Geostationary Operational Environmental Satellite R-Series (GOES-R) Spacecraft Features that Allow Near-Continuous Observation

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Lockheed Martin GOES-R spacecraft effort is being funded by the GOES-R Program Office through NOAA/NESDIS to develop the next generation of GOES-R Space Weather satellites.

Introduction

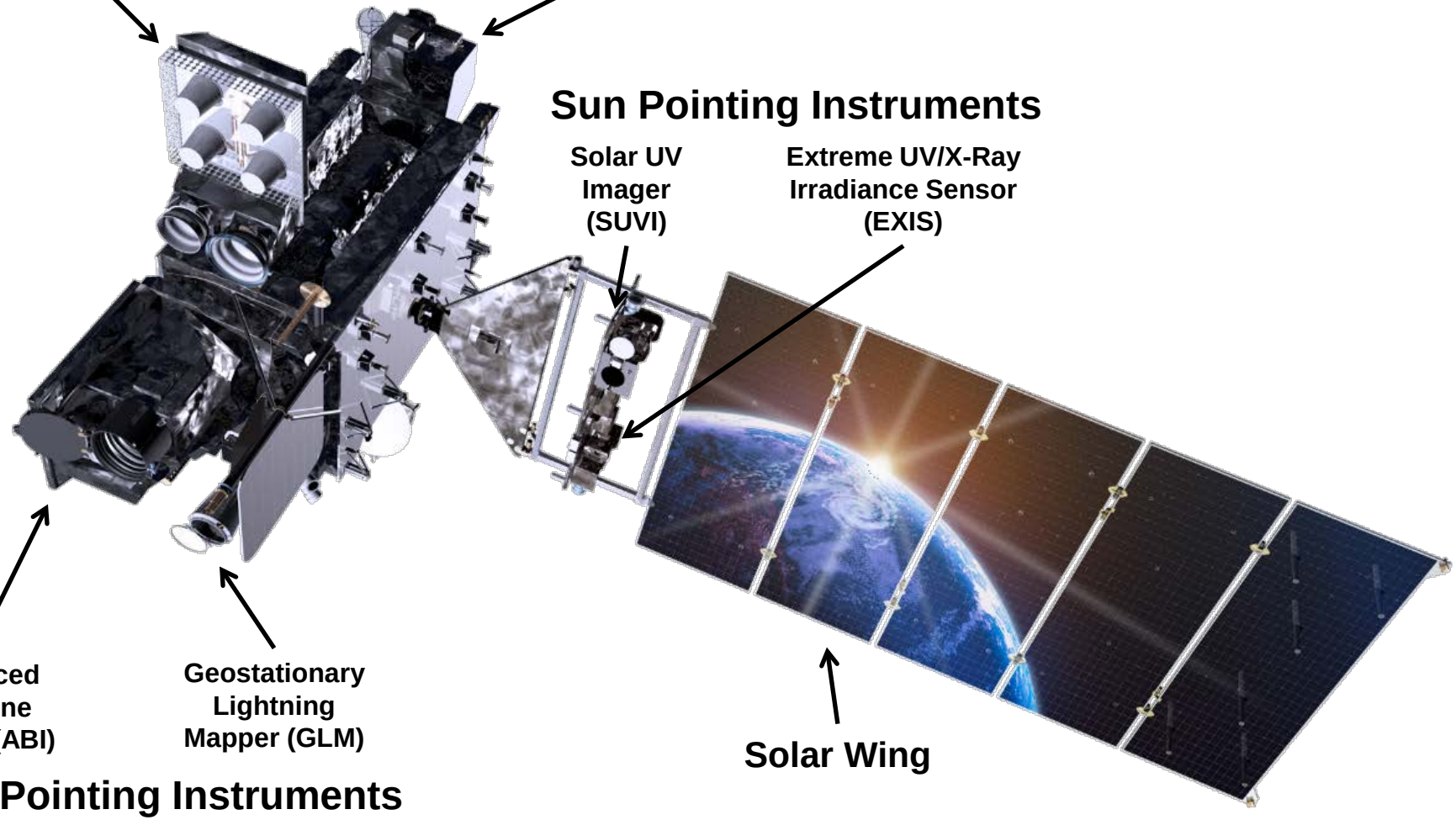
- **GOES-R has Operational Capability for Near-Continuous Observation and Enhances Ability to Observe, Predict, Communicate, and Maximize Weather/Climate Data at New Level of Fidelity and Timeliness**
- **Spacecraft Features that Allow Near-Continuous Observation**
  - **Operate-through station-keeping**
  - **Operate-through momentum adjust maneuvers**
  - **Satellite does not require a yaw flip at any time of the year**
  - **Fault management architecture allows for fault containment at the component level and avoidance of unnecessary safe hold entries for the satellite**

