2022

Small Satellite DCS Use as an Operational Concept

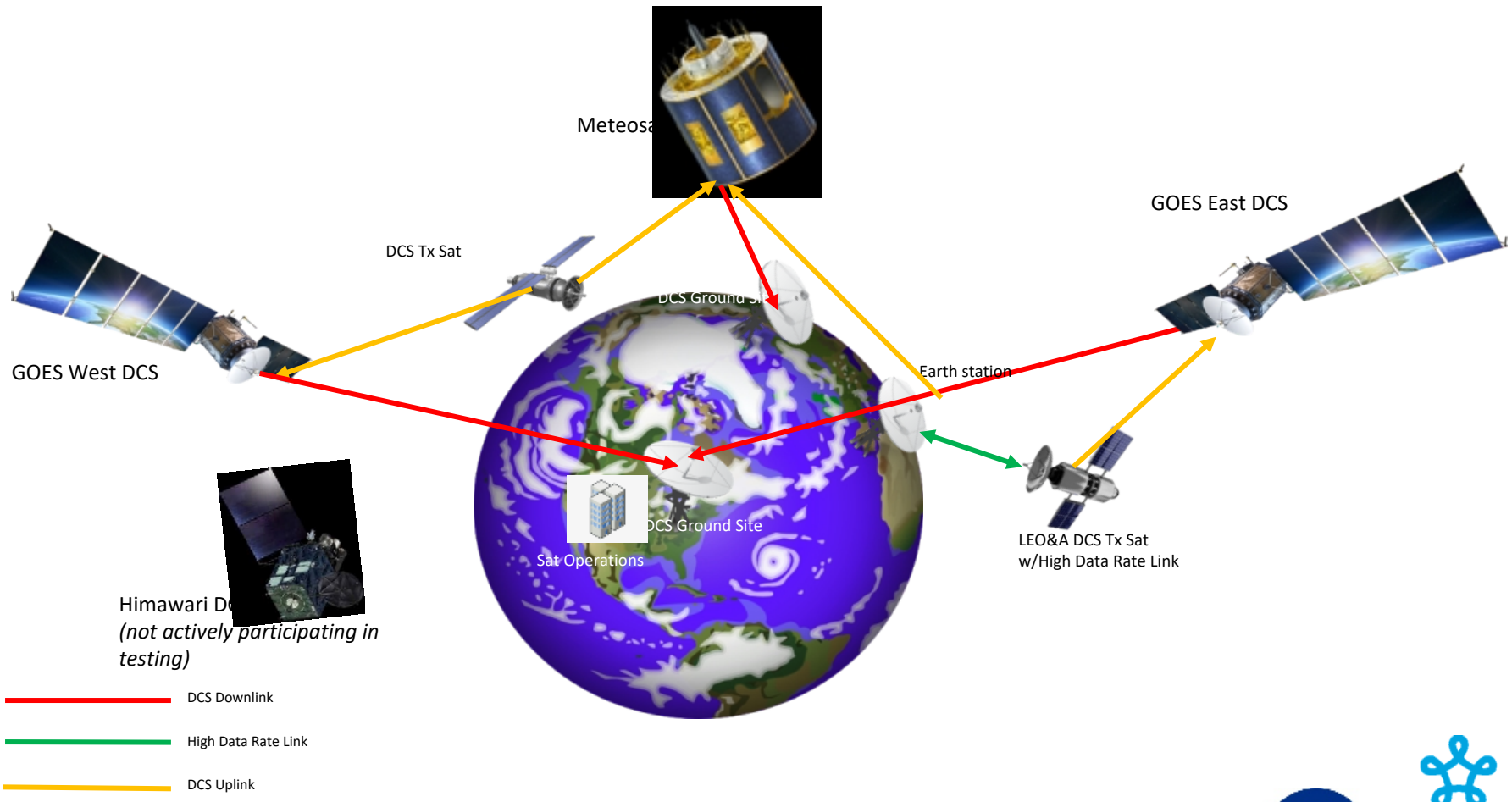
- A Status Update

Presented to CGMS-51 Working Group 1 session, agenda item 8.9

Executive summary of the WP

- The Satellite DCS Use Concept Validation project was originally scoped to determine if satellites can successfully interface with the Data Collection System (DCS) receivers (DCPR) and thus provide a low-rate data (100, 300, or greater bps) service to satellite users.
- Satellite use of the DCS fosters a new means for collecting and distributing meteorological and climatology data. This can be done using DCS equipped smallsats in polar orbits.
  - With a commanding capability be implemented in GOES, this DCS equipped smallsat could also relay these commands from other DCS systems.
- The initial concept has been successfully validated with TES-10.
- The concept is valid and DCS can be utilized to some degree by satellites.
  - The launch and operation of TES-11 will provide a more significant validation of the operational challenges of this concept.
- Best practices for access and protections will need to be considered by CGMS and the DCS hosting agencies once this second test is concluded.
- An agreement will need to be reached regarding the permitted use of DCS by satellite systems and under what conditions.
  - It is expected that the task group on Data Collection Services under WG I will prepare for an initial agreement discussion at CGMS-52.

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



Coordination Group for Meteorological Satellites

CGMS

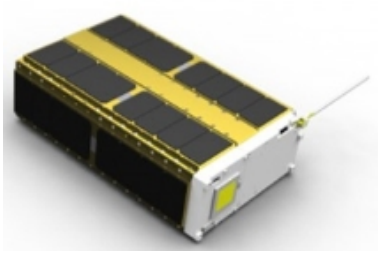
Purpose and Benefits of Sat DCS Use Project

