CGMS

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Direct Broadcast Beyond 2015

NOAA-WP-33 presents a summary of the direct readout plans for future NOAA environmental spacecraft. The transition of the NOAA direct readout services is taking place across several spacecraft constellations. This will encompass many years of development, coordination and implementation. In 2005, replacement of the analog Weather Facsimile (WEFAX) with the new digital LRIT started a transition period that will culminate with the implementation of the High Rate Information Transmission/Emergency Managers Weather Information Network (HRIT/EMWIN) service combined with the transition from today's GOES Variable (GVAR) retransmission format to the GOES Re-Broadcast (GRB) service on the GOES-R spacecraft constellation. NOAA's current direct broadcast services will change dramatically in data rate, data content, and frequency allocation, and driving changes to the field terminal configurations. The geostationary and polar-orbiting environmental satellite constellations will employ higher data rates, larger bandwidths, and new downlink frequency allocations. Environmental data users must employ new field terminal receivers unique to each particular broadcast service.

Direct Broadcast Beyond 2015

1. Introduction

The National Oceanic and Atmospheric Administration (NOAA) is in the process of transitioning its current direct broadcast services to the most up-to-date digital formats. The new Global Specifications for Low Rate Information Transmission (LRIT) and the Advance High Rate Picture Transmission (AHRPT) digital formats are intended to improve the quality, quantity, and availability of meteorological data from direct broadcast meteorological satellites.

The transition of the NOAA direct readout services is taking place across several spacecraft constellations. This will encompass many years of development, coordination and implementation. Replacement of the analog Weather Facsimile (WEFAX) with the new digital LRIT, in 2005, started a transition period that will culminate with the implementation of the GOES Re-Broadcast (GRB) service on the GOES-R spacecraft constellation. NOAA's current direct broadcast services will change dramatically in data rate, data content, frequency allocation and field terminal configurations.

2. Current Broadcast Services

The current direct readout services are derived from satellite sensor data from NOAA's GOES and POES systems. NOAA's geostationary (i.e., GOES) direct readout services include Low Rate Information Transmission (LRIT), Emergency Managers Weather Information Network (EMWIN), Data Collection System (DCS) and GOES VARiable (GVAR) broadcasts. The polar orbiting (i.e., POES) direct readout services include the analog Automated Picture Transmission (APT) and digital High-Rate Picture Transmission (HRPT) transmissions.

LRIT is a communications transponder service provided through the GOES spacecraft. This low-rate digital service involves the retransmission of low-resolution geostationary and polar orbiter satellite imagery or other meteorological data through the GOES satellites to relatively low cost receiving units within hemispheric receiving footprint of the satellite. The low-resolution geostationary and polar satellite images are produced at the NOAA Environmental Satellite Processing Center (ESPC) facility in Suitland, Maryland. This imagery is produced from the retransmitted GVAR data streams received at the facility from each of the operational GOES spacecraft. The ESPC ingests these retransmitted GVAR data streams through a Front End Processor. Based on an automated schedule, the data is subset into areas, reduced in spatial resolution, if necessary, and enhanced according to predefined look-up tables. The resultant LRIT products and imagery (IR and visible) are referred to as sectors which are spatial subsets of the full earth disc corresponding to an area of interest to weather forecasters. The generated sectors are then transmitted from the ESPC as digital product via dedicated communications lines to the Wallops Command and Data Acquisition Station (WCDAS) for transmission through the GOES spacecraft.

On the current operational spacecraft (GOES 11/13) and the backup spacecraft GOES 12/14/15, the LRIT service will remain a128 kbps service. The current LRIT service also contains a copy of the EMWIN data and a copy of the consolidated DCS data stream, both of which are also currently transponded in their own service domains. A combined HRIT/EMWIN service at 400 kbps will be deployed on the GOES-R series spacecrafts (GOES-R will no longer provide a dedicated EMWIN transponder, and the continuance of DCS being embedded in the HRIT stream is under review). The GOES-R HRIT (LRIT) service complies with the CGMS Global Specification for LRIT/HRIT (i.e., CGMS Document Number CGMS 03, Issue 2.6, dated August 12, 1999).

