CGMS

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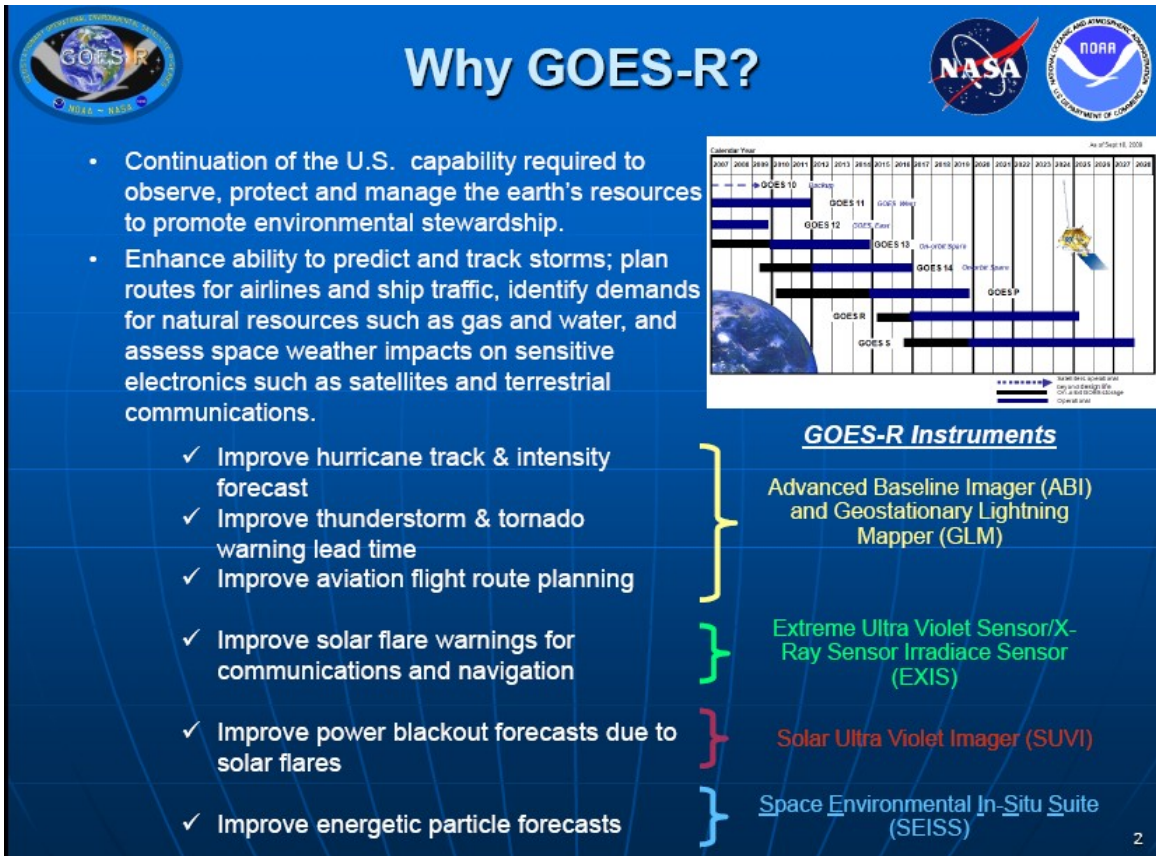
GOES-R OVERVIEW

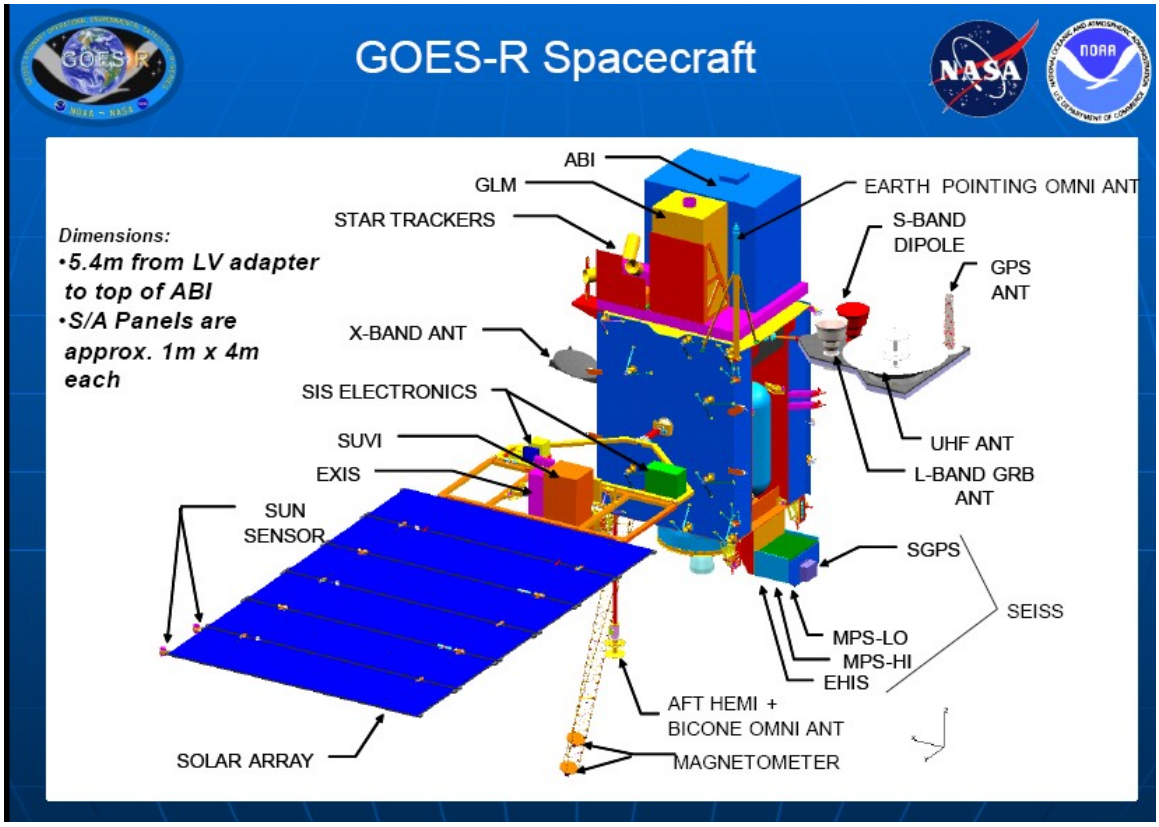
1.0 INTRODUCTION

The GOES-R series of spacecraft, set to launch in 2015, is expected to double the clarity of today's satellite imagery and provide at least 20 times more atmospheric observations from space. The next-generation GOES system will provide significantly improved image resolution and increase the rate of imagery coverage of earth surfaces from every 30 minutes to every 5 minutes and every 30 seconds for severe weather events. GOES-R advanced sensor technology will measure data such as solar activity, the charged particle environment, the Earth's magnetic field, temperature and moisture profiles, cloud properties, ozone estimates, and solar x-ray flux to support accurate weather forecasting, severe storm tracking, and meteorological research.



