Raytheon
Customer Success Is Our Mission

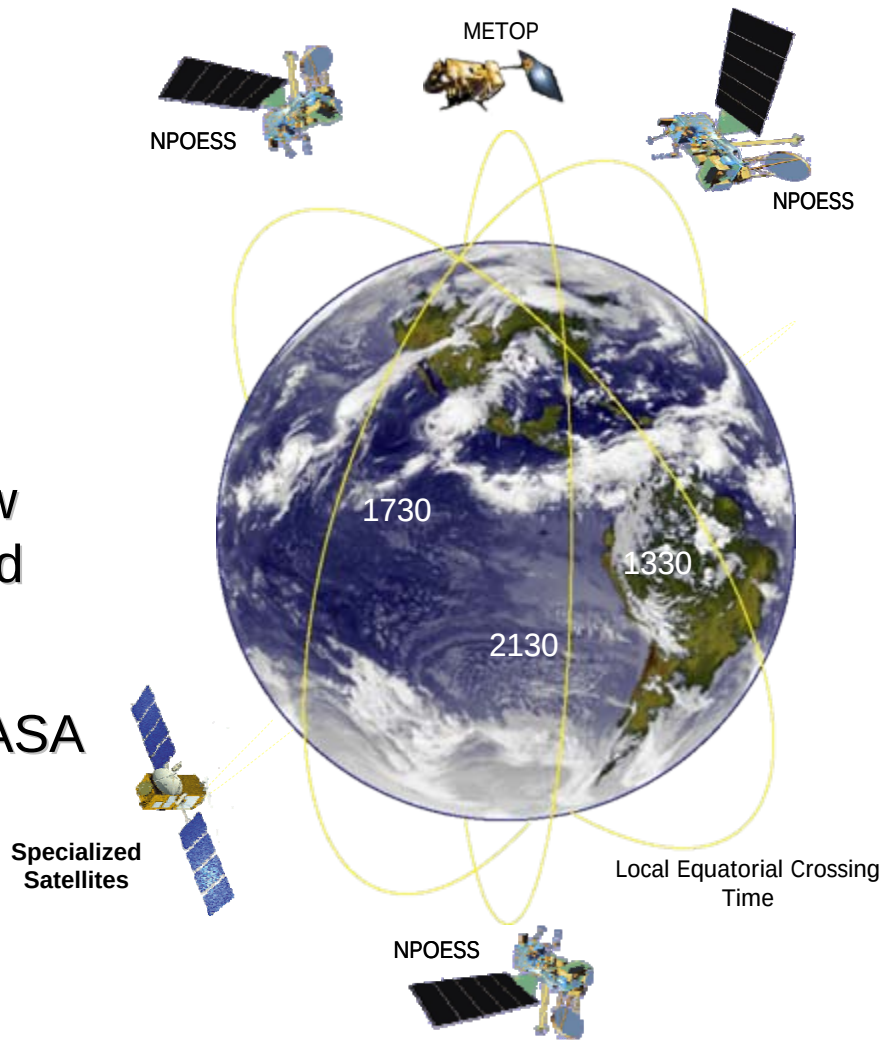
NPOESS Introductory Video

Tri-agency Effort to Leverage and Combine Environmental Satellite Activities

Raytheon
Customer Success Is Our Mission

- Mission

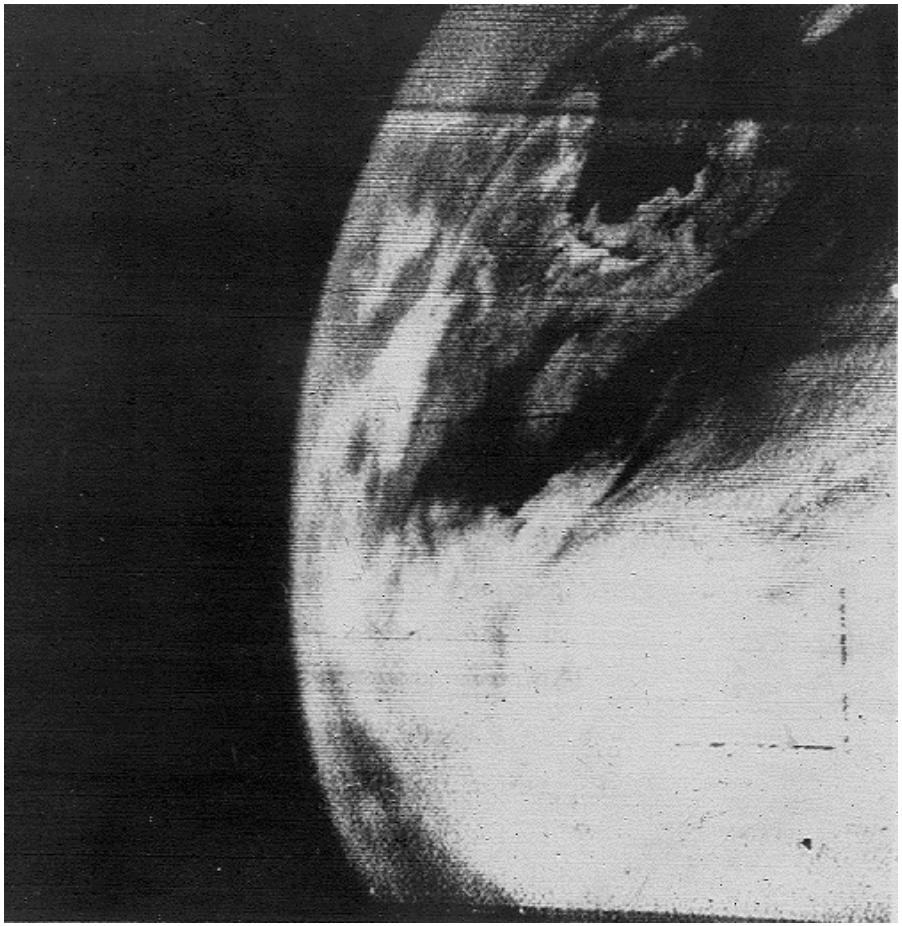