With its two operational GOES satellites, NOAA currently acquires raw data from its two primary instruments used to carry out the main mission. The Imager is a multi-channel instrument that senses radiant energy and reflected solar energy from the Earth's surface and atmosphere. The Sounder is a multi-channel instrument that provides data through vertical atmospheric temperature and moisture profiles, surface and cloud top temperatures, and ozone distribution. Raw data from these instruments is down-linked to the ground to be processed into GVAR formatted data. The GVAR data is up-linked to its corresponding GOES satellite, together with auxiliary data inputs from additional ground equipment, for global re-broadcast to users.

The GVAR data format is primarily used to transmit Imager and Sounder meteorological data. Other functions of GVAR data include transmission of calibration data, satellite navigation data, administrative and operational text messages. The GVAR format was developed as an evolution of the Mode-AAA format used for the early spin-stabilized GOES spacecraft and which would have severely limit the capabilities for data dissemination from the Imager and Sounder of the newer three-axis stabilized spacecraft platform. The Mode-AAA format used a fixed-length transmission. The GVAR format supports variable scan line lengths. The last GVAR mission is supported by GOES-P launched in March 2010.

The APT service provides a reduced resolution data stream from the AVHRR instrument. Any two of the AVHRR channels can be chosen by ground command for processing and ultimate output to the APT transmitter. A visible channel is used to provide visible APT imagery during daylight, and one IR channel is used constantly (day and night). A second IR channel can be scheduled to replace the visible channel during the night time portion of the orbit. The analogue APT signal is transmitted continuously and can be received in real time by relatively unsophisticated, inexpensive ground station equipment while the satellite is within radio range overhead. The characteristics of the transmitted signal remain unchanged in the NOAA KLM satellite series from those in the TIROS-N series (NOAA 8 through NOAA 14), while there is a minor change in the data format to account for a sixth channel on the AVHRR/3 instrument beginning with NOAA-K (a switchable channel 3 or 3A). NOAA will continue to support the afternoon (PM) polar-orbiting mission with its APT service through NOAA N'. The HRPT system provides data from all spacecraft instruments at a rate of 665,400 bps. The S-band real time transmission consists of the digitized unprocessed output of five Advanced High Resolution Radiometer (AVHRR) channels, plus the TIP (HIRS, SBUV, SEM, DCS instruments) data and Advanced Microwave Sounding Unit (AMSU) data (AMSU-A and AMSU-B) on NOAA 15 through 17 and AMSU-A and Microwave Humidity Sounder (MHS) on

NOAA 18/19. All information necessary to calibrate the instrument outputs is also included in the data stream. The last of the APT-pm and HRPT missions is supported by NOAA-N', launched February 06, 2009 is operationally known as NOAA-19.

3. Future Direct Readout Services

As future environmental satellites improve their monitor and observing capabilities, they will produce far more data than the current satellite series. The geostationary and polar-orbiting environmental satellite constellations will employ new downlink frequency allocations, larger bandwidths, and faster data rates. Environmental data users must employ new field terminal receivers unique to that particular broadcast service.

Joint Polar-orbiting Satellite System

Since 1994, the U.S. government was merging the Nation's military and civil operational meteorological satellite programs into a single, integrated, end-to-end satellite system capable of satisfying both civil and national security requirements for space-based remotely sensed environmental data. The joint program formed by a Presidential Decision Directive was the National Polar-orbiting Operational Environmental Satellite System (NPOESS).

On February 1, 2010 a new Presidential Decision Directive titled **Restructuring the National Polar-orbiting Operational Environmental Satellite System** was issued. This directive required a major restructuring of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) in order to put the program on a more sustainable pathway toward success. NOAA and the United States Air Force (USAF) will no longer continue to jointly procure the polar-orbiting satellite system called NPOESS. The United States Department of Defense (DOD), NOAA and NASA have and will continue to partner to ensure a successful way forward for the respective programs, while utilizing international partnerships to sustain and enhance weather and climate observations.

