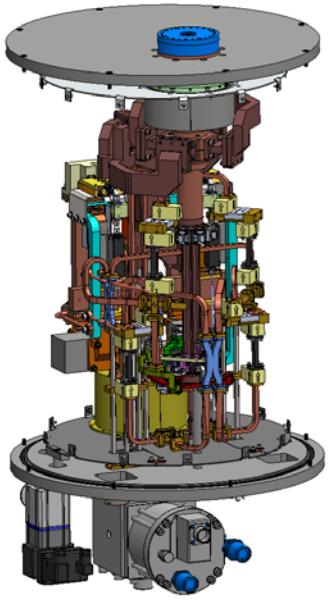
RF Electronics

– JPL will procure, integrate, test and deploy the systems to support DSS-35 and DSS-36. Due mainly to obsolescence issues, the following subsystems will have new equipment delivered:

- **Microwave Subsystem (UWV)** – X-band feed mods and new X/X/Ka-band LNA package. (Completed fabrication)
- **Block VI Exciter** – new FPGA based design consolidates Direct Digital Synthesizer, Uplink Ranging, and Command Modulation Generator hardware functions. (Completed PDR)
- **Downlink Tracking & Telemetry Subsystem (DTT)** – new FPGA based design which consolidates the Ranging, Receiver and Telemetry processing (Completed PDR)
- **Frequency and Timing (FTS)** – new Frequency Distribution equipment to distribute frequency references signals at the antenna. (Completed CDR)

– Significant portions of these developments are commercially procured equipment, integrated with new JPL designs and existing equipment.

– DSS-35 modkits delivery 10/2013.



X/X/Ka Cryogenic Package

DAEP Elements Implementation Approach

80 kW Transmitter & Microwave

- JPL manages a subcontract with Continental Electronics Corporation (CEC) for design and fabrication of new 80 kW & 20 kW transmitters.
- JPL manages a subcontract with Communications Power Industries (CPI) for design and fabrication of new 100 kW klystrons. (CPI delivered 3 prototype 100 kW klystrons)
- CPI and CEC are new designs based on JPL specifications.
- JPL developed high power microwave components necessary to integrate the 80 kW transmitter(s) into the existing DSN UWV system. (completed)
- Current BWG transmitter controller upgraded to interface and control new and current delivered transmitters. (completed)
- JPL will integrate, test and deploy the CEC provided 20 kW and 80 kW transmitters into the uplink systems (transmitter, feed, microwave components, control system) of the DSN.

CEC 80kW Transmitter

DSS-13 Motor Generator
(OLD)

HVPS
(NEW)

100kW klystron

Continental Electronics

DAEP Accomplishments

- 100 kW Klystron SN/01, SN/02 & SN/03 delivered by CPI
- Downlink – Receiver, Ranging and Telemetry consolidation PDR completed
- GDST Antenna and Servo Preliminary Design Review completed.
- DSS-35, 36 Facilities design by GHD/CSIRO completed.
- Uplink – Block-VI Exciter PDR completed.
- 80 kW High Power Microwave components development and prototypes completed.
- GDST Antenna and Servo Critical Design Review completed. (12/2011)
- DSS-35 pedestal foundation base, ring wall, roof and the access ramp completed.

DAEP Accomplishments

- All CEC 80 kW prototype transmitter reviews completed. Prototype delivery scheduled for August 2012
- Antenna prototype panels (9 rows), mirrors and subreflector have been fabricated and tested at Cospal Italy.
- Antenna steel structure is currently being fabricated and trial assembled at the Schwartz-Hautmont (S-H) facility in Valencia, Spain. (on going)
- System level DAEP Preliminary Design Review completed

DAEP Summary

- All contracts are underway for antennas, associated facilities modifications and new transmitters.
- High risk CPI 100kW klystron and JPL high power uplink microwave components have been designed, prototyped and successfully tested at GDSCC to support the 80kW transmitter implementation and testing at vendor facility.
- Open issues, which might affect project delivery date, have plans in place or are being created, to maintain DSS-35 Operational Date. There are no known open issues that affect performance.
- Overall good progress has been made in all areas (procurements, contracts, design and development) and the project is confident that DSS-35 & 36 antennas and the three 80kW Uplink systems will be delivered according to plan.