- Identified as a risk mitigation factor in partially protecting DCS users from aggregate RFI as a result of increased use of the 401-402 MHz band.
- Determine if the Data Collection System (DCS) can support satellites equipped with data collection platforms (DCPs).
- Provide an alternate approach for smallsats to use the UHF band (401-402 MHz) in a shared manner with other DCS users.
- Enable use of DCS for satellite derived climatology and meteorological data
- Establish increased use of international DCS channels and interoperability with other DCS service providers.
- Provide sufficient data for NOAA and the CGMS to determine if use of DCS by satellites is to be made available and, if so, the requirements necessary for it to be granted.
- Use of DCS by satellite systems will enable low-data rate communications from any point in orbit to satellite ops team at any time.
- Can potentially be used to expand reach of DCS to arctic/polar regions

Satellite DCS Use Concept Validation Project Status

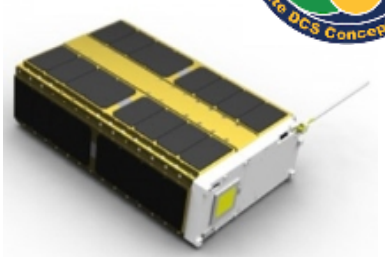
TechEdSat-10

- Completed validation portion of testing and re-entered atmosphere 15 Mar 2021
- Satellite transmissions through DCS successful
- **Project goal achieved**



TechEdSat-11

- Cooperative International DCS testing with EUMETSAT (JMA Observing)
- Develop an operational case for sat use of DCS
- Goal is to validate an operational capable use of DCS by small satellites



TechEdSat-12

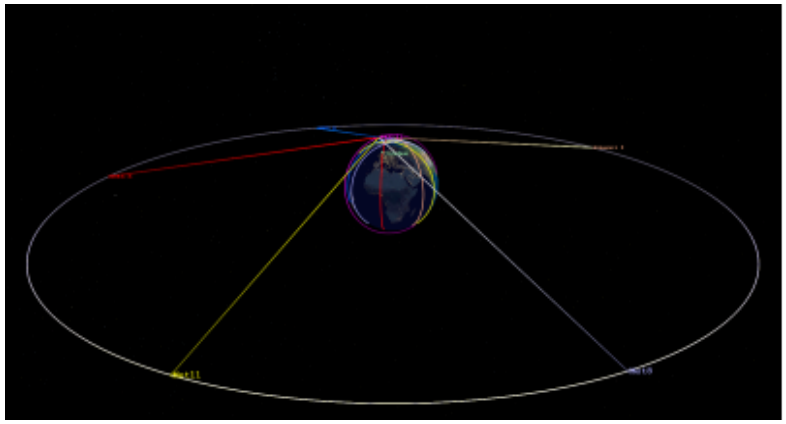
- Expected to launch during TES-11 operations in 2nd to 3rd QTR 2023.
- Will carry a DCS satellite payload.
- Enables opportunity for a dual DCS satellite test scenario

