

MISSION SERVICES  
PROJECT

CODE 450

# *CONCEPT OF OPERATIONS*



## *Space Network Concept of Operations*

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# *CONCEPT OF OPERATIONS*



## *Agenda*

- Concept of Operations
- Scheduling
- Real-Time Operations, Service Control and Service Assurance
- Capacity Modeling and Replenishment

# *CONCEPT OF OPERATIONS*



## *Concept of Operations*

- The Space Network is designed as a highly automated user driven/controlled system for supporting Spacecraft Tracking and Data Acquisition.
- Space Network operations utilizes three major segments:
  - Space Segment (TDRS Constellation)
  - Ground Segment (WSC/GUAM)
  - Monitor and Control Segment (NCC)

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## *Schedule Driven Operations*

- TDRSS is a schedule driven network
  - Each scheduled event is completely described by a Scheduling Order (SHO).
  - The SHO is the tool used by the NCC for specifying customer requirements to TDRSS.
  
- Scheduling Order (SHO)
  - A SHO is made up of a header, followed by a data set consisting of selected fixed and reconfigurable parameters that completely specify the service type, subtype, start/stop times and parametric values to be employed by the TDRSS in establishing the support services.



## *NCC Database*

- Contains the user specified mission Service Specification Codes that describe the T&DA services to be provided. The Service Specification Codes are utilized in the development of the SHO
  
- Service Specification Codes
  - Describes an established set of Respecifiable and Reconfigurable parameters for a single TDRSS service
  - Respecifiable Parameters
    - Those whose initial value can be changed PRIOR to the scheduling of an event
  - Reconfigurable Parameters
    - Those whose initial values can be changed while the service is in progress for example data rate, transmit and receive frequency
    - Service Specification Codes also contains information relative to the SN element support requirements for each service, such as MOC interface channels.
  
- Prototype Events
  - A single Prototype Event consists of multiple Service Specification Codes.
  - Designed for use with routine user spacecraft contacts

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## SSAR Normal Service Specification Code

Example of an S-band Single Access Return Normal (SSAR-N) Service Specification Code

```

SIC ..... 0207
Service Specification Code ID (I## to L##) ..... I05
Service Specification Code Type ..... SSAR
Service Configuration (Normal or Shuttle) ..... Normal
Antenna (SA1,SA2,Either) ..... Either
Data Source Configuration
(Dual,SingleAlternate,SingleIdentical) ..... SingleAlternate
DG1 Channel Configuration (I,Q,IQ) ..... IQ
DG2 Modulation (BPSK or QPSK) ..... QPSK
Receiver Configuration (Cross or Normal) ..... Normal
SSA Combining ..... No
Return Channel Time Delay ..... Yes
*Polarization (Left or Right) ..... Left
*Data Group (1 or 2) ..... 1
*DG1 Mode (1=coho,2=noncoho,3=coho/noInt,4=coho/Int) ... 2
*DG2 Type (0=noncoho/IQ,1=noncoho/noInt,2=coho/noInt,
3=coho/IQ,4=noncoho/I,5=noncoho/Q,6=coho/Q,7=coho/I) . 1
*Minimum EIRP (0.1 dBW) ..... -030
*Maximum EIRP (0.1 dBW) ..... +080
*Transmit Frequency (0221600000 to 02300000000 daHz) .... 0228750000
*I/Q Power Ratio (0.1 dB) ..... 000
*Despun Antenna (0=NoType,1=Type1,2=Type2) ..... 0
*TSW Set ID (AAAAAAAAA) .....

I channel:
User Interface Channel ID (UIFC ID) ..... M51
Symbol Format Conversion ..... No
Data Coding (uncoded,code1,code2,code3) ..... code1
Maximum MDM Data Rate (000000000 to 002000000 bps) .. 000192000
Maximum HDRM Data Rate (000125000 to 003000000 bps) .. 0
Maximum Data Rate (000001000 to 003000000 bps) .. 000192000
*Initial Data Rate (000000100 to 003000000 bps) .. 000192000
*Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-L
*Data Stream ID (three-digit octal) ..... 120
*Data Bit Jitter (0.00%,0.01%,0.10%) ..... 0.10%
*G2 Inversion if code1 (0=Normal,1=Inverted) ..... 1

Q channel:
User Interface Channel ID (UIFC ID) .....
Symbol Format Conversion ..... No
Data Coding (uncoded,code1,code2,code3) ..... code1
Maximum MDM Data Rate (000000000 to 002000000 bps) .. 000192000
Maximum HDRM Data Rate (000125000 to 003000000 bps) .. 0
Maximum Data Rate (000001000 to 003000000 bps) .. 000192000
*Initial Data Rate (000000100 to 003000000 bps) .. 000192000
*Data Format (NRZ-L,NRZ-M,NRZ-S,BiP-L,BiP-M,BiP-S) ... NRZ-L
*Data Stream ID (three-digit octal) .....
*Data Bit Jitter (0.00%,0.01%,0.10%) ..... 0.10%
*G2 Inversion if code1 (0=Normal,1=Inverted) ..... 1

```

\* = reconfigurable and respecifiable

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## *TDRSS Scheduling*

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## *Definitions*

- Constrained Scheduling
  - User specifies exact time and spacecraft to use to support the event
  
- Flexible Scheduling
  - User requests a specified number of minutes of contact from any TDRS in a specified cluster within a specified window of opportunity.