2.0 GOES-R SPACECRAFT

The basic spacecraft contract is for two satellites with options for two additional satellites. GOES-R will feature the first-ever, space-based detection system for lightning activity over land and water. The new satellites also are expected to bring other key benefits, including data that will improve warnings for heat stress and bolster forecasts for unhealthy air quality, and advanced solar-monitoring instruments for space weather forecasts and warnings of solar storms.



In May, 2009, Lockheed Martin Space Systems Co. was selected to build two satellites for the GOES-R Series. The basic contract is for two satellites with options for two additional satellites. The total estimated value of the basic contract, including the options, is $1.09 billion. The new series, poised to begin launching in 2015, will provide more than 30 times the information of today's GOES satellites.

Harris Corporation was awarded a 10-year; potential $736 million contract to provide a complete, end-to-end solution for the NOAA GOES Ground Segment. The Harris team will design, develop, deploy and operate the GOES-R ground segment, which will receive and process satellite data, and generate and distribute weather data to more than 10,000 direct users. Harris will also provide the command and control of operational satellites. Harris is providing a service-based, open-architecture solution that will accommodate the dramatic increase in data to be ingested, processed and distributed.

3.0 INSTRUMENT SUITE

The instrument suite defined for the GOES-R mission will provide improved performance over the legacy suite of GOES instruments. The GOES-R series of satellites will be comprised of improved spacecraft and instrument technologies, which will result in more timely and accurate weather forecasts, and improve support for the detection and observations of meteorological phenomena that directly affect public safety, protection of property, and ultimately, economic health and development.

Increased Performance

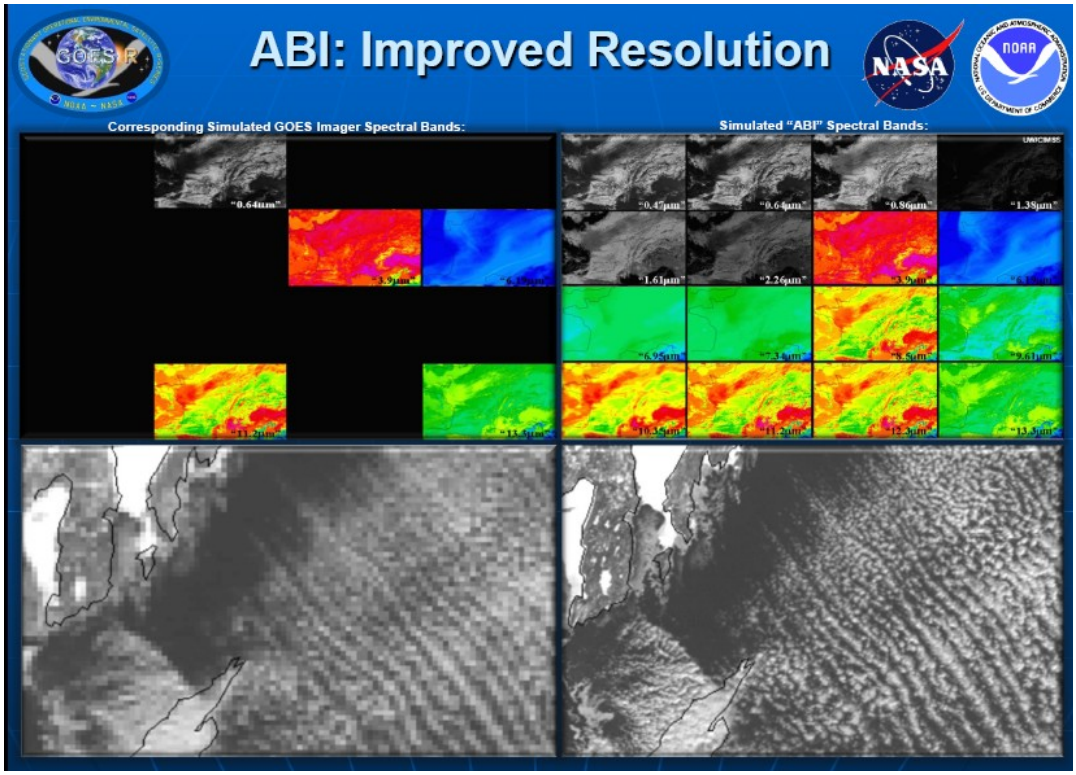
Performance Capability	GOES I-M	GOES N-P	GOES R
Imaging			
Visible Resolution	1 km	1 km	0.5 km
IR Resolution	4-8 km	4-8 km N 4 km O/P	1-2 km
Full Disk Coverage Rate	30 min	30 min	5 min
# of Channels	5	5	16
Solar Monitoring	GOES-M only	Yes	Yes
Lightning Detection	No	No	Yes
Operate through Eclipse	No	Yes	Yes
Ground System Backup	Limited	Limited	Limited
Archive and Access	Limited	Limited	Yes
Raw Data Volume per spacecraft	2.6 Mbps	2.6 Mbps	75 Mbps

GOES-R provides twice the clarity of the images, greater than 20 times more information, and refreshes the data 6X faster than the current GOES system.

