



AGENDA

- **GENERAL**
- **GN COMMAND SUPPORT**
- **GN TELEMETRY SUPPORT**
- **GN TRACKING SUPPORT**

**MISSION
SERVICES PROJECT**

CODE 450

**SN SUPPORT OF GN
MODE OF OPERATIONS**



GENERAL



SN SUPPORT OF GN MODE OF OPERATIONS

- **THE SN HAS MODIFIED WSC TO ALLOW COMMAND/TELEMETRY AND TRACKING SUPPORT FOR GN MODE S-BAND COMMUNICATIONS.**
- **SPACE LOSS ASSOCIATED WITH SN OPERATIONS ONLY ALLOWS GN MODE SUPPORT USING SSA SERVICE**
 - **TYPICALLY, 1 - 2 Kbps COMMAND**
 - **8-16 Kbps TELEMETRY RATES ARE OBTAINABLE (USING OMNI ANTENNA)**
- **TDRSS HAS SUPPORTED GN MODE OF OPERATIONS FOR MANY PROJECTS (ORBITING SPACECRAFT, ELVs, REENTRY OPERATIONS)**
 - **SEE BACKUP PAGE 19 FOR HISTORY OF PROJECTS SUPPORTED**
- **CURRENT RF ICDs SHALL REFLECT ANY APPLICABLE CONSTRAINTS UNTIL SPACE NETWORK USERS GUIDE (SNUG) REV. 8 IS ISSUED**

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GN COMMAND SUPPORT



GN COMMAND SUPPORT

- **GN COMMAND SUPPORT MODES**
 - **COMMANDS CAN BE MODULATED DIRECTLY ONTO THE CARRIER OR A SUBCARRIER**
 - » **DIRECT DATA MODULATION RF CHARACTERISTICS**
 - DATA RATE – 125 bps TO 1Mbps**
 - MODULATION INDEX – 0.2 TO 1.5 RADIANS**

 - » **SUBCARRIER (BPSK) MODULATION RF CHARACTERISTICS**
 - DATA RATE – 125 bps TO 8 Kbps**
 - SUBCARRIER FREQUENCY – 2, 4, 8 OR 16 KHz**
 - MODULATION INDEX – 0.2 TO 1.8 RADIANS**

REFER TO BACKUP PG.20/21 FOR ADDITIONAL DETAIL



GN COMMAND SUPPORT (cont'd)

- **FREQUENCY SWEEP CHARACTERISTICS (GN MODE)**
 - **SWEEP RANGE - 10 Hz to 600 KHz (10 Hz PRECISION)**

 - **SWEEP DURATION – 1 TO 120 SECONDS (1 SECOND PRECISION)**

 - **NO MODULATION IS APPLIED DURING AN SN SWEEP**

REFER TO BACKUP PG. 22 FOR ADDITIONAL DETAIL



GN COMMAND SUPPORT (cont'd)

- **COMMAND DATA CAN BE TRANSMITTED TO WSC USING TWO METHODS**
 - **LEGACY NASCOM MDM – 4800 BIT BLOCK ENCAPSULATED (IP) FORMAT**
 - **TCP/IP (CLOSED) IONET – TCP/IP FORMAT WHEN USING THE WDISC (PTPs)**

- **COMMAND IDLE PATTERN GENERATION**
 - **LEGACY NASCOM MDM (FOR COMMAND RATES \leq 8 Kbps).**
 - » **WSC WILL GENERATE IDLE PATTERN OF ALTERNATING 1's AND 0's APPLIED TO THE CARRIER/SUBCARRIER**
 - **WDISC**
 - » **ALL THE IDLE PATTERN CAPABILITIES OF THE PTP ARE AVAILABLE (INCLUDES PROVISION FOR NO IDLE PATTERN)**



GN COMMAND SUPPORT (cont'd)

- **OPERATIONAL CONSIDERATIONS**
 - **ALL SN USER SERVICES MUST BE SCHEDULED VIA SN SCHEDULING ORDER (SHO)**

 - **NCC WILL COORDINATE WITH THE WSC THE APRIORI CONFIGURATION PARAMETERS PREVIOUSLY DISCUSSED (i.e., MODULATION INDEX, SWEEP PARAMETERS) THAT MUST BE INITIALLY CONFIGURED IN THE WSC DATABASE**

 - **SWEEP CONTROL AT AOS (OR REACQUISITION) IS MANAGED BY SN OPS**
 - » **VERBAL COORDINATION REQUIRED WITH THE MOC TO IDENTIFY SWEEP AND COMMAND PERIODS**

