2022 TWG Spring Technical Review Meeting

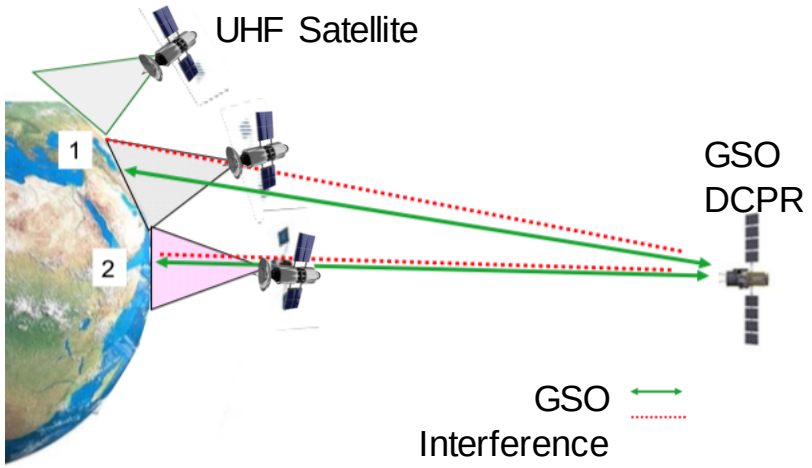
Satellite DCS Use Concept Validation Project