- Provide a national, operational, polar-orbiting remote-sensing capability
- Achieve National Performance Review (NPR) savings by converging DoD and NOAA satellite programs
- Incorporate new technologies from NASA
- Encourage international cooperation



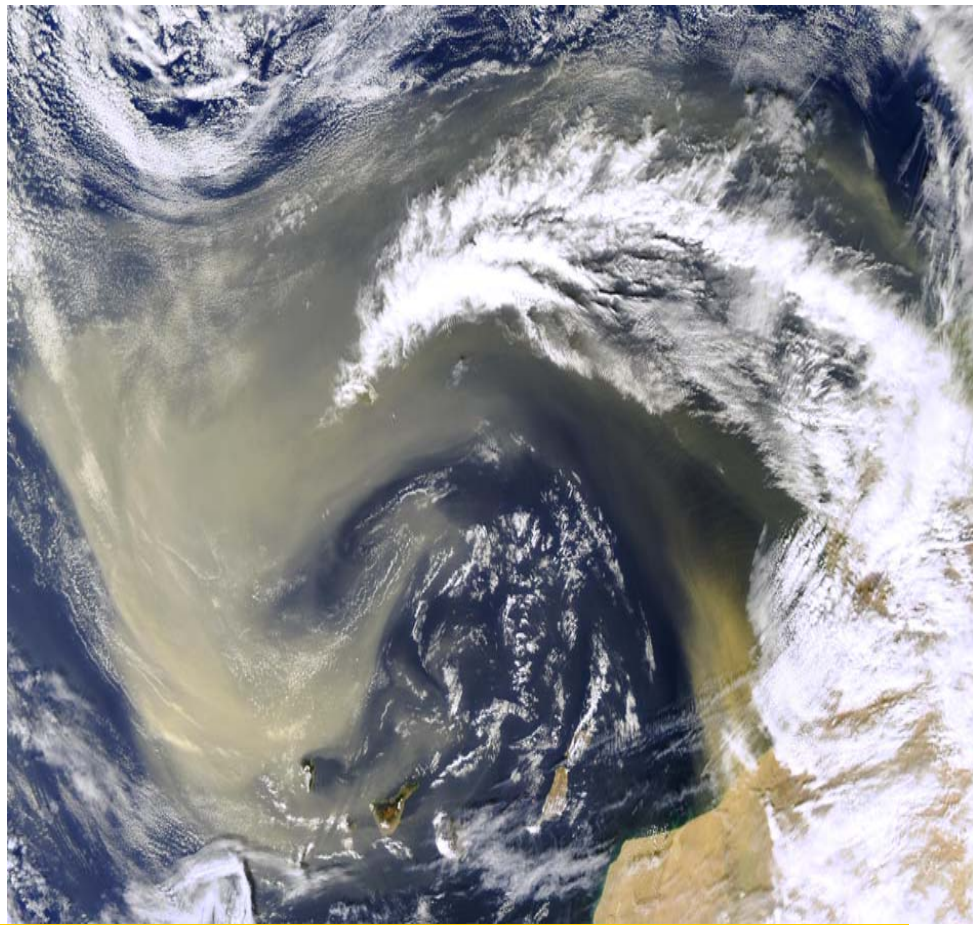
Building A More Capable System
The Historical Context

