GOES Data Collection System (GOES-DCS)

Report of the 122nd GOES DCS Technical Working Group Meeting: Wednesday, March 21, 2018

at the

Embassy Suites
3974 NW S River Drive
Miami, FL 33142

Richard Antoine - GOES DCS Program Manager - NOAA/NESDIS/OSPO/SPSD/DSB
Scott Rogerson – Argos Program Manager - NOAA/NESDIS/OSPO/SPSD/DSB
Letecia Reeves – GOES DCS Customer Liaison - NOAA/NESDIS/OSPO/SPSD/DSB
Valerie Randall - Science Systems and Applications, Inc. (SSAI) - NOAA/NESDIS/OSPO/SPSD/DSB
Jason Dong - Science Systems and Applications, Inc. (SSAI) - NOAA/NESDIS/OSPO/SPSD/DSB
Paul Seymour - Systems Integration & Development, Inc (SID) - NOAA/NESDIS/OSPO/SPSD/DSB

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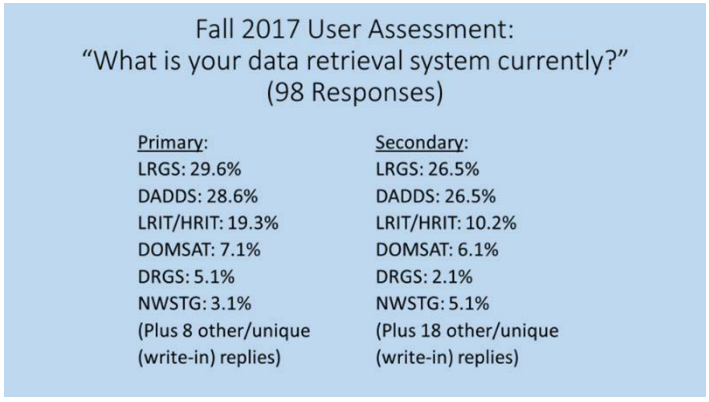
1.0: Introductory Remarks – Scott Rogerson / Rich Antoine – NESDIS/OSPO/SPSD/Direct Services Branch

Scott Rogerson formally opened the meeting and welcomed everyone, then made introductory remarks. He stated that NOAA had an exciting year in 2017-2018 with GOES-16 becoming the operational GOES-East and the GOES-17 launch. He detailed the reason that we did not hold meetings at the NOAA Satellite Conference in New York and the following decision to hold this set of meetings in Miami. He then introduced Richard Antoine as the new GOES DCS program manager for NESDIS/OSPO (as of 21 Feb).

Rich provided a summary of current GOES DCS challenges & opportunities and reviewed the agenda for today's meeting.

- Transition(s) to GOES-R series:
  - GOES-16 Transitioning to becoming GOES-East
  - GOES-17 Transitioning to become GOES-West planned for late 2018
- Complete Transition from LRIT to HRIT/EMWIN
- Continuation of DOMSAT service until May 2019
- DADDS System Refresh (hardware & software)
- Frequency (spectrum / interference) management
- Program/system management:
  - Channel assignments
  - System use agreements
  - User education & assistance, etc.
- Enhanced capabilities & other advances including
  - 2-way platforms
  - New file formats
  - Potential use of system by Small Satellites (small-sats)

Scott then summarized the User Assessment completed after the Fall 2017 meeting noting the still heavy reliance on internet solutions and the low number of organizations relying on the NWSTG feed. The results are detailed in the graphic below.



Finally; Scott gave an update on the NOAA geostationary satellite constellations including:

- GOES-16 assumed operations as GOES East on December 18, 2017
- GOES-S / GOES-17 lifted off at 5:02 p.m. EST on March 1, right at the opening of the launch window, from Cape Canaveral Air Force Station, Florida, aboard an Atlas V 541 launch vehicle from Launch Complex 41.
- GOES-T is planned to launch in 2020

Note: See the presentations "1.0 Introductory Remarks.pdf" and "1.1 GOES-R Series Update.pdf" at http://www.noaasis.noaa.gov/DCS/twg.html.

2. User Reports

2.1: Bahamas User Report – Shenika Maura – The Bahamas Department of Meteorology

Slide 1.

Shenika stated that the Bahamas is made up of 700 islands and keys. The only way to get reliable data is to put automatic weather stations on as many as possible. DCS is only available on 8 of the islands. They have 22 stations in the Family Islands in the Bahamas but only 14 are currently up and running. The data is used for climatology, situational awareness before and after hurricanes and to respond to stakeholders including insurance companies, etc. As part of a new project, 4 new radars will be installed soon which will also have automatic weather stations as part of the systems.

Shenika recommended that the DADDS website to be accessible from more than one user at a time and that 5-10 years of data be online.

Action 122-1: NOAA to investigate request from Bahamas Met Service to maintain 5-10 years of GOES DCS data on website.

Note: See the presentation "2.1 User_Report-Bahamas.pdf" at: http://www.noaasis.noaa.gov/DCS/twg.html.

2.2 CO-OPS User Report – Nathan Holcomb – NOAA/NOS/CO-OPS

CO-OPS currently has approximately 460 permanent stations actively transmitting via GOES. Approximately 30-40 permanent stations transmitting via IP, Radio, or Iridium only. They also regularly deploy a number of seasonal gauges each year; approximately 50 for 2018. Currently about 150 of the permanent stations have been upgraded to V2 transmitters.

Their stations provide meteorological observations but also do water connectivity. They also use buoys that transmit to a shore stations which then upload to GOES. They are transitioning some of these to Iridium, so they can get them farther from shore. They also use current meters.

Phillip Whaley asked the question why do the CO-OPS stations have two-way communications capability? The answer is that they do use it to initiate an IP connection and can reboot the system. This is short burst transmissions.

Note: See the presentation "2.2 User_Report-CO-OPS.pdf" at:
http://www.noaasis.noaa.gov/DCS/twg.html.

2.3: TVA User Report - Jeff Stichler – Tennessee Valley Authority River Forecast Center

Jeff Stichler presented a user report from the TVA. He briefed that they do hydrological data collection in support of TVA's mission to operate the river system/watershed to meet navigation, recreation, power production and hydrothermal needs. The have 232 total TVA owned and operated DCP's that observe rain, stream, combination rain and stream. They also pull data from 64 USGS DCP's and 65 USACE DCP's. These gather data over the 7 states spanning the TVA.

Their primary receive system is HRIT with LRGS providing backup. They have taken DOMSAT offline as of 2015. They also have a legacy direct readout DRGS. They are looking to upgrade it. They may change to a 3.5 meter dish and move it to another TVA building. This would become primary when it comes online with HRIT as a backup.

In an answer to a question, they stated that the raw data is online and some other information is online specifically for the Whitewater Rafting industry.

