Joint Polar Satellite System (JPSS) Ground Segment Support to the GOSAT-3 Mission

Dan DeVito
JPSS Program

- JPSS will acquire the GOSAT-3 mission data from the High Speed Transmission Link (HSTL), route all acquired data to JAXA, and concurrently route AMSR-3 data to NOAA.

- JPSS intends to support the GOSAT-3 mission by building upon the existing Ground Segment capabilities and Concept of Operations used to support GCOM-W1. This strategy will help ensure the JPSS Program will be able to support GOSAT-3 in a timely manner.

- As with GCOM-W1, access to processing software executables and collaboration on calibration/validation are key to the use of the GOSAT-3 data by NOAA.

- NOAA is exploring ways to take advantage of the direct reception of AMSR-3 data using the Low Speed Transmission Link (LSTL)

- JAXA's responses to the questions provided on July 25th helped to begin determining what Ground Segment modifications will be necessary for GOSAT-3.

The roles & responsibilities, architecture and concept of operations in this presentation are notional.

- Instruments
  - AMSR-3: ~270kbps collection rate (TBC)
  - TANSO-3: ~13.3Mbps collection rate (TBC); day light only
- Mission Life: 5 Years
- Orbit: 98 deg, polar sun-sync, 666km altitude, +/- 20km, 13:30 LTAN (TBC)
- Launch readiness date / duration: No earlier than (NET) 2022 / 5 years
- Data Storage: 35GB (3 days of AMSR-3 data and 5 orbits of TANSO-3 data)
- Communication links:
  - High Speed Transmission Link (HSTL) for downlink of stored mission data
  - Low Speed Transmission Link (LSTL) for real time broadcast of AMSR-3 data
  - Encryption: None
- Data routing: AMSR-3 to JAXA and NOAA; TANSO-3 to JAXA
- Data timeliness:
  - AMSR-3: less than 150 minutes from observation to Level 1 Product, 95% of the time (TBC)
  - TANSO-3: keep up day to day and prevent data loss
- Operational availability and data availability (TBC)

	Item	HSTL	LSTL
Carrier Characteristics	Frequency	X-band（Central Frequency: 8.175GHz)	S-band（Center frequency: 2.220GHz)
	Modulation	PCM-QPSK (Differential encoding: Modulo-2)	PCM→CONV(1/2)→QPSK
	Polarization	RHCP	RHCP
	Bit rate	200M or 400Mbps (TBD)	999.424bps (Before Convolution）
	Antenna Type	Omni	Contoured
	EIRP	Above 15.1 dBm** (Elevation@5deg, 400Mbps)(*) above 13.15 dBm** (Elevation@90deg, 400Mbps)(*) (*)　In case of 200Mbps, the EIRP will be 3dB lower.	above -11dBm (Elevation@5deg) above -18dBm(Elevation@90deg)

**Note: EIRP is assumed to be dBW as indicated in JAXA provided RF link analysis

Assumptions and Constraints

- The HSTL can be acquired using an existing X-Band,13M antenna with a G/T of 36 dB/K beginning at 5 degree elevation or less
  - EIRP is 12.1 dBW (Elevation @ 5 deg, 200 Mbps); 10.15 dBW (Elevation @ 5 deg, 200 Mbps)
  - EIRP is 3 dB higher if a 400 Mbps downlink rate is used
- AMSR-3 and TANSO-3 are downlinked on separate virtual channels
- TANSO-3 orbital duty cycle is between 40% and 60%
- Up to one year of overlapping support is needed between GOSAT-3 and GCOM-W1
- JAXA will provide relative priorities between GCOM-W1 and GOSAT-3 in the event of resource conflict
- A pre-scheduled backup antenna is not required to meet operational and data availability requirements
- Antennas at Troll may have insufficient performance to acquire the HSTL

Loading Analysis for HSTL Data Acquisition

- Objective: Assess the ability to support the GOSAT-3 mission using existing JPSS Ground Station capabilities at:
  - Svalbard only
  - Fairbanks only

- Analysis performed using GOSAT-3 mission parameters, assumptions and constraints

- Results from Svalbard only analysis:
  - A Svalbard only solution could meet the needs of the GOSAT-3 mission
  - Some contacts will be too short to acquire all TANSO-3 data collected during the previous orbit but can be downlinked during the next pass
  - No systematic loss of TANSO-3 data regardless of orbital duty cycle
  - The NOAA-owned SG4 antenna could be used for primary support to GOSAT-3 by moving S-NPP and JPSS to other antennas at Svalbard and/or Ground Stations
  - RF conjunction may exist between GOSAT-3 and other missions using Svalbard

