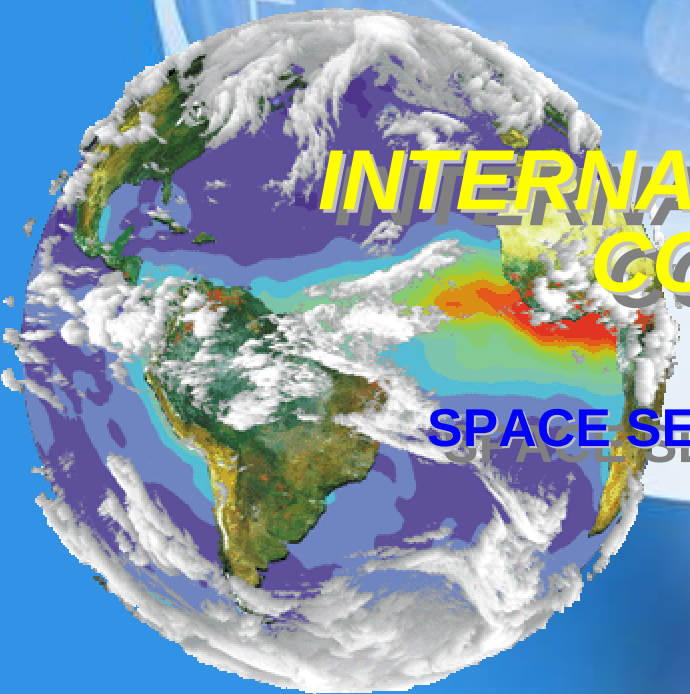
NPOESS

Entering a New Era

National Polar-orbiting Operational Environmental Satellite System

Delivering Global Data



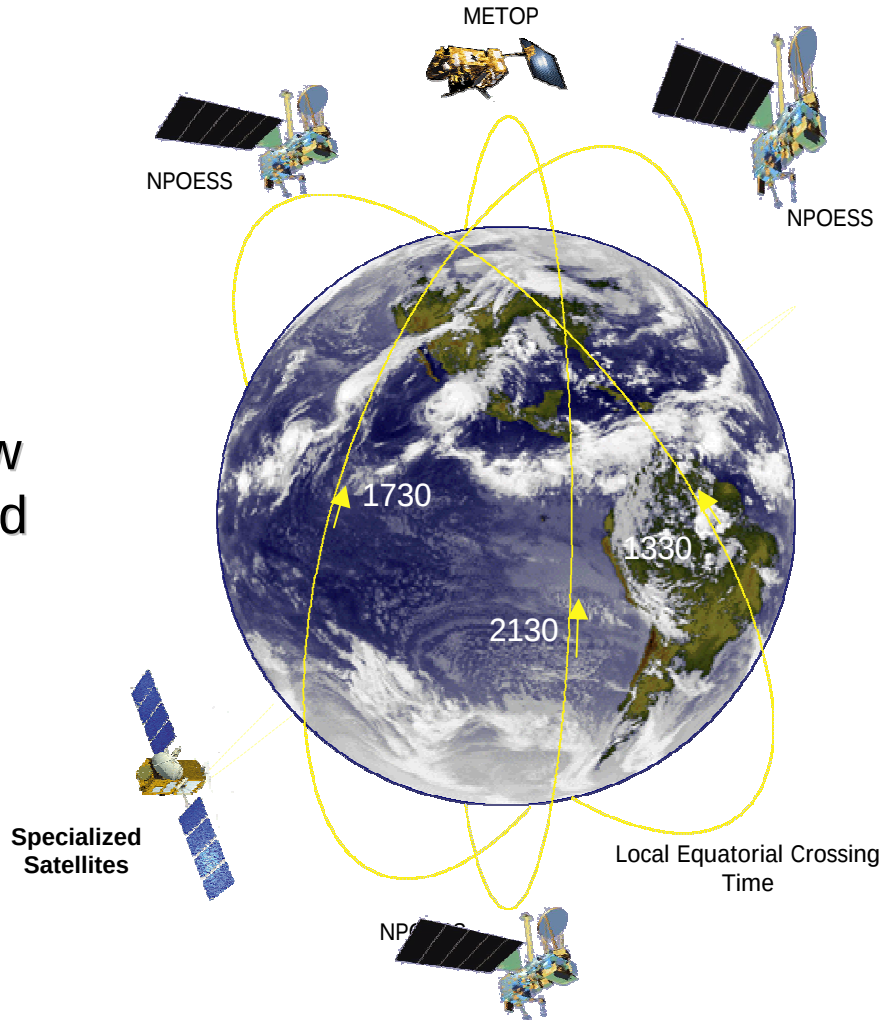
INTERNATIONAL TOVS STUDY CONFERENCE-14

HAL J BLOOM
SPACE SEGMENT PROGRAM MANAGER
MAY 26, 2005

NOAA/NASA/DoD Tri-agency Effort to Leverage and Combine Environmental Satellite Activities

- <u>Mission</u>

- Provide a national, operational, polar-orbiting remote-sensing capability
- Achieve National Performance Review (NPR) savings by converging DoD and NOAA satellite programs
- Incorporate new technologies from NASA
- Encourage International Cooperation



Program Schedule

2002 A&O Contract Award

2003 NPP Delta Critical Design Review

2005 NPOESS ΔPreliminary Design Review

2006 NPOESS Critical Design Review
NPP Ground Readiness

2008 NPP Launch

2009 NPOESS Ground Readiness

2010 NPOESS C1 Launch

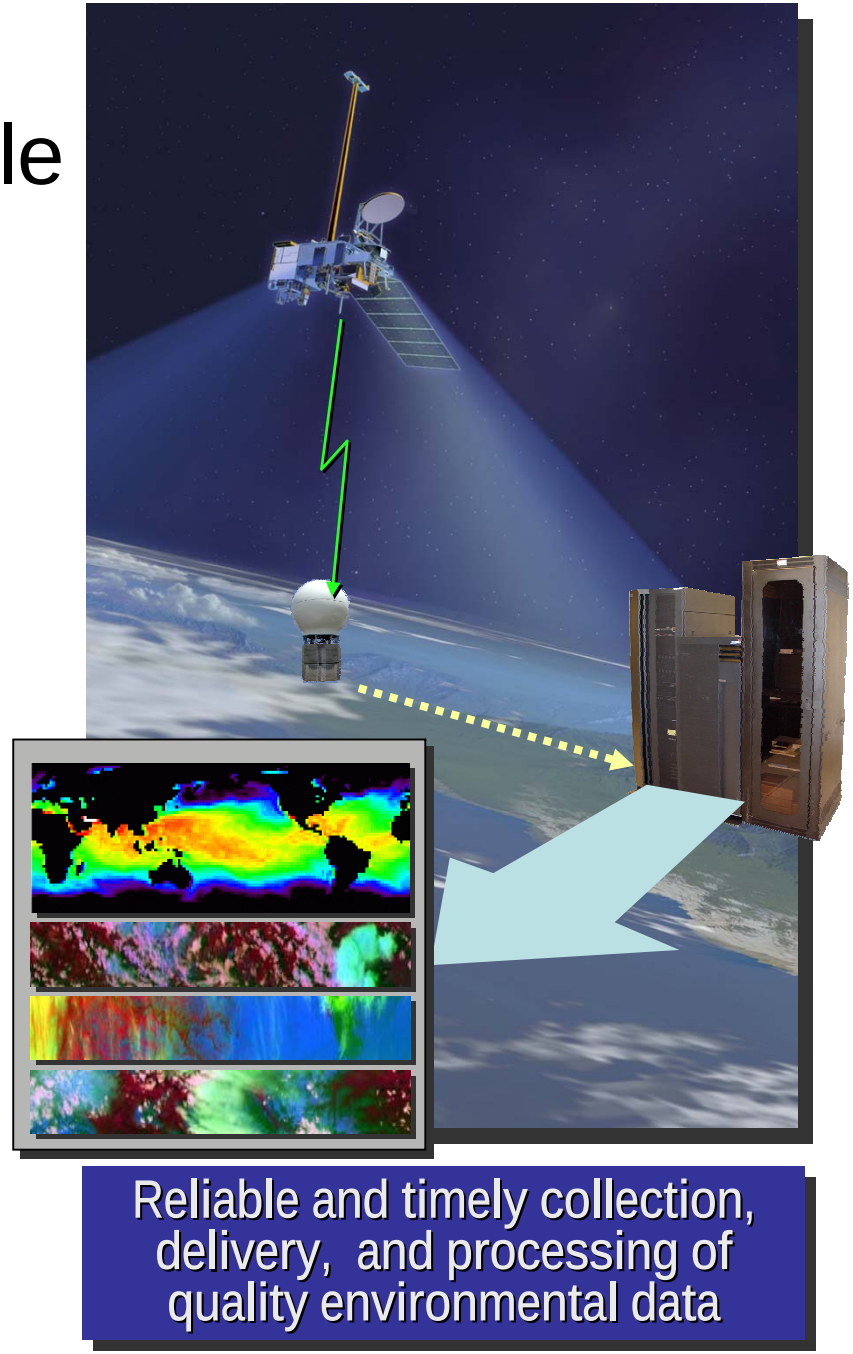
2011 NPOESS C2 Launch
Field Terminal Segment Readiness
Initial Operational Capability