Note: See the presentation "2.3 User_Report – TVA.pdf" at:
http://www.noaasis.noaa.gov/DCS/twg.html.

2.4 USACE User Report - LySanias Broyles – Corps of Engineers

LySanias presented the USACE user report. He noted that, as always, we need owners to update their PDTs as soon as possible. This is our first source of metadata and we want to ensure we have the data in HADS entered correctly. He went over the Districts and the distribution of the DCPs. He noted that there were approximately 2900 DCP's spread across 10 channels.

- ~2936 owned GOES DCP Id's
- ~2527 active GOES platforms (all 300 baud)
- Channels: 17, 25, 31, 49, 58, 73, 88, 161, 162, 177
    - Channel 41 vacated by Mobile District last year
- Western districts are converting their line-of-site platforms to GOES (SPL completely converted)

- Of 38 districts, over ~90% have at least one local LRIT/HRIT receive system
- Still a desire for more frequent transmissions at critical locations
- Some also transmit on random channel while exceeding observation threshold
- Supplementing GOES DCP's with r/t DAMS-NT over LAN at some locks and dams, etc.

He noted that USACE still wants more frequent observations from some critical infrastructure sites. If they are not using iridium, they will use random observations when they hit critical levels. They still are planning on using 2-way DCPs especially for remote stations. Some regions are increasing their number of DCPs to meet programmatic goals and they are also increasing the number of parameters. They are also continuing to update their Group IDs in DADDS. He stated that like the Bahamas, Rock Island also find it useful to have the data for insurance reasons especially for accidents resulting from floods.

LySanias then asked any USACE Offices to give a verbal report. You can find the statistics for each region on their slide presentation at 2.4 User_Report-USACE.pdf" at: http://www.noaasis.noaa.gov/DCS/twg.html.

Some highlights were:

- Portland has 150 gauges They are in the process of replacing line of site radio and they are replacing them with both GOES and Iridium. They want to get all the data back through HRIT/EMWIN.

- Seattle monitors 180 DCP's they use but only own 9. Data is critical to their operations. They are also looking into using iridium.

- Pittsburg owns 220 and monitors others. They do not use Iridium or line-of-site communications. They do not have a satellite dish, so they use the internet (DDS).

- Mobile uses 200 platforms and own 10. They also have HRIT/EMWIN.

- New Orleans uses 95 DCP's that use water level. Primary reception is through LRGS. They are acquiring HRIT/EMWIN. They will be using both GOES and Iridium in the future. They noted that their customer wants to have a manual to know how to operate their DCPs.

- Los Angeles uses their own DCP's plus USGS gauges, some being automatic weather stations. They use self-timed and random channels. They can go to random during rapidly changing events.

- St. Louis uses 128 DCPs. 122 are active. DRGS is used but they also have LRIT.

- St Paul is expanding the use of more and more DCPs. They own some that they are using 15-minute transmissions for. They receive their data through HRIT stations.

- Jacksonville wants to know how we can get configuration files to DCPMON.

- LySanias noted that 20 districts are replacing DOMSAT with HRIT/EMWIN. They still want to have the local capability to collect data. He would like to emphasize that it is important to have the ability to collect local data in case the cloud services are down.

- Dan Schwitalla from EROS stated that the USGS has 12,000 DCP's. There are 6,900 on GOES-East and 51 on GOES-West. They are using expanding the use of Iridium and working with Verizon on Virtual Private Networks.

- Brian Jackson from the NWS noted that HADS monitors 17,000 DCP's but own none. He noted that it would be great to have POC's for all the DCPs.

Action 122-2 Investigate how to make configuration files available in the USACE DCP Monitor system.

Note: See the presentation "2.4 User_Report-USACE.pdf" at: http://www.noaasis.noaa.gov/DCS/twg.html.

3. GOES DCS Program Updates – Seth Clevenstine / Letecia Reeves / Valerie Randall – NESDIS/OSPO/SPSD/Direct Services Branch:

HRIT/EMWIN Update:

Seth introduced himself. He briefed the HRIT architecture. All the data comes through the NESDIS Product Distribution and Access (PDA) system. He also went over the GOES constellation highlighting that GOES-West is on the legacy LRIT system and is uplinked to GOES-15. HRIT/EMWIN is produced in the PDA and uplinked to GOES-16. The legacy LRIT processing systems will be decommissioned after GOES-17 becomes GOES-West.

He also went over the product suite and the organization of the products into virtual channel ID's highlighting the DCS channels. DCS has 5% guaranteed bandwidth with a maximum of 10%. GOES-16 data may be added to CBU, in the near future. Currently, DCS uses 3.73% in a pretty stable manner as it comes from the DADDS.

Seth also showed a GOES-16 example of DCS having latency spikes. It has been determined that his is an issue with the PDA tailoring process. HRIT will be getting a special process to have its own tailoring which will alleviate this. The spikes make up 1.8% of the total throughput.

He also briefed that there will be a HRIT/EMWIN User Group telecom held April 26th. Post launch testing of GOES-17 will be discussed along with input on the product suite.

Noted that the EMWIN is not operational and EMWIN users are advised to point to GOES-14 for now. Seth said they are looking to add Geostationary Lightning Mapper (GLM) in the summer of 2018.

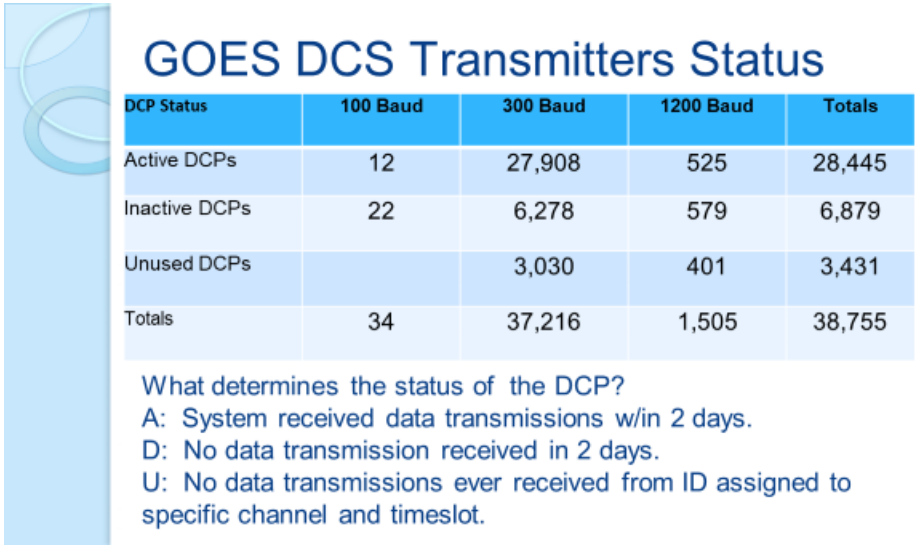
They are looking to have GLM in the summer of 2018.

