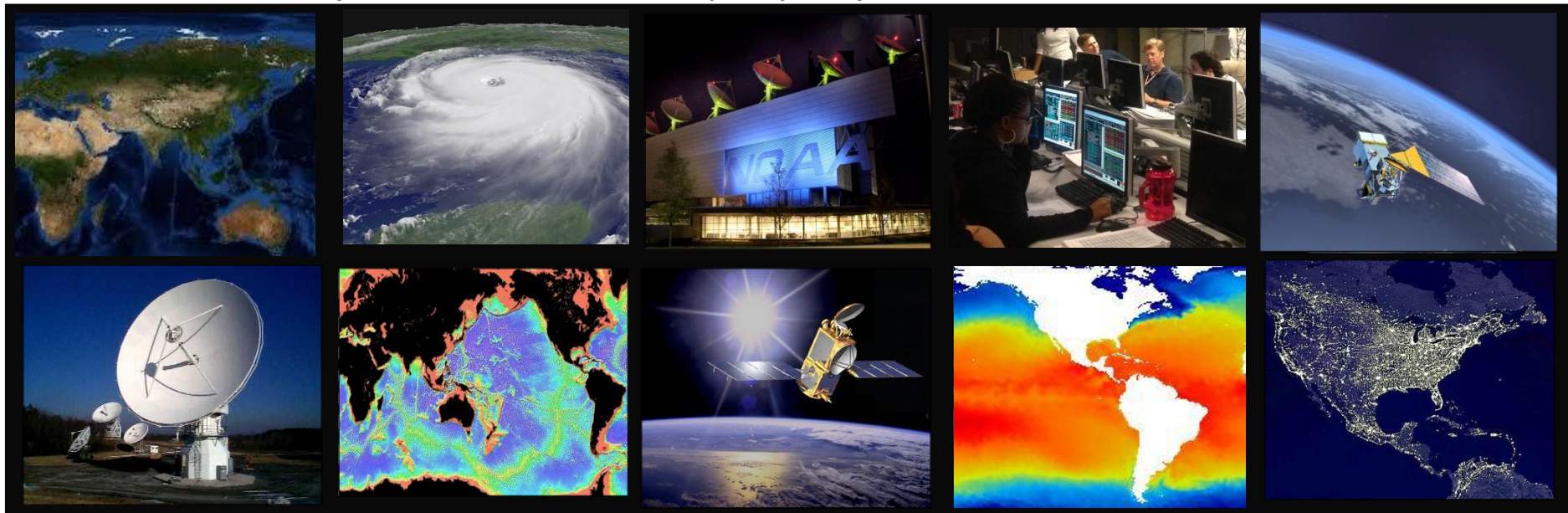


Small Satellite DCS Use Concept Validation Project

• *American security*

• *American prosperity*

• *American health*



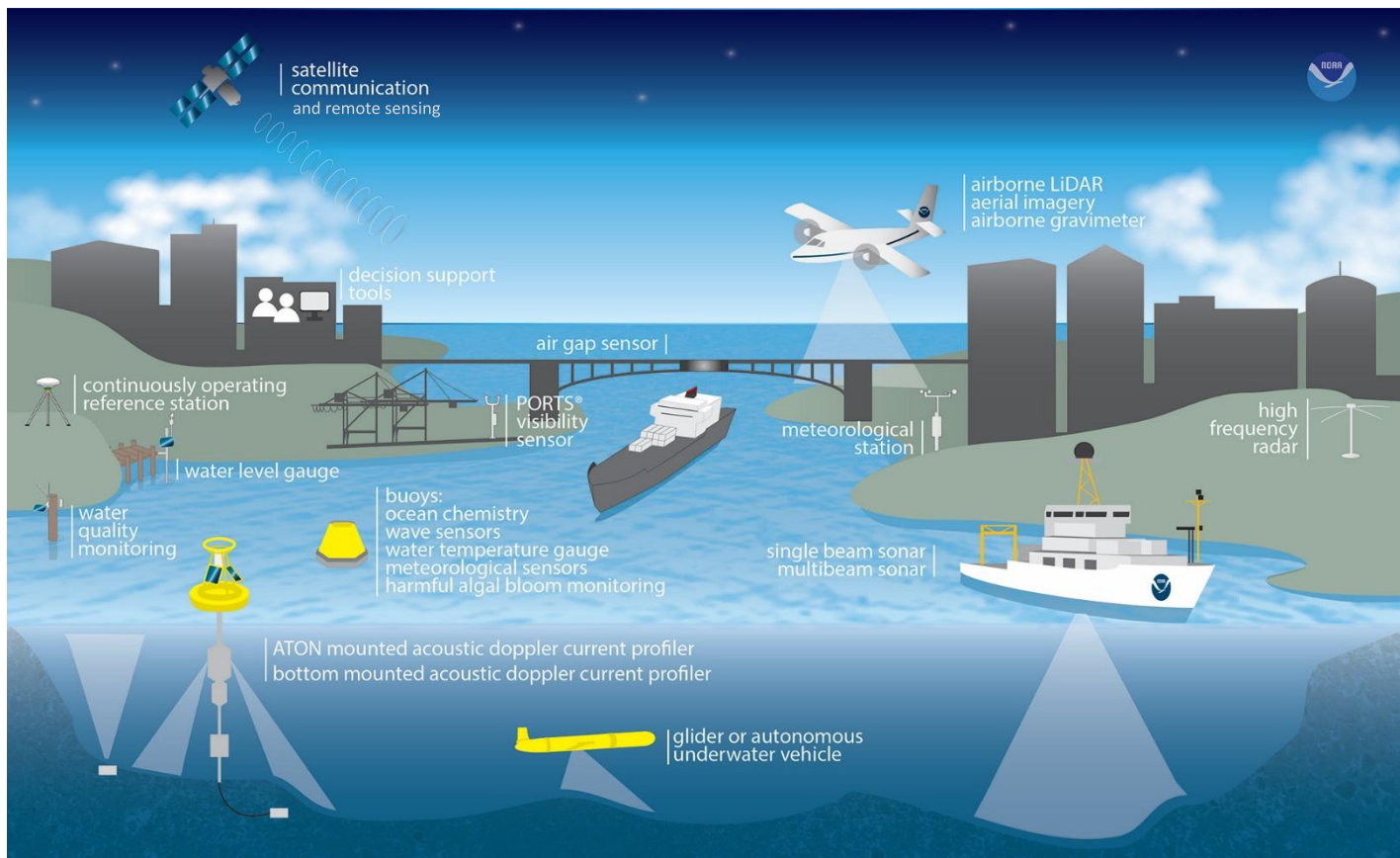
May 5, 2020

GOES DCS Technical Working Group (TWG) Meeting

Beau Backus

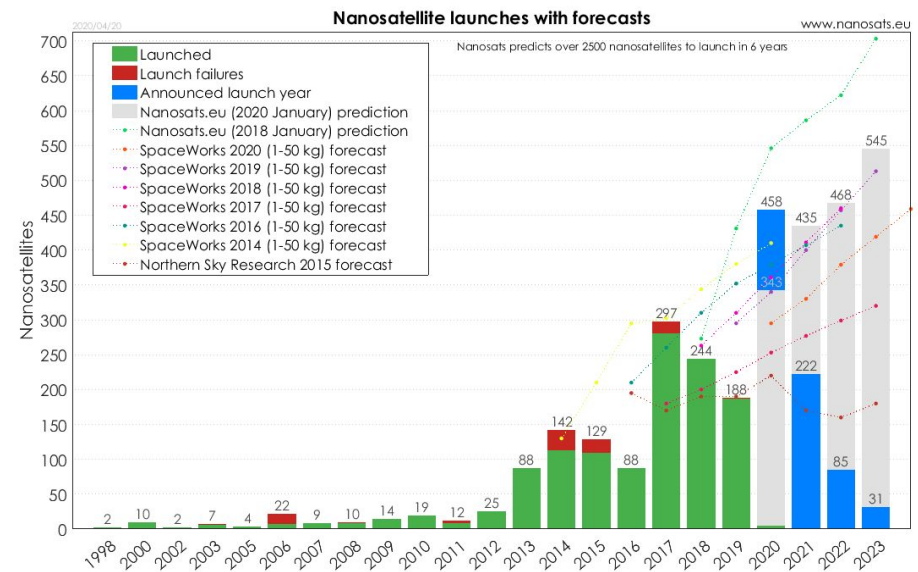
NOAA/NESDIS Spectrum Management

Spectrum: A Critical Resource Enabling NOAA Missions