2013 NPOESS C3 Launch

2015 NPOESS C4 Launch

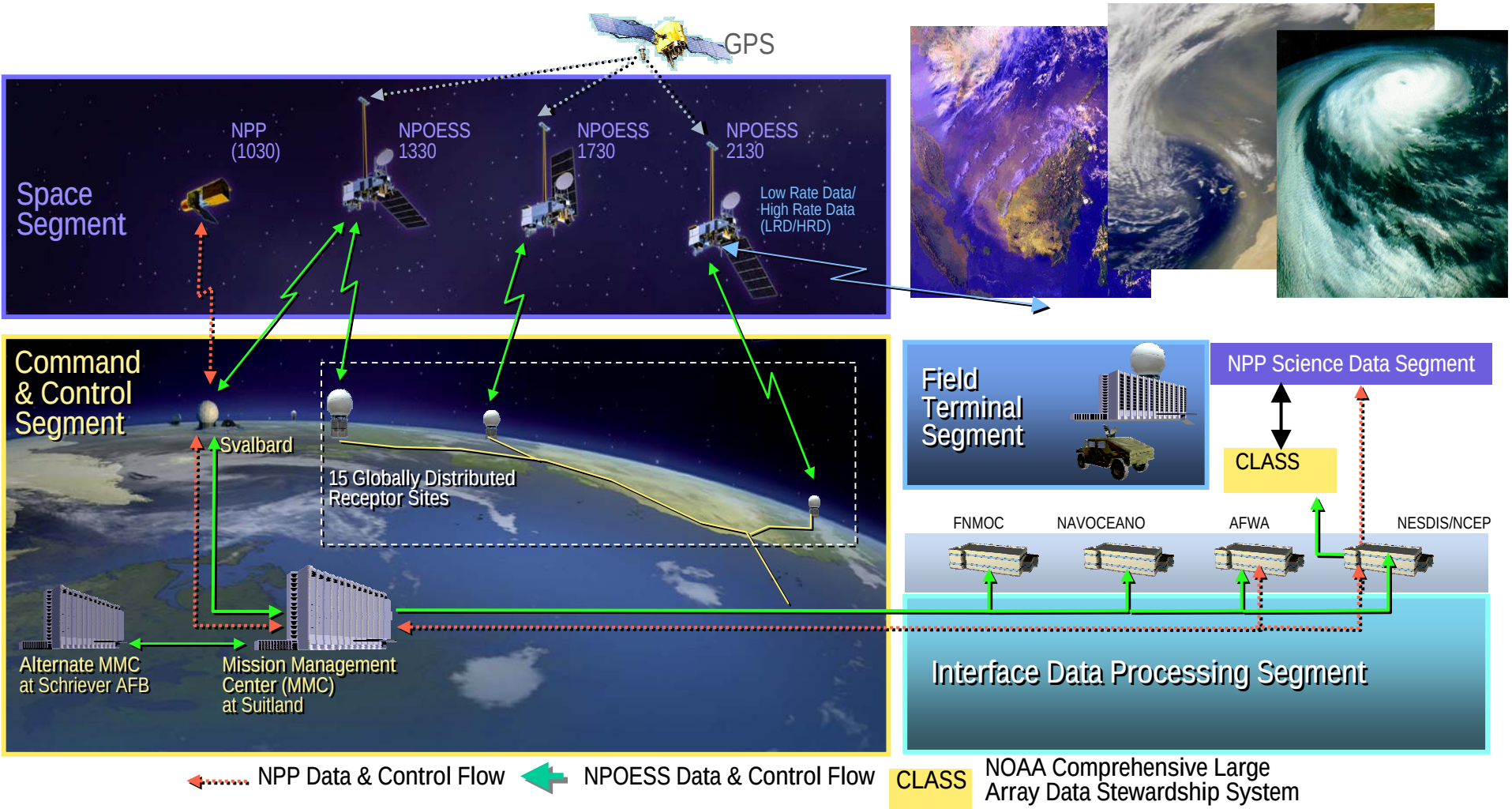
2017 NPOESS C5 Launch

2020 End of Program

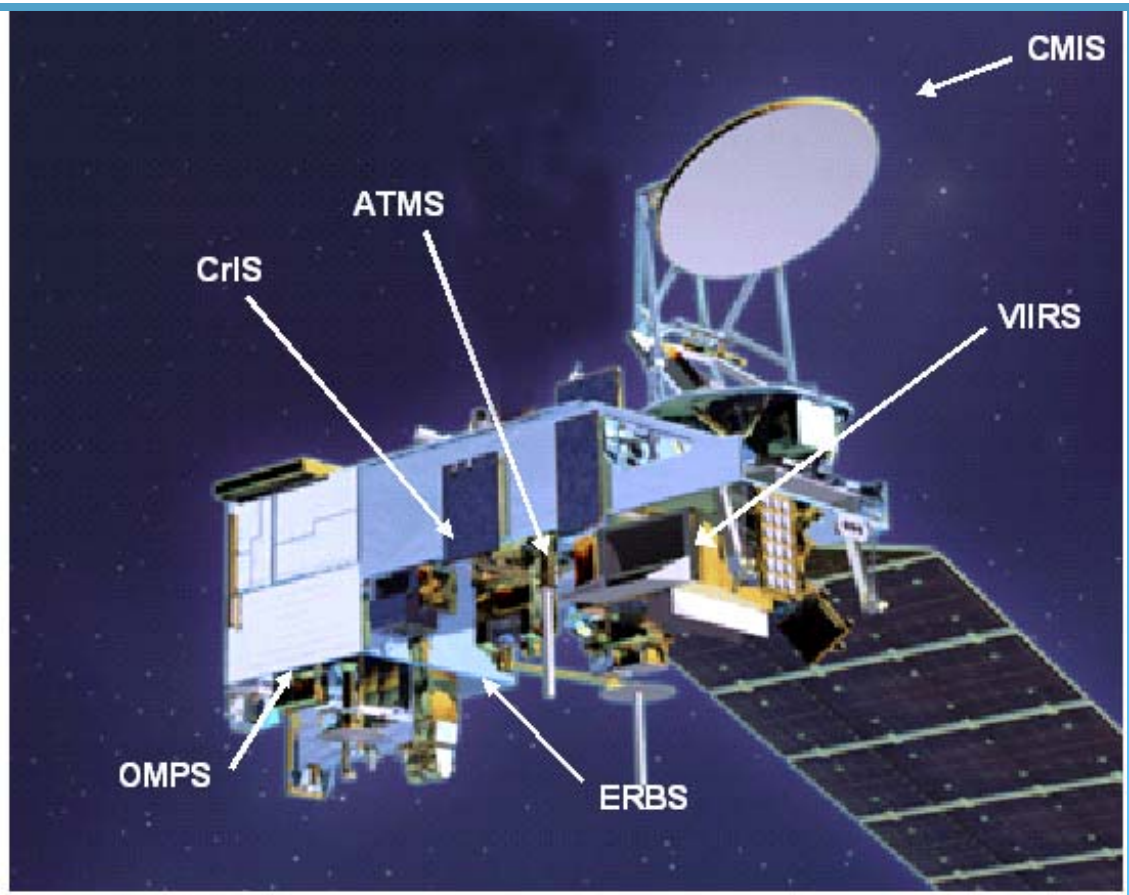


Reliable and timely collection, delivery, and processing of quality environmental data

NPOESS Top Level Architecture



NPOESS Satellite and Sensors



NPOESS 1330 Configuration

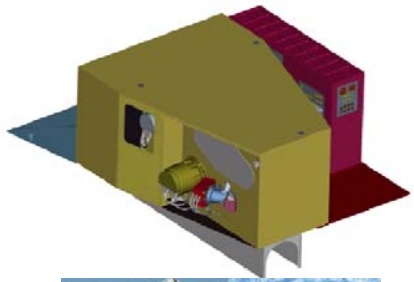
	1330	1730	2130	NPP
VIIRS	X	X	X	X
CMIS	X	X	X	
CrIS	X	X		X
ATMS	X	X		X
SESS	X	X	X	
OMPS	X			X
ADCS	X	X		
SARSAT	X	X	X	
ERBS	X			
SS	X	X	X	
ALT		X		
TSIS		X		
APS			X	

