# *Ground System as an Enterprise – Software Architecture Considerations*

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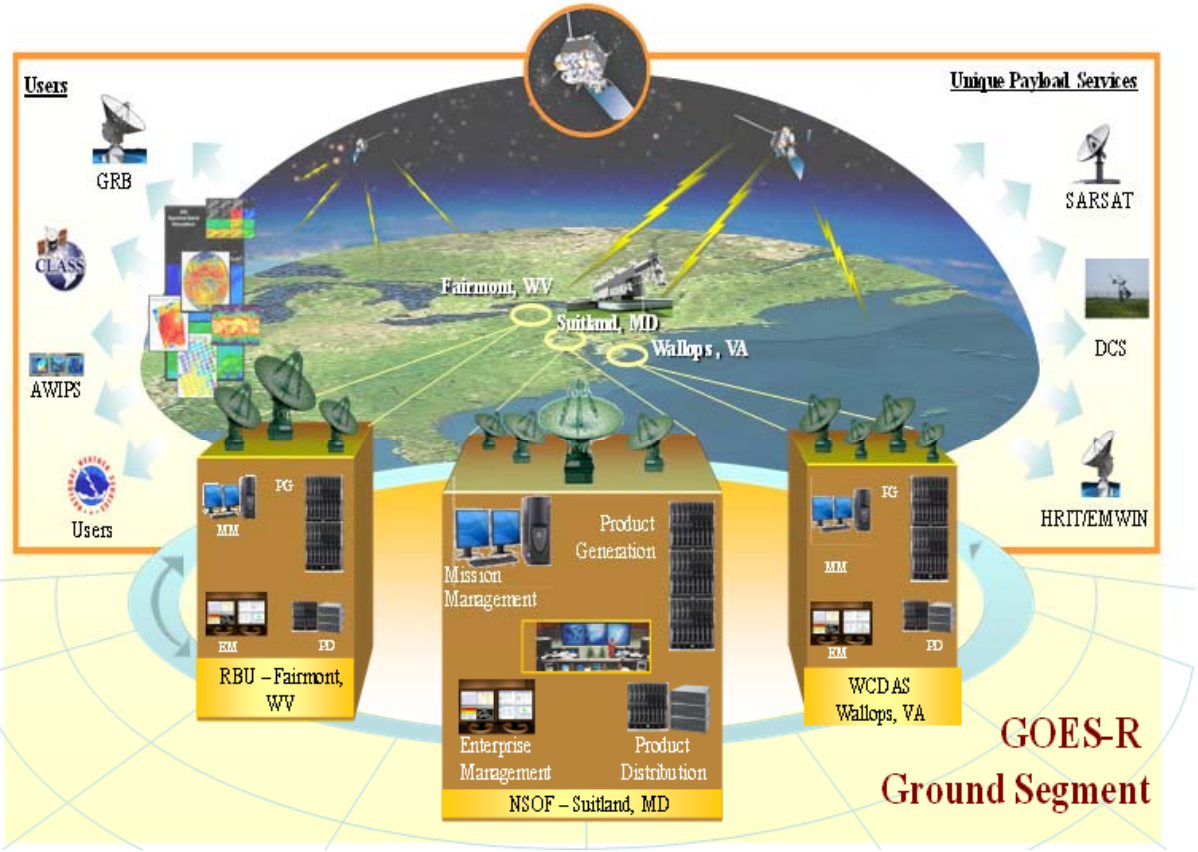
## System Overview*




Operational NOAA Mission:
Continuous satellite images and measurements of Earth's environment:

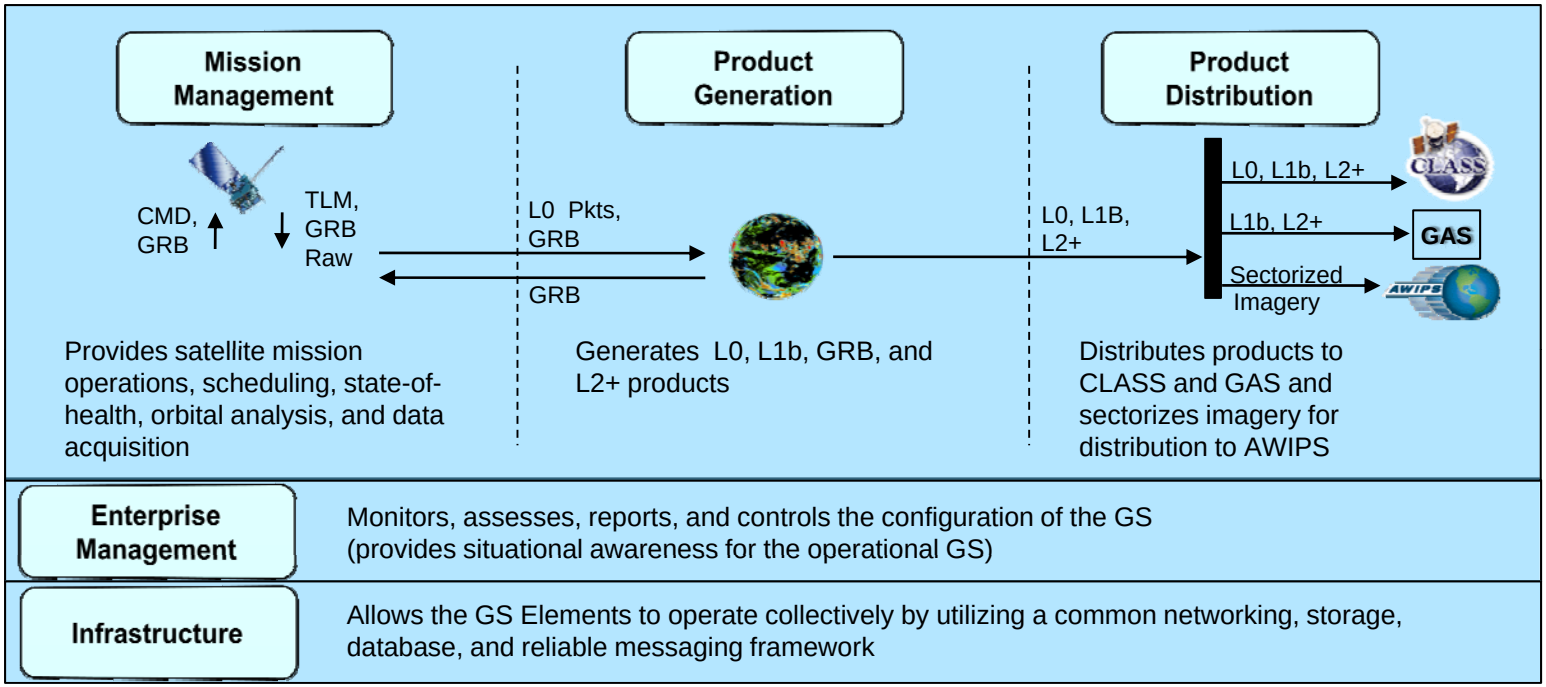
- Atmosphere, Clouds,
- Precipitation,
- Land & Ocean Surface,
- Solar flares,
- Cosmic Radiation,
- Air Pollution,
- Lightning

System features:

- Two Geostationary Satellites
- Three Facility Locations
- Multiple Data services
- Multiple Users
- Enterprise Management

* Ref: GOES-R Brochure in backup material

# Four Architecture Elements




| | |
|---|---|
| MM | Mission Management |
| PG | Product Generation |
| PD | Product Distribution |
| EM/IS | Enterprise Management |

# Many Stakeholders & Needs

- Products provide timely and accurate forecasts and information for
  - Public safety
  - Protection of life and property
  - Nation's economic health and development
  - GPS and cell phone performance
  - Power Grid Impacts

- Stakeholders range from NWS, FAA, DOD, and DHS to county and local level emergency managers and individuals

# Enterprise-Level Challenges

- Large number of stakeholders
- Many products and services
- Near Real-Time Data & Product Delivery
- Continuous data production
- Efficient Processing
- OTS vs custom development
- Integrating and harmonizing
- Security
- Ability to upgrade science algorithms and infrastructure
- Robust to Failures

# Over-The-Counter Considerations

- OTS (software and hardware) vs custom development decisions
  - Trade Study
  - Selection Study
  - Analysis
  - Justification

- Include a look at the ability of an OTS package to be integrated


# Integrating and Harmonizing

HARRIS

- Difficulties faced
  - Integrating OTS with custom developed packages
  - Meeting all requirements using OTS
  - Tight Latency and refresh requirements

- Efficient interfaces
  - Continuous data and product delivery in near real time
  - Archive support for large data volumes

# Environments & Security Zones

- Define three environments
  - Operations environment (OE)
  - Development Environment (DE)
  - Integration and Test Environment (ITE)

- Establish three security zones
  - Satellite Operations Zone (SOZ)
  - Product Production Zone (PPZ)
  - Development Environment and I & T Zone (DITZ)