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## *Definitions*

- Forecast Period
  - Schedule Add Requests (SARs) received electronically, 14 to 28 days prior to beginning of schedule week
  - Scheduling priorities utilized
  - Resource availability confirmed
  - Scheduling conflicts analyzed
  - Possible resolutions provided to customers
  - Activates a confirmed schedule for TDRSS customers
  - Forecast Analyst (FA) point of contact

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## *Definitions*

- Active and Realtime Periods
  - Schedule requests can be received at WSC up to 7 minutes in advance of event start
  - Scheduling priorities not utilized
  - Coordinates support based on customer requests and resource availability
  - Scheduling conflicts analyzed and realtime conflict resolution performed
  - Transmits current TDRSS schedules daily
  - Scheduling Operator (SO) point of contact
  - 24 hour support provided



## *Types of Support*

- Normal Support
  - Completion of normal mission/science objectives
  
- Critical Support
  - Completion of major mission objectives
  
  - Health and welfare of the spacecraft
    - May be needed to preclude an emergency
  
  - Science data
    - Targets of opportunity
  
- Emergency Support
  - Crew health and welfare
  - Spacecraft/major systems

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## *SN Priority List*

- Forecast Scheduling
  - The SN Priority List is created for the use of operations personnel at the Network Control Center (NCC) and White Sands Complex (WSC). The list provides strict guidelines for mission support in the event of service request conflicts during the forecast period and the list is utilized to resolve conflicts.
  
- Active and Realtime Scheduling
  - After the confirmed schedule is transmitted, the Priority List does not apply; priority is given to the confirmed scheduled request, except for the absolute priorities. Final authority is reserved for the Technical Manager or Mission Managers on duty, who may refer to the priority list for guidance.



## *SN Priority List*

Absolute Priority (Applies to all Periods)

1. Emergency

- a. Human
- b. Spacecraft

2. STS Launch and Landing Support

3. ELV Launch support

4. Critical Support

- a. Spacecraft Operations
- b. Science (e.g. Target of Opportunity)

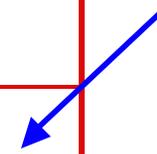
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## Scheduling Process

M	T	W	T	F	S	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Target Week



**Day**

**Activity**

- 1 Forecast Scheduling has received SARs for target week 15-21. SARs can be received 14 to 28 days in advance.
- 1-5 Forecast Scheduling generates weekly schedule and performs conflict resolution for target week.
- 8 Forecast Schedule for the target week is activated - the schedule leaves the forecast period and enters the active period. Reject messages for any requests that could not be scheduled are automatically transmitted, and confirmed schedules are transmitted to customers.
- 8 POCCS may begin submitting updates for the target week to the realtime Scheduling Operator. Updates may be submitted anytime up to 7 minutes prior to event start time. Realtime Scheduling Operator will perform conflict resolution.

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*Real-Time Operations, Service Control and  
Service Assurance*

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## *Real-Time Operations*

- Defined as that period in which the user and the SN perform the activities necessary to support the Command, Telemetry and Tracking operations for a user spacecraft:

Activity	Timeline
Process SHOs received from NCC <ul style="list-style-type: none"> <li>• Syntax checking</li> <li>• Equipment reservation</li> </ul>	Any time from 48 hours to 10 minutes prior to event start
Process NCC supplied state vectors Generate TDRS Pointing Angles and Doppler data	6 minutes prior to event start
Pre-Service Test	3 minutes prior to event start
TDRS antenna slew; Position TDRS SA antenna toward user spacecraft	2 minutes prior to event start
Generate commands to configure ground equipment and TDRS	1-2 minutes prior to event start
Initiate Forward, Return and Tracking services as specified in the SHO	At event start
Acquisition	

### Operations Timeline



## *User Performance Data (UPD)*

- User performance data is returned to the user MOC in real-time allowing the the user to monitor the on-going TDRSS event.
- Example of typical UPD information provided to the user is:

<b>Forward Service</b>	<b>Return Service</b>
Link Status	Link Status
Data Validity	Data Validity
Cmd Channel PN Modulation	Receiver Configuration
Doppler Compensation	Doppler Tracking Status
Signal EIRP	Receiver Lock
Radiated Carrier Frequency	Symbol Sync
Power Mode	Decoder Lock
Clock Presence	IR Signal Strength C/No
Data Transition Density	I and Q channel BER