Issue: Growing Demand for 400 MHz

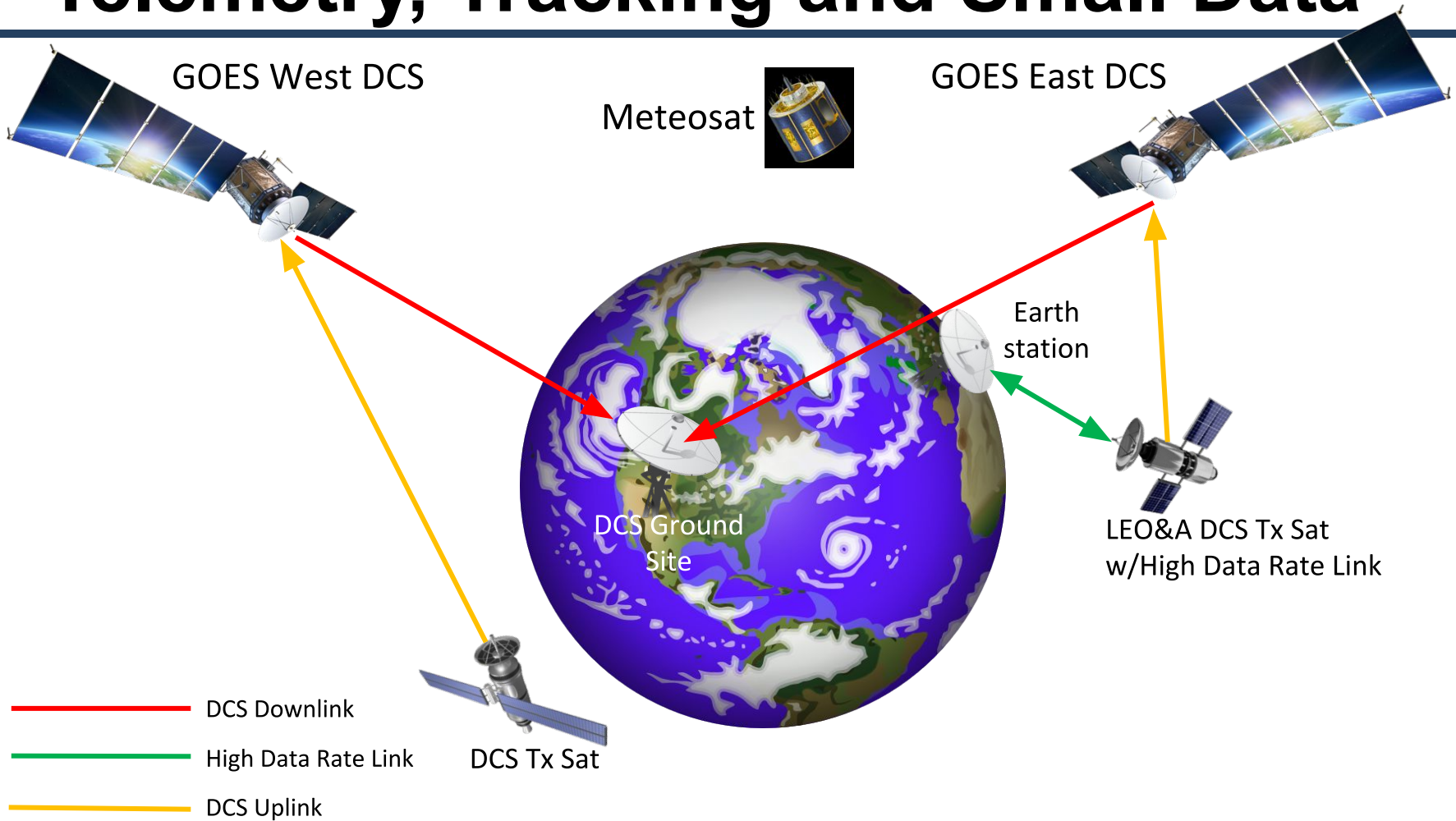
- DCS Transmitters, located throughout the United States & Protectorates (US&P) as well as many other countries, use the 401-402 MHz band to uplink data to the DCPR on GOES (and other) satellites in GEO and non-GEO.
- Satellites are also allocated to use this band (space-to-Earth) for space operations purposes.
 - Typically, these satellites transmit in all directions relatively equally and thus also radiate in the direction of GOES and other DCS receiving satellites.
 - This energy, aggregated across multiples of these satellites (even multiples of constellations) is expected to become an increasingly significant source of RFI to the DCS system over time.



