An Asset Contention Period: The Deep Space Network's (DSN's) 03-04 Challenge

Steve Silverman
steve.silverman@ jpl.nasa.gov
(818) 393-4138
FAX (818) 393-7661

The Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California, 91109, USA

DSN Background

- The DSN was established in 1963.
- It is a world-wide network of antennas in support of interplanetary spacecraft missions and selected Earth orbiting missions.
- There are three Deep Space Communications Complexes:
  - Barstow, CA; Madrid, Spain; Canberra, Australia
- Each complex has one 70m, and a mix of 34m BWG, 34m HEF, 26m antennas
- Each complex is connected to JPL via 3 T-1 circuits.

The Deep Space Communications Complexes

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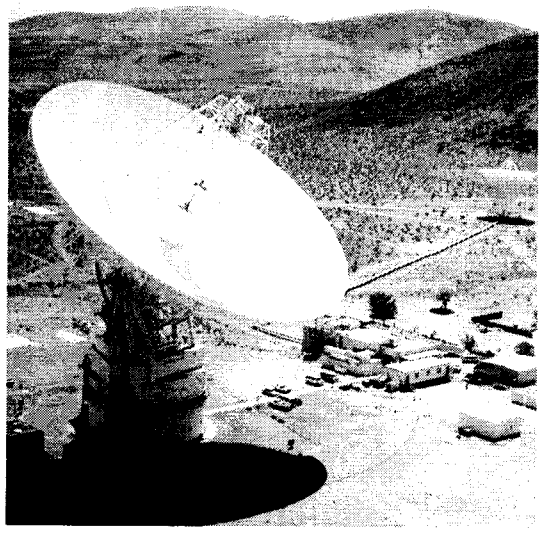