NOAA
Satellite and Information Service

May 10, 2022

Beau Backus, JHUAPL, supporting
NOAA Satellite and Information Service

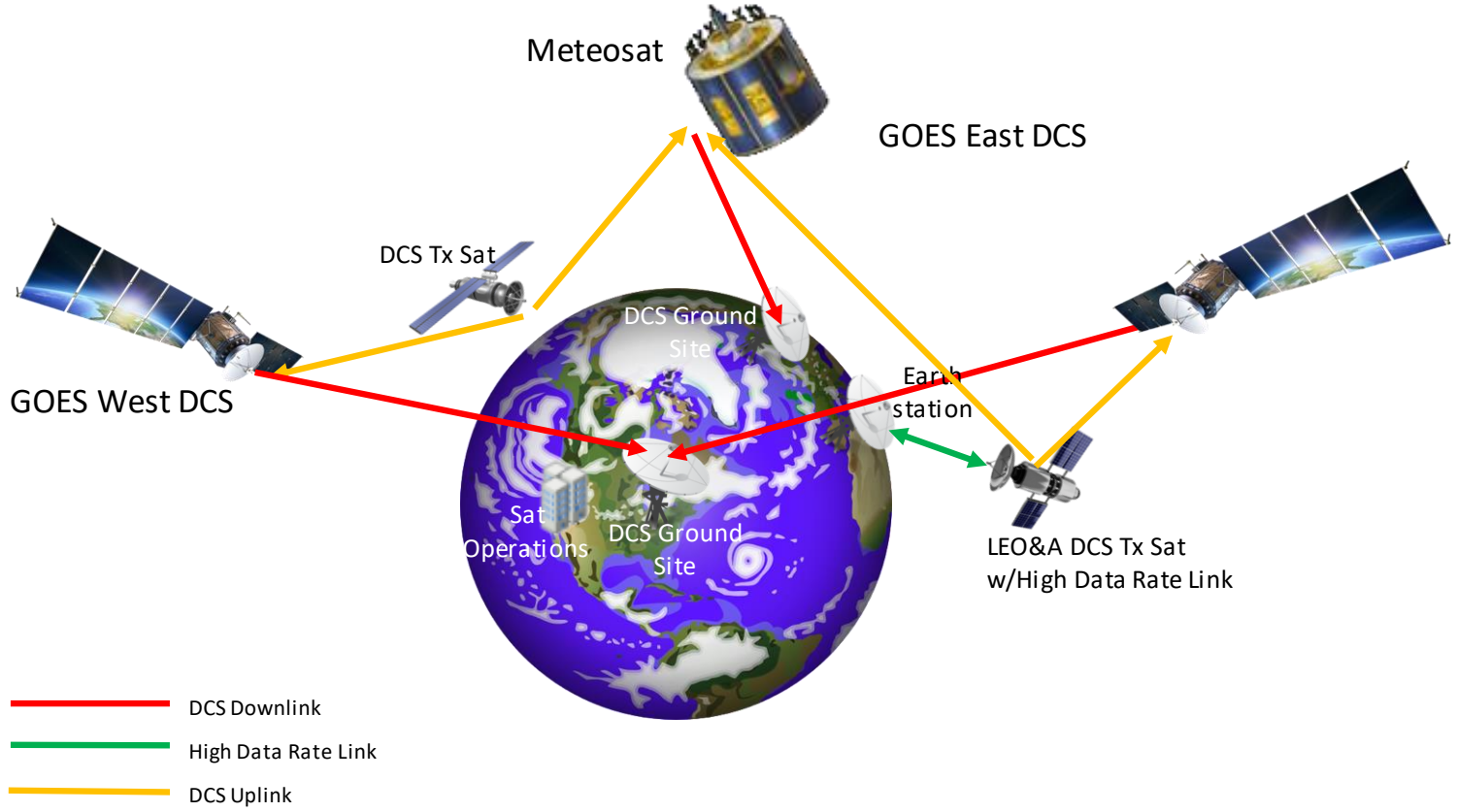
MetSats and Space Ops in 401-402 MHz



- DCS Transmitters (met aides) use the 401-402 MHz band to uplink data to the DCPR on GOES (and other DCPR equipped) satellites
- Satellites are also allocated to use this band (space-to-Earth) for space operations purposes.
  - Typically, these satellites transmit with omni antennas and so they inadvertently also radiate in direction of the DCS receiver on GOES, etc.
- Spacecraft with omni antennas increasing in numbers, resulting in a heightened need to protect DCS from RFI, which is difficult and costly to resolve.

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

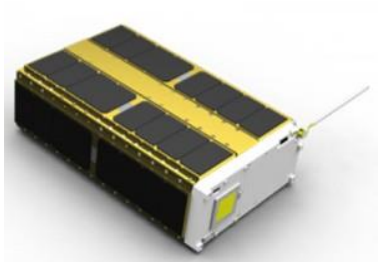
Concept: Use of DCS for Satellite Telemetry, Tracking and Small Data



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.

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

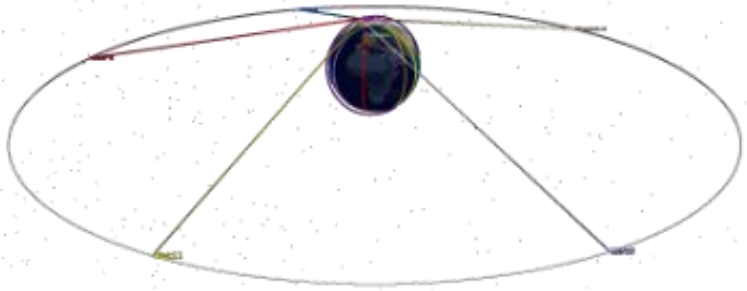
- Cooperative International DCS testing with EUMETSAT (JMA Observing)
- Develop an operational case for satellite use of DCS
- Goal is to validate an operational capable use of DCS by small satellites

TechEdSat (TES) DCS Mission

- TES-10 was a proof-of-concept using basic HW/SW for initial success.
- The experiment was conducted multiple times, with a pause between each test sequence to allow the power system to recharge
- Success criteria is data transfer from TES-10 to GOES and back through DCS channels to mission operations team
  - Success criteria accomplished on 20 Aug 2020

Satellite DCS Scope

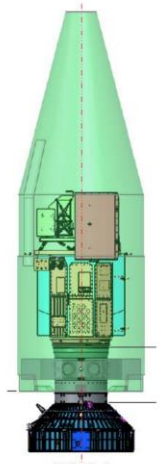
- **TechEdSat-11**
  - Demonstrate that DCS messages of varying sizes can be reliably transmitted from a LEO platform and received on the ground through the GOES and Meteosat DCPR systems, error-free.
  - Additional performance characterization of the LEO transmitter interoperability with the four DCPRs.
  - Demonstration of an extended message transmission and/or potential future operational scenarios involving LEO DCS UHF transmitters.