Please contact Seth with any issues or input and seth.clevenstine@noaa.gov.

GOES-DCS Program Update:

Letecia briefed that DCS was down to 12 active 100 baud DCP's. There are also 22 that are not active. We hope they do not come online and they can be weeded off the system.

Statistics for 100 Baud, 300 Baud and 1200 BAUD are contained in the graphic below along with an explanation of what is meant by "Active," Inactive," and "Unused" DCS's. She noted that the status of the DCP's is determined solely on received transmissions.



Letecia also briefed the CS2 transition status. She briefed that there have been 600 more conversions since last September and almost 1/3 of the total platforms are now CS2. Letecia noted that we are getting closer to be able to create new channels. The statistics are shown in the graphic below. A plan is being prepared to move forward on channel creation.

She also briefed the standard channel assignment policies.

- GOES DCS Transmitter Standard is HDR CS2
- Standard Transmission Rate is 300 bps
- The Current Standard Window is 5 or 10 seconds.
- Standard Transmission Period is 1-hour w/exception to the following…
    - Users with strong justification for faster transmissions may be granted more frequent transmissions.
    - Users with Tide Gages being used for Tsunami Monitoring are transmitting every 5 minutes
    - Users in some flash flood prone and burn scar areas are granted every 30 minutes or every 15 minutes

It is hoped that creation of new channels will alleviate the "strong justification" requirement.

Letecia also briefed that the key to optimize transmission is efficient use of the DCS system using compression whenever possible, not sending redundant information and not sending messages in ASCII. She noted that NOAA will be reaching out to users to reprogram transmitter to only do random transmission at 300 bps.

System Use Agreements:

Valerie presented a discussion on DCS system use agreements. She stated that she has taken responsibility for the SUAs. She stated that there are 49 pending SUA's mostly due to lack of a POC. The oldest is from 1985 due to no point of contact and they have active DCP's.

She stated that the SUA process has moved to an online system. The primary is DADDS DCS1. If you have issues with DCS1, please try one of the other 3. She reiterated to NOT lose your 4-character PIN as this is the key to changing your password.

Change to GOES-West Location:

Scott Rogerson showed a presentation from the Direct Readout Program Manager, Jim McNitt. The highlight was the information that GOES-S is currently in the storage position at 89.5 degrees West. It was noted that when it moves to the GOES-West position later in 2018 it will be placed in a geostationary orbit at 137 degrees West vice 135 degrees West. It was noted that this would either require a satellite dish and LNB repoint or it may be optimal to do so.

Note: See the presentations "3. GOES DCS Program Updates.pdf" and TWG – HRIT.pdf at: http://www.noaasis.noaa.gov/DCS/twg.html.

4. Wallops CDAS Updates – Travis Thornton/Phillip Whaley – Wallops Command & Data Acquisition Station

Philip Whaley provided a brief on the GOES DCS Program from the viewpoint of NOAA's Wallops Virginia Command and Acquisition Station (WCDAS). He briefed the layout of WCDAS. The new antennas are backwards compatible with GOES-NOP. He showed where the uplink pilot antennas for DCS. He also briefed the constellation showing that GOES-14 is currently supporting EMWIN and LRIT in support of the GOES-East transmission. This is a best-effort project. GOES-17 is deploying antennas and post-launch testing or PLT will begin in April.

He noted that the GOES-R frequency plan has changed but does not affect the uplink but does affect the DRGS downlink. The GOES-R DRGS downlink frequency changes from 1679.70 to 1680.10.

Phillip noted that both DADDS are prime as they are ingesting independently. The only Prime designation is which one is feeding DOMSAT and the National Weather Service Telecommunications Gateway (NWSTG). WCDAS puts WMO headers on 86% of the DCS messages and sends them to the NWS. He asked whether we should put WMO headers on all the messages. There was no clear opinion and resulted in an action to discuss this with the users.

CBU is a consolidated backup of uplink downlink and processing. The systems are controlled by WCDAS. There have been more failovers than expected. There are also split configurations including HRIT. The frequency of failovers has led to a higher level of proficiency.

Phillip noted that DADDS is sending data for the LRIT legacy systems with a backup of LRGS. HRIT is fully integrated into DADDS. Both WCDAS and NSOF can feed the PDAs at both NSOF and CBU. HRIT has a larger footprint and can also use a 1-1.2 meter antenna.

Phillip briefed that he is the NOAA DCPRS Certification Official. He makes recommendations to OSGS for official certifications.

He also noted that there has been some interference with the pilot frequency. He implored people to let everyone know to not interfere with the pilot frequency. There is a backup antenna at Goddard, but it is not identical to the system at WCDAS.

Dave Lubar asked whether you can you have a second pilot at another location. The answer was that there is a rack at CBU. They put in the wrong antenna for DCS for the pilot. Phillip is working to put identical systems to the ones at WCDAS.

Action 122-3: As WCDAS puts World Meteorology Organization (WMO) headers on 89% of messages and sends them to the NWSTG, consider putting WMO headers on all the messages; or assess whether we should be doing this at all by seeing if there are user requirements for this.

Action 122-10: NOAA to investigate back-up (remote) pilot options including reuse of Goddard equipment or a new system for the CBU.

Note: See the presentation "4. Wallops CDAS Updates.pdf at: http://www.noaasis.noaa.gov/DCS/twg.html.

5. STIWG Report – LySanias Broyles - U.S. Army Corps of Engineers

LySanias Broyles presented report of the STIWG

Briefed the two working groups: DCS Preservations and Open DCS standardization. DCS Preservation is primarily concerned with the frequency issue and the Standardization group with OpenDCS.

He noted that agencies should emphasize the importance of the DCS frequencies to operations. It is important to detail what is happening vs briefing what might happen. There are occasions where the STIWG can brief other communities and congress to show how vital the information is for warning and relief efforts to protect lives, property and the environment.

He briefed that the Cove Software version of OpenDCS will become the baseline and they will incorporate the Sutron enhancements. The first release will be the National Ocean Service enhancements. The process will not impede enhancements but will make sure they will be available to everyone. The Corps of Engineers has language in MOU's and MOAs or agreements between all the agencies to be able to cooperate on future development of OpenDCS.

Also discussed was the new HRIT format options. The following points were briefed:

- Proposed expanded use of binary to replace ASCII header
- Add new performance, quality and status information
- Would like to transmit old and new signals simultaneously
    - Dependent upon the selected format and payload

- NOAA and Microcom requesting feedback from manufacturers and users to best address the format proposal
- Option 1: Change ASCII to binary and provides a single character quality indicator (e.g. G = "Good")
- Option 2: Expanded binary to include all the DEMOD information currently discarded; provides more granularity and disclose the path the data took to get to the user

LySanias also briefed the Spectrum Interference Monitoring effort that is beginning.