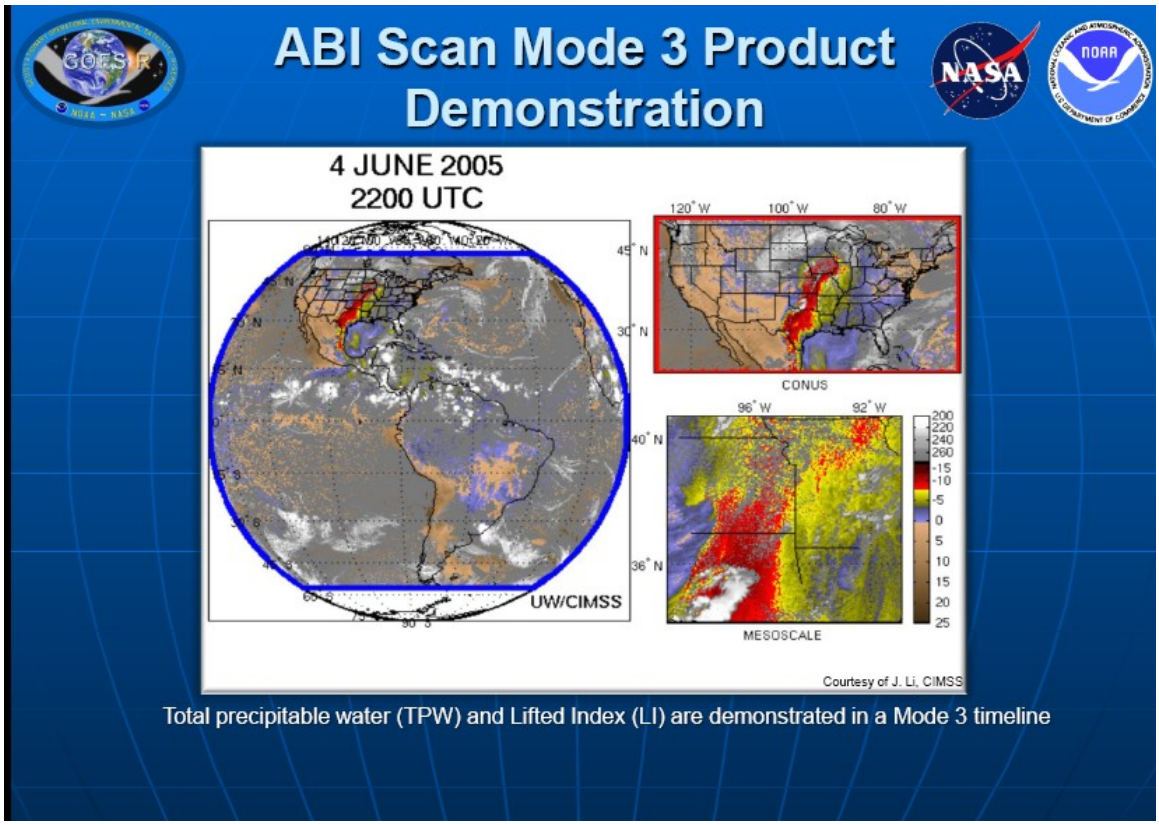
The GOES-R instrument suite consists of:

Advance Baseline Imager

The GOES-R multi-spectral Advanced Baseline Imager (ABI) provides greater spectral coverage (16 bands), a 4X improvement in spatial resolution (2Km IR, several at 1Km and 0.5Km at 0.64 microns) and 6X faster image scanning (5 minute Full Disk, 30-second Mesoscale) over the current GOES Imager.



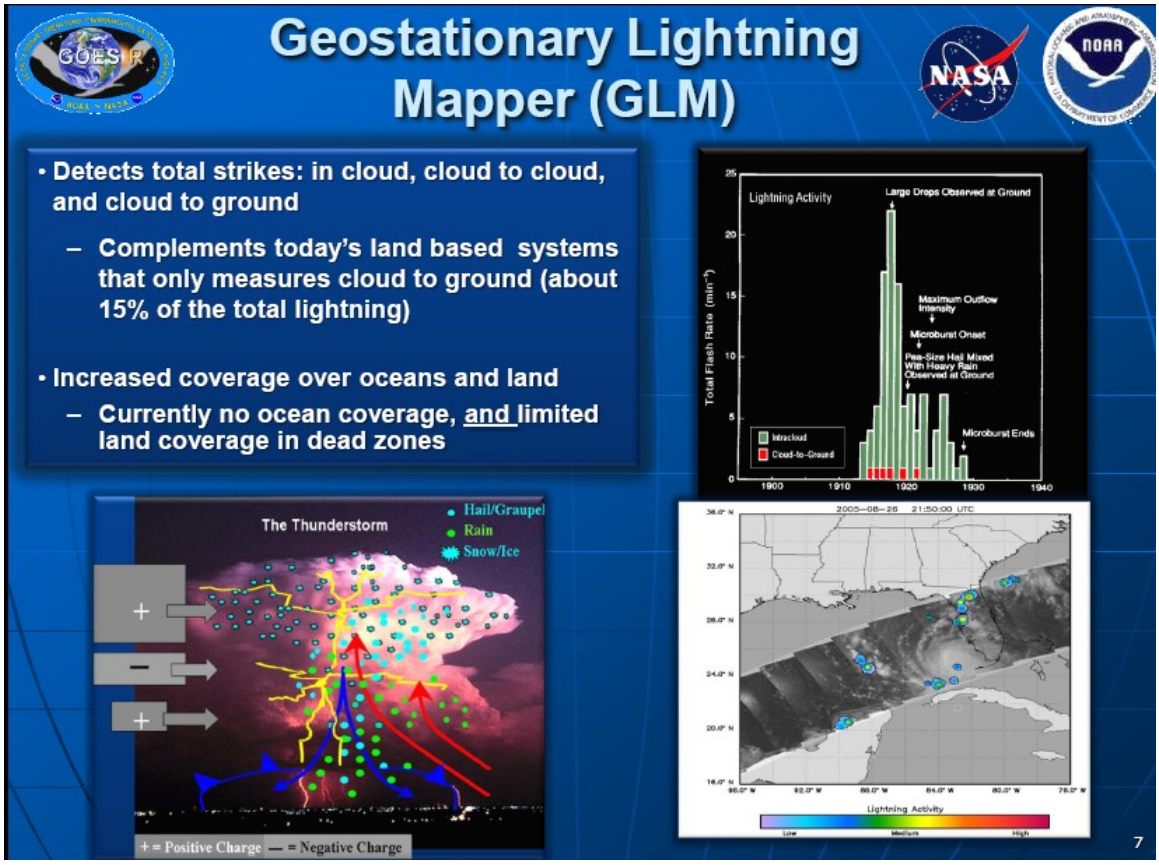
The increased spectral coverage provided by ABI, especially with the additional water vapor channels, will provide many of the legacy Sounder products alone or in combination with other remote sensing or model-derived information. These products will have increased spatial coverage (full disk) and faster refresh rates (5 minutes) over the current Sounder capability (CONUS area in one hour). Improvements in vertical resolution of sounder products await the development of an operational hyperspectral sounder for the GOES program.