- Results from Fairbanks only analysis
  - A Fairbanks only solution will not meet the needs of the GOSAT-3 mission
  - Approximately 4 contiguous "blind" orbits
  - AMSR-3 latency requirements will not be satisfied
  - Systematic loss of TANSO-3 data is certain if orbital duty cycle is >50% and HSTL downlink rate is 200 Mbps
  - RF conjunction may exist between GOSAT-3 and other missions using Fairbanks

Notional Architecture for GOSAT-3 HSTL
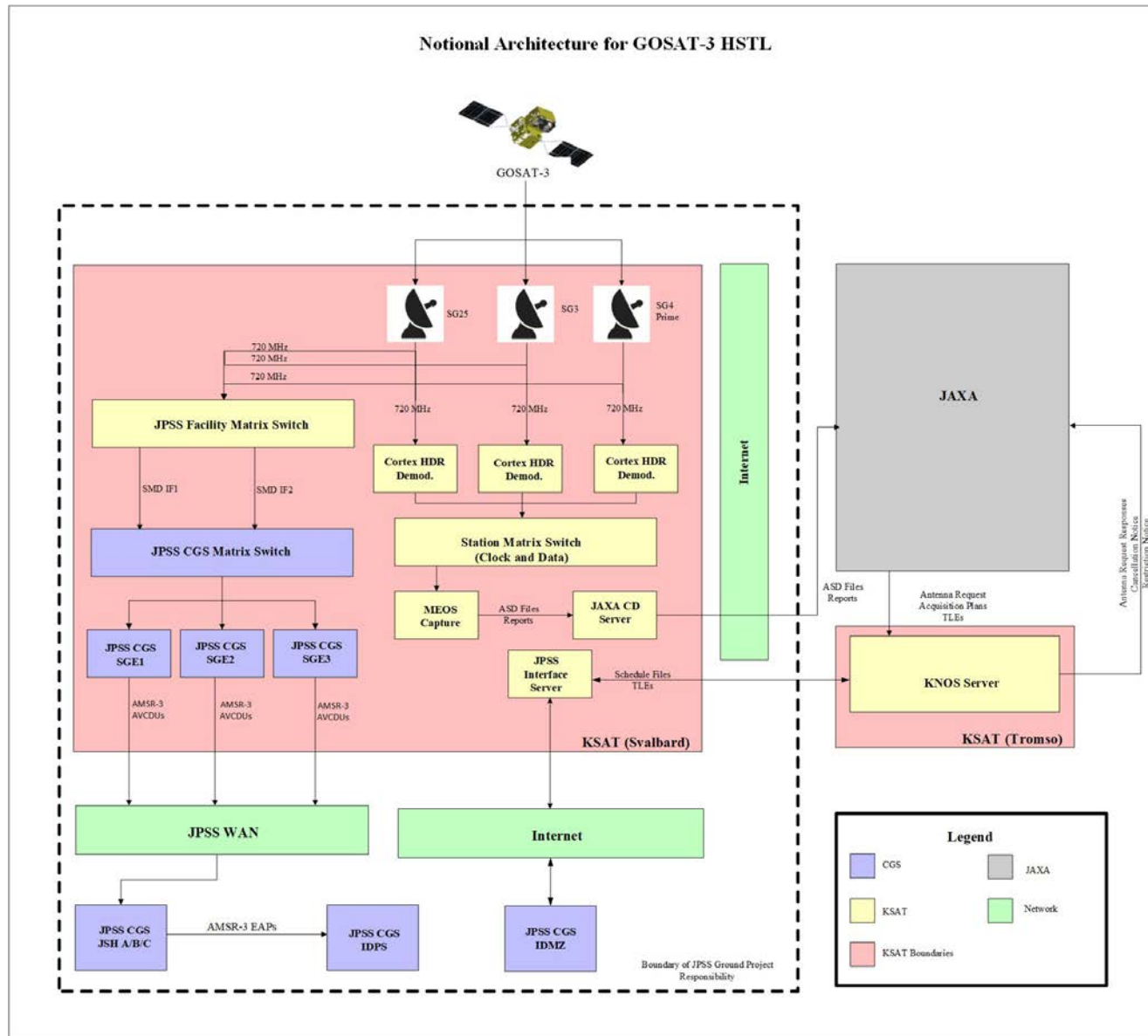
Notional Concept of Operations (ConOps)

- GOSAT-3 HSTL ConOps will be similar to GCOM-W1

- One contact per orbit (~15 per day) for downlinking HSTL mission data; RF link sufficient to provide at least an 8 minute average contact using a 13M antenna

- AMSR-3 data downlinked prior to TANSO-3

- Only AMSR-3 data will be routed to NESDIS

- Contact scheduling and mission status between JAXA and NOAA/JPSS are coordinated through Kongsberg Satellite Services (KSAT) under contract with JPSS Ground Project

- The HSTL containing the mission data are received using the JPSS owned SG-4, 13M X-band antenna and down converted to 720 Mhz intermediate frequency (IF) signal. KSAT owned SG-3 and SG-25 antennas will be used during planned SG-4 outages.