Introduction (concl)

- **Spacecraft Features that Allow High-Fidelity Accurate Science Data Collection**
  - **Vibration isolation for the Earth-pointed instruments**
  - **Precision mechanisms and control electronics and an identification-based active solar array vibration damping controller for Sun-pointed instruments**

- **Together, these features strive toward 100% (Near-Continuous Observation) availability for this advanced weather satellite while maximizing science data collection (High-Fidelity Observation), assuring the acquisition and downlink of vital Earth and space observation data used for weather and climate prediction**

GOES-R Architectural Overview



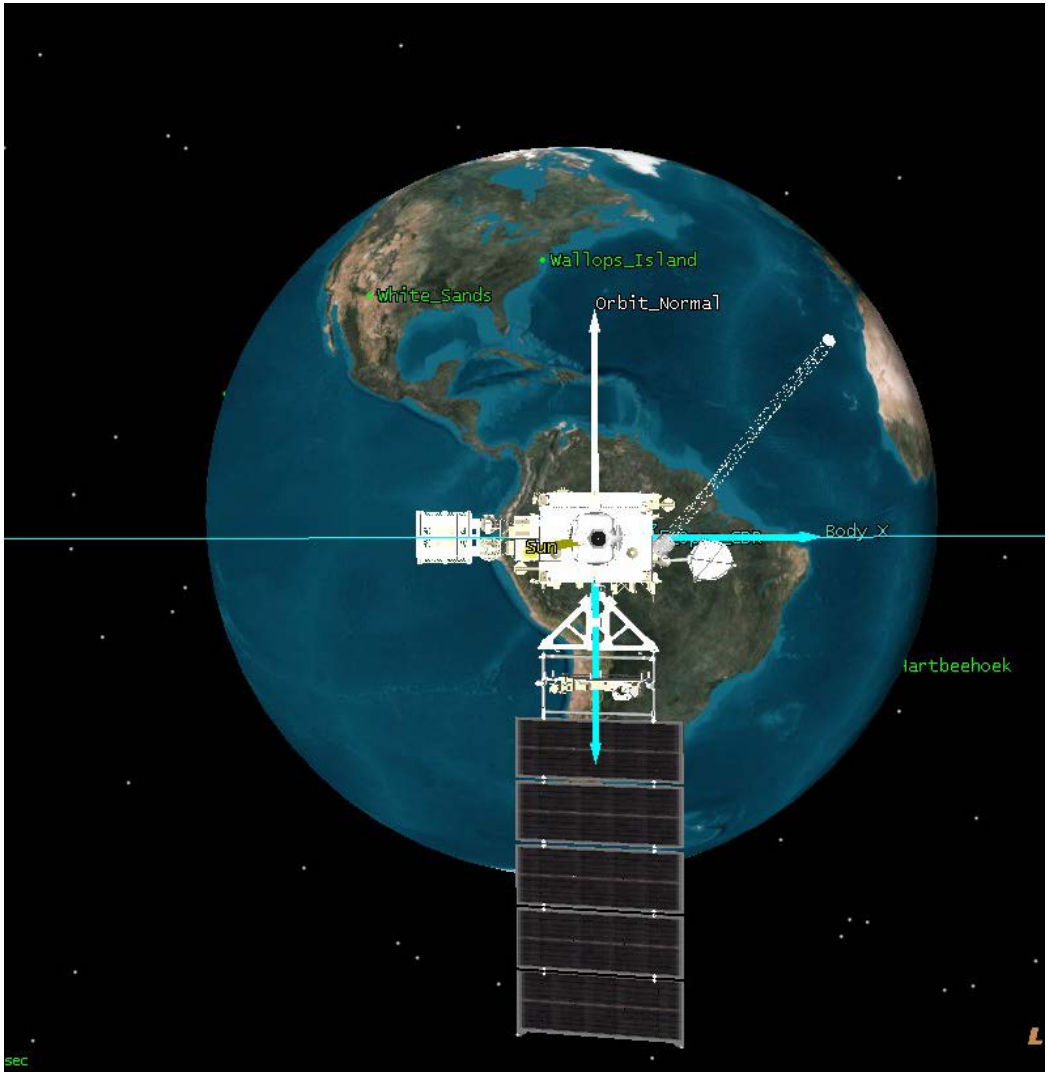
Operational Pointing

Earth Pointing Instruments

and

Antenna Wing

toward Earth



Sun Pointing Instruments

and

Solar Wing

toward Sun

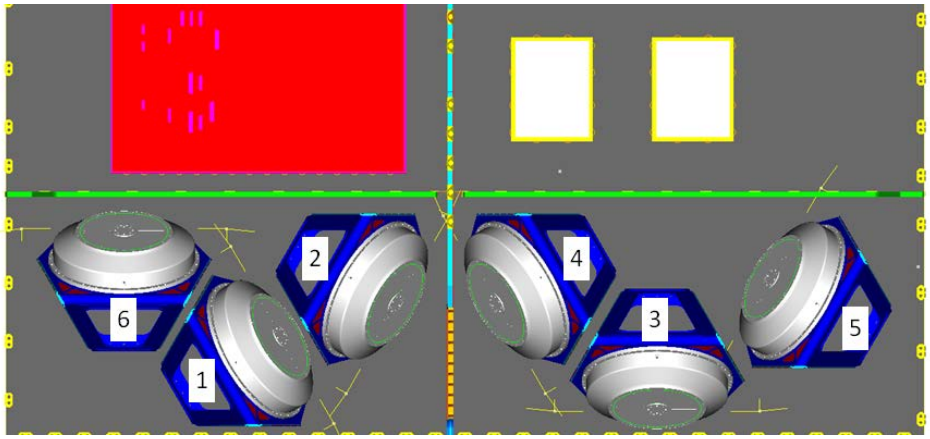