- DRGS, L/HRIT Spectrum Interference Monitoring
- NOAA to perform a 2-year study on the 1675 – 1680 MHz band
- NIFC is monitoring and documenting interference to their DRGS; looking for long-term solutions for affordable monitoring in the future
- USACE has developed a scope of work to encompass mitigation, monitoring and reporting capabilities for impacted Corps assets

He noted that the LRIT to HRIT transition has experienced some issues with the broadcast but overall has gone pretty well gone pretty well. He noted that they are also looking at cost for the hypothetical conversion of GOES DCS to Iridium. There are two parts to this: 1) hardware and 2) service subscription.

Also summarized was the performance of GOES DCS during natural disasters. IPO modems were affected by Hurricane Hardy. The messages from the Internet dropped off and the GOES stayed healthy. A few stations had issues with solar panels. 99% of the data was lost on internet DCP stations.

It was noted that the NOS report is online at the NOAASIS DCS page.

Note: See the presentation "5. STIWG Report.pdf at:
http://www.noaasis.noaa.gov/DCS/twg.html.

6. Manufacturer Remarks

6.1: Manufacturer Remarks – Wade Loseman – Sutron Corporation

A presentation was given by Wade Loseman detailing their product and services, specifically those for use with geostationary satellites.

Note: See the presentation "6.1 Manufacturer – Sutron.pdf" at:
http://www.noaasis.noaa.gov/DCS/twg.html.

6.2: Manufacturer Remarks – Mike Maloney – Cove Software

Mike Maloney gave a talk noting that Cove Software was working on OpenDCS, supporting LRGS and DECODES and continues to support those installations.

6.3: Manufacturer Remarks – Perry West – Microcom Design

Perry West gave a presentation concentrating on their re-branding, new name, Microcom Environmental, and new logo. He noted that they have previously concentrated on the receive side of DCS but that they are now tailoring their approach to include the transmit side. Also noted that the foundation of the product line is the Xpress Product which is fully integrated.

Note: See the presentation "6.2 Manufacturer – Microcom.pdf at: http://www.noaasis.noaa.gov/DCS/twg.html.

7. Spectrum Report / Discussion– David Lubar – The Aerospace Corporation / GOES-R Program Office

David Lubar summarized the spectrum issues associated with the 1675-1695 MHz downlink bands, including the recently sold Advanced Wireless-3 band above GOES and the proposals for sharing some of the GOES spectrum below 1680 MHz. A discussion of small satellites in 401-403 MHz and international items associated with the upcoming 2019 International Telecommunications Union (ITU) World Radiocommunications Conference (WRC-19) associated with 401-403 MHz was conducted. The NOAA SPRES study was described and subcontractors for Project 1 were allowed to brief their request for completion of a user survey. Additionally, a request was made for participants to provide all DRGS, LRIT & HRIT/EMWIN station locations and specifics to the subcontractor for Project 8. The importance of user participation in these spectrum studies was stressed, and the time critical schedules upon which the various projects are conducted were presented.

- ***Action 122-4: Letecia to send out the link to the on-line version of the Alion Survey to all DCS users as well as the Program Manager for HRIT/EMWIN and GRB.***
- ***Action 122-5: Respond to NOAA SPRES Subcontractor, Alion Sciences, by completing the DCS User Survey for All Users https://docs.google.com/forms/d/e/1FAIpQLSfbcfa2APQHW6okffTJOfxFW8coIak81jk6jWxBDOm6n-8Dtg/viewform. This is very time critical to support the contractor schedule under the NOAA Spectrum Pipeline Reallocation Engineering Study (SPRES) which will study if the 1675-1680 MHz spectrum can be shared. Please complete this survey in next 30-60 days.***
- ***Action 122-6: Provide the location, exact latitude and longitude for all Federal and non-Federal stations (including foreign) for DRGS, LRIT, HRIT/EMWIN to the NOAA SPRES Contractor Shared Spectrum Company so that they have a correct and***

comprehensive list of receiving stations. Send to Dr. Todd Martin at tmartin@sharedspectrum.com and please copy beau.backus@noaa.gov. Please provide within next 30-60 days along with a point of contact with email and phone for your organization.

Note: See the presentations "7. Spectrum Report.pdf," and "7.1 Users Survey – Alion.pdf," at: http://www.noaasis.noaa.gov/DCS/twg.html.

8. Small-Sat Project Update – Beau Backus – Senior Spectrum Manager, NOAA/NESDIS Spectrum Management

Beau Backus presented a talk on the "Satellite DCS Use Concept Validation Project." DCS transmitters (Earth-to-space) operate in the 401-402 MHz frequency band, which is shared with satellite operations (space-to-Earth). Traditionally, this has not been a problem to the DCS receivers located on GOES. However, with the rapid growth of small satellites and their reliance on small omni-directional antennas, this shared use of the band is becoming a concern. The energy transmitted from these small satellites is not just transmitted to the ground, but in all directions, including towards the DCS receiver. This poses a growing risk to the DCS for reliable reception of the terrestrially based DCS transmitters. The concept for the project is to enable satellite to access the DCS at a low data rate (300 & 1200 bps) for their launch, early orbit and anomaly communication needs. Being a part of the DCS will protect other DCS users from interference by those DCS satellite users. An initial tiger team review of the concept found that the idea was viable and worth investigating further. A validation of the concept is being worked with NASA Ames and Microcom Design to host a DCS prototype board on a hosting small sat (TechEdSat 8) and verify that data can be transmitted from the LEO satellite to the GEO DCS receiver. The test will be conducted on DCS channel 495. The current plan, should the concept prove viable and is implemented, that satellite DCS users will primarily use the international DCS channels - which will also enable satellite DCS users to work with other DCS receivers globally. The first phase of the project is planned to be completed by end of 1st quarter 2019 and the second phase, should it be implemented, approximately one year later.

It was further noted that there do not appear to be any "show stoppers" and that current thinking is that this fits within NOAA's ongoing efforts to use spectrum efficiently. There were a few challenges noted including, doppler shift, transmission power, loading factors, international cooperation, extent of use permitted and spectrum regulations. Some regulations may have to be amended as space to space communication is not permitted in this band.

Note: See the presentation "8. Small-Sat Project Update.pdf" at: http://www.noaasis.noaa.gov/DCS/twg.html.

9. Two-Way Prototype Update – Brett Betsill – Microcom Design, Inc.

Microcom Design provided an update and the status of the Two-Way bench prototype. The presentation initially provided some history and background on the Two-Way; specifically, the original DCPI and the follow-on DCPC work by NOS/Sutron.

