Weather System Follow-On—Microwave (WSF-M) Ground Overview

23 February 2022

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Acknowledgements

- Naval Research Laboratory (NRL)/Blossom Point Tracking Facility(BPTF)
  - *Josh Brooks, Station Manager*
  - *Thomas Morgan, Technical Director*
  - *Derek Neuberger, Mission Support Director*
  - *Michael Riley, Software Engineering Lead*
  - *Shannon Gilbert, Project Manager*
- Ball Aerospace
  - *Quinn Remund, Chief Engineer*
  - *Everett Hamilton, System Integration Lead*
  - *Ron Munzer, Ground Lead*
- Aerospace Corporation
  - *Bruce Thomas, Sr. Project Leader*
  - *Martha Johnson, Sr. Project Engineer*
  - *Arlene Kishi, Project Leader*
  - *Anil Agrawal, Sr. Project Engineer*

Roles on WSF-M Ground

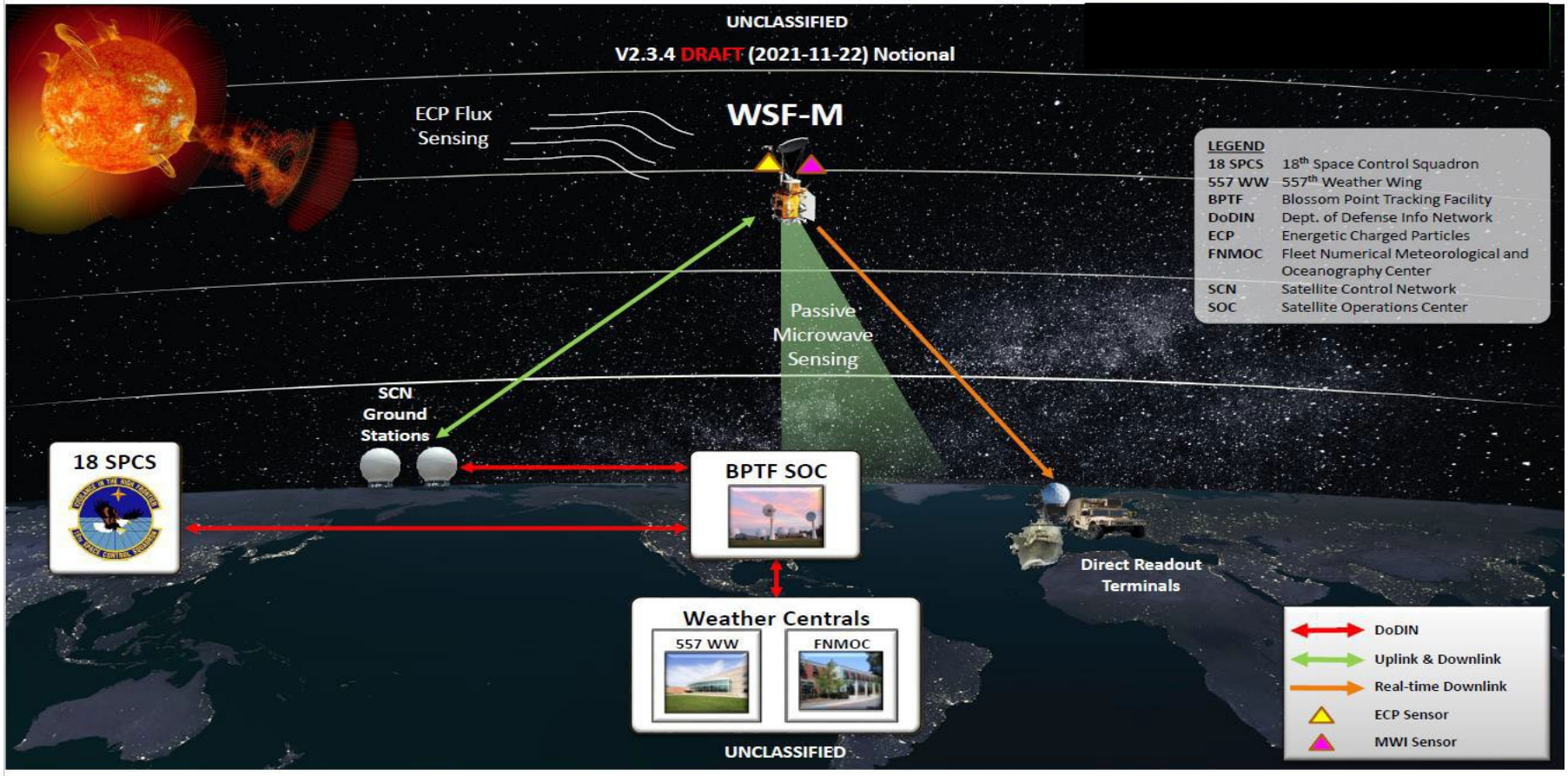
- Naval Research Laboratory/Blossom Point Tracking Facility
  - *Welcome, Maryland, USA*
  - *Government Furnished Equipment (GFE)/Subcontractor to PMO*
  - *Responsible for Ground Segment*