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GN TELEMETRY SUPPORT



GN TELEMETRY SUPPORT CAPABILITY

- **DIRECT CARRIER DEMODULATION**
 - **THE TDRSS INTEGRATED RECEIVER (IRs) ARE SUPPRESSED CARRIER RECEIVERS THAT CAN RECOVER MODULATION DIRECTLY FROM THE CARRIER**
 - » **BPSK DEMODULATION IS A NORMAL IR SUPPORT MODE. GN TELEMETRY SUPPORTS ARE CONFIGURED AS DG-2.**

 - » **PCM/PM DEMODULATION – DIRECT CARRIER DEMODULATION REQUIRES EXTENSIVE USER TESTING BECAUSE OF DEPENDENCY ON EIRP, DATA RATE, PCM DATA FORMAT (NRZ OR BI-PHASE), MODULATION INDEX AND DATA TRANSITION DENSITY.**

 - » **THE HIGHER THE MODULATION INDEX AND DATA DENSITY THE BETTER THE CHANCE OF DATA RECOVERY. THE SN HAS SUPPORTED BI PHASE MODULATION AS LOW AS 0.8 RADIAN SUCCESSFULLY**



GN TELEMETRY SUPPORT CAPABILITY (cont'd)

- **SUBCARRIER DEMODULATION**
 - **THE TDRSS IR CAN BE DETUNED TO RECOVER PSK DATA MODULATED ON A SUBCARRIER (i.e., 1024 MHz)**

 - **A LOSS OF 3 dB CAN BE EXPECTED SINCE THE IR ONLY RECOVERS UPPER OR LOWER SUBCARRIER/SIDEBAND (NOT COMBINED)**



GN TELEMETRY SUPPORT CAPABILITY (cont'd)

- **TELEMETRY DATA CAN BE RECEIVED FROM WSC USING TWO METHODS**
 - **LEGACY NASCOM MDM**
 - » **SN 4800 BIT BLOCK ENCAPSULATED (UDP) DATA FORMAT (NISN CONVERSION DEVICE REQUIRED)**

 - **TCP/IP (OPEN OR CLOSED) IONET –**
 - » **THE WSC WDISC PTPs ALLOW IP SOCKET CONNECTIONS**
 - » **VARIOUS IP PACKET STRUCTURES ARE SUPPORTED (i.e., ASYNCHRONOUS, CCSDS, ETC.)**
 - » **MOCs MUST MEET NISN SECURITY REQUIREMENTS TO ACCESS THE CLOSED OR OPEN IONET**



GN TELEMETRY SUPPORT CAPABILITY (cont'd)

- **OPERATIONAL CONSIDERATIONS**
 - **ALL SN USER SERVICES MUST BE SCHEDULED VIA SN SCHEDULING ORDER (SHO)**

 - **WDISC SUPPORT REQUIRES THAT UNIQUE PTP DESKTOP CONFIGURATIONS BE ESTABLISHED FOR INTERFACE TESTING AND OPERATIONS.**

 - **THE TDRS SYSTEM NORMALLY ACCOMMODATES A FREQUENCY UNCERTAINTY UP TO 3 KHz.**
 - » **GREATER THAN 3KHz UNCERTAINTY REQUIRES AN EXPANDED FREQUENCY SEARCH TO 40 KHz, INITIATED BY NCC OR WSC**

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GN TRACKING SUPPORT



GN TRACKING SUPPORT

- **TDRSS CAN PROVIDE 1 WAY AND 2 WAY DOPPLER TRACKING DATA IN SUPPORT OF GN MODE**

- **1 WAY DOPPLER TRACKING**
 - **NON COHERENT TRANSPONDER MODE REQUIRED (or Tx ONLY)**
 - » **ALL TDMs SENT TO FDF**
 - **FDF CAN PROVIDE USER TRANSPONDER FREQUENCY INFORMATION FROM THE 1 WAY TRACKING DATA MESSAGES (TDMs)**

- **2 WAY DOPPLER TRACKING**
 - **COHERENT TRANSPONDER MODE REQUIRED**
 - » **ALL TDMs SENT TO FDF**
 - **FDF CAN PROVIDE USER ORBIT DETERMINATION USING THE 2 WAY GN MODE TRACKING DATA**

- **BOTH 1 AND 2 WAY TRACKING DATA SERVICES CAN BE SCHEDULED SIMULTANEOUSLY WITHIN A SINGLE TDRS EVENT TO FACILITATE TIMELY MODE CHANGES**



GN TRACKING SUPPORT (cont'd)