The presentation then covered the two studies performed by Microcom. The extensive study in 2015 on all aspects of a potential Two-Way link; the results of this study were presented at the April 2015 TWG. A follow-up study was performed in 2016 and the results presented at the 2016 TWG in Sioux Falls, SD. The key recommendation of the first study was to use Frequency Hopping Spread Spectrum (FHSS) instead of Direct Sequence Spread Spectrum (DSSS). The follow-on study further confirmed the expected performance of this approach.

Microcom provided a timeline update on the status of the project. The bench prototype task began in the fall of 2016; Microcom essentially completed the development of the Modulator by the end of 2016. Work began on the demodulator, but work was suspended due to budget concerns and other priorities in early 2017. Resumption of work on the Two-Way prototype was delayed due to the unexpected DCS management change.

A new work assignment to resume the development was authorized in early October 2017, and the work focused on the demodulator. Target goal was to have performance measurements to present at this conference. However, a couple of minor technical changes delayed completing performance measurements. Prototype modulator and demodulator have been mated and Microcom is getting close to running performance tests.

Microcom designed and produced a custom circuit board that could produce a variety of test signals to support the development of the demodulator. The modulator design was based on the Pilot/Test Transmitter designed by Microcom for NOAA in 2009/2010. In addition to the test signals, the prototype modulator can produce a complete FHSS BPSK signal at 200 bps with pseudo-random data.

Microcom developed the demodulator using a combination of off-the-shelf evaluation modules and custom bread-boarded circuits. The demodulator is fully functional and able to demodulate a FHSS BPSK modulated signal.

Microcom's presentation showed several graphical slides that demonstrated the functionality of the Two-Way modulator and demodulator as summarized below.

- The modulated output spectrum from the modulator with the signal not hopping showing the Root Raised Cosine (RRC) modulation spectrum.
- A spectrum captured with a long-term average that showed the modulated FHSS signal hopping through its eight center frequencies.
- The 455 kHz IF spectrum captured at the output of the demodulator's mixer that showed no degradation from the de-hopping function as the demodulator's Local Oscillator (LO) is hopped in concert with the incoming hopped signal. At each hop point, the demodulator's LO is offset in frequency by 455 kHz from modulator's frequency to produce the IF spectrum.

- An oscilloscope trace of the modulated 455 kHz IF showing the data modulation of 200 symbols per second with the time domain envelope of the RRC.
- An oscilloscope screen capture showing the demodulated In-phase (I) and Quadrature (Q) components along with a timing signal trace indicating frequency hop transitions and a trace the showed the data bit recovery. The key points made were …
- The I/Q traces are analog representations of the ARM processing recreated by sending the digital information to a Digital-to-Analog Convertor (DAC).
- The I component carries the RRC demodulated data.
- The Q component shows the phase stability; specifically, the lack of any transient in the Q output at the hop points confirms that phase coherence is maintained as the carrier frequency is hopped.

With bit and byte recovery having been achieved and received data is flowing to the computer, Microcom is working on completing a Test Utility that will interface to both the modulator and demodulator and score Bit Error Rate (BER) performance. The Test Utility will pass Reed Solomon encoded data to the modulator and receive the raw data from the demodulator. The Test Utility will perform the Reed Solomon correction and score both the uncorrected BER and corrected BER. Test runs will be performed with simulated Gaussian noise and/or simulated LMR interference. Included with the slide on these topics was a screen capture of the Test Utility showing data being sent and received. However, the Test Utility does not presently include the Reed Solomon encoding and decoding, which is the next task to be completed by Microcom.

Microcom wrapped up by discussing the possible next steps in the evolution of the Two-Way. First, Microcom covered the next steps as part of the current task: 1) finalizing the Test Utility, 2) initial performance tests, 3) possible demodulator fine tuning as a result of the initial testing, 4) final performance testing, and 5) preparing a summary report with findings and submit to NOAA.

Microcom then discussed possible future tasks. The most likely next future step is to transition the bench prototype to an Off-the-Air Demonstration unit. Future steps include the possible follow-on data rate and error coding evaluation, and a full system demonstration.

Following the presentation, several discussion topics were raised by the audience as summarized below.

- Philip Whaley asked how extensive the possible future step of a follow-on evaluation for the data rate and error-coding would be. Brett Betsill from Microcom reiterated that this is only "possible" task and tied back to the original study where alternative error-correction codes, such as Turbo and Low-Density Parity Check codes were mentioned. Mr. Betsill also noted that it would never be possible to achieve kilobit per second data rates, but even a modest increase from 200 bps to 250 or 300 bps could be quite beneficial. Philip Whaley stated that he would recommend not spending too much time on such a task and instead moving more quickly to a realizable system.
- Philip Whaley also asked if the Two-Way system would require dedicated DCS channels to support responses from commanded platforms. Mr. Betsill replied that this was a key concept

in how the system was envisioned, and that it would most likely utilize some of the new CS2 channels to provide this capability.

- Phil Bartlett of FTS asked if the Two-Way study had considered scheduling of message reception. Mr. Betsill commented that this was in fact the case, and the concept would be to utilize DADDS to know which platforms had a Two-Way receiver and when they would be listening for commands. As an example, Mr. Betsill noted that platform with a receiver may only "listen" for commands for 5-10 minutes following their self-timed transmission window to lower battery consumption. DADDS would have to factor this information in when scheduling the command to be sent to the platform. Mr. Betsill further noted since there would undoubtedly be a significant time lag between when a command is requested and when it is actually sent, DADDS ability to send emails would be useful to notify the user that the command had been sent and a response received.
- Warren Dorsey commented that the receiver design information would at some point be published.

Action 122-7: Item: Microcom Design to share DCPI test results with the user community as they become available.

Action 122-8: DCS Program to prepare some vehicle for getting user input on the DCPI two-way communication project.

Action122-9: DCS Program manager to prepare a briefing for OSPO and NESDIS Management on estimates on the costs to bring the DCPI two-way communication project to completion for GOES-R Series and the next generation of satellites.

Note: See the presentation "9. Two-Way Prototype Update.pdf" at: http://www.noaasis.noaa.gov/DCS/twg.html.

10. New File Format Proposal Update - Brett Betsill – Microcom Design, Inc.

Microcom provided an update on the recommendation to develop a new DCS file format for the HRIT dissemination.

The original file format was developed in the 2003-2005 timeframe and only provides the 1980's era DAPS DCS message statistics. A notable deficiency in these statistics is the 50 Hz resolution of frequency deviation from the channel center, which is insufficient based on the latest DCP specification that requires transmitters to maintain an overall frequency stability of ±125 Hz. Other suggested improvements included more use of binary fields instead of ASCII in the message headers and better resolution on the received signal strength and phase noise measurements.

Microcom summarized the steps that have been taking since the proposal was first presented at the September 2017 TWG. These steps included producing an updated proposal based on the TWG feedback that was presented to the STIWG in November 2017, and the NOAA Outreach that was done in December. NOAA would still like to receive additional manufacturer feedback.