- Ball Aerospace
  - *Boulder, Colorado, USA*
  - *Prime Contractor*
  - *Responsible for Ground System*

- Aerospace Corporation
  - *Los Angeles, California and Omaha, Nebraska, USA*
  - *PMO Technical Support*
  - *Mission Assurance and Systems Engineering*

PMO – Program Management Office

Mission Overview – What does WSF-M do?



- Mission data is downlinked to SCN ground stations twice per orbit; routed via SCN and BPTF to Centers
- Realtime data is also continuously broadcast to Direct Readout Terminals
- External elements process the mission data and produce MWPSD
- ECP data in telemetry is processed at BPTF

SCN = Satellite Control Network
BPTF = Blossom Point Tracking Facility
EGS = Enterprise Ground Services
LEO = Low Earth Orbit
OSVW = Ocean Surface Vector Wind
MWPSD = Microwave Processed Sensor Data
TCI = Tropical Cyclone Intensity
ECP = Energetic Charged Particles

WSF-M Vitals

- Size – Stowed: 85” x 136”; deployed: 120” x 218”
- Weight – ~1240 kg (SC ~702 kg, PL ~ 271 kg)
- Power – ~ 760 W End of Life
- Altitude – 833 km (LEO)
- Orbit – Sun-synchronous Polar
  - *1800 +/- 30 min Local Time Ascending Node (LTAN)*
- Two SCN contacts per orbit
  - *Dual-Band Uplink (S & L) S-Band Downlink*
- Launch date – Q4 CY 2023,
- Mission – Enables fielded forces to perform global reconnaissance of ocean surface wind, wave conditions and tropical cyclone development and movement