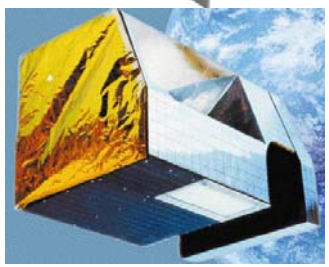
Landsat	X

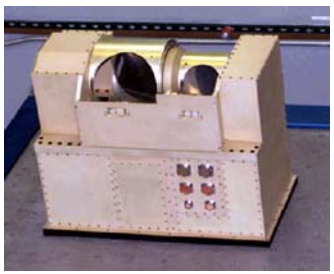
X = changed since award

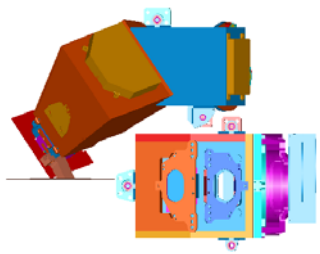
Single Satellite Design with Common Sensor Locations and "ring" Data Bus Allows Rapid Reconfiguration and Easy Integration

Development Sensor Highlights





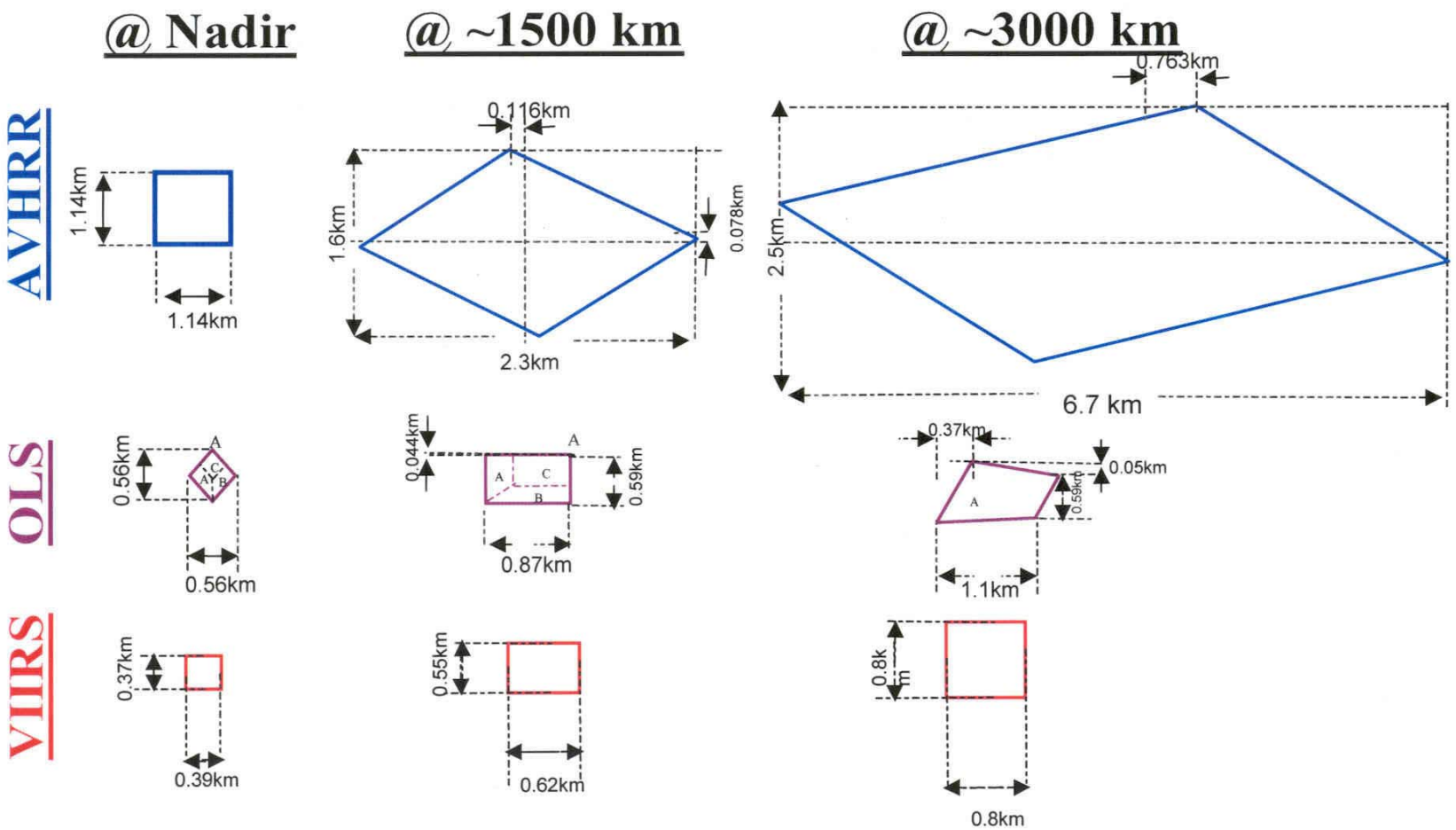




- Visible/Infrared Imager Radiometer Suite (VIIRS)
- Raytheon Santa Barbara **Prototype in assembly/qual, flight unit in production**
  - 0.4 km imaging and 0.8 km radiometer resolution
  - 22 spectral bands covering 0.4 to 12.5 μm
  - Automatic dual VNIR and triple DNB gains
  - Spectrally and radiometrically calibrated
  - EDR-dependent swath widths of 1700, 2000, and 3000 km
- Crosstrack InfraRed Sounder (CrIS)

  ITT Ft Wayne Prototype in qualification, flight unit in production
  - 158 SWIR (3.92 to 4.64 μm) channels
  - 432 MWIR (5.71 to 8.26 μm) channels
  - 711 LWIR (9.14 to 15.38 μm) channels
  - 3x3 detector array with 15 km ground center-to-center
  - 2200 km swath width
- Advanced Technology Microwave Sounder (ATMS) - NASA
- Northrop Grumman Electronics **Flight unit in protoqual**
  - CrIS companion cross track scan
  - Profiling at 23, 50 to 57, 183 GHz
  - Surface measurements at 31.4, 88, 165 GHz
  - 1.1, 3.3, and 5.2 deg (SDRs resampled)
  - 2300 km swath width
- Ozone Mapping and Profiler Suite (OMPS)
- Ball Aerospace **Flight unit in production**
  - Total ozone column 300 to 380 nm with 1.0 nm resolution
  - Nadir ozone profile 250 to 310 nm with 1.0 nm resolution
  - Limb ozone profile 290 to 1000 nm with 2.4 to 54 nm resolution
  - Swath width of 2800 km for total column

VIIRS Dramatically Improves Spatial Resolution & Sampling



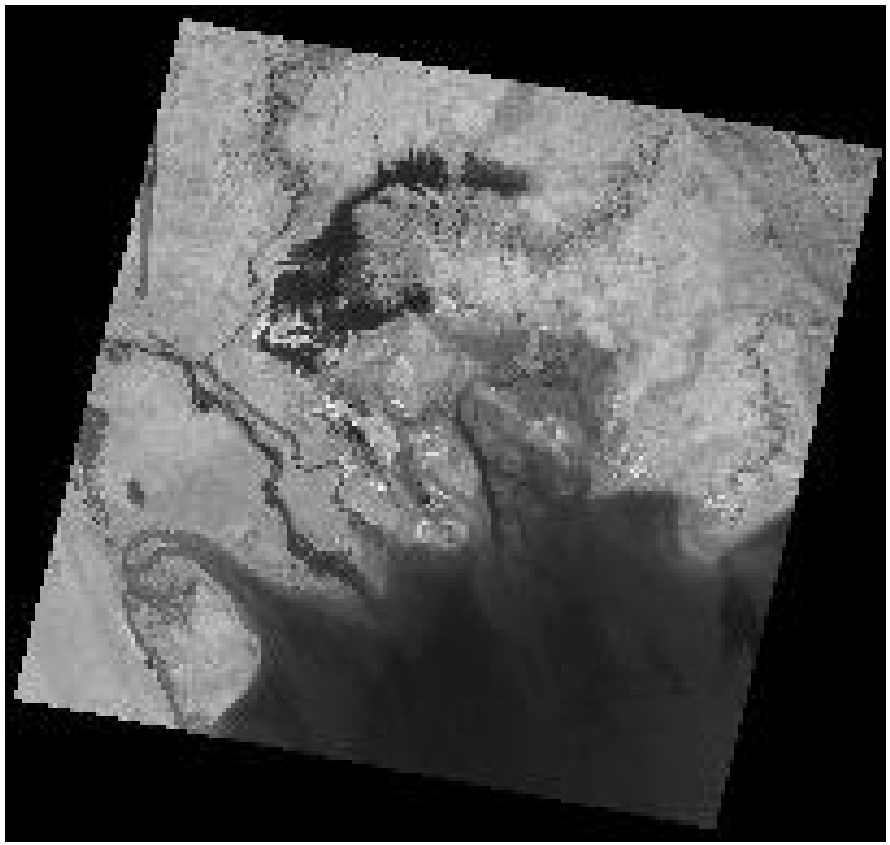
Note: MODIS pixel growth rate is similar to AVHRR