Station Keeping and Momentum Adjustments

Operating Through Periodic Station-Keeping and Momentum Adjustments Requires the Following Elements:

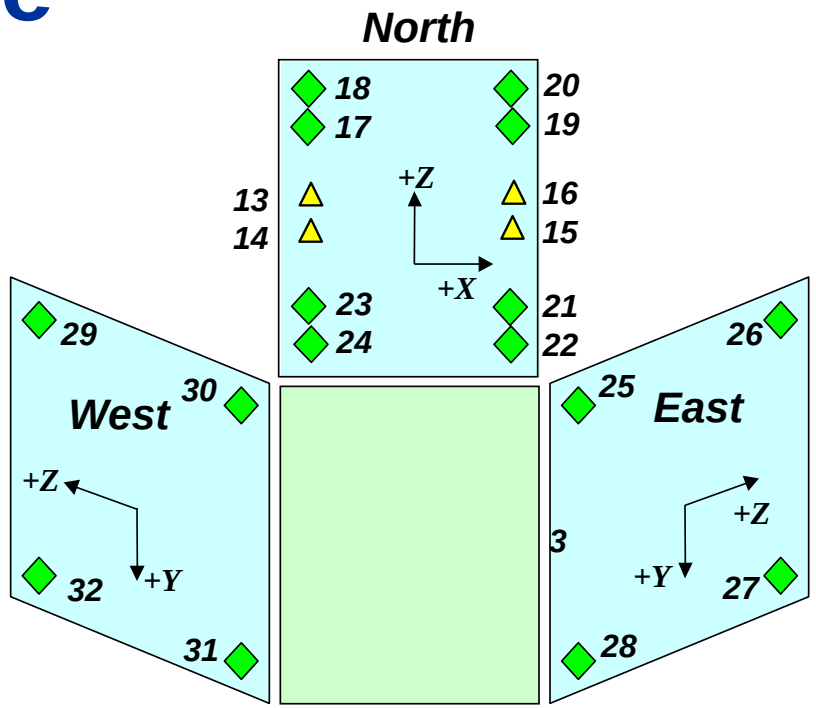
- **Reaction Wheel Assemblies (RWAs)**
  - **High-Torque, Low-Disturbance RWAs provide attitude control to minimize transients and cancel thruster torques for maneuver "operate through"**
  - **Also feed forward ABI-predicted interface forces and torques (PIFT) for scanning disturbances**
- **Low-Thrust Operate-Through Thruster System**
  - **Arc-Jets for north-south delta-V adjustments**
  - **Low Thrust REAs (LTRs) developed and qualified for this mission with Thrust Level ~ 100 times lower than the current GOES thrusters (2 lbf) for momentum adjustments**
  - **Autonomous thruster calibration system calibrates the torques produced by thruster firing to maintain feed forward accuracy and minimize attitude transients**