- **TRACKING DATA CONSTRAINTS**
 - **TDRSS DOES NOT PROVIDE GN MODE RANGING SUPPORT**

 - **3 WAY TRACKING SUPPORT IS NOT CURRENTLY PROVIDED IN CONJUNCTION WITH GN STATION SUPPORT**



RESOURCES

- **WDISC WEBSITE (SYSTEM INTERFACE AND REQUIREMENT DOCUMENTS ARE FOUND HERE)**
 - <http://nmsp.gsfc.nasa.gov/wdisc/>
- **TDRSS ONLINE INFORMATION CENTER (DETAILED TRACKING AND DATA RELAY SATELLITE SYSTEM INFORMATION INCLUDING A LINK TO THE SN USER GUIDE REV. 7)**
 - <http://nmsp.gsfc.nasa.gov/tdrss/>

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BACKUP



SN HISTORY FOR SUPPORTING GN MODE OPERATIONS (ORBITING AND GROUND BASED SPACECRAFT)

- **COMMAND**
 - ON-ORBIT – FUSE, EO-1
 - GROUND TEST – TIMED, MAP

- **TELEMETRY**
 - ON-ORBIT – FUSE, EO-1, NOAA-16, GPS, TOMS/EP, LUNAR PROSPECTOR, ACRIMSAT, RADARSAT, HST(GN)
 - GROUND TEST – TIMED, MAP

- **TRACKING (ON-ORBIT)**
 - 1 WAY – WIND, NOAA 14/15/16, POLAR, TOMS, EO-1, FUSE (LOF)
 - 2 WAY – EO-1



GN COMMAND SUPPORT

- **GN COMMAND SUPPORT MODE**
 - **DIRECT DATA MODULATION RF CHARACTERISTICS**
 - DATA RATE – 125 bps TO 1Mbps (NRZ) IN 1bps INCREMENTS**
 - MODULATION INDEX – 0.2 TO 1.5 RADIANS OR BPSK (PI/2 RADS) IN 0.1 RADIAN INCREMENTS**
 - WAVEFORM – NRZ- L, M, S Bi-PHASE – L,M,S**

 - **SUBCARRIER (BPSK) MODULATION RF CHARACTERISTICS**
 - DATA RATE – 125 bps TO 8 Kbps**
 - SUBCARRIER FREQUENCY – 2, 4, 8 OR 16 KHz (SQUAREWAVE OR SINEWAVE)**
 - MODULATION INDEX – 0.2 TO 1.8 RADIANS IN 0.1 RAD INCREMENTS**



GN COMMAND SUPPORT (cont'd)

- COMMAND DATA FORMATS SUPPORTED**
 - » NRZ – L,M,S AND Bi-PHASE – L,M,S
 - » WITH OR WITHOUT IDLE PATTERN
 - » WDISC CAN SUPPORT BCH ENCODING (WITH OR WITHOUT RANDOMIZATION)

- RATIO OF SUBCARRIER FREQUENCY TO DATA RATE (^2 MULTIPLE)**
 - NRZ- 2, 4, 8, 16, 32, 64,128
 - Bi-PHASE - 4, 8, 16, 32, 64,128
 - EXAMPLE – FOR A 16 KHz SUBCARRIER , NRZ FORMAT, VALID DATA RATES ARE 8, 4, 2, AND 1 Kbps, 500, 250, AND 125 bps

- COMMAND DATA TRANSITIONS WILL BE COHERENT WITH THE SUBCARRIER ZERO CROSSING WITHIN +/- 1 DEGREE**



FREQUENCY SWEEP

SN SWEEP IS A AUTOMATED SAWTOOTH WAVEFORM THAT IS SWEPT +/- A RANGE AROUND A DOPPLER COMPENSATED FREQUENCY (AS OPPOSED TO A FIXED FREQUENCY REFERENCE WITH GN MODE OF OPERATIONS). BECAUSE THE SWEEP IS AROUND A COMPENSATED FREQUENCY, A NARROWER SWEEP RANGE THAN USED FOR GN OPERATIONS MAY BE ADEQUATE.

SN RF MARGINS FOR COMMAND ARE MUCH LESS THAN GN. CONSEQUENTLY, A SLOWER SWEEP RATE MAY BE REQUIRED TO ENSURE CARRIER LOCK IS MAINTAINED AFTER CAPTURE

ACQUISITION TIME IS TYPICALLY LESS CRITICAL FOR SN OPERATIONS THAN GN OPERATIONS BECAUSE OF THE MUCH LONGER CONTACT PERIODS

THE WSC TELEMETRY (RETURN) SERVICE SHOULD ACQUIRE LOCK ON DATA AFTER COMPLETION OF A FORWARD LINK SWEEP.