Artist‘s concept of WSF-M

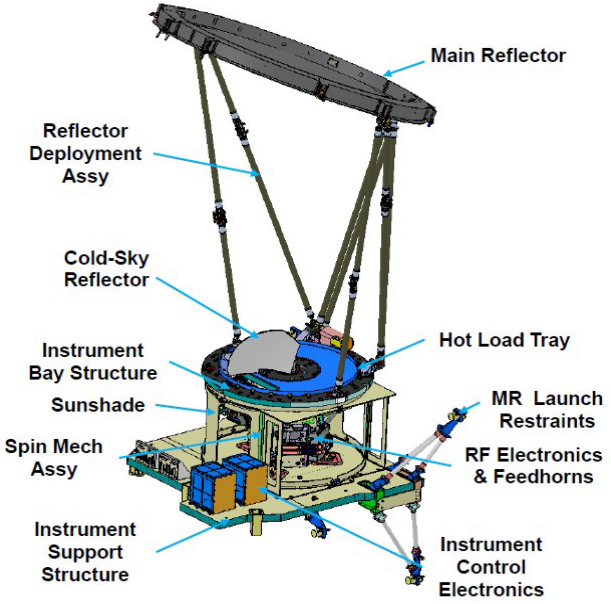
Image courtesy of Ball Aerospace

SC – Space Craft
PL – Payload
LEO – Low Earth Orbit
CY – Calendar Year

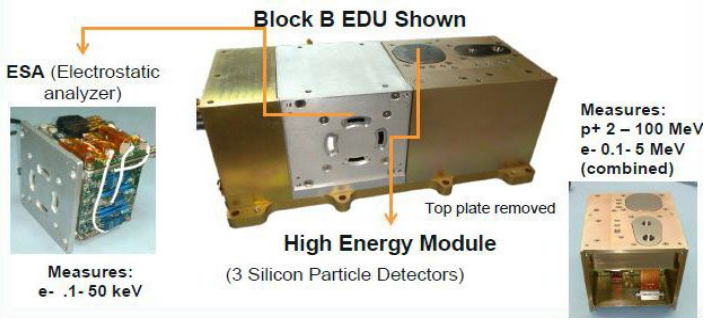
WSF-M Mission Areas

Space Based Environmental Monitoring (SBEM) WSF-M Instrumentation

- Primary Payload - Microwave Imager (MWI)
  - *Ocean Surface Vector Winds (OSVW)*
  - *Tropical Cyclone Intensity (TCI)*
  - *Snow Depth/Snow Water Equivalent (SWE)*
  - *Soil Moisture (SM)*
  - *Sea Ice Characterization*
    - Sea Ice Age
    - Sea Ice Concentration



- Secondary Payload - Energetic Charged Particles (ECP)
  - *Space Environment Awareness (SEA)*
  - *Space Domain Awareness (SDA)*



Images courtesy of Ball Aerospace

NRL/Blossom Point Tracking Facility (BPTF)

WSF-M Satellite Operations Center (SOC) location

Blossom Point Rd, Welcome, Maryland, USA

WSF-M Ground Capability Summary

- BPTF proven, mature, highly available and robust Satellite Operations Center (SOC) with dedicated local antennas
- Features “Lights Out” operation
- Existing operational interfaces to SCN and scheduling
- Existing HW / SW architecture; Neptune™ telemetry, tracking and command, Ground Resources Monitoring, automated Ground Ops well suited for WSF-M mission
- 70+% reuse “as-is”