Thrusters have Very Accurate Repeatability for Precision RWA Feed Forward (Predictive) Control Algorithms

Hardware for Operate-Through Feature



Reaction Wheel Assemblies (RWAs)



Operate-Through Thrusters (LTRs and Arcjets)		
Thrusters	*N (lbf)*	*Function*
North LTR 17-24	0.10 (0.02)	Yaw/roll RWA momentum adjust (MA)
East/West 25-32	0.10 (0.02)	Yaw/pitch momentum adjust and E/W Delta-V
Arcjets 13-16	0.22 (0.05)	North/South Delta-V (2 fired simultaneously)

Initial Architecture Included Biannual Yaw Flip

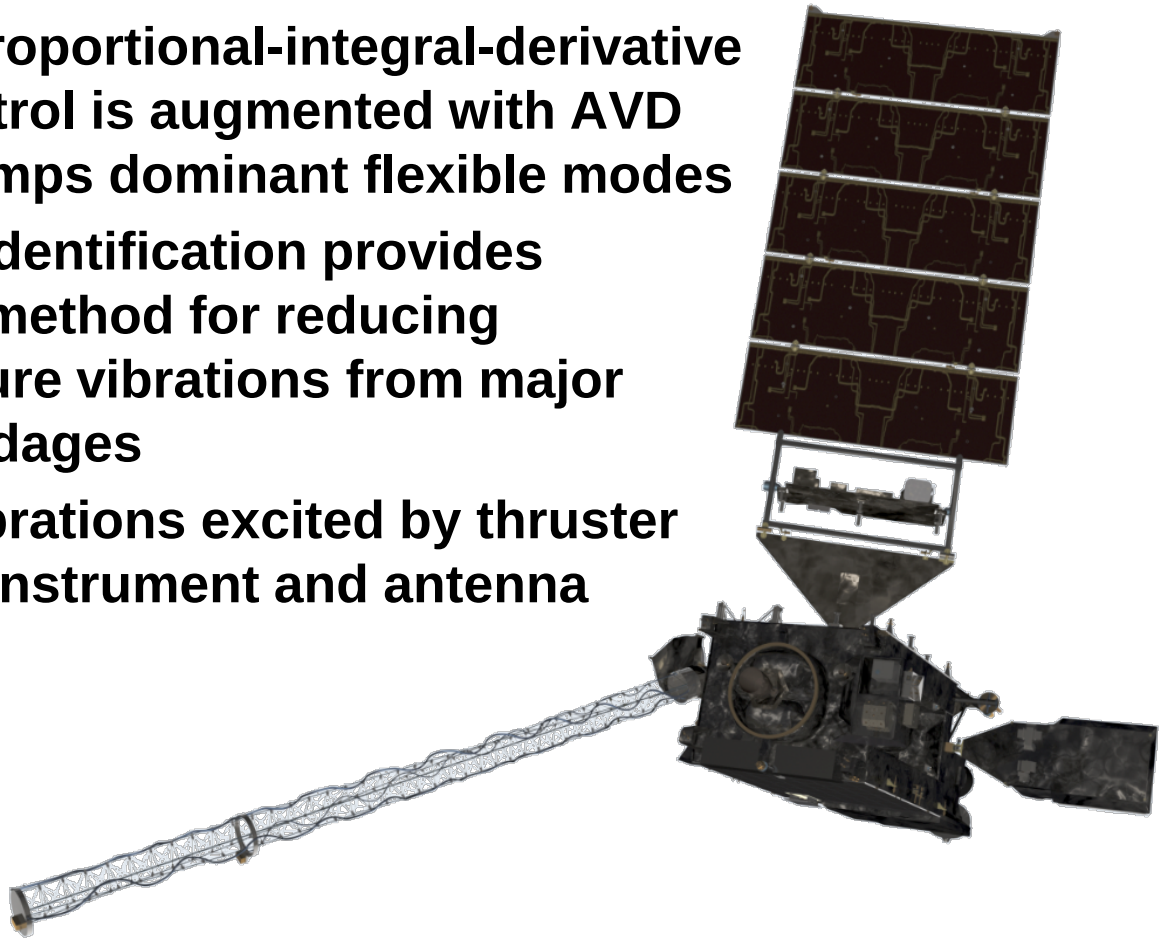
Note that Current Architecture Does Not Require Yaw Flip, Enhancing Availability