Coordination Group for Meteorological Satellites

Satellite DCS Mission Goals

TechEdSat-11

- Demonstrate that DCS messages of varying sizes can be reliably transmitted from a LEO platform and received on the ground through the GOES and Meteosat DCPR systems, error-free.
- Additional performance characterization of the LEO transmitter interoperability with the three to four available DCPRs.
- Demonstration of an extended message transmission and/or potential future operational scenarios involving LEO DCS UHF transmitters.



TES-11 in Polar Orbit communicating with GOES and Meteosat. TES-11 will be visible to and will coordinate operations with GOES, Himawari, and Meteosat DCPRs.

TES-11 Success Criteria

- Primary Mission Success
  - TES-11 successfully transmits a message to at least two of the four DCPRs (hosted on GOES and Meteosat; at minimum one of GOES and one of Meteosat)
  - Message is received error-free by the associated ground-based DCS demodulators and is retrieved by the mission operations team.
    - Goal: Demonstrate the above at least 5 times
    - Goal: TES-11 will reach at least three DCPRs within one orbit.
    - Goal: TES-11 will successfully transmit messages that will be received simultaneously by a GOES and Meteosat hosted DCPR.
    - Goal: TES-11 will successfully transmit single messages that will be received error free by a Meteosat and by a GOES hosted DCPR using an iDCS channel.
    - Goal: Demonstrate long duration error free message transmission and reception, e.g. > 2 minutes (TBR – analyzing heating factors)
- Minimum Mission Success
  - Successfully completing first bullet above

iDCS Channel Use with Satellite Use Concept

Satellite Shared Use Channels

Ch #	Use	Frequency (MHz)
1	Fixed	402.0355
2	Fixed	402.0385
3	Random	402.0415
4	Random	402.0445
5	Random	402.0475
6	Random	402.0505
7	Random	402.0535
8	Random	402.0565
9	Random	402.0595
10	Fixed	402.0625
11	Fixed	402.0655

- DCS channels are used either by fixed timing or random access *(Alert Mode)*
  - Random permits changing data Tx rates
- Satellites best for random access channels
  - Allows for Doppler shift in frequency
- Will fit in iDCS channels as shown
  - Both terrestrial and space users can share channels
  - May need to relocate some incumbent users, that don't require the unique iDCS capabilities, out of the iDCS channels

Conclusion

- DCS systems have been under pressure from small satellite constellation companies that wish to increase use of this band for space operations.
  - Satellite use of the DCS system is expected to alleviate some risk and further strengthen the value of protecting the system.
- Satellite use of the DCS may also foster a new means for collecting and distributing meteorological and climatology data.
- The initial concept for Satellite use of DCS has been successfully validated.
  - **The concept is valid and DCS can be utilized to some definable degree by satellites.**
- The launch and operation of TES-11 will provide a more significant validation of the operational challenges of this concept.
  - The TES-11 demonstration will be complete by the end of 2023 if our launch occurs as expected.
  - An additional experiment involving both TES-11 and TES-12 as dual DCS hosting satellites may be possible in 4th QTR of 2023.
- **Once this second stage of our project is completed, then the more important and challenging phase of determining a policy for satellite use of DCS by the respective organizations and CGMS on this matter should begin.**

Key issues of relevance to CGMS:

- ☐ Evolution of DCS use to include satellites will need a best practice from the CGMS and the respective organizations should have procedures for that use established
- ☐ New use and channel plan for international channels
- ☐ Reference to HLPP 2.1.2

To be considered by CGMS:

- ☐ For information at WG-1 and consideration by TGDCS