Raytheon
Customer Success Is Our Mission

First Image from TIROS-1 (Early 60s)



EOS-Aqua MODIS Image-250 m



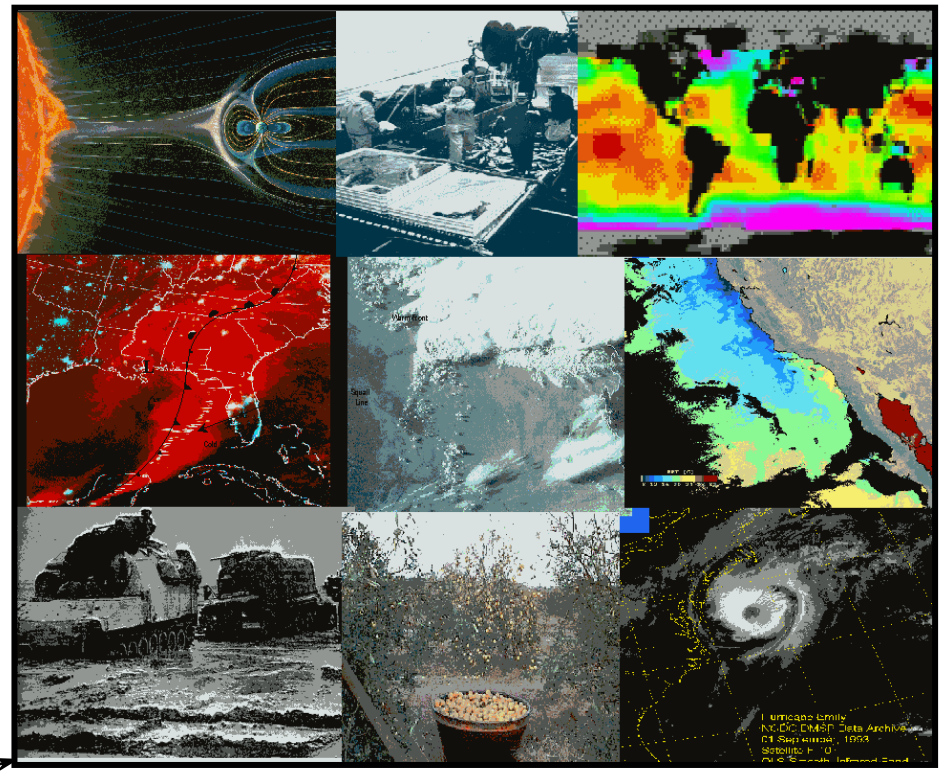
Saharan Dust off the Canary Islands18 February 2004

NPOESS Requirements

Raytheon
Customer Success Is Our Mission

Convergence of Alternatives

- Integrated Operational Requirements Document (IORD-I)
  - **59 Data Products**
  - **9 Enhancement Products**
  - **1 System Characteristic Key Performance Parameter (KPP)**
- Validated by Joint Agency Requirements Committee (JARC) JARC 1996
- IORD-II
  - **55 Data Products**
  - **21 Enhancement Products**
  - **2 System Characteristic KPPs**
- Validated by Dec 2001