The ABI will provide sixteen spectral channels compared to five channels on the current GOES I/P series imager. This increase will allow more comprehensive monitoring of atmospheric conditions such as aerosol concentration, cirrus cloud location, and cloud properties. ABI will also provide data products with a spatial resolution of at least half the current imager, down to 0.5 km in the visible band. With its high temporal coverage, full disk every 5 minutes, and ability to continue operations around local midnight, ABI will provide continuous and timely monitoring of weather. This is further augmented by ABI's ability to revisit a specified 1000 kilometer region every 30 seconds to track severe weather.

Geostationary Lightning Mapper

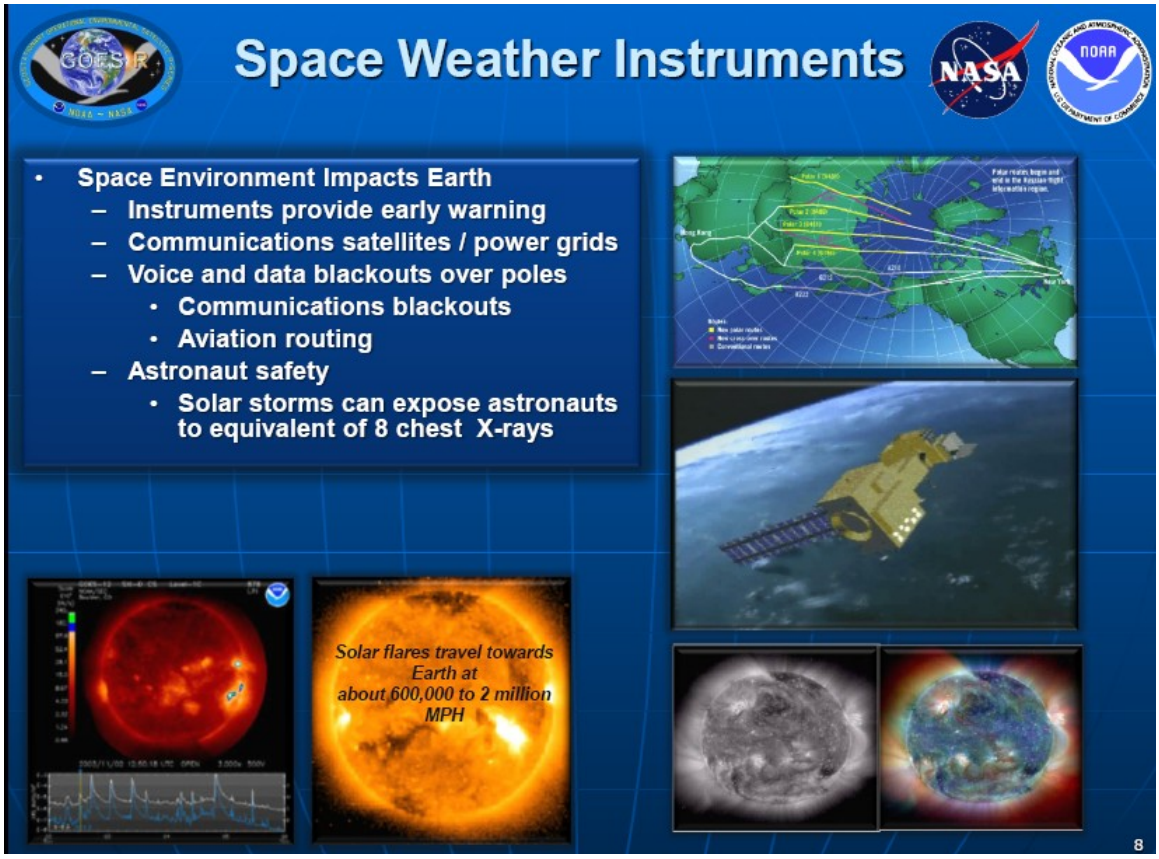
The GOES-R instrument suite includes a new instrument, the Geostationary Lightning Mapper (GLM). GLM's ability to monitor lightning on a global scale will provide new insight into the formation, distribution, morphology and evolution of storms. Data from GLM will help protect communities by increasing severe storm and tornado warning times. GLM also enables investigations into the mechanisms at the core of the global water and energy cycle.



GLM's lightning observations will penetrate cloud tops and detect convective activity continuously over whole continents and adjacent oceans. This lightning characteristic of clouds is inadequately measured, both temporally and spatially, by current observing systems. With improved insight into the dynamics and life cycles of storms and weather systems, GLM will greatly improve understanding of the fast time scale elements of atmospheric convection. This will lead to a better understanding of the Earth's climate system, which, combined with longterm GLM observations, will lead to significant improvements in monitoring changes in storm climatology. In addition, since intense and increasing in-cloud flashes are known to precede severe weather by tens of minutes, the real-time transmission and distribution of GLM data will improve warning times for severe storms, particularly tornadoes.

Space Weather Instruments

The GOES-R sensors for monitoring space weather include the Space Environment In-Situ Suite (SEISS), and a new solar imaging instrument suite: Solar Ultraviolet Imager (SUVI) and Extreme Ultraviolet and X-ray Irradiance Suite (EXIS). SEISS will provide insight into the effects of space weather on earth's environment and help track natural radiation in and around the earth. SUVI, another GOES-R instrument to be built by Lockheed Martin, will image the solar disk in multiple UV spectral bands with increased resolution, sensitivity and dynamic range over the SXI instrument currently on GOES-N. EXIS will provide significant improvement to specification and forecast models of the thermosphere and ionosphere.



4.0 UNIQUE PAYLOAD SERVICES

4.1 Auxiliary Communication Services

In addition to supporting environmental sensing payloads, GOES-R will carriy an array of UHF, S-band, L-band antennas to support the following auxiliary communication services.

4.1 Data Collection

The GOES Data Collection System (DCS) collects near-time environmental data from more than 19,000 data collection platforms located in remote areas where normal monitoring is not practical. The DCS receives data from platforms on ships, aircraft, balloons and fixed sites. These data are used to monitor seismic events, volcanoes, tsunami, snow conditions, rivers, lakes, reservoirs, ocean data, forest fire control, meteorological and upper air parameters. The GOES-R DCS is similar to GOES-N.