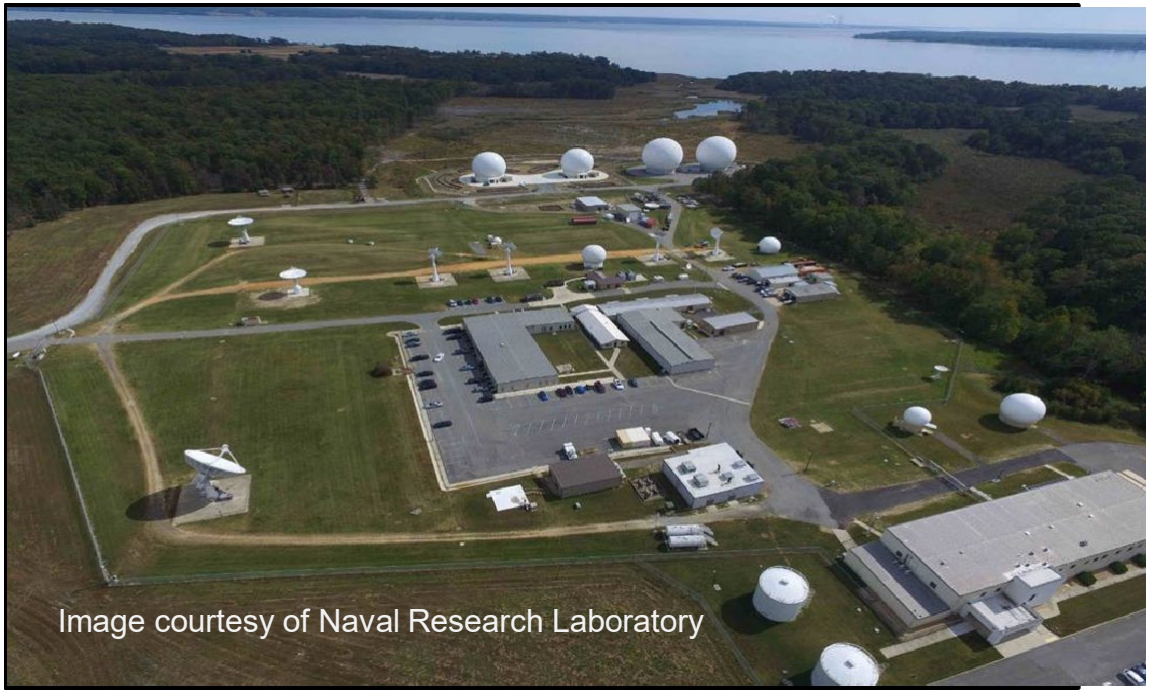


Image courtesy of Naval Research Laboratory

BPTF proven provider with existing capabilities

WSF-M Ground System Architecture

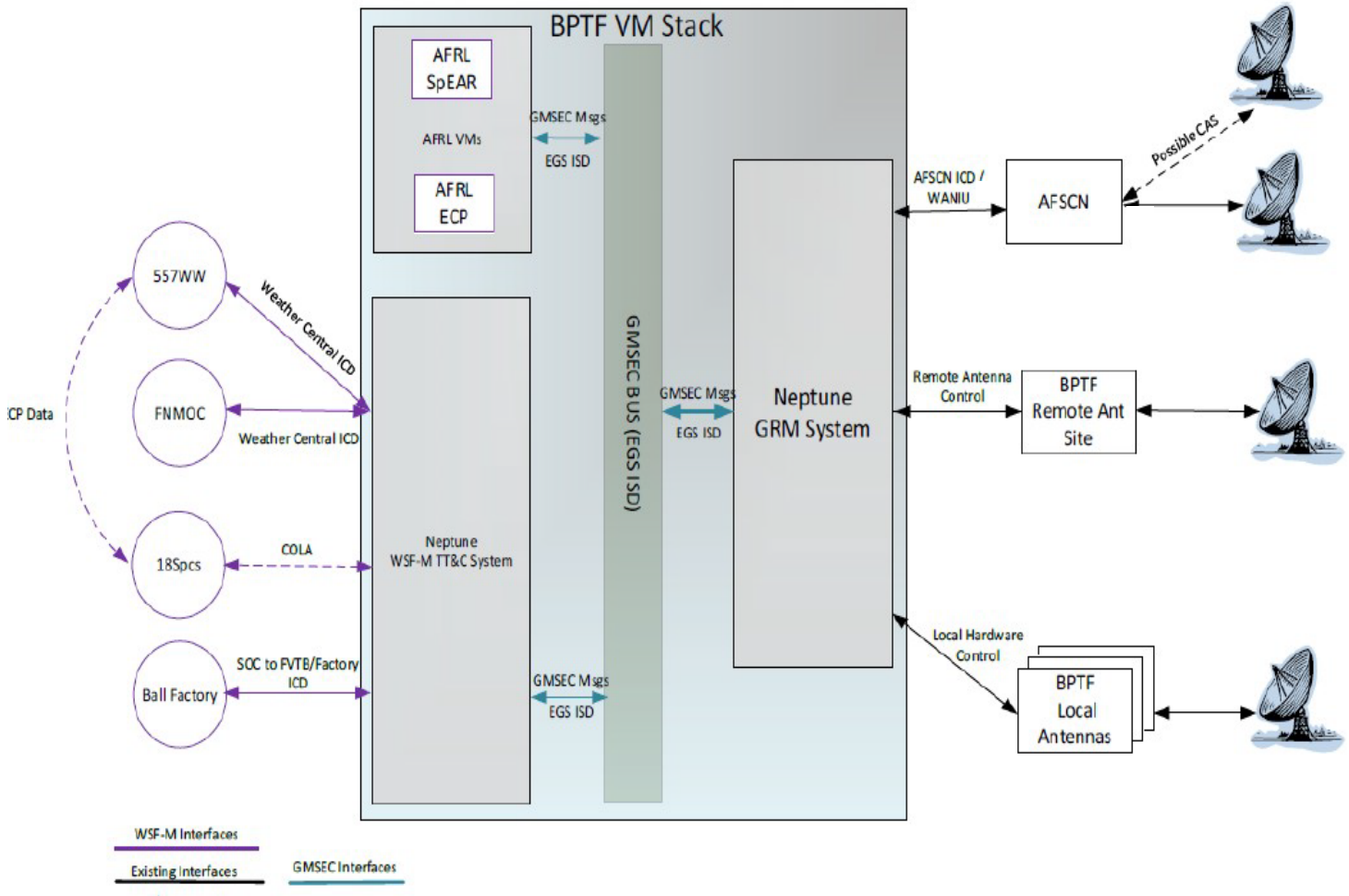


Image courtesy of Naval Research Laboratory

BPTF "Lights out" Operations

AKA Automated Ground Operations (AGO)

- In operation since 2007 at BPTF
- Primary Mission Operations performed at BPTF using Neptune® AGO
- BPTF personnel onsite (M-F 8x5), On-call 24x7
- 28 contacts/day (2 per orbit) utilizing the SCN