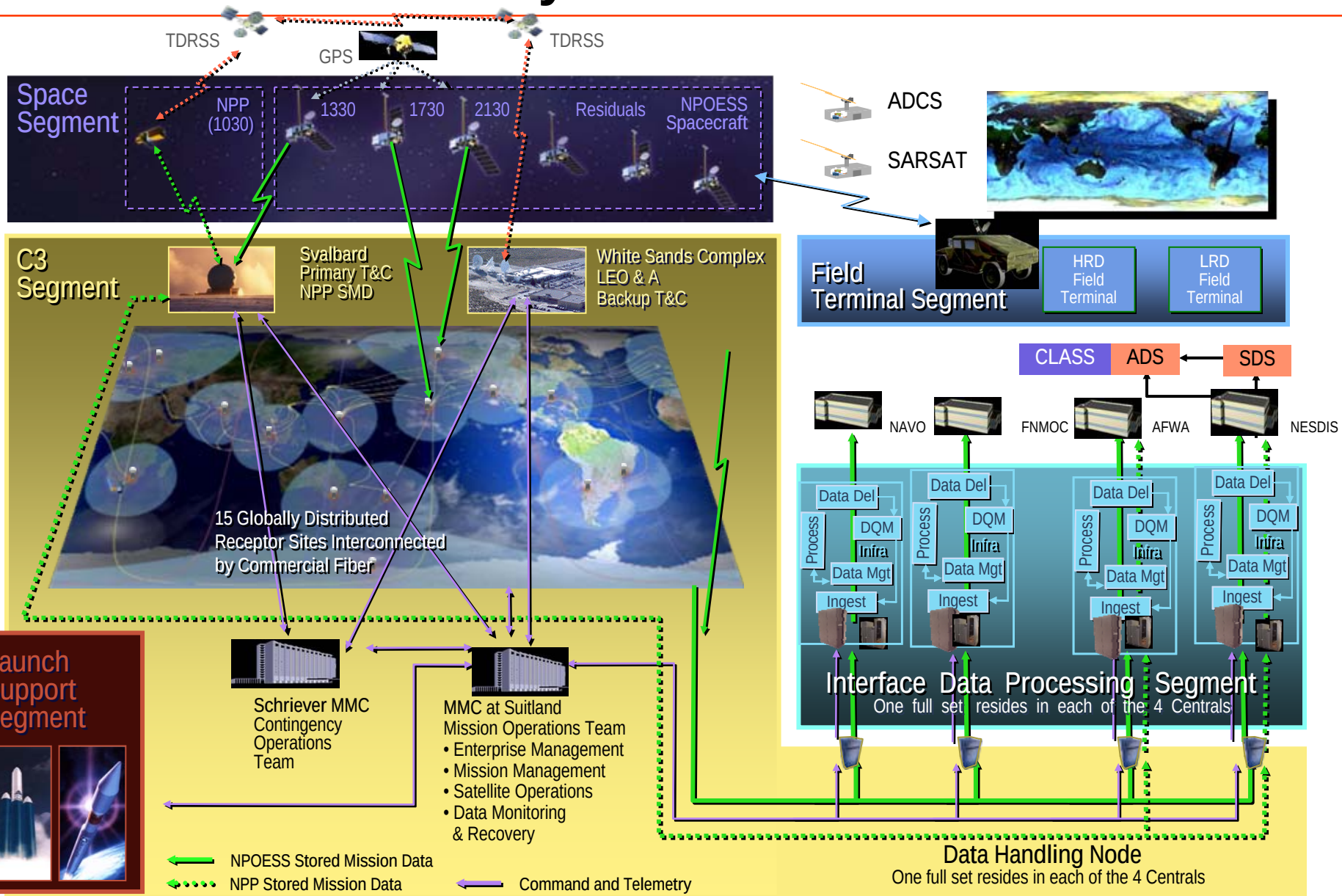


Convergence of Requirements

Converged Requirements Provide Foundation