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## *Ground Control Message Requests (GCMR)*

- Ground Control Message Requests provide the user with a means to interact with TDRSS as the event is on-going
  
- An example of some of the user interactions during operations are shown:
  - Reacquisition Request
  - Forward Link Sweep
  - Expanded User Frequency Uncertainty Request
  - Reconfiguration Request (Reconfigurables)
    - Data Rate
    - Data Format
    - Transmit or Receive Frequency
  
- Interactions vary depending on type of service

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## *Service Assurance*

- Monitor performance data from WSC
- Receive and process status reports from supporting elements
- Coordinate fault isolation

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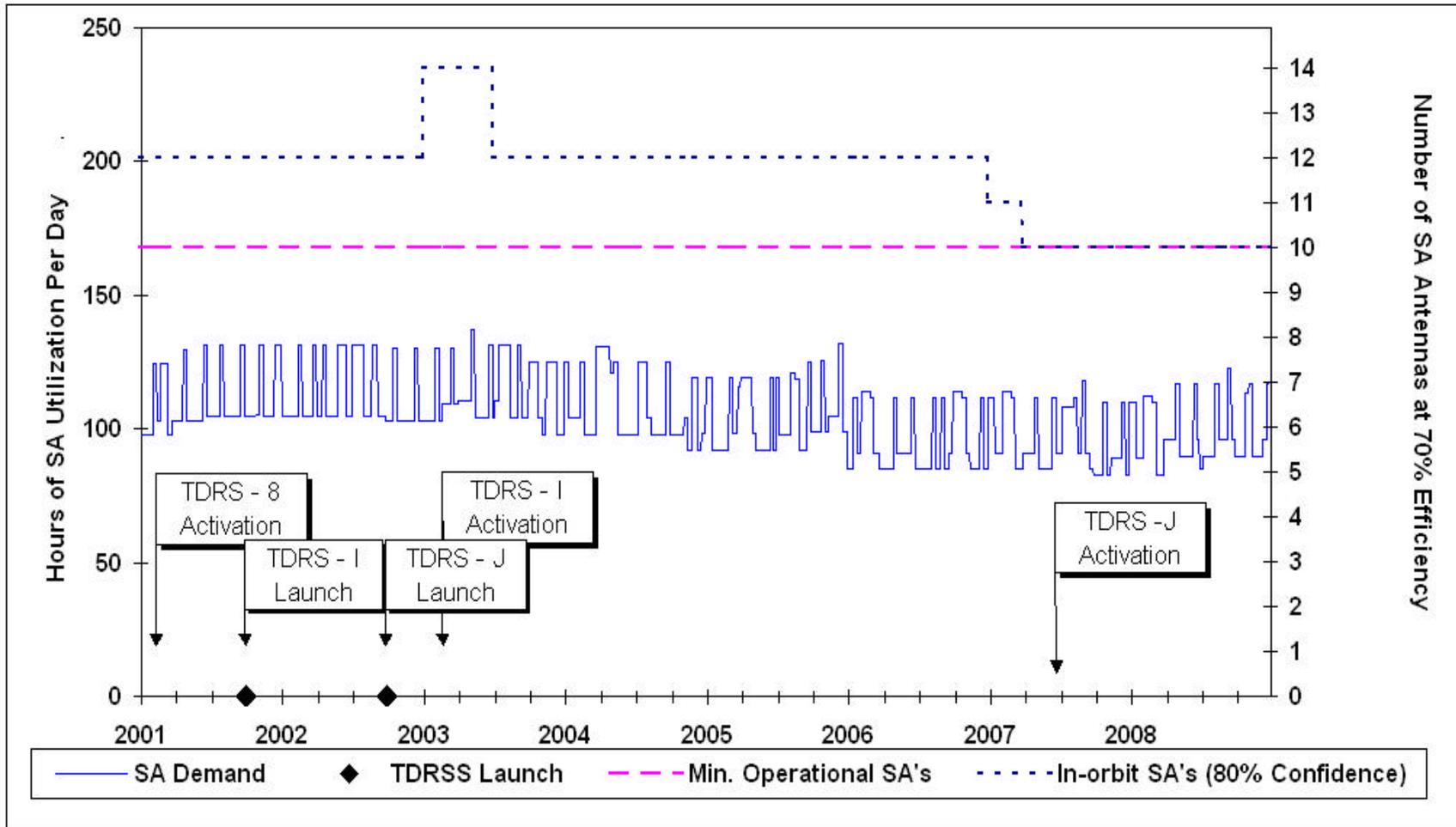


## *Capacity Modeling and Replenishment*

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## SA Demand Versus TDRSS On-Orbit Capacity



Note: Minimum required operational SA's reflects 4 SA's in East Node, 4 SA's in West Node, 2 SA's in ZOE to meet the projected demand while providing needed operational balance.

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## *Present TDRSS Constellation*