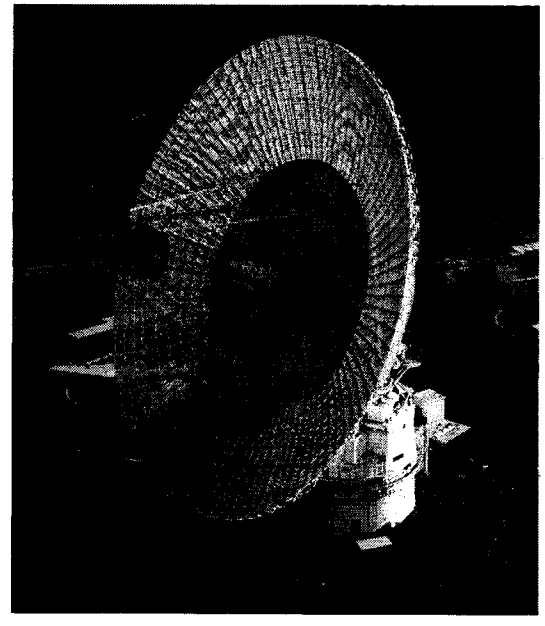

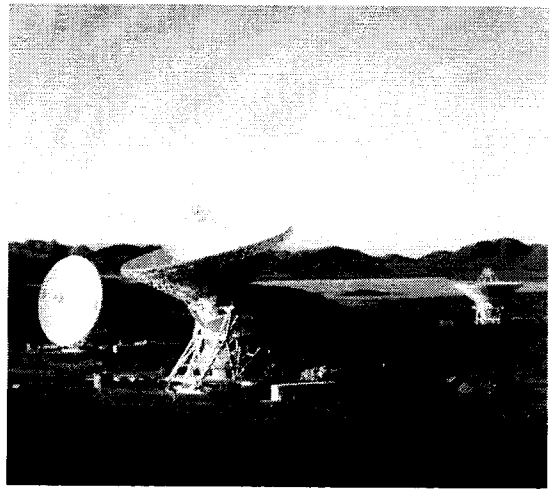

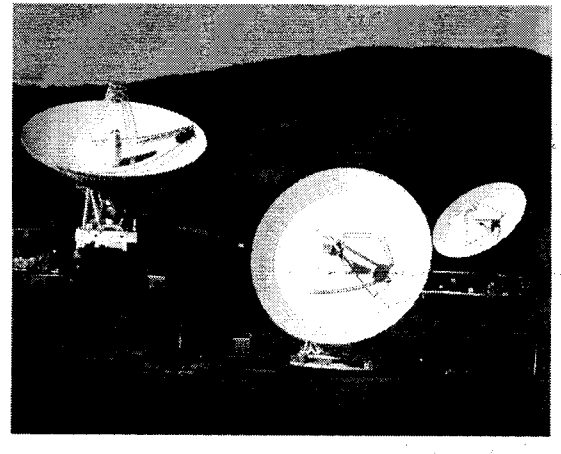

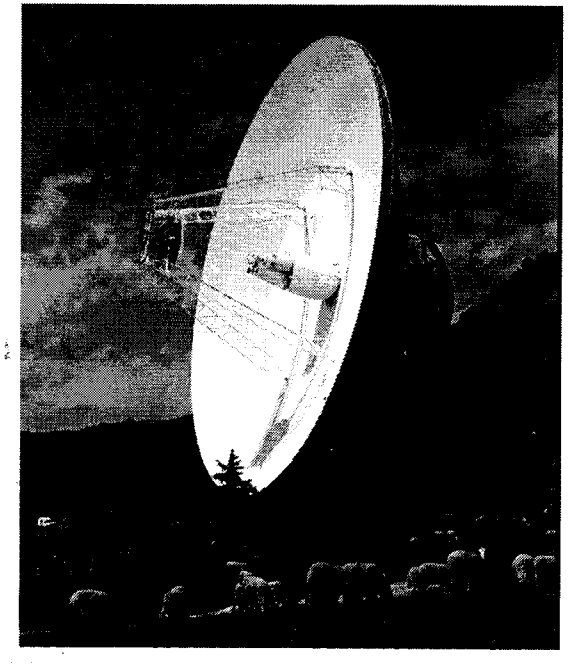

GDSCC (Goldstone) CDSCC (Canberra) MDSCC (Madrid)