4.3 Data Broadcast Services

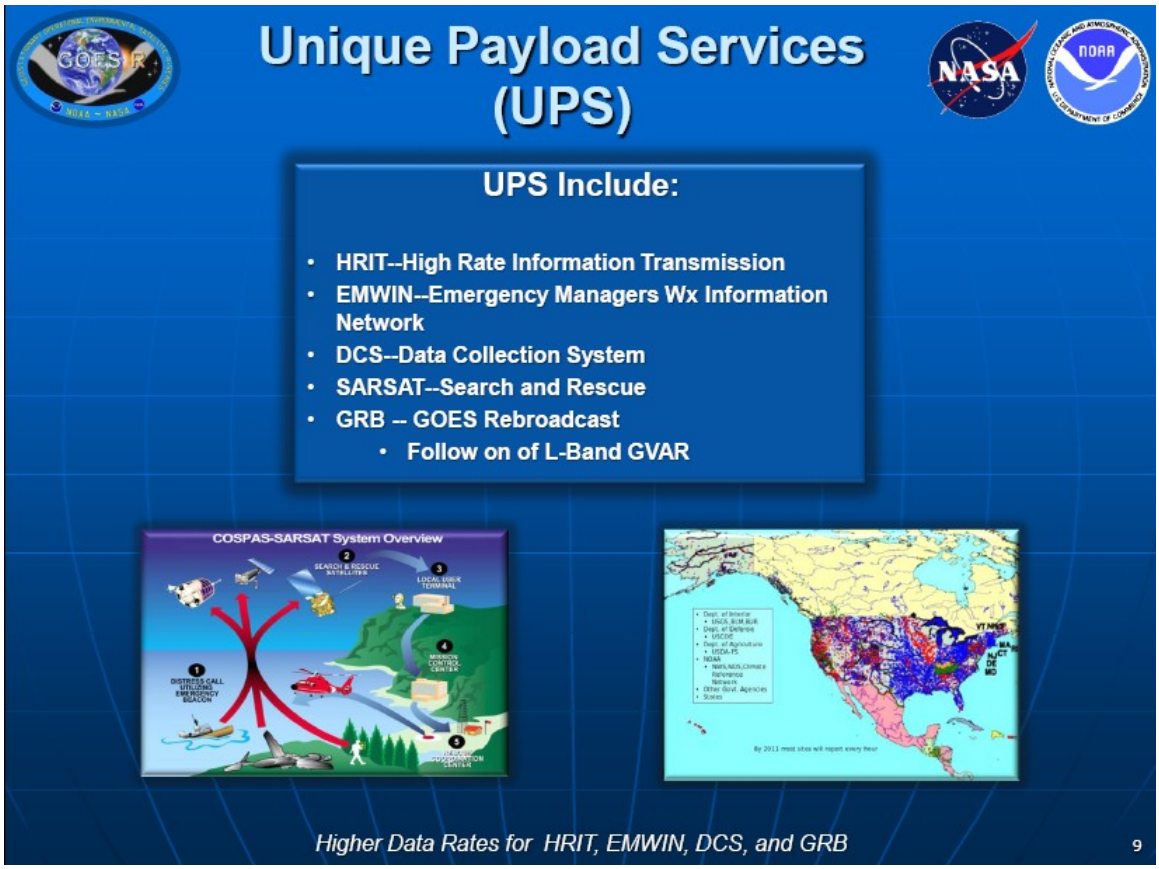
GOES Rebroadcast (GRB): The GOES Rebroadcast (GRB) is a communication service that provides processed mission data to the user community. Raw data from the environmental sensors is processed into calibrated navigated data sets at the receive site. The processed data is then uplinked to GOES for broadcast to users within view of the satellite. The current GRB baseline is just under 24 Mbps, which is more than an order of magnitude increase over GOES-N GVAR.

Low Rate Information Terminal (LRIT): The low rate information terminal (LRIT) transmission is a communication service provided through a transponder onboard the GOES satellite. The LRIT service evolves from the current WEFAX system which provides a wide dissemination of GOES imagery and other data at the relatively low information rate of 128

kbps. The LRIT has a requirement to upgrade the user information rate to 256 kbps, technically making it a high information rate (HRIT) system in accordance with CGMS Global Specifications for HRIT/LRIT.

Emergency Manager's Weather Information Network (EMWIN): The emergency manager's weather information network (EMWIN) transmission is a communication service provided though a transponder onboard the GOES satellite. EMWIN is a suite of data access methods that make available a live stream of weather and other critical information to Local Emergency Managers and the Federal Emergency Management Agency (FEMA). 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 HRIT/EMWIN.

Search and Rescue (SAR): The Search and Rescue (SAR) subsystem onboard the GOES satellite is a dedicated transponder that detects 406 MHz distress signals transmitted by Emergency Locator Transmitters (ELT) carried on aircraft, Emergency Position-Indicating Radio Beacons (EPIRB) aboard marine vessels, and Personal Locator Beacons (PLB) used in land-based applications. The distress signals are relayed by the GOES satellite to a ground station located within the field-of-view of the satellite. The information is then passed to a mission control center and ultimately to a rescue coordination center from where help is dispatched.



5.0 GOES-R FLIGHT STATUS

The GOES-R space segment consists of a constellation of one or more satellites each nominally located at 75 degrees West longitude (East location) and at 135 degrees West longitude (West location) at geostationary altitude, 0 degrees inclination. The satellite consists of the spacecraft bus, the instrument payloads and the auxiliary communication services payloads. The notional baseline architecture accommodates the Advanced Baseline Imager (ABI), Solar Imaging Suite (SIS) and GOES Lightning Mapper (GLM) on the A Satellite.