The presentation also included information to try to clarify areas of possible confusion with regard to the proposal. Specifically, that the proposal is currently to modify just the DCS file format utilized solely by the HRIT transmission link. No other changes are presently being proposed to other dissemination protocols nor requiring a change in the actual DCP messages.

Microcom next reviewed and summarized the various reasons for the proposed changed that were previously presented at the September 2017 TWG; i.e. better DCS message quality statistics, reduced message header size to improve efficiency, and the opportunity the new HRIT link may offer to support a transition period.

Microcom then presented the updated format recommendations that had been previously provided to the STIWG in November 2017. There are now two suggested formats to consider and decide which, if either, should be implemented.

The first update format is similar to the originally proposed format with the minor additions of a secondary source field as suggested by Philip Whaley and a CRC field to allow validating each DCS message within the HRIT file.

The second proposed format increases the DCS message header reduction by eliminating the Original Address combining the Channel and Spacecraft fields into a single Channel/Spacecraft field. Further, the format would replace the Message Arm Code and replace it with a Message Arm Flag byte. It was explained that the use of a Message ARM Flag byte would eliminate multiple DCS Information messages should it be decided to include the DCS Informational messages in the HRIT stream.

Informational DCS messages are generated by DADDS and are intended to convey DCP issues (e.g. Out of Time Window, Wrong Channel, etc.) to the end user so that the issues can be addressed and rectified. Sometimes, more than one issue exists and multiple Informational messages need to be sent. The use of an ARM Flag byte would eliminate the issuance of the multiple Informational messages while still conveying the appropriate information. If adopted, this approach would provide a more efficient mechanism to supply the users with this needed information.

Microcom then reviewed some transition ideas that had previously been presented or suggested at the September 2017 TWG. Specific topics covered were: 1) being able to support a transition period where both formats are transmitted; 2) how to identify the two different formats at the receiver; 3) how long the transition period would last; and 4) the possibility that when both streams are being transmitted that it may be necessary to designate different priorities for each of the streams, which would also result in different time latencies.

The presentation concluded with a discussion on the possibility of extending the improved message quality statistics to the other DCS dissemination protocols as had been suggested at the September 2107 TWG. It was emphasized that there is currently no formal proposal being considered; it is simply a discussion topic. The three major DCS dissemination protocols were reviewed. No

change to the DOMSAT protocol should be considered since the DOMSAT service is slated to be terminated in May 2019. Both the DAMS-NT and DDS protocols can be extended to support the improved message statistics while maintaining backward compatibility. While these two protocols could be updated concurrently, it was pointed out that the DAMS-NT protocol feeds data to the LRGS/OpenDCS programs that utilize the DDS. As such, until the DAMS-NT protocol is updated, the improved message quality statistics would not be able to appear in the DDS protocol

Following the presentation, several discussion topics were raised by the audience as summarized below.

- Philip Whaley pointed out that there are only a small number of LRIT/HRIT receiver manufactures and that any update to the receivers to handle the new format should only require software/firmware updates; i.e. no hardware should need to be modified. Mike Maloney of Cove Software, LLC and Brett Betsill of Microcom Design concurred with this assessment.
- Mike Maloney further noted that the Dartcom LRIT/HRIT receiver, which is sold by Ott/Sutron, performs file processing in the computer so any change to the DCS file format will certainly not require hardware modifications to the receiver.
- Mike Maloney questioned the need for the individual CRC on each message and asked whether or not files are received with errors. Microcom indicated that this is a rare occurrence but does occasionally happen; perhaps one file every week to two weeks out of approximately 20,000 files per day. With this information, Mike Maloney concurred that the individual message CRC would be useful.
- Dave Lubar from Aerospace asked if Dr. Esteban Valles was aware of this proposed file format change so, if necessary, it could be addressed in the software-based LRIT/HRIT radio prototype design. While the proposed changes have been published and an outreach performed by NOAA, Microcom responded that no specific contact had been made with Dr. Valles. As such, an action item was assigned to Microcom to contact Dr. Valles by email.

Action 122-11: Investigate planning a test for a dual feed of DCS with the old and new formats.

Action 122-12: Work with the HRIT/EMWIN Program Manager to plan for up to 10% DCS usage on HRIT/EMWIN.

Action 122-13: Investigate planning a test for a dual feed of DCS with the old and new formats on GOES-16.

Action 122-14: Microcom to share the proposals with Aerospace (Dr. Esteban Valles) for the software defined radio prototype.

Note: See the presentation “10. New HRIT File Format Proposal.pdf” at: http://www.noaasis.noaa.gov/DCS/twg.html.

11. Any Other Business / Future Plans – All

There were no suggestions for new topics.

12. Draft / Review Action Items – All

The Action Items were reviewed. See Appendix I for a list of all the actions with references to the applicable document page.

13. Closing Remarks – All

There was general discussion of this being an excellent meeting with thanks to all the organizers, logistics personnel, presenters and participants including those on the telecon and WebEx.

14. Adjournment

The meeting was adjourned at 4:30 PM.

Appendix I – Action Items and Recommendations:

- Action 122-1: NOAA to investigate request from Bahamas Met Service to maintain 5-10 years of GOES DCS data on website. See Page 04.
- Action 122-2 Investigate how to make configuration files available in the USACE DCP Monitor system. See Page 07.
- Action 122-3: As WCDAS puts WMO headers on 89% of messages and sends them to the NWSTG, consider putting WMO headers on all the messages; or assess whether we should be doing this at all by seeing if there are user requirements for this. See Page 11.
- Action 122-4: Letecia to send out the link to the on-line version of the Alion Survey to all DCS users as well as the Program Manager for HRIT/EMWIN and GRB. See Page 13.
- Action 122-5: Respond to NOAA SPRES Subcontractor, Alion Sciences, by completing the DCS User Survey for All Users https://docs.google.com/forms/d/e/1FAIpQLSfbcfa2APQHW6okffTJOfxFW8coIak81jk6jWxBDOm6n-8Dtg/viewform. This is very time critical to support the contractor schedule under the NOAA Spectrum Pipeline Reallocation Engineering Study (SPRES) which will study if the 1675-1680 MHz spectrum can be shared. Please complete this survey in next 30-60 days. See Page 13.
- Action 122-6: Provide the location, exact latitude and longitude for all Federal and non-Federal stations (including foreign) for DRGS, LRIT, HRIT/EMWIN to the NOAA SPRES Contractor Shared Spectrum Company so that they have a correct and comprehensive list of receiving stations. Send to Dr. Todd Martin at tmartin@sharedspectrum.com and please copy beau.backus@noaa.gov. Please provide within next 30-60 days along with a point of contact with email and phone for your organization. See Page 13.
- Action 122-7: Item: Microcom Design to share DCPI test results with the user community as they become available. See Page 17.
- Action 122-8: DCS Program to prepare some vehicle for getting user input on the DCPI two-way communication project. See Page 17.
- Action122-9: DCS Program manager to prepare a briefing for OSPO and NESDIS Management on estimates on the costs to bring the DCPI two-way communication project to completion for GOES-R Series and the next generation of satellites. See Page 17.
- Action 122-10: NOAA to investigate back-up (remote) pilot options including reuse of Goddard equipment or a new system for the CBU. See Page 11.
- Action 122-11: Investigate planning a test for a dual feed of DCS with the old and new formats. See Page 19.
- Action 122-12: Work with the HRIT/EMWIN Program Manager to plan for up to 10% DCS usage on HRIT/EMWIN. See Page 19.
- Action 122-13: Investigate planning a test for a dual feed of DCS with the old and new formats on GOES-16. See Page 19.
- Action 122-14: Microcom to share the proposals with Aerospace (Dr. Esteban Valles) for the software defined radio prototype. See Page 19.