# Sample Security Principles

- Configure firewalls to deny all except for traffic absolutely required for mission needs
- Implement “disjointed protocols” valid for one specific interface and none other
- Configure system so no two-way traffic will go directly between operations and other zones
- Restrict outbound traffic by specified source- and destination-restricted protocols and ports

# Harmonization Opportunities

- OTS vs custom development
- Security control with separate zones
- Separate environments for operations, development and integration and test
- Harmonizing (integrating the pieces)

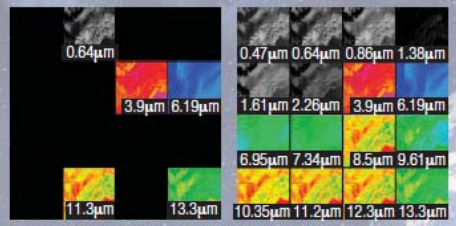
# *Backup Information*

# GOES-R Brochure Side 1

## GOES-R Capabilities

- Spectral, spatial, and temporal resolution improved by factors of 3, 4, and 5
- Lightning detection with real-time maps of all lightning activity in the Western Hemisphere
- Increased dynamic range, resolution, and sensitivity in monitoring solar X-ray flux improves models of the ionosphere
- Real-time solar extreme ultraviolet movies in 6 channels improves models of flares and coronal mass ejections
- Monitoring of low energy ionizing responsible for spacecraft charging
- Re-broadcast provides 10 times more data than the current GOES Variable Format

**Current GOES (5 Channels)** | **Future GOES-R (16 Channels)**




Images courtesy of the Cooperative Institute for Meteorological Satellite Studies (CIMSS)

**Mass** < 2800kg, **Size** ~ 5.5 meters, **Power** > 4000W
Image courtesy of Lockheed Martin

## GOES-R Communications Mission:

Remote environmental sensing instruments are only part of the payload on the GOES-R Series satellites. In addition, there are several GOES-unique communications capabilities upon which thousands of users depend. These special-purpose "transponders" relay data directly to users to meet critical needs. They include:

### HRIT/EMWIN

High Rate Information Transmission/Emergency Managers Weather Information Network (HRIT/EMWIN). HRIT is a new high data rate (400 Kbps) combination of today's LRIT (Low Rate Information Transmission) and EMWIN services; delivering selected imagery, charts, other environmental data products, and text messages (NWS Watches and Warnings) to hemispheric users.

### DCS

Data Collection System (DCS). GOES-R spacecraft relay data transmissions for nearly 30,000 in-situ environmental data platforms from across the hemisphere. GOES-R will support 300 bps, 1200 bps, and CDMA platforms.

### SARSAT

All GOES-R satellites support the Search and Rescue Satellite Aided Tracking (SARSAT) service by relaying distress signals from in-situ Emergency Position Indicating Radio Beacons (EPIRBs) and other transmitting devices.

### GRB

GOES-R Re-Broadcast (GRB). GRB will contain the Level 1b data from each of the GOES-R instruments and is the GOES-R version of today's GOES Variable Format (GVAR).

## Contact Information:

GOES-R is a collaborative development and acquisition effort between NOAA and NASA.


GOES-R Program Office
Code 417
NASA Goddard Space Flight Center
Greenbelt, MD 20771
301-286-1355
Or contact us through our website:
www.GOES-R.gov


*the next generation*

## GOES-R

the nation's weather satellite

The Geostationary Operational Environmental Satellite "R" series (GOES-R) program is a key element to meeting the National Oceanic and Atmospheric Administration's (NOAA) mission. The advanced spacecraft and instrument technology used on the GOES-R series will result in more timely and accurate weather forecasts. It will improve support for the detection and observations of meteorological phenomena that directly affect public safety, protection of property, and ultimately, economic health and development. The first launch of the GOES-R series satellite is scheduled for 2015.

# GOES-R Brochure Side 2

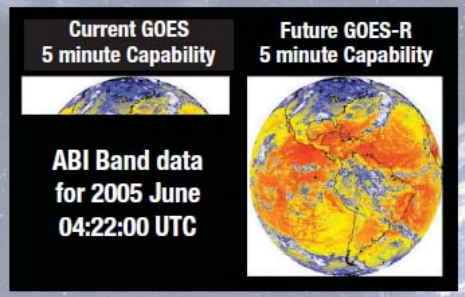
## GOES-R Instruments: Earth, Solar, & Space Weather




### ABI

The GOES-R Advanced Baseline Imager (ABI), a sixteen channel imager with two visible channels, four near-infrared channels, and ten infrared channels, will provide three times more spectral information, four times the spatial resolution, and more than five times faster temporal coverage, than the current system.