- The IF signal is split and sent directly to the KSAT owned pre-processors and to the JPSS owned pre-processor via the JPSS Facility Matrix Switch

- The KSAT owned systems separate the mission data into files by application packet identifier and route to JAXA

- The JPSS owned systems route the mission data AMSR-3 Virtual Channel Data Units (VCDUs) to NSOF and CBU using the Service Link Extension (SLE) protocol

- Higher order processing and product distribution is performed by the Interface Processing Segment (IDPS) and NEDIS Data Exploitation (NDE) system.

- To leverage existing capabilities with minimal adjustment, the primary schedule coordination will be performed with KSAT coordinating between JAXA and NOAA.

- The planning and scheduling interface will be similar to Mission Operations Information Files (MOIFs) used between JAXA/INPS and KSAT for GCOM-W1.

Data File	Source/Destination	Frequency / Due Date	Coverage
Antenna Request	JAXA/KSAT	First: Thurs in 5 weeks before target week Last: Wed in previous week of target week	1 Week (Mon – Sun)
Antenna Request Response	KSAT/JAXA	Each response is submitted as soon as practical after receipt of Antenna Request	1 Week (Mon – Sun)
Acquisition Plan	JAXA/KSAT	2 times per week: Tuesday and Friday	
Cancellation Notice	KSAT/JAXA	As needed	
Restriction Notice	KSAT/JAXA	First: Mon in 5 weeks before target week	1 week
Orbit Data Provision	JAXA/KSAT	At 9:00 UTC everyday	N/A

- Assuming the file frequency and coverage is the same as GCOM-W1, NOAA intends to schedule GOSAT-3 contacts using the Antenna Request file and assumes changes identified in the Acquisition Plan file are infrequent

  – Reacting to changes within the scheduled week are labor intensive for NOAA operations

Backup

- **JAXA**
  - Conduct the operations of the satellite
  - Determine and control the satellite orbit
  - Develop a mission operations plan for spacecraft and each instrument
  - Develop data acquisition plans for each ground station
  - Generate commands based on the mission operations plan and transmit them to the satellite
  - Perform range and range rate (R&RR) operations
  - Send mission operation information files to KSAT
    - Antenna request files
    - Acquisition plan files
    - Two line element files
  - Retrieve APID Sorted Data (ASD) files from KSAT and process them to Level 0 data and Level 1-3 products
  - Store all Level 0 data and Level 1 data
  - Provide sensor health and status information via a secure website accessible by authorized users
  - Provide AMSR-3 processing executables and calibration tables to NOAA/JPSS

- **KSAT**
  - Receive mission operation information files from JAXA
    - Antenna request files
    - Acquisition plan files
    - Two line element files
  - Coordinate antenna scheduling with NOAA/JPSS
  - Send mission operation information files to JAXA
    - Antenna request response files
    - Cancellation notices
    - Restriction notices
  - Acquire GOSAT-3 HSTL via X-band downlink
  - Generate HSTL ASD files
  - Generate Acquisition Result Report and Processing Result Report for each pass
  - Send GOSAT-3 HSTL files to JAXA via S-FTP
    - ASD files
    - Processing result report files
    - Acquisition result report files

- **KSAT**
  - Send HSTL IF to JPSS Pre-processors
  - Archive GOSAT-3 files locally
    - ASD files – 7 days required
    - TLE files – 7 days required
    - Scheduling files – 14 days required
    - Report files – 7 days required

Notional Roles and Responsibilities

- **NOAA/JPSS**
  - Receive mission operation information files from KSAT
    - Antenna request files
    - Acquisition plan files
    - Two line element files
  - Coordinate antenna scheduling with KSAT
  - Send mission operation information files to KSAT
    - Antenna request response files
    - Cancellation notices
    - Restriction notices
  - Receive HSTL IF from KSAT
  - Generate AMSR-3 VCDUs
  - Route and process AMSR-3 VCDUs to Level 0 and Level 1 using JAXA provided executables and calibration tables
  - Process AMSR-3 Level 1 data to higher order products
  - Archive and distribute Level 1 and higher order products to NOAA users
  - Generate GOSAT-3 mission notices and distribute to NOAA users