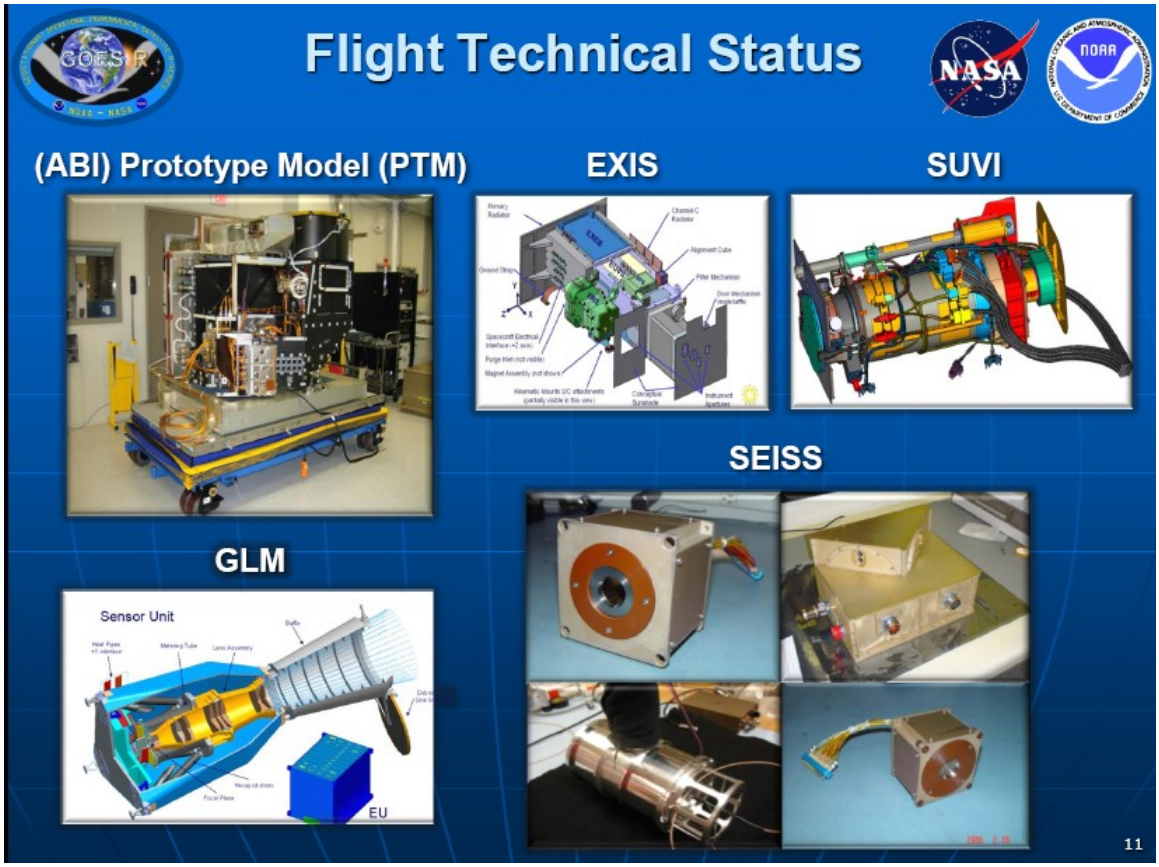
GOES-R Flight status

Element	Function	Contractor	Status
Spacecraft	Platform for the environmental sensors and communications	Lockheed Martin Space Systems Company	Kick off this week
Advanced Baseline Imager (ABI)	*Primary Instrument:* Provides imagery of the Earth's surface, atmosphere and ground cover	ITT	Engineering unit in test
Geostationary Lightning Mapper (GLM)	Detects the frequency and location of lightning activity	Lockheed Martin Space Systems Company	Critical design underway
Space Environmental In-Situ Suite (SEISS)	Monitors the space environment	Assurance Technology Corporation	Critical design phase: Brassboard development
Extreme Ultra Violet / X-Ray Irradiance Sensor (EXIS)	Provides real time measurement of solar activity. Observes the sun's emissions and provides early detection and location of flares	Laboratory for Atmospheric and Space Physics	Critical design underway
Solar Ultra Violet Imager (SUVI)		Lockheed Martin Space Systems Company	Critical design underway
Magnetometer	Measures the magnitude and direction of the Earth's magnetic field	Lockheed Martin Space Systems Company	Kick off this week

5.1 Flight Technical Status

All the GOES-R instruments are in the implementation phase. Lockheed Martin is designing and developing the new GOES-R Geostationary Lightning Mapper (GLM). GLM is a first of its kind capability—today's ground-based national lightning detection networks are designed to locate mostly cloud-to-ground lightning—a small fraction of the total.

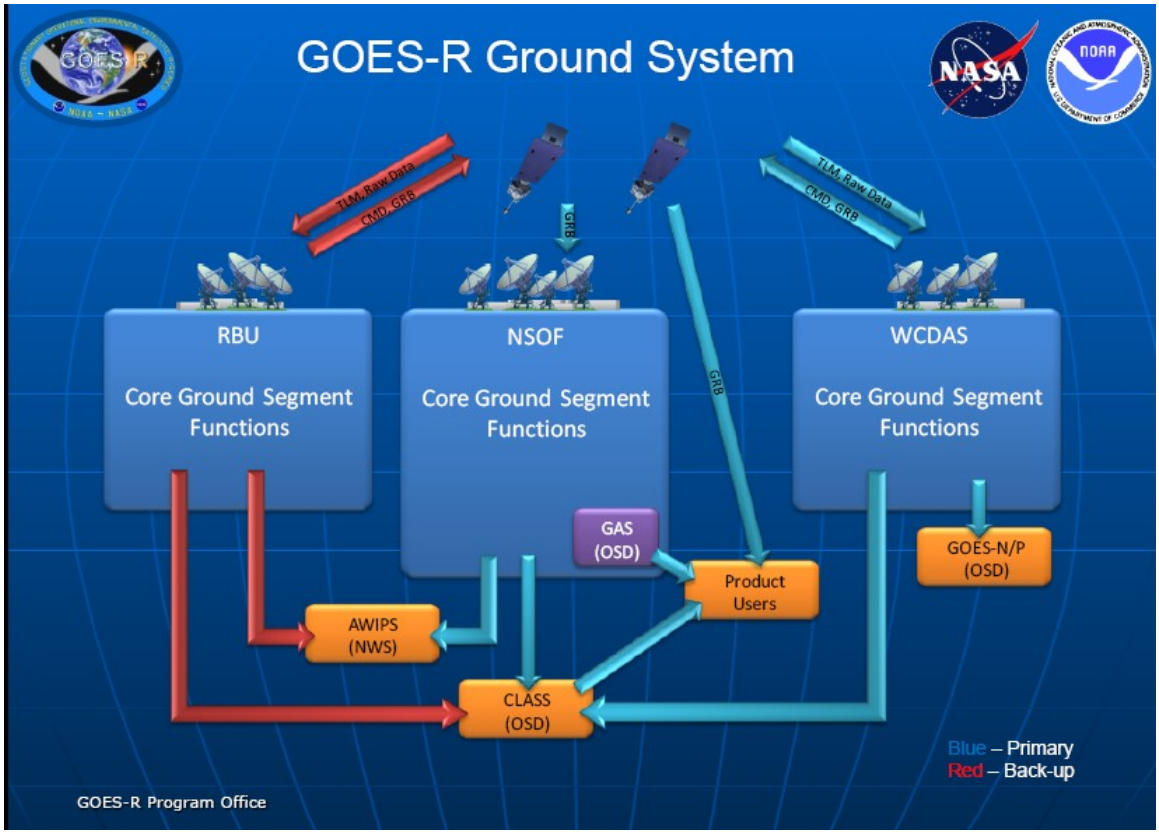
ITT Corporation is presently nearing completion of a prototype model of the Advanced Baseline Imager (ABI), leading to the development of the first flight model. The flight model will improve hurricane monitoring and severe weather warning capability by scanning the earth nearly five times faster with a four- fold improvement in spatial resolution over the current GOES. The space weather and solar imaging instruments [Space Environment In-Situ Suite (SEISS), the Solar Ultra Violet Imager (SUVI) and Extreme Ultraviolet and X-Ray Irradiance Sensor (EXIS)] are continuing their development efforts. These space environmental sensors will significantly improve NOAA's ability to detect space phenomena and provide warning to affected earth systems such as communications systems, GPS navigation, aviation routing, and power grids.