Appendix II: List of Acronyms

AEP-	Alberta Environment and Parks (Canada)
ARM-	A Family of Reduced Instruction Set Computing from ARM Holding
ASCII-	American Standard Code for Information Interchange
Baud-	Symbols per Second or Pulses per Second – In binary equal to Bits per Second
BLM-	Bureau of Land Management
Bps-	Bits per Second
BPSK-	Binary Phase Shift Keying
CBU-	Consolidated Backup Facility, Fairmont, WV
CDA-	Command and Data Acquisition Station (Wallops, VA and Fairbanks, AK)
COOPS-	Center for Operational Oceanographic Products and Services (NOAA/NOS)
CS1-	Certification Standard 1
CS2-	Certification Standard 2
DADDS-	Data Collection System (DCS) Administration & Data Distribution System
DAPS-	GOES Data Collection System Automatic Processing System (DCS)
DCP-	Data Collection Platform
DCPI-	Data Collection Platform Interrogate
DCPC-	Data Collection Platform Command
DCPR-	Data Collection Platform Radios
DCS-	Data Collection System (GOES)
DEMOD-	Demodulation or Demodulator
DOMSAT-	Domestic Satellite (Commercial Satellite Broadcast Service)
DRGS-	Direct Readout Ground System
DSSS-	Direct Sequence Spread Spectrum
EMWIN-	Emergency Managers Weather Information Network (NWS)
EROS-	Earth Resources Observation and Science Center
FCC-	Federal Communications Commission
FCDAS-	Fairbanks Command and Data Acquisition Station, AK
FHSS-	Frequency Hopping Spread Spectrum
GLM-	Global Lightning Mapper (GOES-R Series Instrument)
GOES-	Geostationary Operational Environmental Satellite
HADS-	Hydrometeorological Automated Data System (NWS)
HDR-	High Data Rate
HRIT-	High Rate Information Transmission, GOES R Series (G16)
HRIT/EMWIN	High Rate Information Transmission / Emergency Managers Weather Information Network (replaces legacy LRIT and EMWIN on the GOES-R Series satellites)
IRAC-	Independent Radio Advisory Committee
ITU-	International Telecommunications Union
LEO-	Low Earth Orbit
LNA-	Low Noise Amplifier
LNB-	Low-noise Block Downconverter
LRGS-	Local Readout Ground System
LRIT-	Low Rate Information Transmission, GOES 13, 14 & 15 broadcast
NIFC-	National Interagency Fire Center (BLM)

NOAA -	National Oceanic and Atmospheric Administration
NESDIS -	National Environmental Satellite, Data, and Information Service
NOS-	National Ocean Service (NOAA)
NSOF-	NOAA Satellite Operations Facility, Suitland, MD
NWS-	National Weather Service
NWSTG-	National Weather Service Telecommunications Gateway
OpenDCS-	Open Source Data Collection System
OSPO-	Office of Satellite and Product Operations
PDA-	Product Dissemination and Access (NESDIS/OSPO dissemination system)
PDT-	Platform Data Table
PLT-	Post-Launch Testing
POC-	Point of Contact
Small-Sat-	Spacecraft with mass < 180 kg and < the size of a large kitchen fridge (NASA)
SPRES-	Spectrum Pipeline Reallocation Engineering Study
STIWG-	Satellite Telemetry Interagency Working Group (DCS)
SUA-	System Use Agreement
TVA-	Tennessee Valley Authority
TWG-	Technical Working Group (DCS)
USACE-	U.S. Army Corps of Engineers
USGS-	United States Geological Survey
WBU-	Wallops Backup, Goddard Space Flight Center, MD
WCDAS-	Wallops Command and Data Acquisition Station, VA
WMO-	World Meteorological Organization

Appendix III – Participants:

First Name	Last Name	Organization
Ruth	Abney	U.S. Army Corps of Engineers (USACE)-Portland District
Phillip	Allegretti	Vaisala
Hadi	Alrahahleh	U.S. Army Corps of Engineers (USACE)
Quentin	Anderson	Tennessee Valley Authority
Richard	Antoine	NOAA / NESDIS / OSPO / SPSD / DSB
Edward	Ary	U.S. Bureau of Reclamation
David Felipe	Baccaro	ADR Technology, SAC
Beau	Backus	NOAA / NESDIS Spectrum Management
Philip	Bartlett	FTS (Forest Technology Systems)
Brian	Bell	U.S. Army Corps of Engineers (USACE)-Seattle District
Brett	Betsill	Microcom Design, Inc.
LySanias	Broyles	U.S. Army Corps of Engineers (USACE)
Tammy	Bryant	U.S. Army Corps of Engineers (USACE)
Chris	Buchner	OTT Hydromet / Sutron
Matt	Ceanfaglione	Microcom Design Inc.
Scott	Chodkiewicz	U.S. Army Corps of Engineers (USACE)
Jorge	Chira	Servicio Nacional de Meteorología e Hidrología del Perú (SENAMHI)
Seth	Clevenstine	NOAA / NESDIS / OSPO / SPSD /DSB
Ignacio	Corrales	Comisión Técnica Mixta de Salto Grande (CTM – Salto Grande)
Adrian	Cortez	International Boundary and Water Commission
Larry	Crippen	Alion Science and Technology
Edison	Cruz	Servicio Meteorológico e Hidrológico Nacional del Ecuador
Dennis	Darby	Tennessee Valley Authority
Dayton	Phillip	U.S. Bureau of Reclamations
Shayne	De Dominicis	Manitoba Hydro
Yu	Deng	NOAA / NESDIS / OSPO
Howard	Diamond	NOAA /OAR / ARL
Jason	Dong	Science Systems and Applications, Inc. (SSAI) / NOAA / NESDIS / OSPO / SPSD / DSB