**ABI covers the Earth approximately 5 times faster than the current imager.**




### GLM

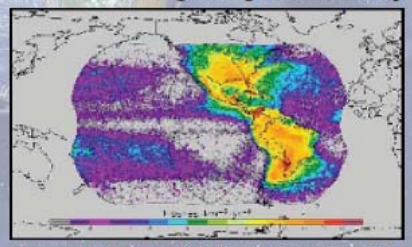
The Geostationary Lightning Mapper (GLM) is an optical transient detector and imager operating in the near-IR that maps all (in-cloud and cloud-to-ground) lightning flashes with near uniform spatial resolution of 8-12 km continuously day and night over the Americas and adjacent oceanic regions.
GLM will provide:

- Early indication of storm intensification and severe weather events
- Tornado warning lead time of 20 minutes or more
- Data for long-term climate variability studies

### Imaging Capabilities

| Parameter | Current Imager | ABI | Comments |
|---|---|---|---|
| Number of Visible Bands | 1 | 2 | Cloud cover, plant health and surface features during the day |
| Number of Near IR Bands | 0 | 4 | Cirrus clouds, low cloud/fog and fire detection |
| Number of IR Bands | 4 | 10 | Upper-level water vapor, clouds, sulfur dioxide ($SO_2$), sea surface temperature (SST) |
| Coverage Rate | 25 min for Full Disk | 5 min for Full Disk | 5 times faster |
| Spatial Resolution of 0.6 µm Band | 1 km | 0.5 km | At the sub-satellite point |
| Spatial Resolution of the IR Bands | 4-8 km | 2 km | At the sub-satellite point |
| On-Orbit Visible Calibration | No | Yes | Improved composite images |

### Mean Annual Lightning Flash Density



Lightning Imaging Sensor (LIS)/Optical Transient Detector (OTD) observations within the GOES-R System Field of view courtesy of NASA LIS Science Team, Huntsville Alabama

### SEISS

Space Environmental In-Situ Suite (SEISS) is an ensemble of electron, proton and heavy ion detecting sensors. SEISS data drives the Solar Radiation Storm portion of NOAA's Space Weather Scales and other NOAA operational Alerts and Warnings.

### EXIS

Extreme UV/X-ray Irradiance Sensor (EXIS) detects solar soft X-ray irradiance (XRS) and solar Extreme UltraViolet (EUVS) spectral irradiance in the 5-127 nm range. XRS monitors solar flares (and helps predict proton events) that can disrupt communications and degrade navigational accuracy. EUVS monitors solar variations that directly affect satellite drag/tracking and ionospheric changes, which impact communication and navigation operations.

### SUVI

Solar UV Imager (SUVI) locates coronal holes, flares and coronal mass ejection source regions. SUVI data characterizes active region complexity, enabling improved forecasting of space weather and early warnings of possible impacts to the Earth environment.

### Magnetometer

The magnetometer measures the time-varying field in the magnetosphere. It provides the only operational measure of the impact of geomagnetic storms at geosynchronous orbit, and it is key for interpreting solar radiation storm measurements by SEISS.

**GOES-R produces multi-band "color" images at the same rate as GOES N/P produces single bands.**


Images courtesy of Solar and Heliospheric Observatory Extreme Ultraviolet Imaging Telescope, a joint NASA/ESA program, and NOAA Space Weather Prediction Center

# ACRONYMS

| Acronym | Description |
|---|---|
| AWIPS | Advanced Weather Interactive Processing System |
| CLASS | Comprehensive Large Array - Data stewardship System |
| CMD | Command |
| DCS | Data Collection System |
| DE | Development Environment |
| DITZ | Development and Integration & Test Zone |
| EMWIN | Emergency Managers Weather Information Network |
| GAS | GOES-R Access Subsystem |
| GRB | GOES-R Rebroadcast data stream |
| GS | Ground System |
| HRIT | High Rate Information Transmission |
| ITE | Integration and Test Environment |
| NSOF | NOAA Satellite Operations Facility |
| OE | operational Environment |
| OTS | Off The Shelf |
| PPZ | Product Production Zone |
| RBU | Remote Backup Facility |
| SARSAT | Search and Rescue Satellite Aided Tracking |
| SOZ | Satellite Operations Zone |
| TLM | Telemetry data |