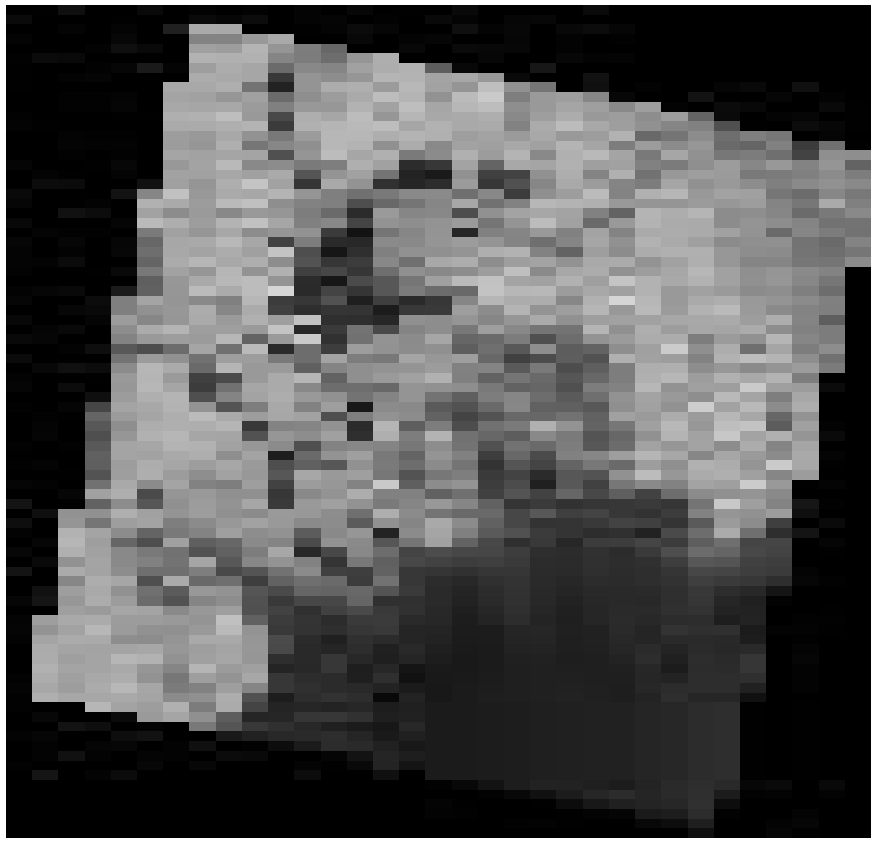
Source: Raytheon, Santa Barbara Remote Sensing