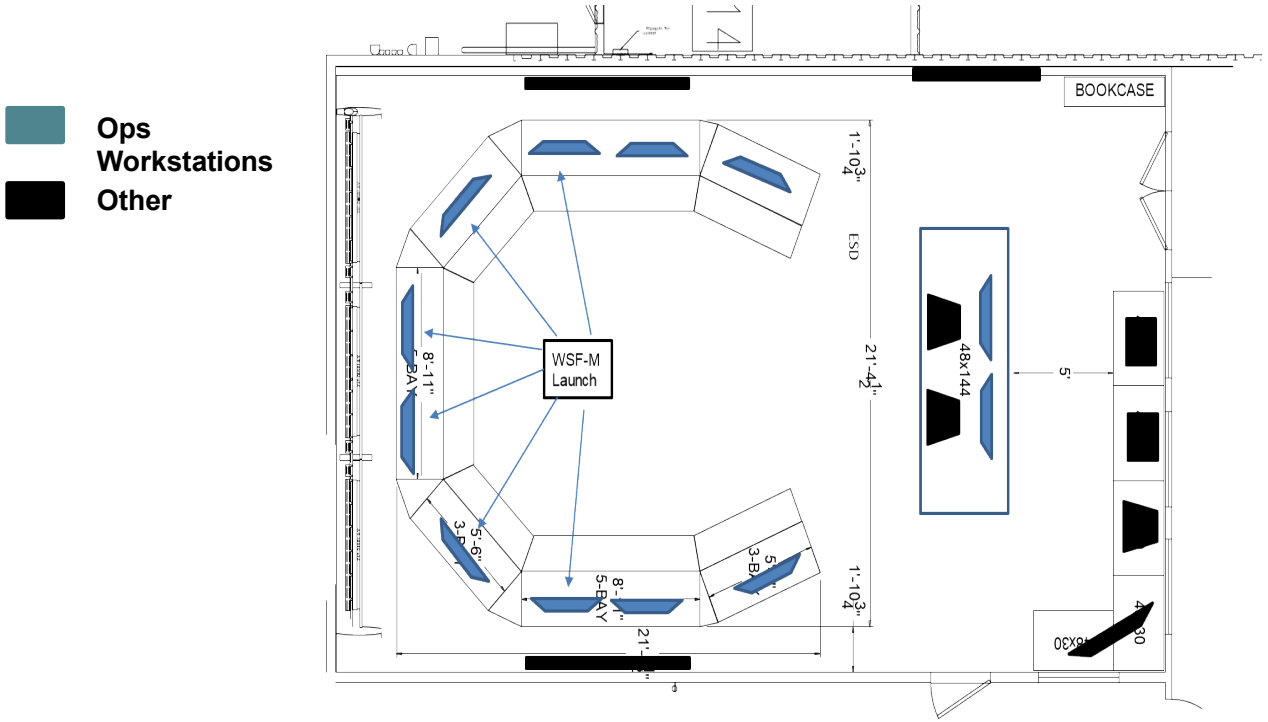


Image courtesy of Naval Research Laboratory

Automated Ground Operations

Automated Tasks

- Receive, process, refine and distribute ephemeris
- Receive and validate inputs for bus and payload tasking
- Receive and ingest schedule inputs and modifications
- Generate and load bus and payload tasking
- Schedule de-confliction
- Resource monitoring, scheduling and de-confliction