NOAA and NASA will take primary responsibility for the afternoon orbit, and DOD will take primary responsibility for the morning orbit. The agencies will continue to partner in those areas that have been successful in the past, such as a shared ground system. NOAA's portion will be named the "Joint Polar Satellite System" (JPSS) and will consist of platforms based on the NPP satellite. The DOD satellite portion will be named the "Defense Weather Satellite System" (*DWSS*). Partnership with Europe through the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) will continue to be a cornerstone of the polar-orbiting constellation, and will ensure the ability to provide continuous measurements.

While the USAF continues to have Defense Meteorological Satellite Program (DMSP) polar-orbiting satellites available for launch for the next few years, NOAA launched its final polar-orbiting satellite in February 2009. Given that weather forecasters and climate scientists rely on the data from NOAA's current on-orbit assets, efforts will focus on development of the first of the JPSS platforms.

NASA's role in the restructured program will be modeled after the procurement structure of the successful POES and GOES programs, where NASA and NOAA have a long and effective partnership. NOAA and NASA will establish a JPSS program at NASA's Goddard Space Flight Center (GSFC). NOAA and NASA will strive to ensure that current requirements are met on the most practicable schedule without reducing system capabilities.

DOD remains committed to a partnership with NOAA in preserving weather and climate sensing capabilities. For the morning orbit, the current DOD plan for deploying DMSP satellites ensures continued weather observations. DOD will fully support NOAA's needs to ensure continuity of data in the afternoon orbit by transitioning appropriate and relevant activities from the current NPOESS effort.

Significant progress has been made with the NPOESS Preparatory Project (NPP) satellite, now with a launch date of September 2011. A key instrument, the Visible Infrared Imager Radiometer Suite (VIIRS), has been tested and shipped from the developers to NPP and integrated onto the spacecraft. The Ozone Mapping and Profiler Suite (OMPS) has been developed, integrated onto the NPP spacecraft, and tested for flight. The Advanced Technology Microwave Sounder (ATMS) has been integrated and tested for flight. NOAA and NASA have taken advantage of the NPP opportunity to add the Clouds and the Earth's Radiant Energy System (CERES) instrument to NPP. This instrument has been integrated onto the spacecraft and tested for flight, thus ensuring the continuity of this critical data set beyond the NASA EOS (Terra and Aqua) missions.

Partnerships are key to the ability to provide continuous polar-orbiting measurements. NOAA, NASA, and the DOD/Air Force have had a productive relationship in polar observations; sharing data, coordinating user needs, and operating satellites. This cooperative relationship is essential and will continue. Likewise, partnerships with Europe through EUMETSAT will continue to be a strong part of the polar-orbiting constellation.