for Combined Program

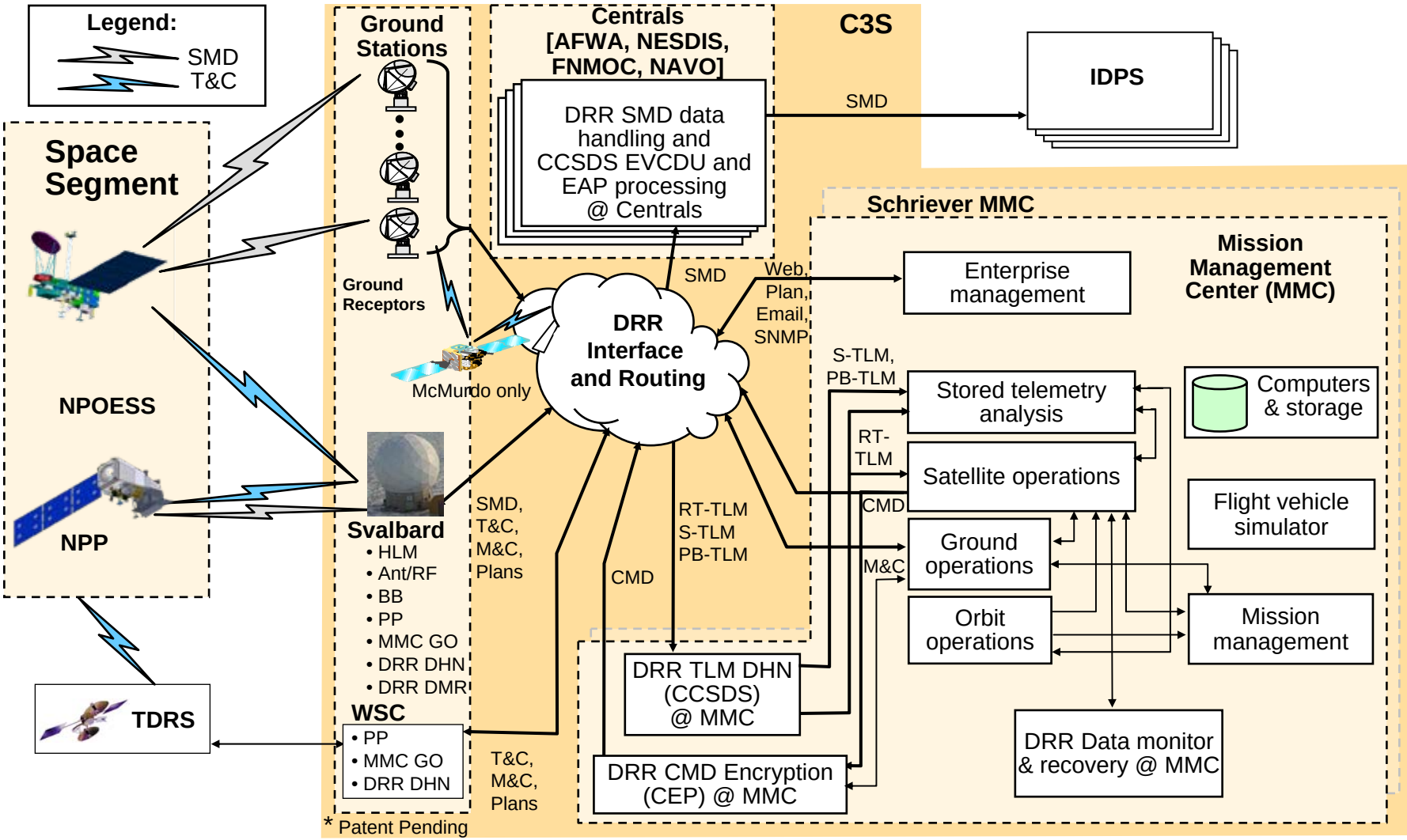
Raytheon
Customer Success Is Our Mission