Connectivity Between JPL and the DSCC's

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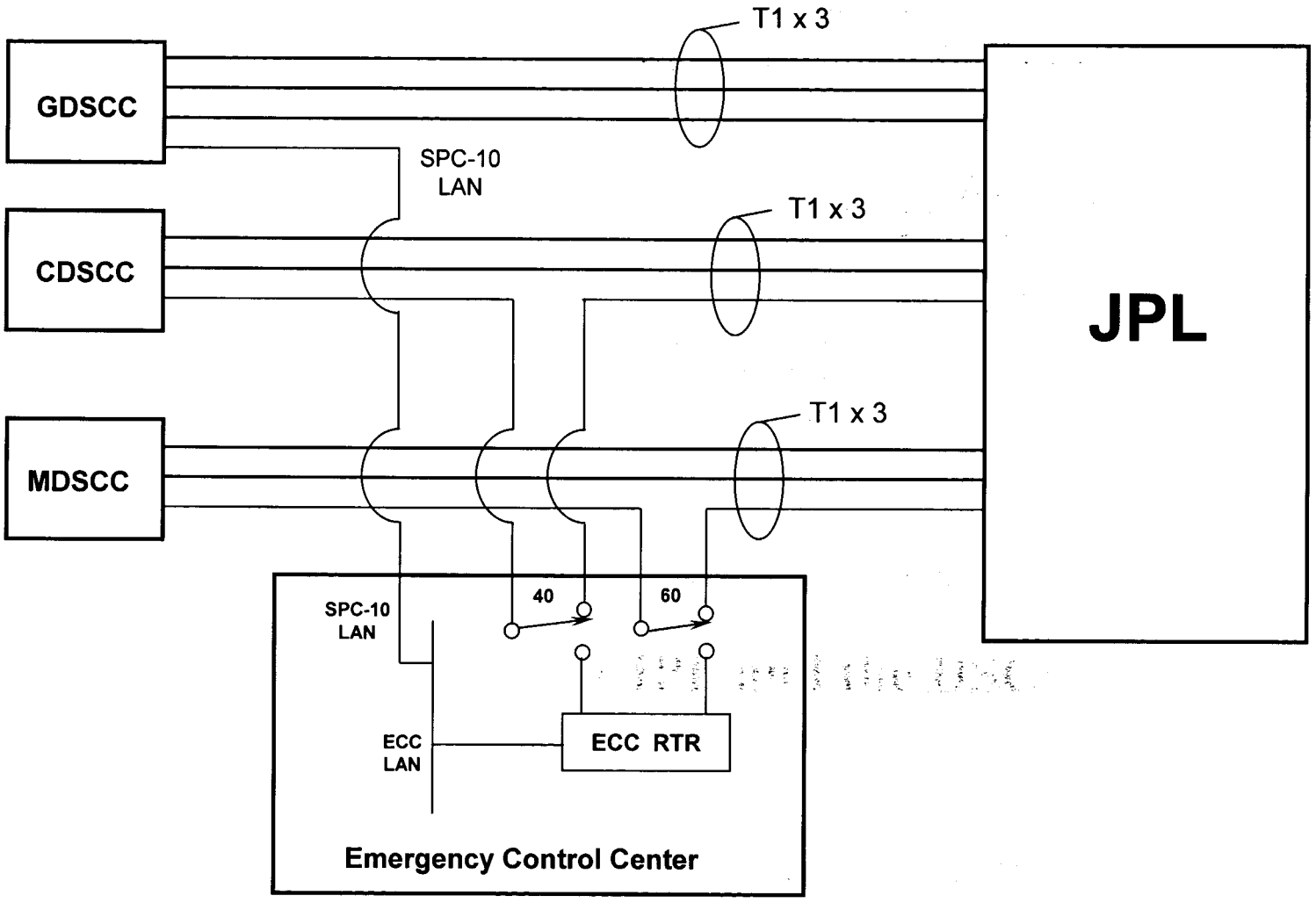