Simulation of AVHRR Visible Channel

Nadir

Edge of Scan



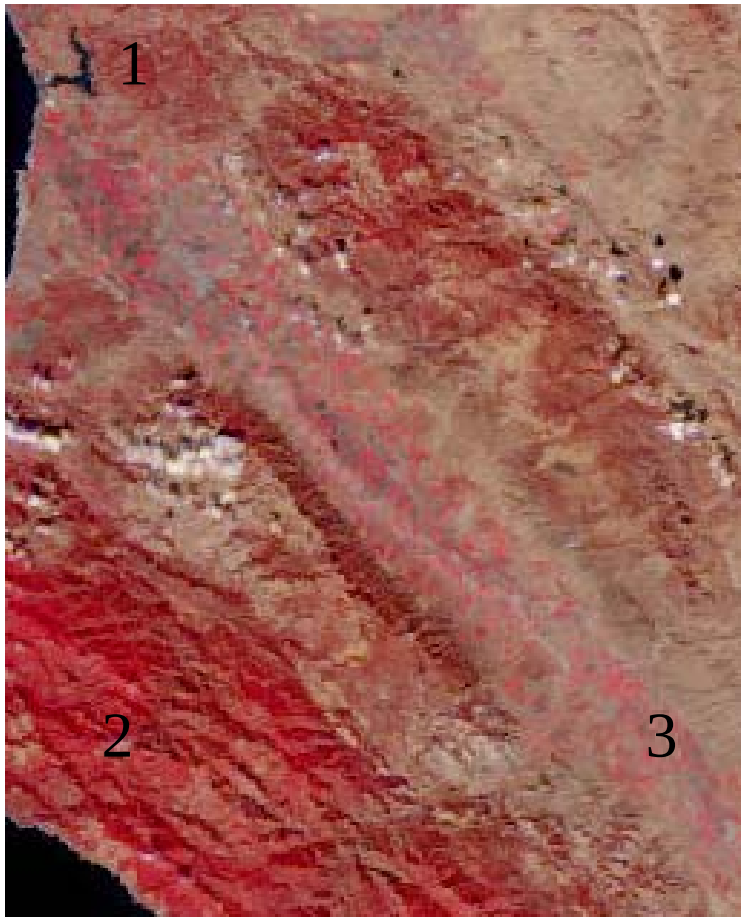


Note: MODIS resolution degrades similar to AVHRR

From Raytheon, Santa Barbara Remote Sensing

MODIS Vegetative Index
10/30/2003

Near Nadir



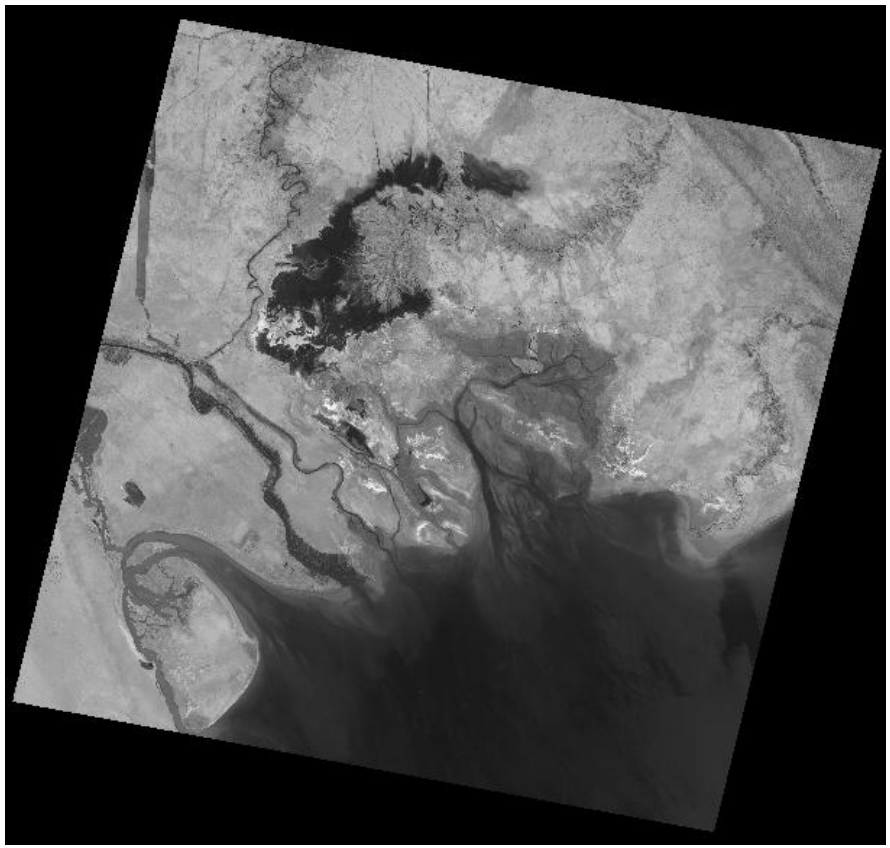
Terra 1950 UTC

Toward Edge of Scan

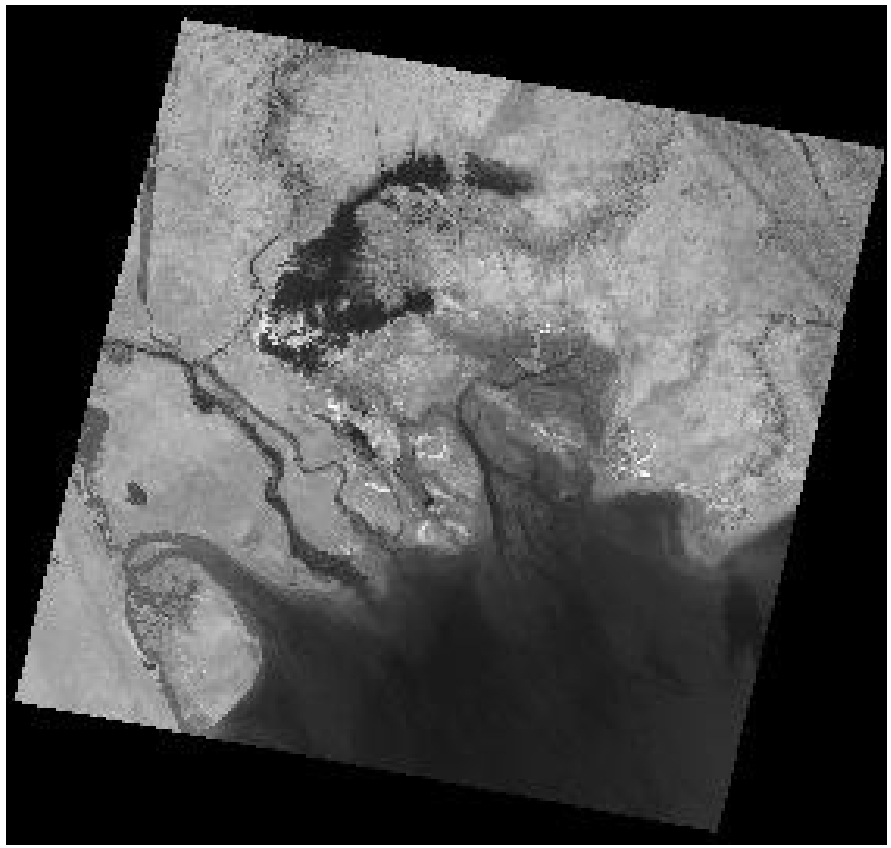
Aqua 2125 UTC

Simulation of VIIRS Visible Channel

Nadir



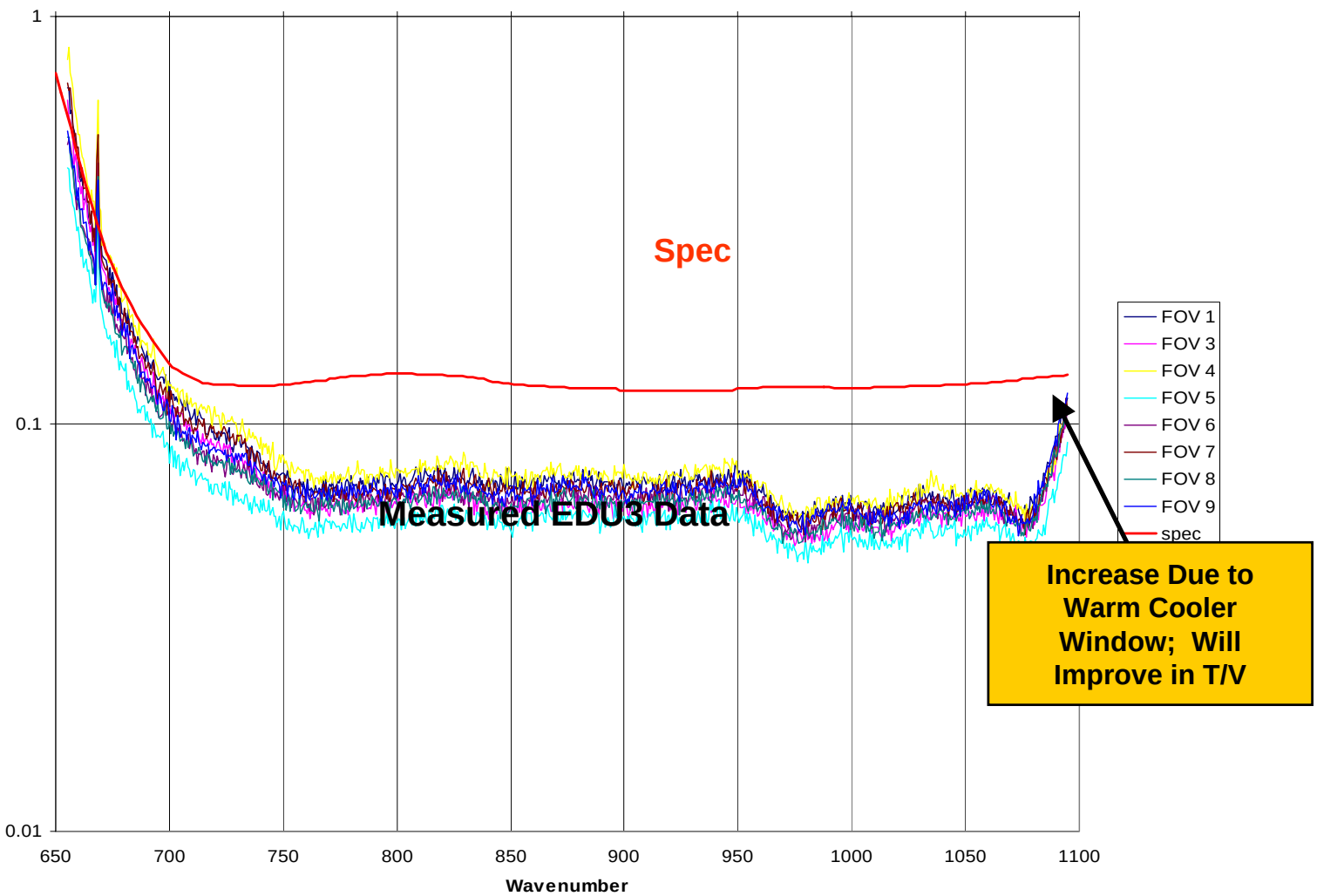
Edge of Scan



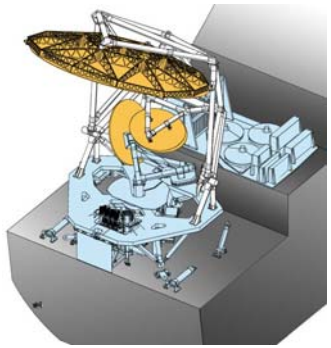
From Raytheon, Santa Barbara Remote Sensing

CRiS LWIR Diagnostic Data (Forward Sweep) for All FOVs

5/30/2004 Data Collect

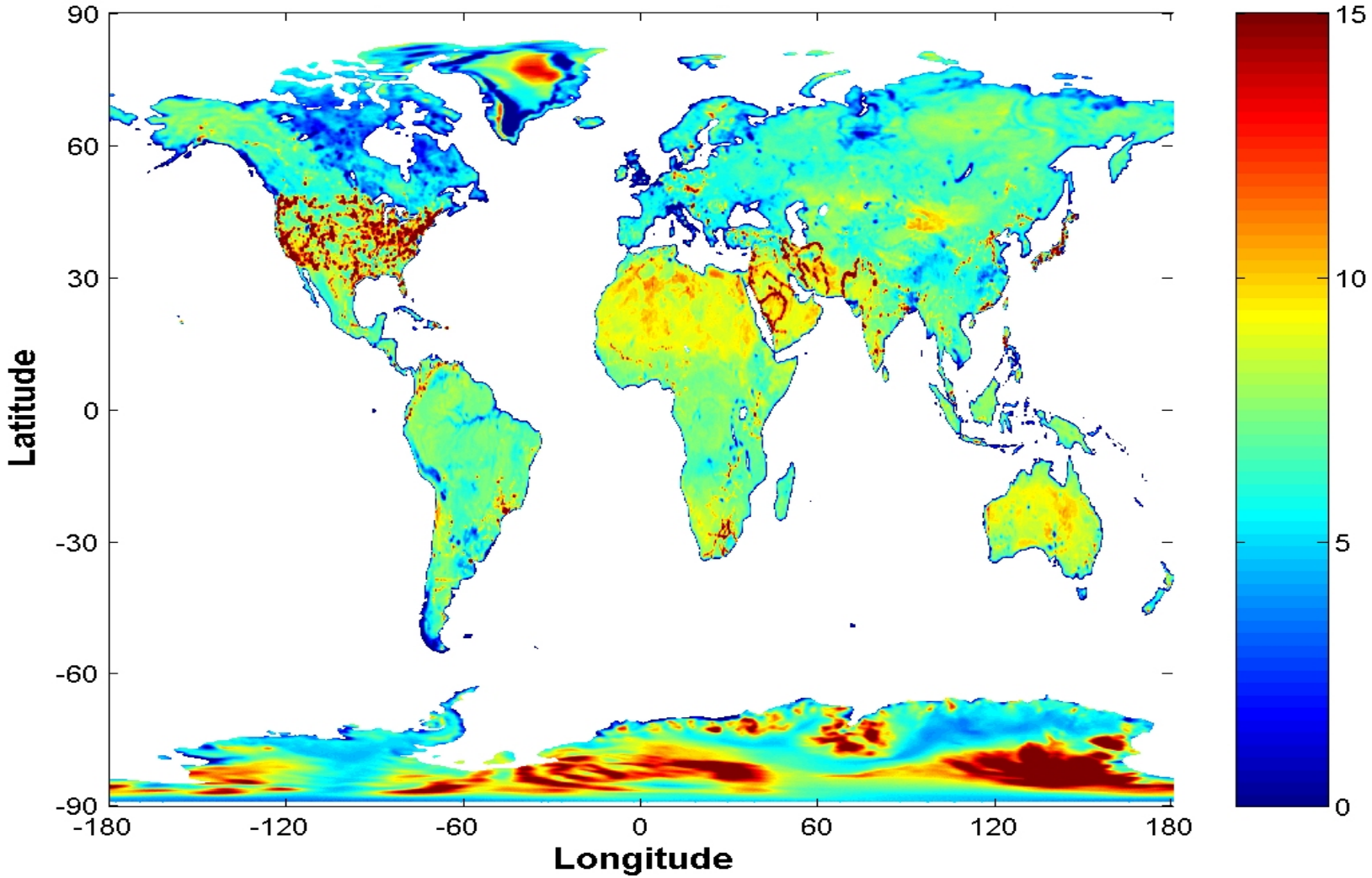


Development Sensor Highlights (cont.)