Fault Management System

- **Fault Management System (FMS) provides detection, isolation, and recovery from single credible faults to maintain the health and safety**
- **FMS performs autonomous corrective action only when required to preserve the health and safety of the satellite**
- **FMS autonomously detects and responds to single faults affecting health and safety, while maintaining availability for easily correctable faults**
- **Health and Safety—Satellite is able to maintain the following:**
  - **Positive Power Balance**
  - **Thermal Balance**
  - **Command Receptivity**
  - **Engineering Telemetry Downlink**
  - **Non-Essential Component Constraints**
- **FMS Detects and Isolates Faults at Lowest Level to Keep Satellite out of Safe Hold if Possible to Preserve Near-Continuous Operation**

Active Vibration Damping

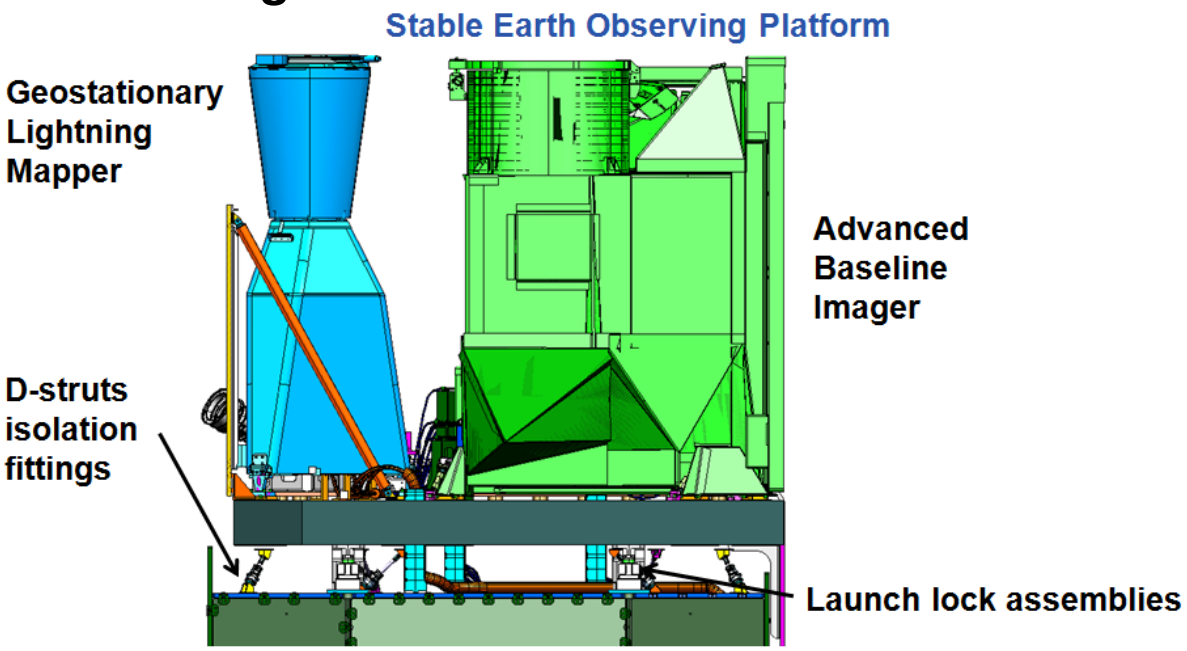
- **Active Vibration Damping (AVD) Control System**
  - **Low bandwidth proportional-integral-derivative (PID) attitude control is augmented with AVD controller that damps dominant flexible modes**
  - **Direct dynamics identification provides damping control method for reducing spacecraft structure vibrations from major spacecraft appendages**
  - **Reduces array vibrations excited by thruster firing to improve instrument and antenna pointing**



- **AVD is US Patent Pending**
  - **U.S. Patent Application No. WO/2008/136881, (filing date Nov 13, 2008) (Goodzeit, Neil E., Weigl, Harald J., Applicants)**

Vibration Isolation for Nadir Platform

- **Earth Pointing Platform (EPP) Active Vibration Isolation and Damping**
  - **Decouples Nadir instruments from spacecraft dynamics and disturbances**
  - **EPP is tunable to avoid instrument modes and cryo-cooler related disturbance**
  - **Enables "operate through" by reducing jitter effects of RWAs and transient effects of thruster firings**
  - **High-accuracy star trackers and IMU dynamically coupled to Earth-pointing Instruments on stiff bench with low thermal distortion**



Summary of GOES-R Spacecraft Features