- Fault detection and resolution of spacecraft and ground station problems
- Notifications via email/text and popup
- Generate and distribute trends/reports/statistic of spacecraft and ground telemetry for engineering analysis
- Payload data processing and dissemination
- Disk space management and archiving
- Failsafe monitoring

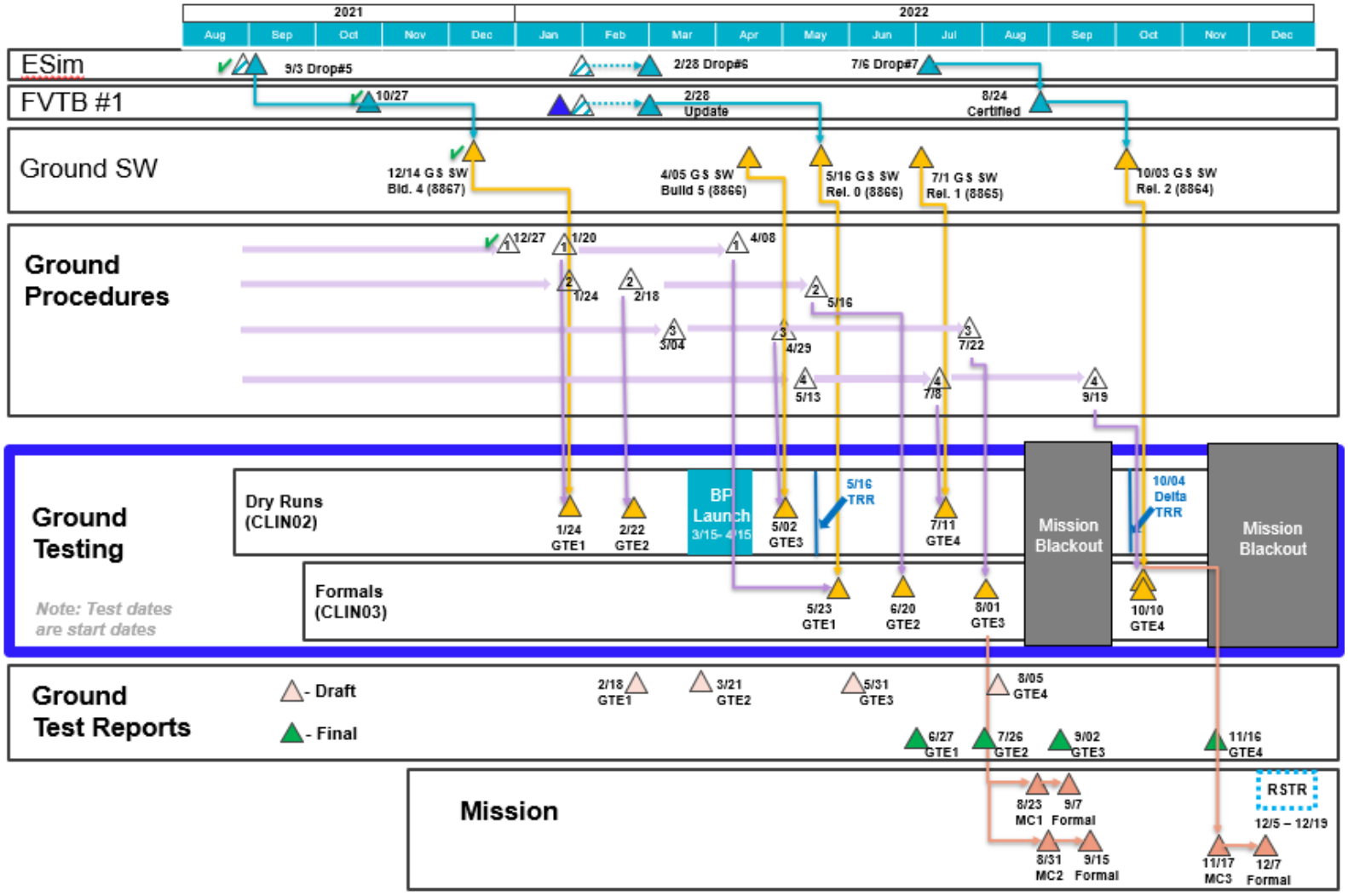
BPTF personnel onsite (M-F 8 AM – 5PM), On-call 24x7 within 1 hour to BPTF