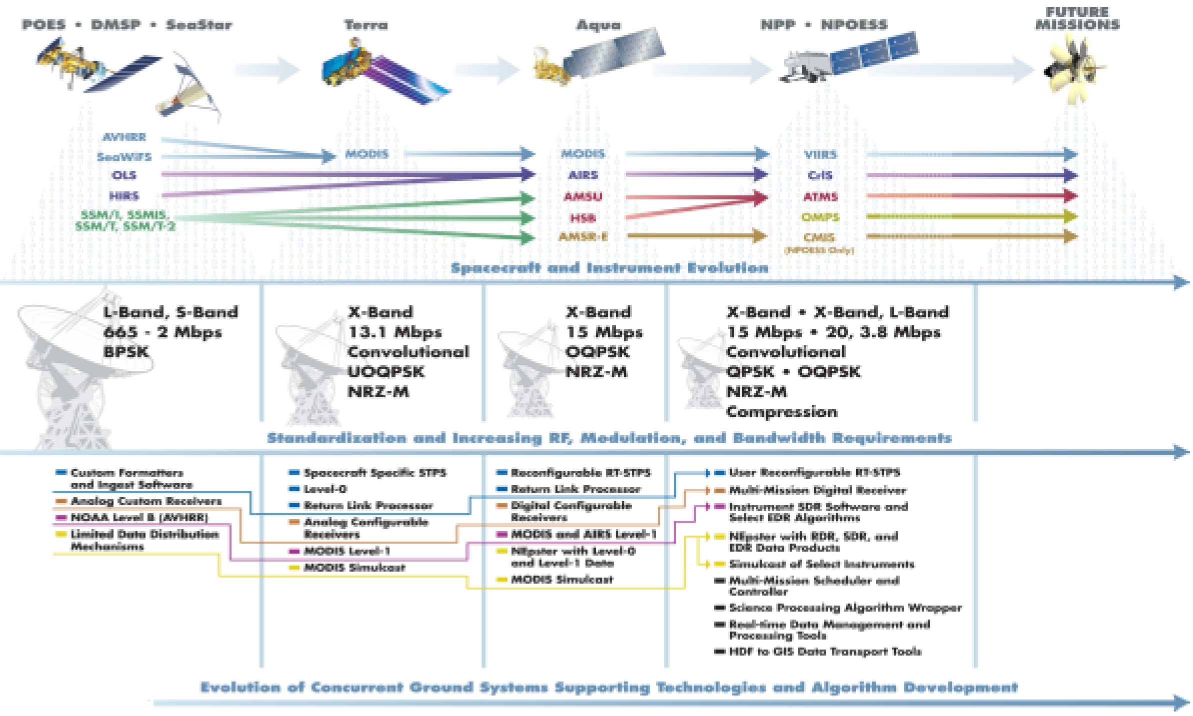

Figure 1: NPP/JPSS Direct Readout Continuity of Services.

Once operational, NPP and JPSS will replace the current POES. The POES spacecraft have revolutionized the way in which we observe and predict the weather. We are evolving the existing "weather" satellites into an integrated environmental observing system by expanding our capabilities to observe, assess, and predict the total Earth system – ocean, atmosphere, land, and the space environment. Data from the advanced sensors will be available four times faster than today significantly improving NWP forecasts and serving data continuity requirements for improved global climate change assessment and prediction.

Over the last nine years, NOAA has been developing the National Polar-orbiting Operational Environmental Satellite System (NPOESS). With a planned delivery of the first operational satellite in 2013, NOAA will begin launching NPOESS spacecraft into three orbital planes (0530, and 1330 equatorial nodal crossing times) to provide a single, national system capable of satisfying both civil and national security requirements for space-based, remotely sensed environmental data. The advanced technology visible, infrared, and microwave imagers and sounders that are being developed for NPOESS will deliver higher spatial and temporal resolution data to meet user validated requirements for 55 atmospheric, oceanic, terrestrial, and solar-geophysical parameters enabling more accurate short-term weather forecasts and severe storm warnings, as well as serving the data continuity requirements for improved global climate change assessment and prediction. Early flight-testing of instruments is planned to reduce development risk and to demonstrate and validate global imaging and sounding instruments, algorithms, and pre-operational ground processing systems through the NPOESS Preparatory Program (NPP) prior to delivery of the first JPSS spacecraft.

Data, including RDRs, SDRs, EDRs, stored raw mission data, stored and real-time telemetry, and stored data from the A-DCS, will be distributed through the data routing and retrieval component of the ground segment to the four U.S. Centrals and to the two mission management/control centers. The primary Mission Management Center (MMC) will be located at the NOAA Satellite Operations Facility in Suitland, Maryland. An alternate MMC will be located in Aurora, Colorado. The Centrals' IDP segment will provide sufficient temporary storage capacity (i.e., storage capacity for multiple passes – minimum of 24 hour storage) to store the RDRs/SDRs/EDRs and ancillary data for immediate use in the Centrals' higher-level product applications. NOAA's NESDIS will maintain the long-term archive.

Direct Broadcast Services

In addition to the space-to-ground transmission of SMD, JPSS will simultaneously broadcast two continuous real-time data streams, at high and low rates, to suitably equipped field terminals worldwide. These direct broadcast/real-time field terminals will be capable of processing RDRs into EDRs by using a JPSS/Field Terminal Segment (FTS) open source processing software package using commercial-off-the-shelf systems. NOAA, though the JPSS/FTS program, will distribute the nonproprietary field terminal software, software changes, and program updates. The direct broadcast X-band community supported by NOAA's Cooperative Institute for Meteorological Satellite Studies (CIMSS) will still be able to acquire tailored software directly from CIMSS.