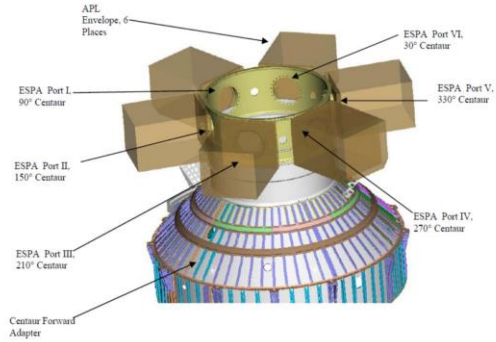
TES-11 in Polar Orbit communicating with GOES and Meteosat. TES-11 will be visible to and will coordinate operations with GOES, Himawari, and Meteosat DCPRs.

TES-11 Delayed Launch to Sep 2022

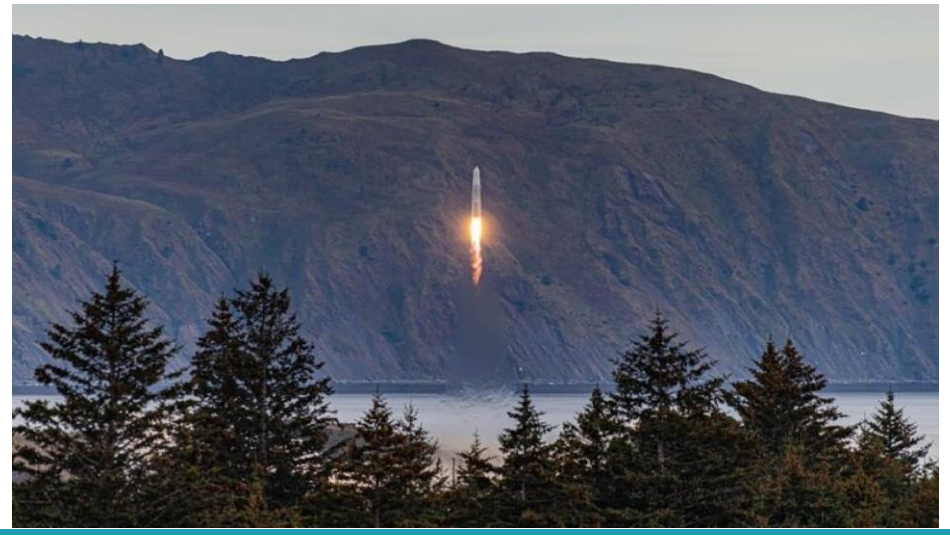
- TES-11 de-manifested from the Landsat-9 launch.
  - De-manifesting of TES-11 from Landsat 9 due to a SIN/VIB (sinusoidal vibration test) failure of the ESPA (Evolved Secondary Payload Adapter) ring
- New ride-share for TES-11 is an ASTRA launch which will place TES-11 in a 490 km near polar orbit at ~85 degrees inclination.
- Launch location is Kodiak, Alaska.
- Current launch date is 4 Aug 2022.



Landsat 9 with an ESPA Ring



USAF and NASA Payloads on the Landsat-9 Mission (Atlas-V)



TES-11 Testing Phases

- The operation phases for TES-11 are driven by the TES-11 near polar orbit and the addition of the Meteosat platform.
- Will demonstrate aspects of potential future operational scenarios as well as on-orbit performance characterization using the two DCS platforms:
  - The number of commands available to configure the Microcom DCS transmitter on-board TES-11 have been significantly expanded allowing operation in modes and frequencies not possible with TES-10
  - The near polar orbit will allow long periods of visibility where Doppler correction is not needed; Phase I and Phase II will utilize Doppler correction off and Doppler correction on (respectively)
  - Phase III will investigate use cases where data transmission occurs when TES-11 can be viewed by two different systems
  - Phase IV will investigate additional details of demodulation performance for each of the systems
- For TES-11 we will have capability to conduct multiple campaigns, involving GOES and Meteosat together, to demonstrate the concept for DCS to provide practical, continuous, and global communication from LEO satellites.