First Name	Last Name	Organization
Christy	Donley	Alberta Environment and Parks Canada
Justin	Dopp	National Interagency Fire Center (NIFC) / Remote Sensing / Fire Weather Support Unit (RSFWSU)
Warren	Dorsey	NOAA / NESDIS / OSGS / PETD (Affiliate)
Yale	Eckert	Alion Science and Technology
Ross	Emry	U.S. Army Corps of Engineers (USACE)
Paul	Fajman	NOAA / NWS / Office of Dissemination
Manuel	Fernandez	ETESA (Empresa de Transmisión Eléctrica, S.A)
William	Finn	International Boundary and Water Commission
Scott	Flynn	U.S. Army Corps of Engineers (USACE)
Kevin	Foley	U.S. Bureau of Reclamation
Tracy	Fraley	U.S. Army Corps of Engineers (USACE)
Allen	Furlow	U.S. Army Corps of Engineers (USACE), Northwestern Division
Charles	Graham	U.S. Army Corps of Engineers (USACE)
Jesse	Gray	Bureau of Land Management
Andrew	Geller	U.S. Army Corps of Engineers (USACE)
Alain	Goulet	Water Survey of Canada, Environment Canada
Matt	Hardesty	Colorado Division of Water Resources (DWR)
Napoleon	Guevara	U.S. Army Corps of Engineers (USACE)
Jim	Heil	NOAA / NWS
Bradley	Heisterman	Bureau of Reclamation (USBR)
Leonel	Herrera	ETESA (Empresa de Transmisión Eléctrica, S.A) – Hidromet
Bill	Hicks	U.S. Army Corps of Engineers (USACE) – New Orleans District
John	Hogue	U.S. Army Corps of Engineers (USACE) – Vicksburg District
Nathan	Holcomb	NOAA/NOS/CO-OPS
Leona	Hyde	Government of Newfoundland and Labrador, Canada
Brian	Jackson	NOAA/NWS/Office of Dissemination
Jonathan	Jenkins	U.S. Army Corps of Engineers (USACE)
Peter	Johnston	Government of Manitoba, Canada
Linnea	Keating	USDA Forest Service

First Name	Last Name	Organization
Stephen	Kissock	U.S. Army Corps of Engineers (USACE)
Brian	Kopp	University of North Florida
Charles	Kottler	U.S. Army Corps of Engineers (USACE) – Pittsburg District
Warren	Krug	NOAA/NOS/CO-OPS/OSTEP (Affiliate)
Jason	Lee	U.S. Army Corps of Engineers (USACE)
Richard	Legner	Government of the Yukon, Canada
Wade	Loseman	OTT Hydromet / Sutron
David	Lubar	Aerospace and GOES-R Program Office / PSE-Spectrum
Mike	Maloney	Cove Software LLC
Cinthia	Martins	Universidade Estadual do Norte Fluminense Darcy Ribeiro (UENF) / Laboratório de Meterologia (CCT LAMET)
Bruno	Matos	Instituto Estadual do Ambiente (INEA) – Brasil
Shenika	Maura	Bahamas Department of Meteorology
Fred	McCallister	U.S. Army Corps of Engineers (USACE)
Joseph	Medina	California Department of Water Resources
Thomas	Miller	Tennessee Valley Authority
Gail	Monds	U.S. Army Corps of Engineers (USACE), Detroit District
Luis Gustavo	Muñoz	Empresas Publicas de Medillin E.S.P.
Jim	Navarro	Air-Sea Monitoring Systems Group
Mike	Nelson	Campbell Scientific, Inc.
Eric	Novotny	U.S. Army Corps of Engineers (USACE), Detroit District
Allen	Phillips	U.S. Army Corps of Engineers (USACE)
Kristin	Powers	U.S. Army Corps of Engineers (USACE), Portland District
Randy	Pierce	Florida Department of Transportation (FDOT)
Paul	Rainey	U.S. Army Corps of Engineers (USACE)
Jean-Marc	Rampersad	Florida International University
Valerie	Randall	Science Systems and Applications, Inc. (SSAI) / NOAA / NESDIS / OSPO / SPSD / DSB
Letecia	Reeves	NOAA / NESDIS / OSPO / SPSD / DSB
Scott	Rogerson	NOAA / NESDIS / OSPO / SPSD / DSB

First Name	Last Name	Organization
Adam	Scarberry	U.S. Army Corps of Engineers (USACE)
Dan	Schwitalla	USGS / Emergency Data Distribution Network (EDDN)
Kimberly	Seaton	Trinidad and Tobago Meteorological Service
Jeffrey	Sellers	U.S. Army Corps of Engineers (USACE)
Paul	Seymour	Systems Integration & Development, Inc / NOAA / NESDIS / OSPO / SPSD / DSB
Bruce	Smiley	BC Hydro, Canada
Teddy	Soto	OTT Hydromet / Sutron
Jeff	Sticher	Tennessee Valley Authority
Bryan	Thomas	Trinidad and Tobago Meteorological Service
Roy	Thompson	National Meteorological Service of Belize
Travis	Thornton	NOAA / NESDIS / OSPO / Wallops Island Command and Data Acquisition Stations (WCDAS)
Augusto	Vargas	Servicio Nacional de Meteorología e Hidrología del Perú (SENAMHI)
Michael	Watterson	Next Phase, Inc.
Terri	Weddell	Alion Science and Technology
Perry	West	Microcom Design, Inc.
Egbert	Westby	National Meteorological Service of Belize
Philip	Whaley	NOAA / NESDIS / OSPO / Wallops Island Command and Data Acquisition Stations (WCDAS)
Bill	Wychulis	NOAA / NESDIS / OSGS

122nd GOES Data Collection System – Technical Working Group – Participants
Yellow Signifies In-person Attendance

Appendix IV: Agenda

122nd GOES DCS Technical Working Group Meeting:
Wednesday, March 21, 2018

Admin

8:00-8:30	Gather in Miami / Remote Connections (WebEx / Conference Line)
8:30-9:00	Introductions (Role)

Session 1:

9:00	Introductory Remarks; Review Actions from Sep 2017 Meeting
9:30	User Reports
10:00	GOES DCS Program Updates – Letecia Reeves, Valerie Randall
10:30	Break
11:00	Wallops CDAS Updates – Travis Thornton, Philip Whaley
11:30	STIWG Report – LySanias Broyles

Lunch

12:00-1:00

Session 2:

1:00	Manufacturer Remarks
1:30	Spectrum Report / Discussion – David Lubar
2:00	Small-Sat Project Update – Beau Backus
2:30	Two-Way Prototype Update – Brett Betsill
3:00	Break
3:30	New File Format Proposal Update – Brett Betsill
4:00	Any Other Business / Future Plans – All
4:30	Draft / Review Action Items – All
4:50	Closing Remarks – All
5:00	Adjourn