The Asset Contention Period

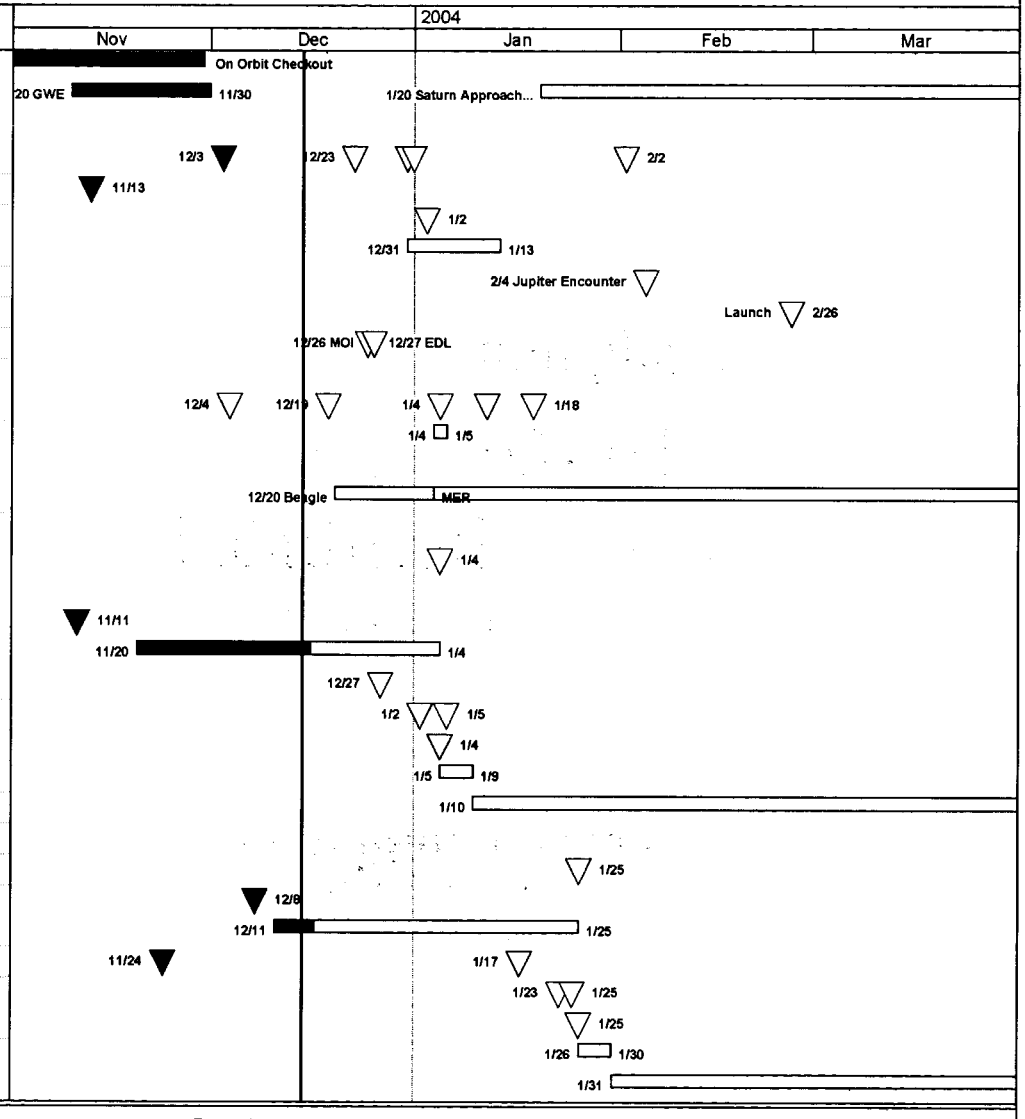
- November 2003 – March 2004
  - Highest density of mission critical activities in the history of the DSN.
    - 44 Mission Critical, 7 key mission phases
  - Late definition of the actual '03-'04 mission set led to short-notice identification of potentially severe DSN capacity shortfall.
  - Potential risk of not meeting operational commitments.

JPL

Key Mission Events: Sept'03-FEB'04

ACP Key Mission Events

ID	Task Name
1	**SIRTF**
4	**Cassini**
9	**Stardust**
10	STARDUST TCMs
26	STARDUST MERR (Encounter)
28	STARDUST Wild 2 Comet Encounter
30	STARDUST Wild 2 Comet Playback
31	**Ulysses**
34	**ROSETTA**
36	**Mars Express 03 Orbiter (ESA)**
41	**Mars Global Surveyor**
42	Orbit Synchronization Maneuver (OSM)
56	Critical EDL data return
57	**Mars Odyssey 2001**
58	Relay Ops
63	**Mars Rover A**
65	EDL
66	EDL M-FSK Tone Rehearsal
70	MER-A Instrument Checkout
72	MER-A Mars Approach
73	MER-A TCM A3 & A4
78	MER-A TCM A5 & A6
84	MER-A Entry-decent-landing
86	MER-A Surface Operations Checkout
88	MER-A Surface operations
89	**Mars Rover B**
91	EDL
98	MER-B Instrument Checkout
100	MER-B Mars Approach
101	MER-B TCM B3 & B4
106	MER-B TCM B5 & B6
112	MER-B Entry-decent-landing
114	MER-B Surface Operations Checkout
116	MER-B Surface Operations



Mitigating the Risk

- DSN Augmentations
  - Implement capabilities to increase the availability of DSN assets
  - Develop new and alternate assets
  - Integrated Master Schedule
    - Manage the complex augmentation period
- Operational Impacts
  - Installation and testing of new implementations
  - Training for new subsystems/capabilities
    - Operational and maintenance
  - Triage Process
    - Real-time reallocation or resource as needed during DSN or S/C emergency