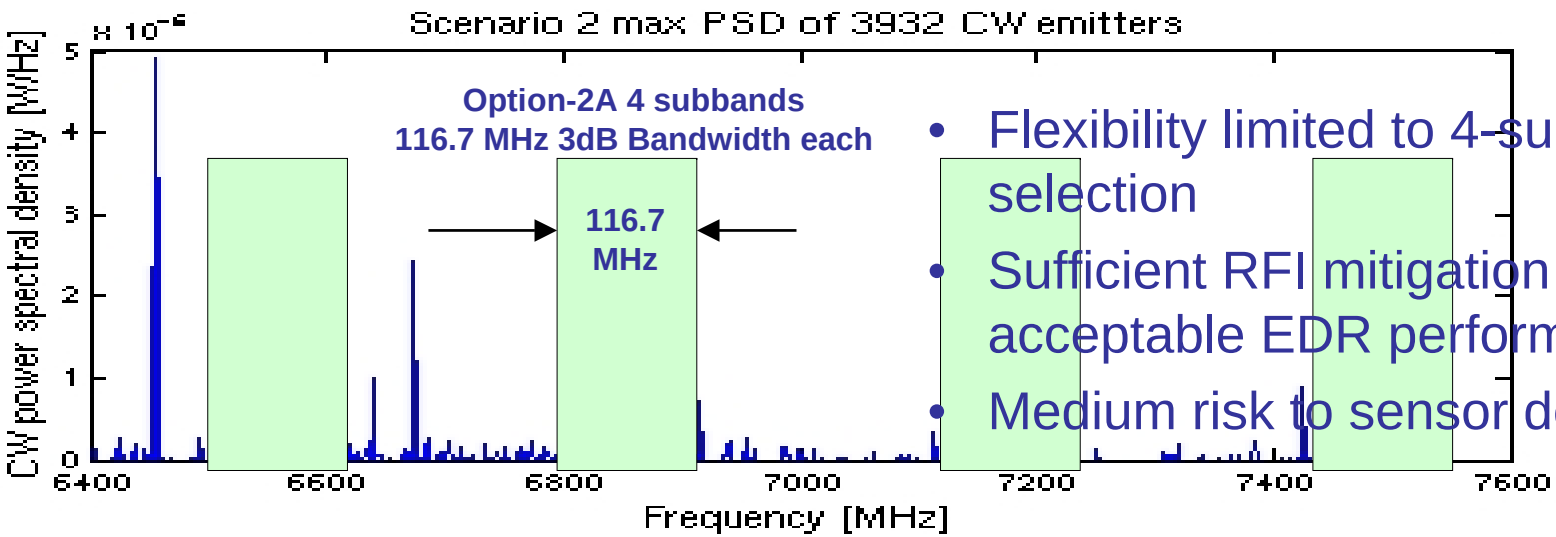


- Conical Scanning Microwave Imager/Sounder (CMIS)
  Boeing Space Systems **Delta PDR complete**
  - 2.2 m antenna
  - RF imaging at 6, 10, 18, 36, 90, and 166 GHz
  - Profiling at 23, 50 to 60, 183 GHz
  - Polarimetry at 10, 18, 36 GHz
  - 1700 km swath width
  - Radio Interference (RFI) ECP complete, negotiations being wrapped up

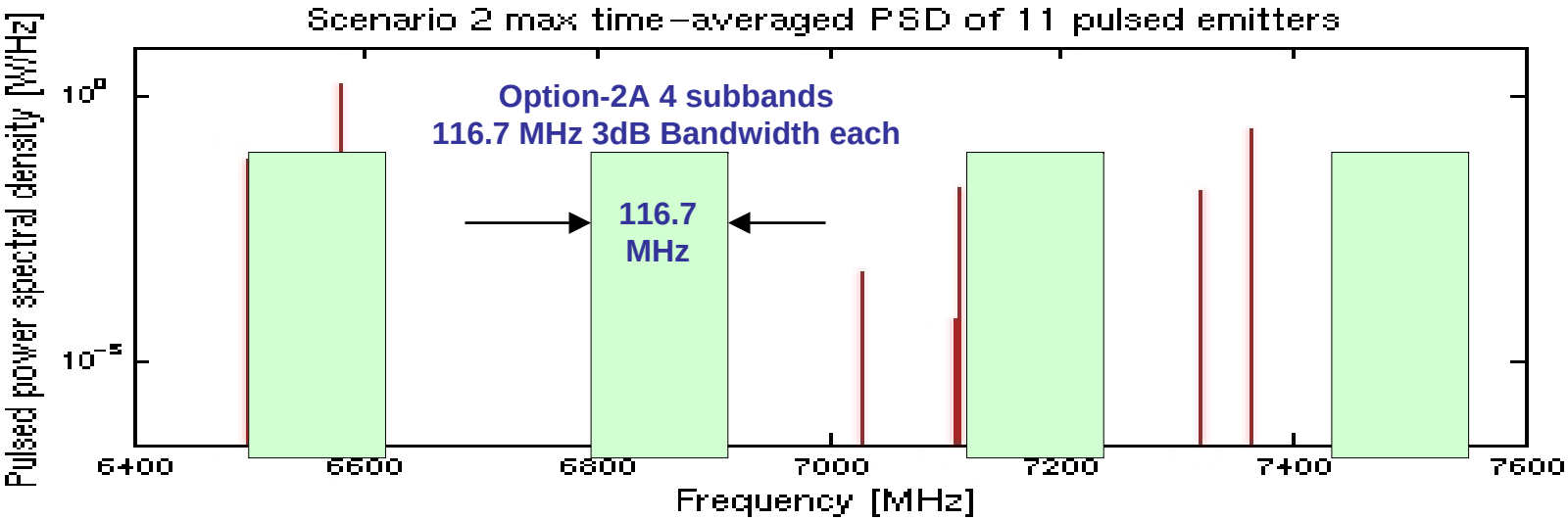
Global RFI from AMSR data



Option 2A RFI Mitigation Concept

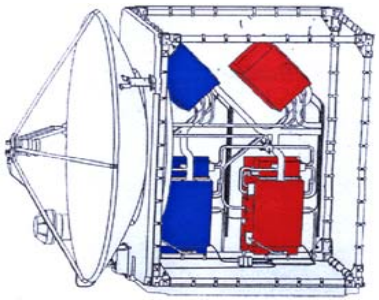


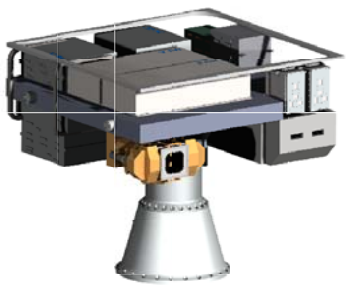
- Flexibility limited to 4-subband selection
- Sufficient RFI mitigation and acceptable EDR performance
- Medium risk to sensor design



Each Spectral line has a unique location, hence not all spectral magnitudes are in CMIS FOV at the same time

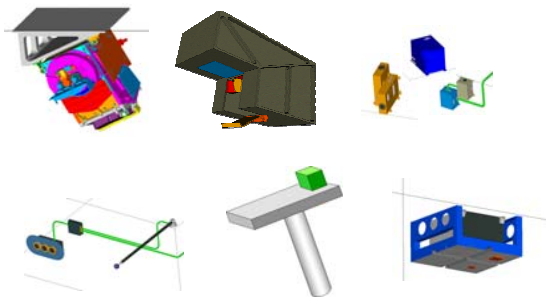
Leveraged Sensor Highlights

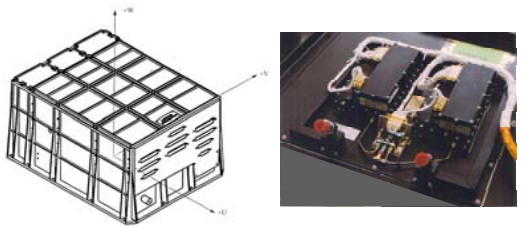


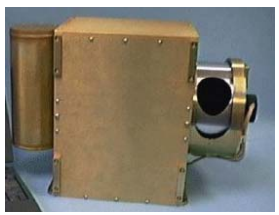


- **Radar Altimeter (ALT)**
  Alcatel
  - Measures range to ocean surface with a radar at 13.5 GHz
  - Corrects for ionosphere with 5.3 GHz radar
  - Corrects for atmosphere with CMIS water vapor measurements
  - Precise orbit determination with GPS
- **Earth's Radiation Budget Suite (ERBS)**
  Northrop Grumman Space Technology
  - Three spectral channels
  - Total radiation measurement 0.3 to 50 μm
  - Shortwave Vis and IR measurement 0.3 to 5 μm
  - Longwave IR measurement 8 to 12 μm
- **Total Solar Irradiance Sensor (TSIS)**
  University of Colorado
  - Two sensors for total irradiance (TIM) & spectral irradiance (SIM)
    - TIM measures total solar irradiance
    - SIM measures spectral irradiance 200 to 2000 nm
  - Pointing platform and sensor suite to be provided by CU LASP
- **Survivability Sensor (SS)**
  Sandia National Labs