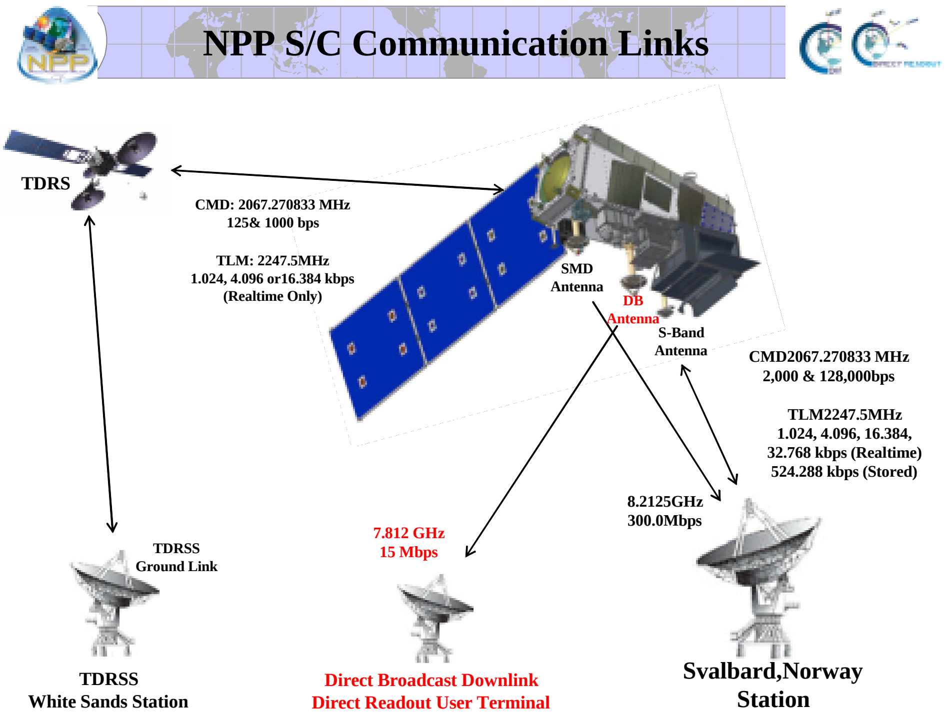

Figure 2: NPP/JPSS Direct Readout Configuration.

The Cooperative Institute for Meteorological Satellite Studies (CIMSS) is actively developing a capability to support NOAA's NPP/JPSS direct broadcast users in the real-time regional applications of ATMS, CrIS, and VIIRS data.

CIMSS is planning to release an independent processing package for NPP, based on the Interface Data Processing Segment (IDPS) operational versions of the VIIRS, CrIS, and ATMS algorithms implemented by Raytheon in the Algorithm Development Library (ADL) version 3.0.

The initial version of the NPP package called "Community Satellite Processing Package (CSPP)" will be available by the end of 2011 as a public release. The first version will likely contain VIIRS SDR and EDR algorithms only; CrIS and ATMS support will be added later. The CSPP project is specifically to support NOAA direct readout users in making the transition from POES to NPP and subsequently to JPSS. CSPP will be a stand-alone package for 64-bit Intel Linux platforms, and will be packaged similarly to IMAPP. It will run from the Linux command line, and will not require other processing framework to make installation friendly and straight forward for future upgrade and maintenance.

Features and Goals of NPP/JPSS component of CSPP is further summarized below:

1. CSPP-NPP/JPSS will have the following features:
   - Ingest CCSDS packet files from VIIRS, CrIS, ATMS and NPP spacecraft diary;
   - Create SDR and EDR products for VIIRS, CrIS, and ATMS using the current operational versions of the IDPS PRO algorithms and lookup tables;
   - Produce all output files in the HDF5 formats defined by the JPSS Common
     Data Format Control Books;
   - Retrieve all required dynamic non-spacecraft ancillary data automatically;
   - Run natively on 64-bit Intel Linux host platforms;
   - Run on Microsoft Windows 78/Vista/XP and Apple OS X platforms via a Virtual Appliance;
   - Allow the end user to customize which EDR products are created;
   - Provide a simple algorithm chaining capability to run algorithms in sequence;
   - Provide detailed logs of all processing operations and give clear indications
     of where and when failures occur;
   - Allow the end user to add customer user-developed algorithms;
   - Provide products optimized for NWS which are AWIPS and/or NOAA NextGen compatible;
   - Provide value-added products for end users that are not part of the JPSS Operational suite, such as images in KML format for Google Earth; Night Fog Detection; Volcanic Ash; and Aviation Safety products;
   - Utilize GPU-based High-Performance Computing (HPC) technology to reduce the latency of CSPP-NPP/JPSS product generation for time-critical regional applications.

2. The CSPP-NPP/JPSS plan to achieve the following goals:
   - Continue to support the US and international community of POES, Terra, and Aqua regional users through the transition to NPP and JPSS;
   - Engage US and international regional users in the calibration and validation of JPSS SDR and EDR products and obtain feedback;
   - Enable users to blend and integrate data for products fusion and applications;
   - Facilitate the adoption of NPP and JPSS real-time products into regional applications such as NWS forecasts, air quality monitoring, aviation safety, and wildfire detection;
   - Allow accelerated development of improved and alternative algorithms for deriving products from NPP and JPSS observations, such as collocated VIIRS/CrIS/ATMS retrievals of temperature, moisture, and cloud products;
   - Conduct proving ground activities in support of US agencies (in particular the National Weather Service) for early and optimal uses of NPP/JPSS data and products;
   - Facilitate training workshops to promote the use of NPP/JPSS regional products and applications and foster the next generation of remote sensing students and scientists;

- Foster collaboration with NOAA, NASA, and other government agencies, universities, and industry partners to facilitate broad and efficient uses of NPP/JPSS data.

JPSS spacecraft will also simultaneously broadcast two types of real-time data to suitably equipped ground stations. These direct broadcast/real-time ground stations (or field terminals) will be capable of processing RDRs into EDRs by utilizing the FTS processing software appropriate for the type of field terminal.

The High Rate Data (HRD) broadcast will be a complete, full resolution data set containing sensor data and a subset of auxiliary/ancillary data necessary to generate EDR's and is intended to support users at fixed, regional hubs. A complete set of auxiliary/ancillary data will also be available at an on-line server for field terminal real-time processing. The HRD broadcast will be transmitted at X-band frequencies in the 7750-7850 MHz band (carrier frequencies of 7812 MHZ and 7830 MHZ), at a data rate of 20 Mbps, and will require a bandwidth of 30.8 MHz, with a tracking receive antenna aperture not to exceed 2.0 meters in diameter. The HRD continuity is expected from NPP through JPSS

The Low Rate Data (LRD) broadcast will be a subset of the full sensor data set and is intended for U.S. and worldwide users of field terminals (land and ship-based, fixed and mobile environmental data receivers operated by DoD users and surface receivers operated by other U.S. government agencies, worldwide weather services, and other international users). Some data compression (lossy or lossless) may be employed for the LRD link. The LRD L-band broadcast will provide data at a rate of about 4.0 Mbps (nominally 3.88 Mbps) at 1706 MHz, using a bandwidth of 8 MHz, with full Consultative Committee for Space Data Systems (CCSDS) convolutional coding, Viterbi decoding, and Reed Solomon encoding/decoding into a tracking receive antenna aperture not to exceed 1.0 meter diameter. The LRD parameters (frequency, bandwidth, data rate, and data content) have been selected to satisfy U.S. requirements for low-rate, real-time direct broadcast, as well as be closely compatible with (but not identical to) the broadcast parameters for the Advanced High Resolution Picture Transmission (AHRPT) format that has been accepted and approved by the Coordinating Group on Meteorological Satellites (CGMS) and will be used on the EUMETSAT MetOp spacecraft. The LRD broadcast will include data required to satisfy the U.S. user-specified, eight highest priority EDRs for real-time broadcast: imagery (from VIIRS) at 800 m HSI from at least one visible and one infrared channel and night time imagery at 2.7 km HSI from the day/night band; atmospheric vertical temperature and moisture profiles (from CrIS, ATMS, and CMIS); global sea surface winds (from CMIS); cloud base height, cloud cover/layers; pressure (surface/profile), and sea surface temperature. Additional lower priority EDRs will also be included in the LRD broadcast on a priority basis and as bandwidth permits. Future communications capabilities (e.g., rebroadcast of processed imagery/data and delivery via the Internet or "commercial" services) may allow other-than-direct satellite-to-ground data transmission to follow-on field terminal systems.