DCS – Data Collection System
DCPR – Data Collection Platform Radio
RFI – Radio Frequency Interference

and remote sensing

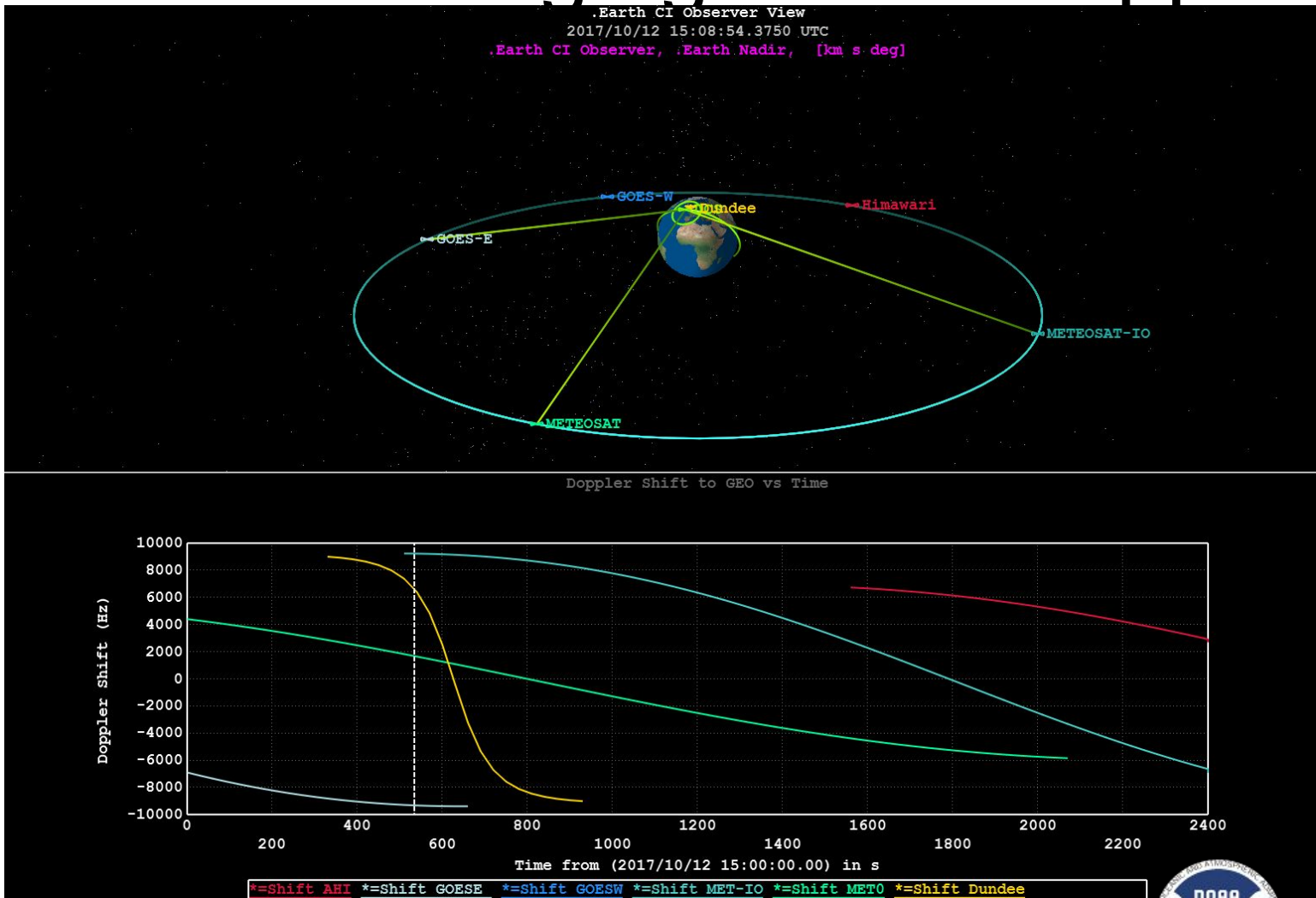
Concept: Use of DCS for Satellite Telemetry, Tracking and Small Data