DSN Augmentations for ACP

- Additional 34m BWG Antenna
  - Build new 34m BWG antenna at MDSCC (DSS-55), complete test and qualification by 11/1/03
    - Provide additional DSN aperture
- 20kW Transmitter Task
  - Add 20kW xmt capability to BWG's
    - Reduce load on HEF antennas
- Accelerate Network Simplification (NSP)
  - Re-plan existing NSP task to complete before ACP
    - Increase DSN reliability during ACP
      - NSP: Replace existing TLM, TRK , CMD subsystems with new hardware and software.

DSN Augmentations (cont'd)

- Array
  - Provide Array capability at overseas complexes (MDSCC and CDSCC)
    - Partial backup for 70m antenna failure
- Multiple Spacecraft per Antenna (2-MSPA)
  - Provides capability for a single antenna to support simultaneous downlink of 2 spacecraft
    - Conserve aperture usage
- Operational Delta DOR
  - Increase NAV accuracy (angular = 5nrad)
    - Reduce the number of doppler-ranging tracks
    - Improve tracking efficiency

DSN Augmentations (cont'd)

- Develop Alternate Assets (for contingency support)
  - Parkes (64m Australian Radio Telescope)
    - Located in Parkes, Australia
    - Backup Antenna for JPL and other missions
    - Upgrade: X-Band D/L capability
      - Add X-band feed, add 10m to solid panel diameter (CSIRO)
      - Add TLM/TRK equipment
      - Extend CDSCC LAN to Parkes
  - New Norcia (35m ESA)
    - Located in Perth, Australia; operated remotely by ESOC
    - Backup SLE service via ESOC
      - Add additional communications services
      - SLE based support via ESOC

Operations

- Training
  - Requirement for additional staffing and training due to new hardware/software subsystems/capabilities
    - New operational roles established
- Triage Process
  - Triage Operations Plan for the ACP
    - Enable rapid management response to DSN failures or Mission emergencies during ACP
    - Activated when:
      - A DSN problem occurs or a S/C has an emergency and:
        - » There are insufficient resources to meet commitments
        - » One or more critical activities are jeopardized
        - » No obvious or simple solutions based on asset availability and/or priority
  - Real-time reallocation of resources

Integrated Schedule

- Integrated Master Schedule
  - Help manage and coordinate new (ACP) implementations along with planned implementations
    - Existing (planned) implementations
      - NSP
        - » Increase reliability and maintainability of TLM, CMD, and RMD
      - Turbo Decoder
        - » Increase TLM performance/reliability
      - BWG axle replacement
      - BWG angle encoders
      - 70m Servo Drive replacement
      - 70m ball joint rework (MDSCC, CDSCC)
      - 26m Automaton
      - Temporal Dependency Network (TDN)

Integrated Schedule (cont'd)