The JPSS LRD broadcast parameters (frequency, bandwidth, data rate, and data content) have been selected to satisfy NOAA requirements for low-rate, real-time direct broadcast, as well as be closely compatible with the broadcast parameters for the Advanced High Resolution Picture Transmission (AHRPT) format that has been accepted and approved by the Coordinating Group on Meteorological Satellites

(CGMS) and will be used on the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Metop spacecraft.

The JPSS LRD service will include data required to satisfy the U.S. user-specified HRPT-like spectral bands for real-time broadcast. These proposed spectral bands are listed in the following table:

AVHRR		Primary Uses	VIIRS	
Channel #	**Wavelength**		**Channel #**	**Wavelength**
1	0.58 - 0.68 µm	Daytime cloud/surface and vegetation mapping	M5	0.662 - 0.682 µm
		Imagery (variable)	DNB	0.5 - 0.9 µm
2	0.725-1.0 µm	Surface water, ice, snow melt, and vegetation mapping	M7	0.846 - 0.885 µm
3A	1.58-1.64 µm	Snow and ice detection	M10	1.58 - 1.67 µm
3B	3.55 - 3.93 µm	Sea surface temperature, night-time cloud mapping	M12	3.61 - 3.79µm
4	10.3 - 11.3 µm	Sea surface temperature, day and night cloud mapping	M15	10.263 - 11.263 µm
5	11.5 - 12.5 µm	Sea surface temperature, day and night cloud mapping	M16	11.538 - 12.488 µm

Table 1: The AVHRR channels are compared to similar channel on the VIIRS instrument.

Currently, LRD is not planned for NPP or JPSS-1. Issues currently being worked by DOC with regard to future availability of L-Band frequencies for government weather prediction could impact LRD availability in the JPSS era.

GOES-R

NOAA has initiated a program to introduce a new advanced imager with significantly improved performance to GOES satellites in year 2015. The new imager has been named the Advanced Baseline Imager (ABI). The ABI will have 16 spectral bands. The 0.59-0.69 micron visible band will have 0.5 km resolution. Bands centered at 0.47, 0.865, and 1.61 micron will have 1.0 km resolution with all other bands being

2.0 km resolution. The new imager scanning rate will be significantly increased to provide a full disk every 5 minutes (Mode-4), or 4 full disks per hour (one every 15 minutes) plus 12 CONUS scans per hour (one every 5-minutes) and 120 mesoscale images per hour with up to two mesoscale regions being observed in each 15 minute interval (Mode 3).

The ABI will provide key performance parameters cloud and moisture imagery for Full Disk, Continental United States (CONUS), and Mesoscale coverage for monitoring, forecasting and severe weather warning. Additional instruments include Space Environment In-Situ Suite (SEISS), Extreme Ultraviolet Sensor/X-Ray Sensor Irradiance Sensors (EXIS), Solar Ultraviolet Imager (SUVI), Magnetometer (MAG), and.Geostationary Lightning Mapper (GLM).

The GOES I-P series (currently GOES 8-15) imager and sounder raw data downlink is 2.6 Mbps. The corresponding entire Level 1b data stream, 2.11 Mbps, is uplinked to the GOES I-P series satellite for broadcast as GVAR data. GVAR data is broadcast in L-band (1685.7 MHz), with binary phase shift keyed (BPSK) modulation.