TechEdSat (TES) Sat DCS Mission

- TES-10+ is a proof-of-concept using basic HW/SW for initial success – and then incrementally advanced
- Experiment is to be conducted at 3 altitudes corresponding to 3 altitude tables resident on the Microcom DCS radio hosted on the TES-10 cubesat
- The experiment will be conducted multiple times at the 3 altitudes, with an interim for the power system to recharge
- Success criteria is data transfer from TES-10 to GOES and back through DCS channels to mission

Most Challenging Issue: Doppler



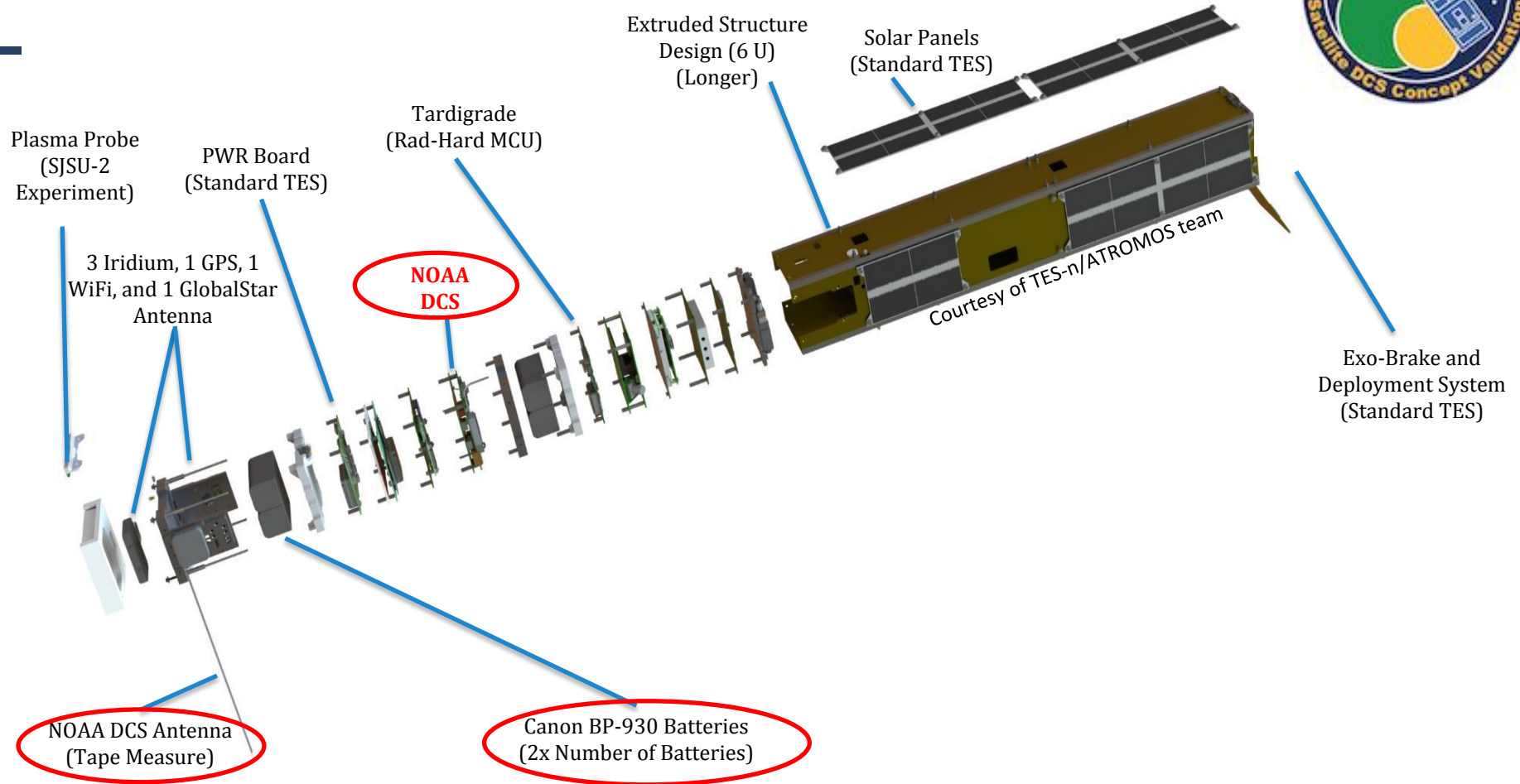
Satellite Connectivity to DCS



- The DCS transmitter on board the S/C will use GPS from the S/C.
- System will turn on for the periods allocated by DCS system
- Analysis being done to account for Doppler shift to other DCS receivers
- Interface definitions established between the S/C host and the DCS board design team
- Final testing completed and satellite transported to ISS on NG-13.

S/C – Space Craft
ISS – International Space Station
NG-13 – ISS resupply launch by Northrop Grummen

TechEdSat-8



TES8/
PS8

S/C – Spacecraft SJSU – San Jose State University
TES – TechEdSat

Satellite DCS Use Test Status

- TechEdSat-8
 - Satellite Failure
 - loss of solar power charging after check-out and early tests
 - suspected cause is from Li-ion battery protection circuitry
 - No actual testing of Satellite DCS use prior to failure
- TechEdSat-10
 - Awaiting ISS ejection in late June/early July
 - Test concept for satellite DCS use
 - Some tests to be conducted without Doppler correction
 - Plan for ground site collection for additional validation
 - Work with EUMETSAT on detecting TES-11 tests
 - Develop and implement DMOD support to Doppler shift