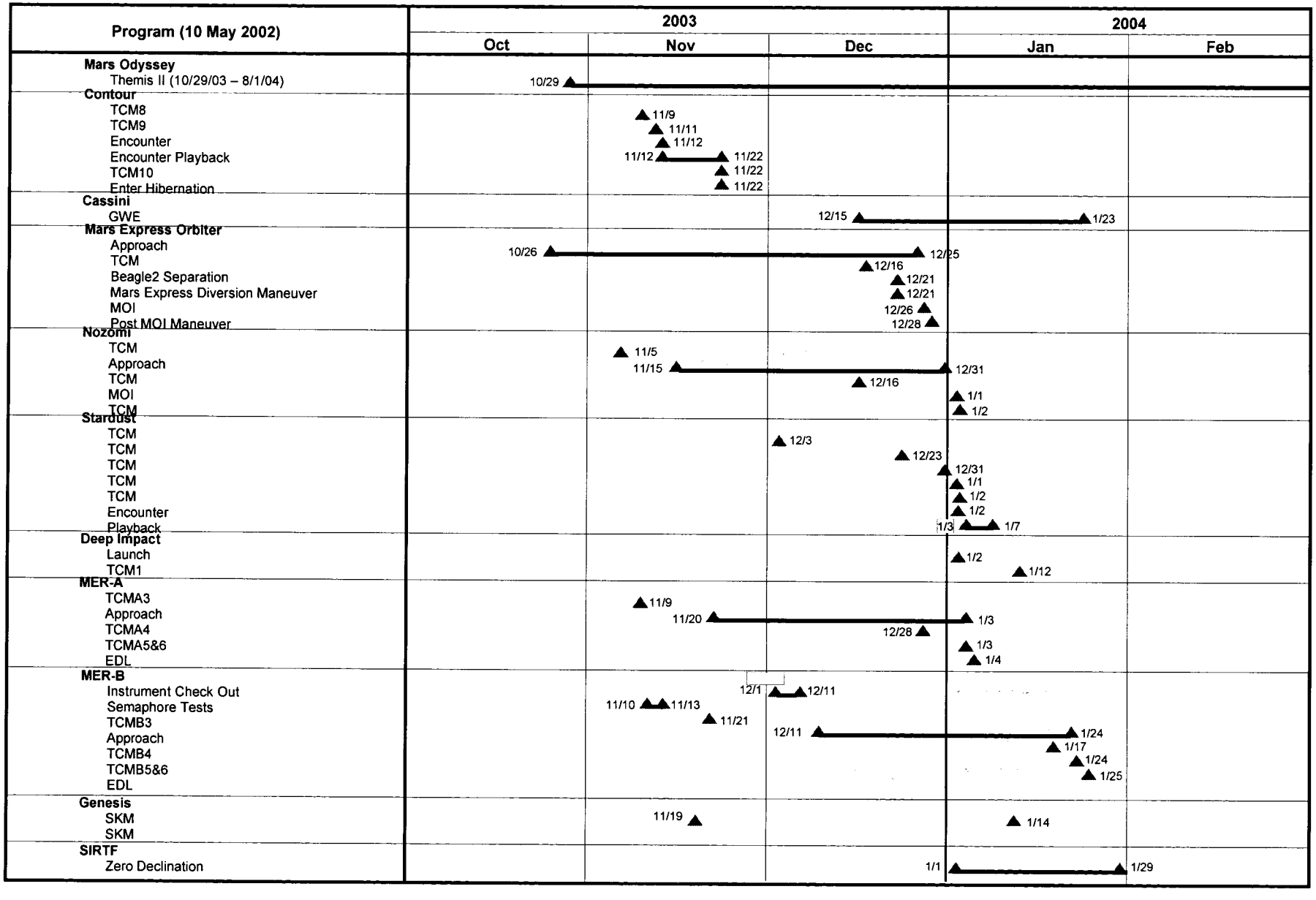
- Capture all development, operations, and commitment milestones
  - Integrate is single schedule
  - Identify linkages between individual tasks and critical paths
  - Update cycle once per month
  - Change control
    - No schedule changes accepted without approval
    - Special change management advisory board appointed (SCG)
      - » Change request reviewed by SCG, recommendations provided to management
      - » Risk assessment
      - » Risk mitigation strategies

Conclusion

- The DSN support to the ACP was successful.
- All new and planned implementations were completed on time, and provided the margin needed to satisfy DSMS Project commitments
- The Integrated Schedule functioned as planned
  - High risk areas were identified
  - Schedule changes were correlated with linked activities
    - Impacts understood
    - Workarounds were established as needed
    - Contingency workarounds were accomplished in areas of high risk and medium likelihood.

Backup Material

Mission Events: Nov'03 - Feb'04



Mission Critical Events: 44 (including 6 MGS maneuvers not shown), and 7 key mission phases