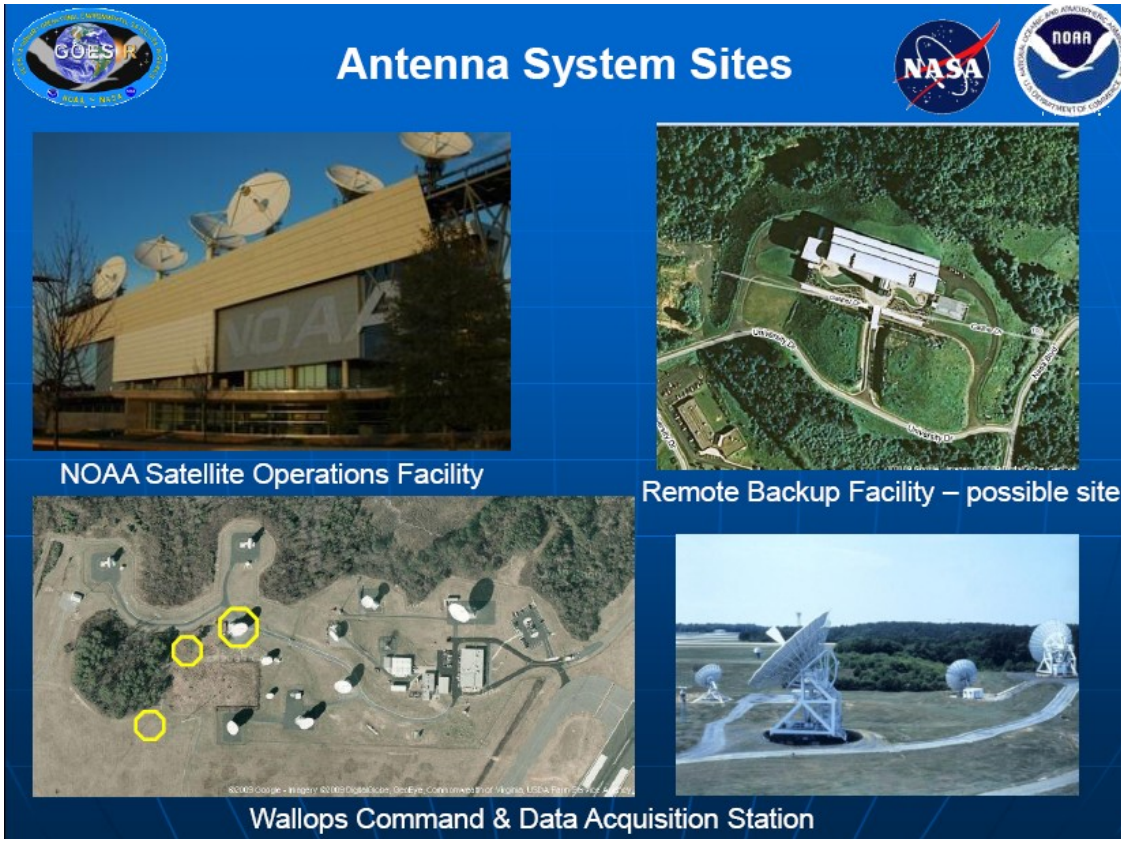
6.0 GROUND SYSTEM

The GOES- R Ground Segment Project (GSP) will acquire the integrated, distributed ground system that will conduct satellite operations and instrument product generation and distribution. Our goal is to provide the latest information pertaining to the acquisition, design, and development of the ground system that will support the GOES- R Series Satellites. The GOES- R ground system will be a collaborative effort between the GSP, NOAA, NASA, and our Ground Segment Contractor.

The focus of the GOES- R Ground Segment Acquisition phase is the full- scale development, design, manufacturing, Test and Evaluation (T&E), integration, deployment, and transition to operations. NOAA will operate and maintain the operational system, with transition to operations support provided by the GSP for a four year period following initial satellite launch. The Operational and Sustainment phase will start after the completion of the transition to operations efforts. The GSP will end following the successful transition to operations and final launch in the GOES- R series.



The ground system is composed of computers which control the satellite and process the satellite's data into products scientists can use the antenna system for command and data acquisition.



The Ground Segment encompasses the following four major functions:

Mission Management (MM) includes mission scheduling, satellite (including instrument) operations, satellite state-of-health trending, orbital analysis, and ground operations.

Enterprise Management (EM) supports all operational functions by monitoring, assessing, and controlling the configuration of the operational systems, networks, and communications for the GOES-R ground segment. EM serves as the "glue" that links the MM, PG, and PD elements and provides for a degree of automated control. EM thus contributes to greater operational availability, efficiency, and safety of the GOES-R system.

Product Generation (PG) includes algorithm support, processed raw data, processing to Level 1b (including calibration, navigation and registration), generation of the data for rebroadcast and for higher level data creation including operational derived products. The government will provide the necessary science algorithms for the generation of user products.

Product Distribution (PD) includes distribution of Level 1b, Level 2+, and derived products to user portals while addressing interfaces with the user for accessing GOES data. The primary user portals include the GOES-R satellite series (e.g., for uplink of Global Re-Broadcast (GRB)), NOAA's National Weather Service (NWS) for AWIPS, and a GOES-R User Access Point at NESDIS/OSDPD.