NPOESS Overview System Architecture



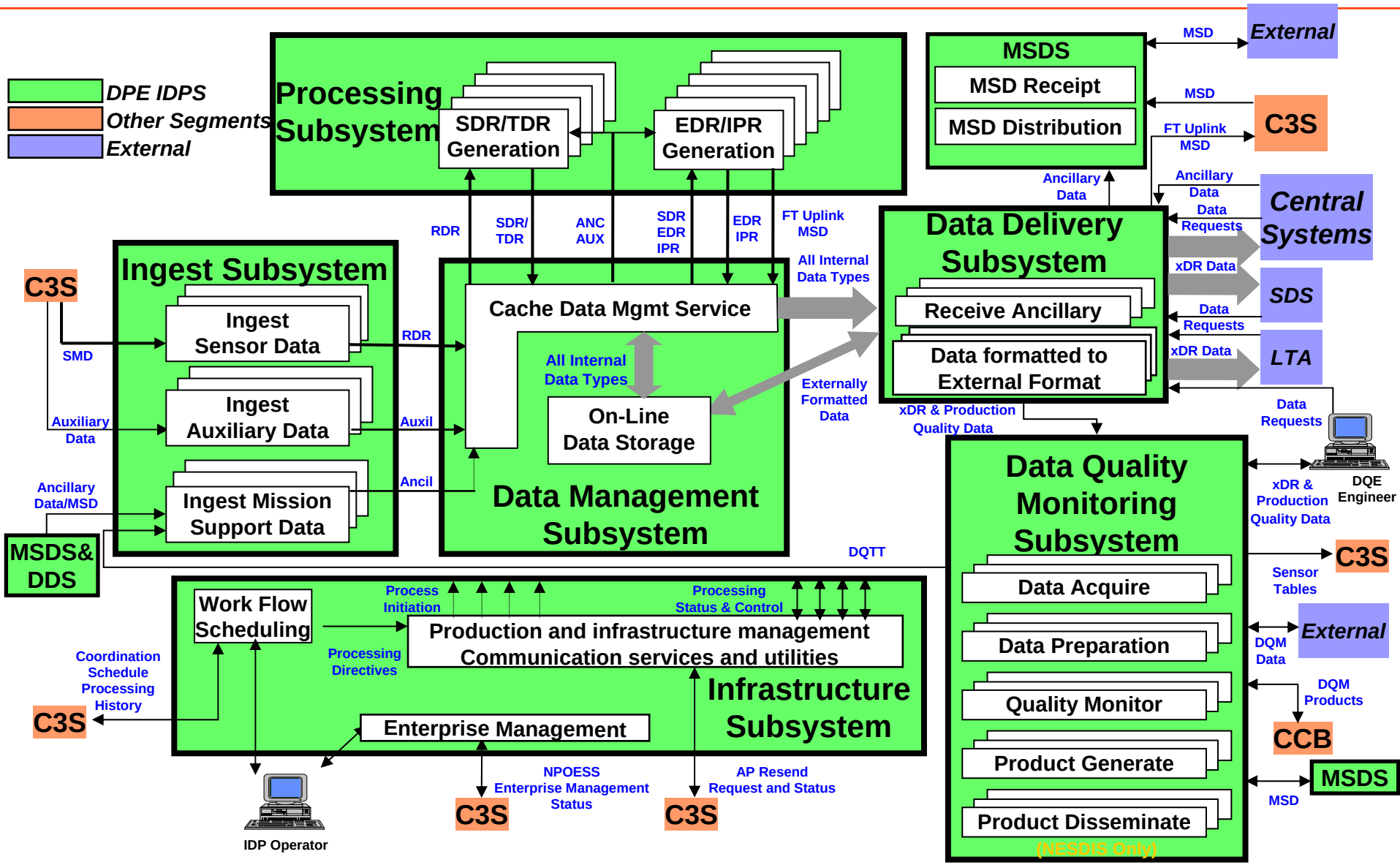
NPOESS Overview C3S Architecture Overview NPP & NPOESS