Key Capabilities met at BPTF

Capability Description
The Ground Segment shall provide the Space Vehicle (SV) Commanding functions specified in the Ground System Capabilities Document (SCD)
The Ground Segment shall provide the Space Vehicle (SV) Communication functions specified in the Ground SCD
The Ground Segment Shall provide the SV Mission Planning and Scheduling functions specified in the Ground SCD
The Ground Segment Shall provide the SV Telemetry Monitoring functions specified in the Ground SCD
The Government Ground will decommutate Space Vehicle Data (SVD)
The Government Ground will build the mission data transfer files for transmission
The Ground Segment shall provide the SMD Routing functions specified in the Ground SCD

Ground Test Schedule

Currently in Ground Test Campaign



Other Ground Considerations

- Back up SOC & Continuity of Operations Plan (COOP)
  - *WSF-M has Continuity of Operations Capabilities – Back up SOC location identified, Fielding/Implementation tied to future funding*

- Blossom Point and Enterprise Ground Services (EGS) relationships
  - *BPTF is currently an R&D node for EGS development and will be an operational node in support of the WSF-M mission. Having efforts in OPS and R&D world, BPTF will be able to offer WSF-M early-adoption opportunities for approved services.*
  - *Operating on the EGS standard, WSF-M will be able to take advantage of potential additional antenna resources and increased redundancy and resilience for TT&C as more nodes and resources are added to the EGS network of networks in the future.*

- COVID considerations/impacts
  - *Working through travel and in-person constraints*
  - *Successful in Ground Schedule and Giver/Receiver re-baseline*

Acronym List

(U) Acronym	(U) Definition
18 SPCS	18th Space Control Squadron
557 WW	557th Weather Wing
AFRL	Air Force Research Laboratories
SCN	Satellite Control Network
AV	All View
BPTF	Blossom Point Tracking Facility
C2	Command and Control
CDM	Conjunction Data Messages
COLA	Collision Avoidance
DoD	Department of Defense
DoDAF	Department of Defense Architecture Framework
DoDIN	Department of Defense Information Network
DRT	Direct Readout Terminal
ECP	Energetic Charged Particles
ECPSDPS	ECP Sensor Data Processing Software
EO/IR	Electro-Optical/Infrared
FNMOC	Fleet Numerical Meteorological and Oceanographic Center
MWI	Microwave Imager
OSVW	Ocean Surface Vector Winds
OV	Operational Viewpoint
PL	Payload
PMO	Program Management Office
SC	Spacecraft
SOC	Satellite Operations Center
SOPS	Space Operations Squadron
SpEAR	Space Environment Anomaly Resolution
TCI	Tropical Cyclone Intensity
TT&C	Telemetry, Tracking, & Command
USSF	United States Space Force
WSF	Weather System Follow-On
WSF-M	Weather System Follow-On-Microwave

Thank you!