Considerations for the dissemination of GOES-R data and products include:

- AWIPS
  - Delivery of sectorized cloud and moisture imagery products to the AWIPS interface point via a dedicated path
- GOES-R Access Subsystem (GAS)
  - Data ingest (no data processing) and distribution system for GOES-R products and data to authorized users
- Comprehensive Large-Array data Stewardship System (CLASS)
  - Long-term archive for GOES-R products (L1b, L2+) and data (L0, cal/val, algorithm software, documentation)
- GOES Rebroadcast (GRB)
  - Data assembled from Level 1b in the form of CCSDS Space Packets for rebroadcast by the GOES-R satellites
- Emulated GVAR (eGVAR)
  - Data selected and assembled from Level 1b for continuity of GOES operations and to facilitate transition from GOES-I/P to GOES-R.

7.0 PROVING GROUND PARTNERS

The Geostationary Operational Environmental Satellite (GOES-R) Satellite Proving Ground project engages the National Weather Service (NWS) forecast and warning community in pre-operational demonstrations of selected capabilities anticipated from the next generation of National Oceanic and Atmospheric Administration (NOAA) geostationary earth observing systems.

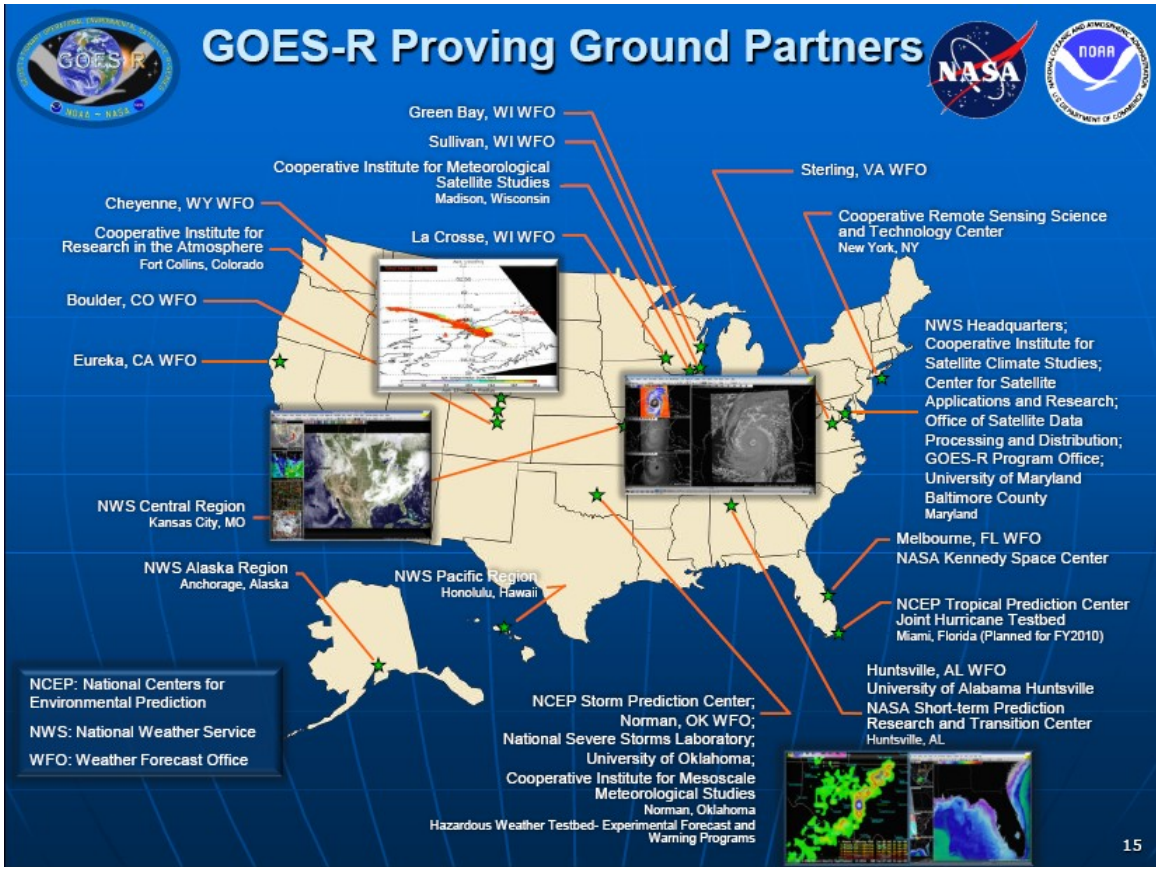
The Proving Ground project objective is to bridge the gap between research-to-operations by:

- Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate various aspects of future GOES-R capabilities
- Infusing GOES-R products and techniques into the NWS operational environment, with emphasis on the Advanced Weather Information Processing System (AWIPS) and transitioning from AWIPS-I ("AWIPS Legacy") to AWIPS-II ("AWIPS Migration").
- Engaging in a two-way dialogue to provide feedback to the developers from the users

A key element of this activity is a sustained interaction between the developers and end users for the purposes of training, product evaluation, and solicitation of user feedback. The Proving Ground relies on close coordination with the GOES-R Algorithm Working Group (AWG) and Risk Reduction programs as sources of demonstration products, and will enhance the operational transition pathway for those programs.

The intended outcomes of this project are Day-1 readiness and maximum utilization for both developers and users of the GOES-R observing system, and an effective transition of GOES-R research products to the operational weather community.

The GOES-R Proving Ground will facilitate the testing and validation of new ideas, technologies and products before they become integrated into operational use. This proving ground is an essential component of GOES-R risk reduction, which will help to ensure that users are ready for the new types of satellite imagery and products that will be available in the upcoming GOES-R era.



8.0 SUMMARY

The first of the GOES-R series of satellites is scheduled for launch in 2015. The GOES-R sensors are making great progress. The ABI Prototype model is in testing and the other sensors are heading towards Critical Design Review (CDR). Also, the Ground Segment development is under way. A major Contractor, Harris Corporation, is onboard and working towards an Integrated Baseline Review and Preliminary Design. The Government Algorithm Development team is making enormous progress on developing a mature ATBD. In addition, the Ground System is starting some initial Cal/Val experiments. The GOES-R Proving Ground activities continue to show progress towards ensuring GOES-R readiness.