Highlights of Other Sensors







- **Space Environment Sensor Suite (SESS)**
  Ball Aerospace **Proposal in evaluation**
  - Sensor suite collecting data on particles, fields, aurora, and ionosphere
  - Suite includes a UV disk imager (BATC), EUV limb imager (BATC), charged particle detectors (Amptek/U. of Chicago), thermal plasma sensors (UTD), a magnetometer (MEDA), and a coherent beacon sensor (AIL)
- **Advanced Data Collection System (ADCS) and Search and Rescue Satellite-Aided Tracking (SARSAT)** **ITAR agreements done**
  - "GFE" to NPOESS from France and Canada
  - ADCS supports global environmental applications
  - SARSAT collects distress beacon signals
- **Aerosol Polarimetry Sensor (APS)**
  Raytheon Santa Barbara Research Center **Full development on hold pending NASA satellite "Glory" plans**
  - Aerosol characterizations of size, single scattering albedo, aerosol refractive index, aerosol phase function
  - Multispectral (broad, 0.4 to 2.25 μm)
  - Multiangular (175 angles)
  - Polarization (all states)

NPOESS P^{3}I

- Need for continued evolution recognized from very beginning of program
  - P3I requirements in paras 1.6 and 4.1.6.8 of IORD II
  - NASA's role in NPOESS (per PDD) is technology development

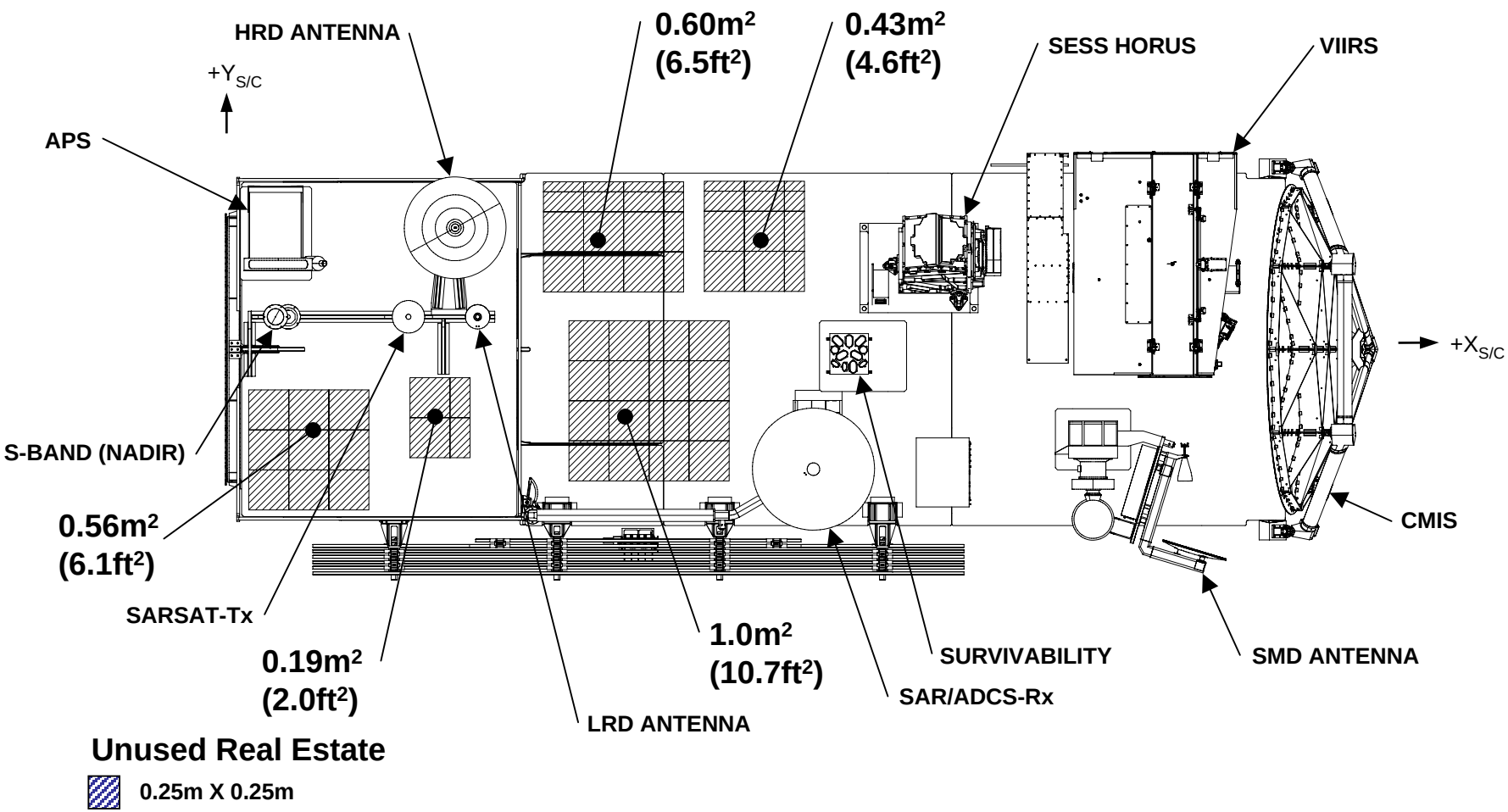
- P3I is built into the NPOESS program to :
  - Respond to changing/modified user needs
  - To track, monitor, and respond to identified user products that the current NPOESS system can not implement due to technological constraints.

- Two forms of NPOESS P3I are envisioned
  - Modification of existing sensor to accomplish need
  - New sensor development required to implement need

Pre-Planned Product Improvement (P3I) EDR Candidates

Tropospheric winds
Neutral winds
All weather day/night imagery
Coastal sea surface winds
Ocean wave characteristics
Surf conditions
Oil spill location
Littoral current
CH4 column
CO column
CO2 column
Optical background
Sea and lake ice
Coastal ocean color
Bioluminescence potential
Coastal sea surface temperature
Sea surface height coastal
Bathymetry
Vertical hydrometeor profile
Salinity

2130 CONFIGURATION



STOWED CONFIGURATION

Expand the Capability of VIIRS to measure/Image water vapor

- Modify VIIRS by adding 6.7μ channel
  - Requires redesign of sensor in midwave to long wave band split
  - Treat as a block change in our production satellites
- First steps already taken by purchasing “lenslets” before vendor went out of business
- Change will take amendment to IORD and additional funds

CrIS Full Resolution Capability

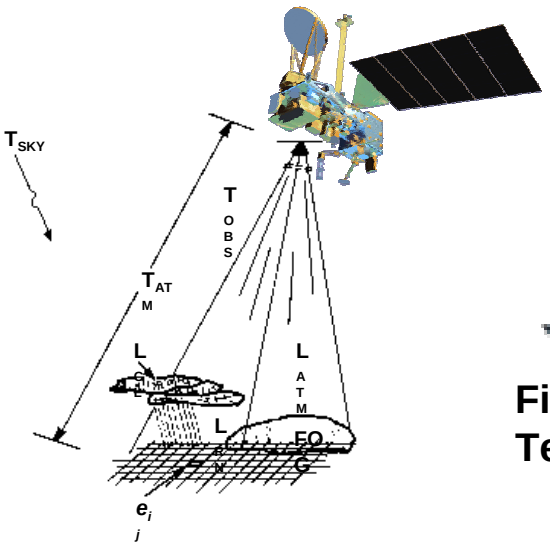
- CrIS data fidelity was reduced to constrain data bandwidth prior to system source selection
  - Full resolution is measured by the instrument, data reduced in OBC
  - What we had

Band	Data provided	Resolution (cm^{-1})
• Short	Fourth	2. 5
• Mid	Half	1.25
• Long	Full	0.625

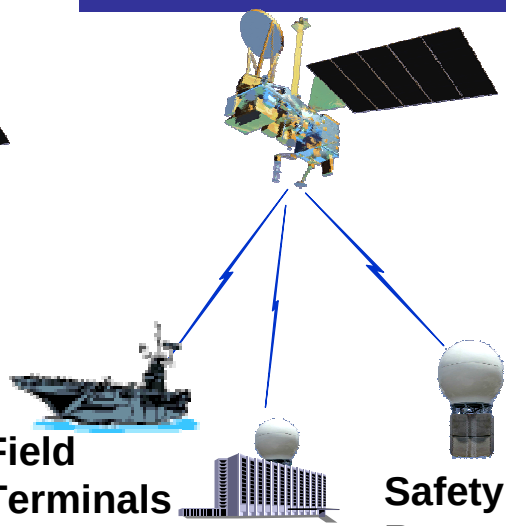
- What we're doing
  - Examining capability to bring down full data
    - Not a data rate problem due to 1394a data bus
  - Studying best way to modify sensor
  - Running simulations to show performance as part of the value trade
- Plan
  - Complete study this winter, determine cost/benefit trades
  - Present to SUAG
- Why?
  - **Carbon trace gasses!**