The GOES-R instrument raw data downlink (includes imager, lightning mapper, and four space environmental instruments) is expected to be approximately 75 Mbps. The corresponding entire Level 1b data stream GOES Re-Broadcast (GRB) will be in the order of 31 Mbps, in a dual circularly polarized data stream. The goal is to downlink the entire Level 1b data stream as GRB data. The GOES-R spacecraft communication system will be significantly different from the previous GOES satellites, driving changes to the direct-receive data sites and the introduction of new data formatting. Because of the large data rate the GVAR format will no longer be used.

The GOES-R Program Office (GPO) has developed a Government Reference Architecture that provides a workable solution to the GOES-R GRB requirements. To minimize the impact on the user, the GRB will continue to be transmitted in L-band, but use an expanded bandwidth (1681 MHz -1692 MHz). Emergency Managers Weather Information Network (EMWIN) has been combined with Low Rate Information Transmission (LRIT) and the separate EMWIN transponder eliminated from GOES-R. The new service will be known as High Rate Information Transmission (HRIT)/EMWIN. On GOES-R, the Data Collection Platform Report (DCPR) service will be operated in the 1679 MHz to 1680 MHz range (seeTable 2).

Service	**Current Frequency Spectrum**	**Current Data Rate**	**Future Frequency Spectrum**	**Future Data Rate**
GVAR/GRB	1685.7 MHz	2.11 mbps	1686.6 MHz	31 Mbps
LRIT→ HRIT	1691 MHz	128 kbps	1694.1 MHz	400 kbps*
EMWIN	1692.7 MHz	9.6 kbps	1694.1 MHz	400 kbps*
DCS/DCPR	1694.5 MHz	100/300/ 1200 bps	1679.9 MHz	300/1200 bps

*Note: HRIT and EMWIN will have a combined service with a data rate of 400 kbps.

Table 2 - Impact on Transmission Frequencies/Data Rates for GOES-R

To fit within the available bandwidth of 11 MHz (centered around 1686.6 MHz), the GRB service will employ dual polarization, having two signals: one right circular and the other left circular polarization. Users will need new field terminal equipment to receive GRB as it replaces GVAR. The GOES-R program investigated providing an interim service that would partially emulate the GVAR, but determined that system would be best served by conducting a controlled system phaseover to the GRB service. The main factor contributing to this decision was the reliance on previous generation satellites and ground equipment remaining available to support the broadcast, coupled with the complexity and risk of fielding two simultaneous services. While there are no plans for a simplified GRB data format during the transitional period prior to GOES-R operations, a key feature in the Ground Segment Project transition plan is maintaining continuous contact with the user communities to ensure they are fully aware of the requirements needed to be able to receive and process the larger and faster GRB data stream. At the Direct Readout Conference held in April 2011, users requested NOAA to develop a minimum system configuration for GRB reception to assist GVAR users in planning their transition.

The GRB transmission format is still being defined, the intent is to take advantage of standard formats and technologies. GRB's dual polarization format represents a complete format change from GVAR, driven by the improved temporal and spatial measurement characteristics of the new instruments. This quantum leap in instrument capability and potential for vastly improved user products necessitates the complete transition of users from GVAR to GRB. Field terminals and user facilities must evolve as GOES-R's capabilities are developed, launched, tested and placed into operational service.

4. Conclusion

The direct readout services from NOAA spacecraft will change significantly over the next eight years. A summary of the spacecraft effects and field terminal changes is listed below:

<u>METOP</u>
APT service is not available
AHRPT format requires upgrades to existing HRPT field terminals or the purchase of a new station

<u>NOAA's POES Constellation</u>
APT frequency change in the 137.1 – 137.937 MHz frequency band for NOAA-18 and NOAA-19 spacecraft
HRPT service remains unchanged

<u>NOAA's NPP/JPSS Constellation</u>
APT service will not available
HRPT will be replaced with the Low Rate Data (LRD) broadcast, requires L-band field terminal upgrade
LRD will not be available on NPP or JPSS-1

High data Rate (HRD) service requires a new X-band field terminal

NOAA's GOES Constellation

GOES VARiable (GVAR) broadcast will be replaced with GOES Re-Broadcast GRB) service, requires new field terminal.

GOES LRIT will be combined with EMWIN and called HRIT/EMWIN for GOES-R at a new higher data rate and a new transmission frequency.