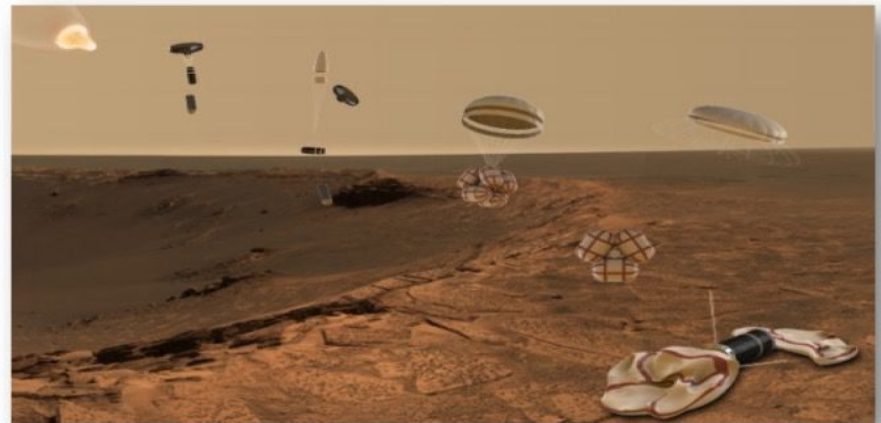
Satellite DCS Use Test Status *(cont.)*

- TechEdSat-11 (Resource Dependent)
 - International DCS testing with EUMETSAT/Meteosat
 - Develop an operational case for satellite use of DCS
 - Remove Doppler correction
 - Use Modified DMODs to support Doppler shift
 - Use random transmit DCS channels
 - Enable command selection between 300 bd/100 bd with respective modulations
 - Command select frequency/channels
 - Launch in late 2020/early 2021

Potential Satellite DCS Use

Future Work

- Develop two-way communications (via GOES)
- Use of higher data rates (1200/1600 baud)
- Alternative modulation schemes for improved efficiencies
- Exploring potential use of DCS for monitoring the surface of Mars



Courtesy of TES-n/ATROMOS team

Conclusion

- The 401-402 MHz band is under pressure from smallsat constellation companies to use for their systems
 - NOAA is working with these companies and with the spectrum regulatory authorities, but effective, long-term solutions remain elusive.
 - Satellite use of the DCS system is expected to alleviate some risk and further strengthen the value of protecting the system
- Issues can be resolved through engineering or policy.
 - No issues deemed to be insurmountable
- We expect to validate the satellite DCS use concept within the next three months.
 - Approach could also be used by the international DCS community, expanding the availability of DCS satellite use of the international DCS bands globally.

A photograph of a satellite in space, showing its large solar panel arrays and various instruments. The Earth's horizon is visible in the lower half of the frame, with a small satellite in the distance. The text "Thank you" is centered in the middle of the image.

Thank you