NPOESS Operational Concept

1. Sense Phenomena



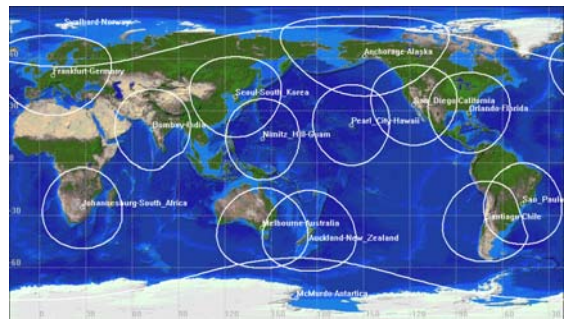
2. Downlink Raw Data



Field Terminals

SafetyNet™ Receptors

3. Transport Data to Centrals for Processing



Global fiber network connects 15 receptors to Centrals

Monitor and Control Satellites and Ground Elements

MMC (Suitland)

Schriever MMC

4. Process Raw data into EDRs and Deliver to Centrals

NESDIS/NCEP

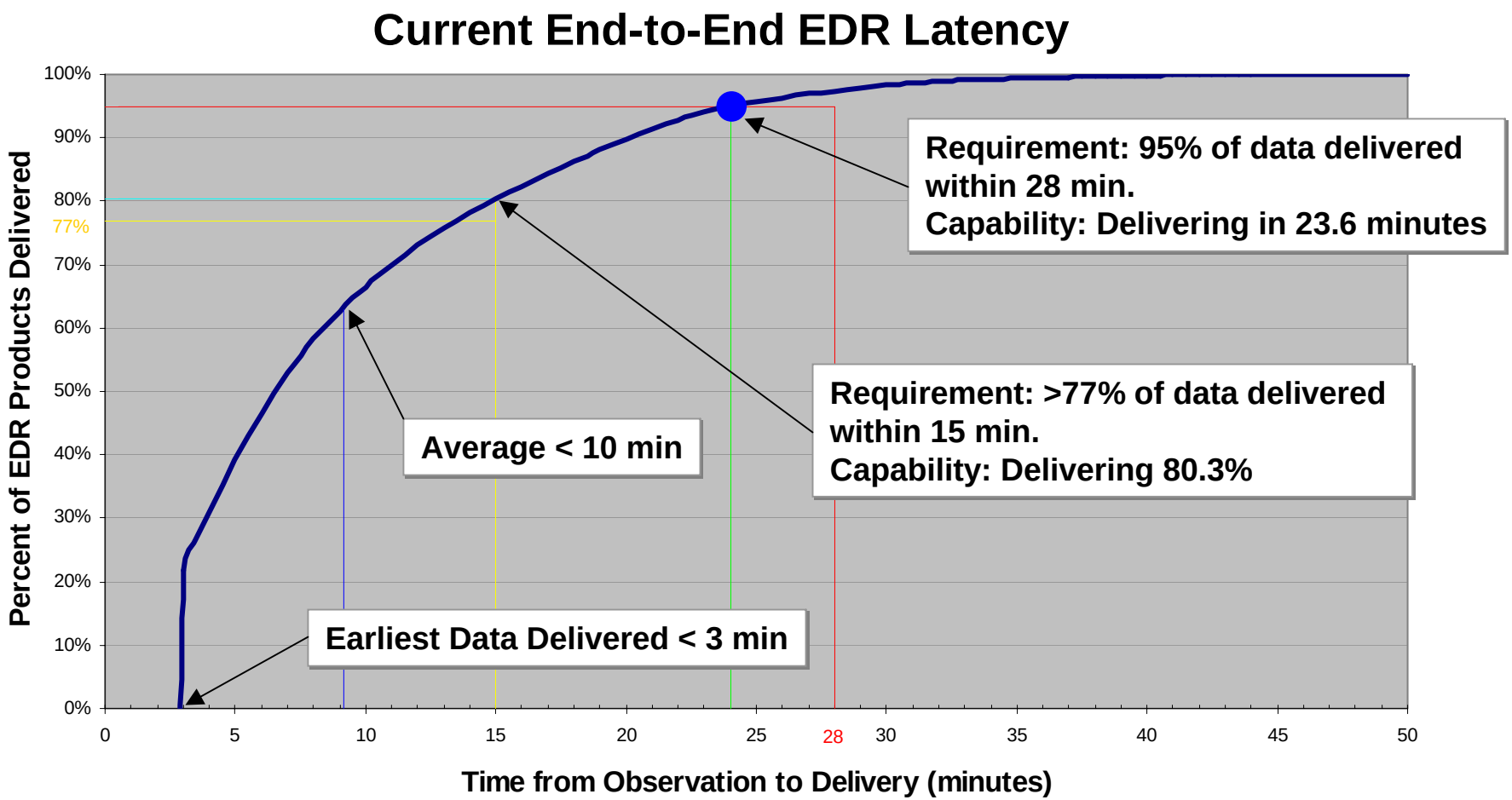
AFWA

FNMOC

NAVO

Full Capability at each Central

NPOESS EDR Processing Timeline



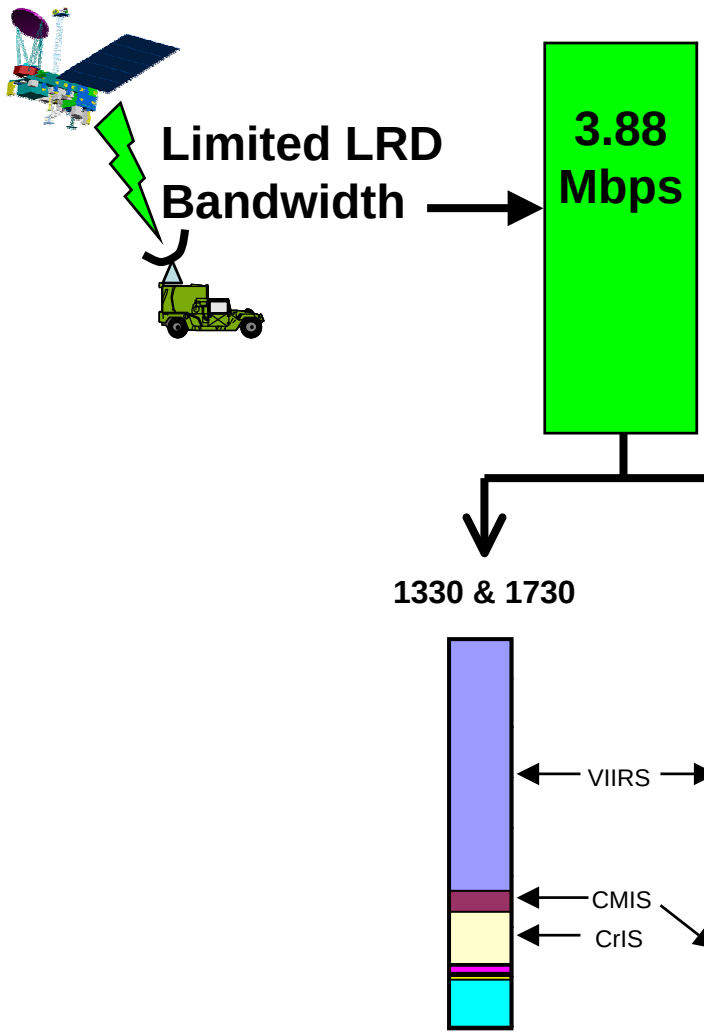
NPOESS Data Basics

- There are three NPOESS data streams, potentially coming down simultaneously
  - **SMD – stored mission data**
    - 100% of data observed by the satellite
    - Set of 15 sites around the world are called "SafetyNet™"
      - Linked to US by ATT fiber optic cable

Real-time links

  - **HRD – high rate data**
    - 100% of NPOESS data as it is observed (real time) by the satellite in view of a readout station (except data from ERBS and TSIS)
    - 20 Mbps at X-band
  - **LRD – low rate data**
    - Selected subset of NPOESS data
    - 6x1 Compression of VIIRS data
    - 3.8Mbps at L-band

NPOESS LRD Approach Balances Performance Provides Flexibility



Selection of compression applied to selected APIDs for downlink for increased mission data throughput

Programmable LRD downlink provides flexibility for the future

Summary

- Program is making solid progress
  - All instruments are in test
    - Preliminary tests show excellent performance!!
    - VIIRS EDU (and probably FU) late to NPP need
  - NPP spacecraft proceeding on schedule
    - Completed C3 tests with NPOESS ground system
    - Completed 1394a data bus -- shows new instruments will “talk” to satellite
    - Launch date will move -- planning in process
- There ARE technical challenges
  - VIIRS has overcome technical problems but has significant schedule problems
  - OMPS detectors are pacing assembly and test
  - CrIS and ATMS are doing fine in test

http://www.worldses.org/conferences/2005/venice/remote/index.html

Two Keynote Speakers