iDCS Channel Use with Satellite Use Concept

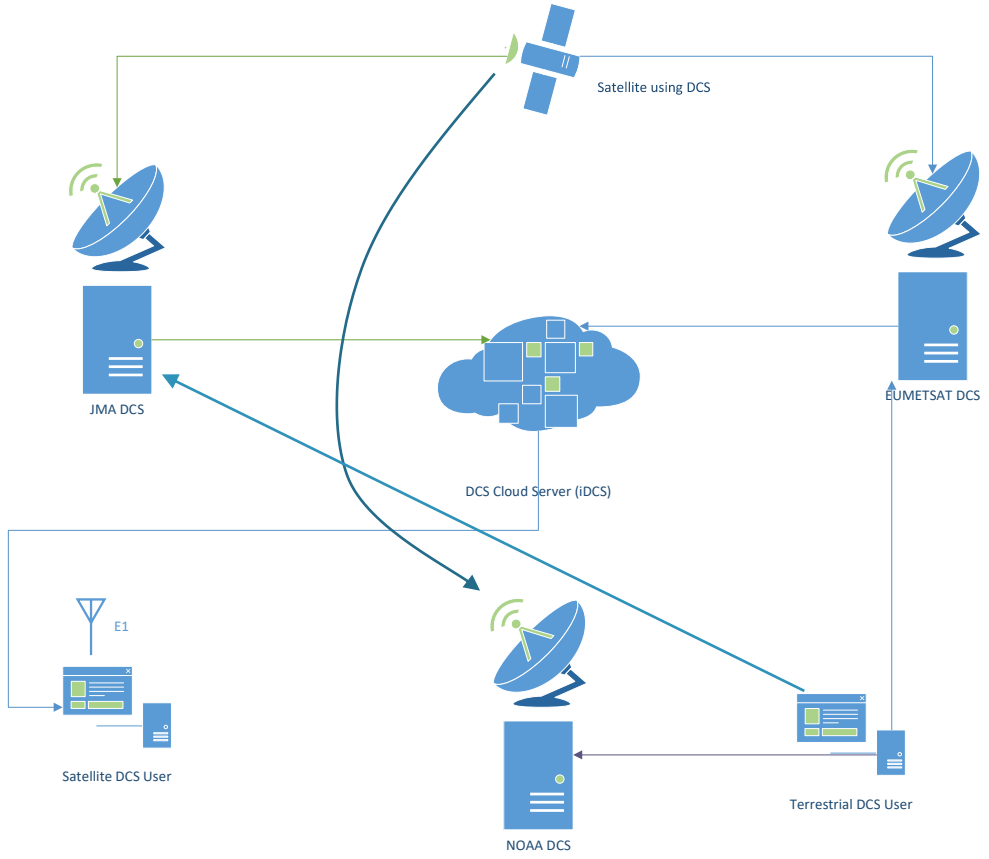
Ch #	Use	Frequency (MHz)
1	Fixed	402.0355
2	Fixed	402.0385
3	Random	402.0415
4	Random	402.0445
5	Random	402.0475
6	Random	402.0505
7	Random	402.0535
8	Random	402.0565
9	Random	402.0595
10	Fixed	402.0625
11	Fixed	402.0655

Satellite Shared Use Channels

- 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
- Would 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

Possible Cloud Interface Concept to Provide Single Source Satellite Data Interface

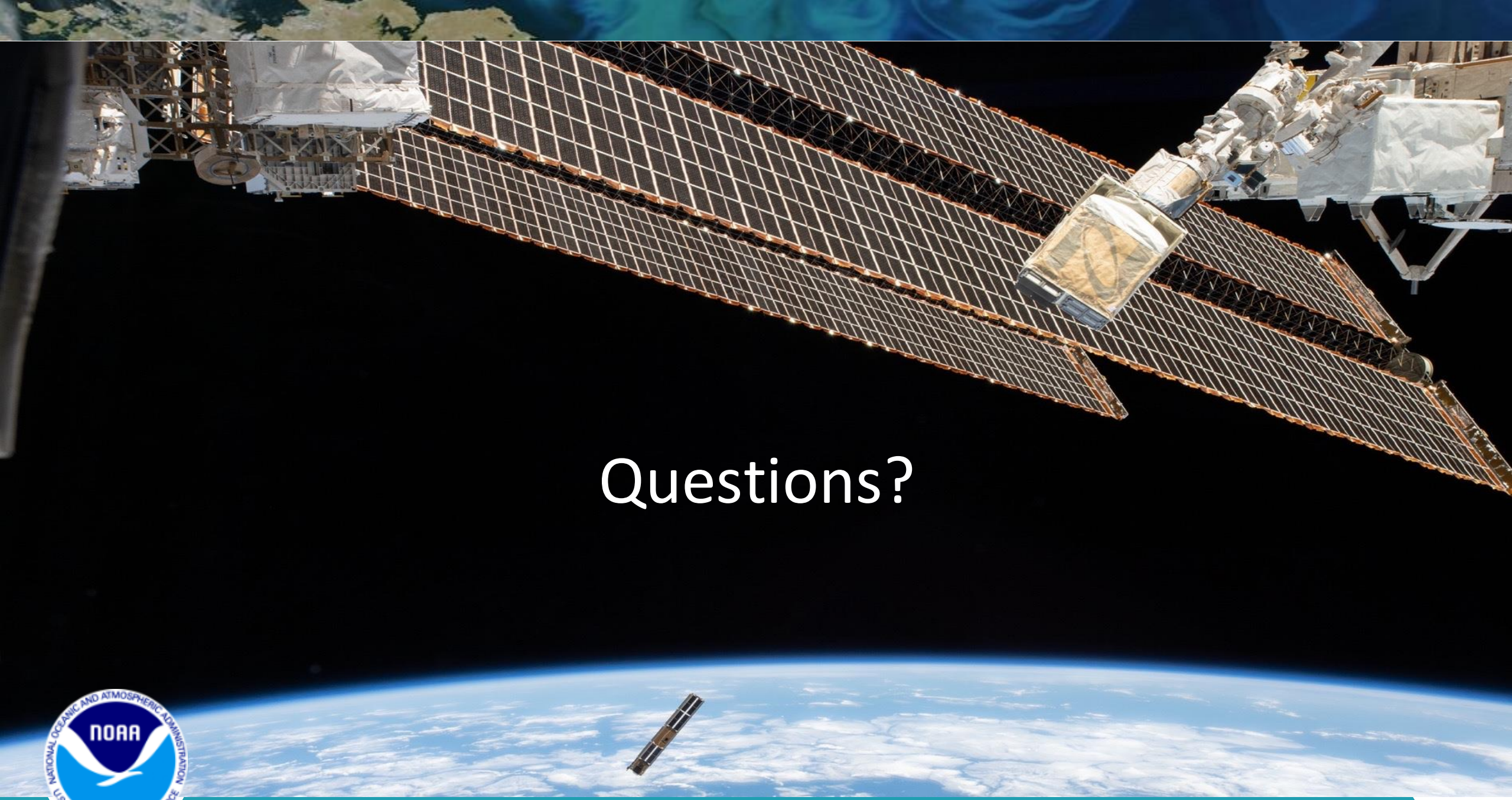
Sat DCS Users would use a single "cloud" server that links to all 3 systems – using iDCS channels.



Terrestrial users use their subscribed DCS data source, as they do currently (i.e. JMA, NOAA, or EUMETSAT)

Conclusion

- DCS systems have been under pressure from small satellite constellation companies that wish to increase use 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 through 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.
  - The TES-11 demonstration will be complete by the end of 2022 if our launch occurs as expected.
- Once this second stage of our project is completed, then the more important and challenging phase of determining policy by the respective organizations and CGMS on this matter should begin.



Questions?