Raytheon
Customer Success Is Our Mission



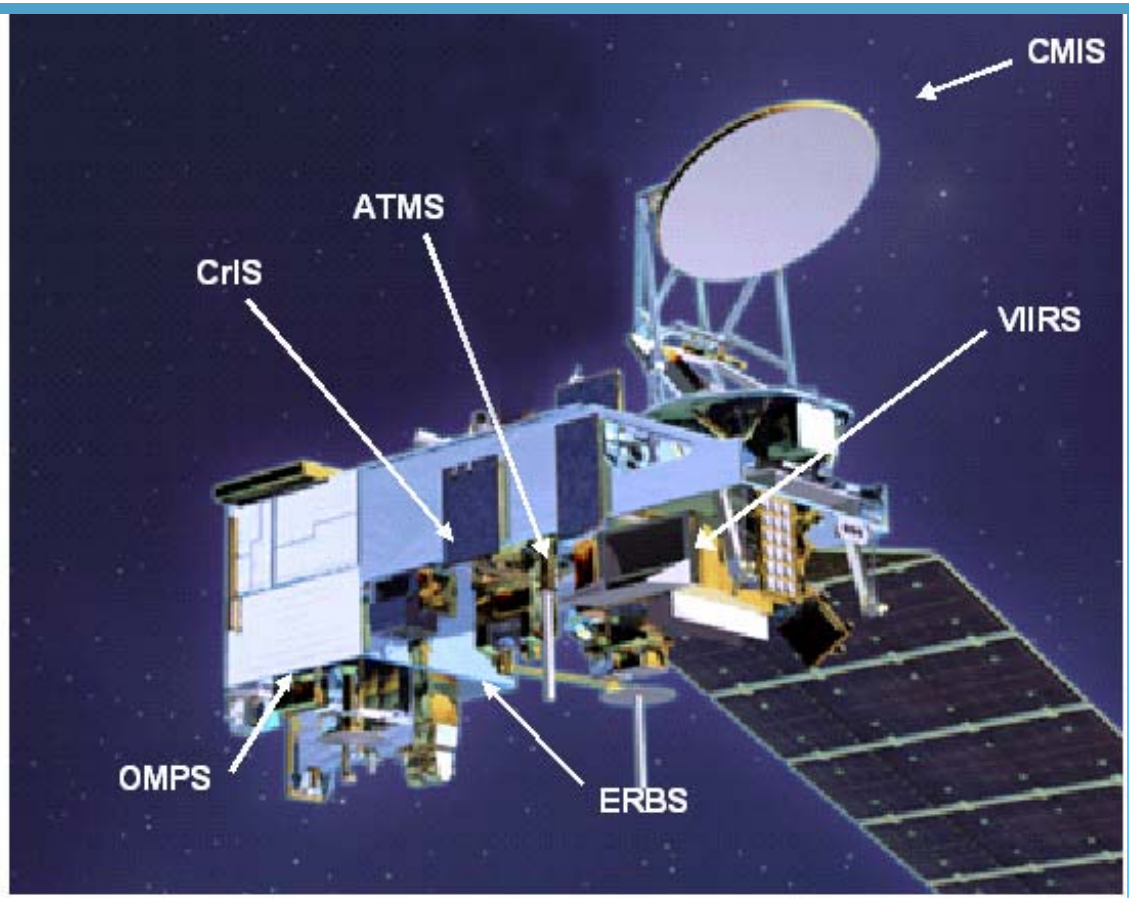
IDPS Functional Block Diagram

Raytheon
Customer Success Is Our Mission



NPOESS Satellite and Sensors

Raytheon
Customer Success Is Our Mission

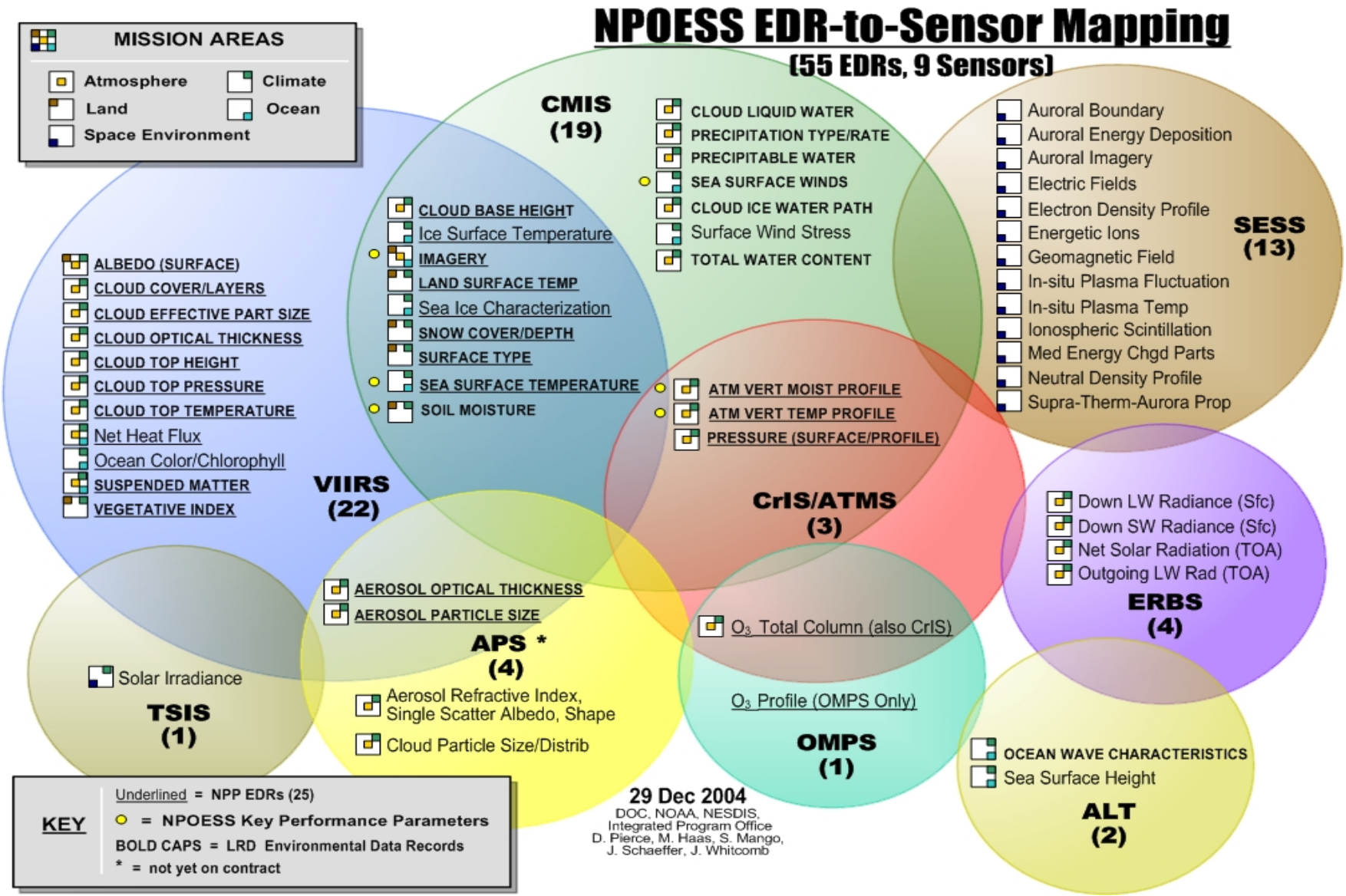


NPOESS 1330 Configuration

	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	
TSIS		X		
ERBS	X			
ALT		X		
APS			X	
SS	X	X	X	

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

NPOESS EDR-to-Sensor Mapping



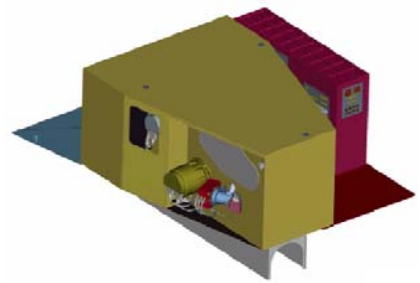
Development Sensor Highlights

Raytheon
Customer Success Is Our Mission

- Visible/Infrared Imager Radiometer Suite (VIIRS)

  Raytheon Santa Barbara

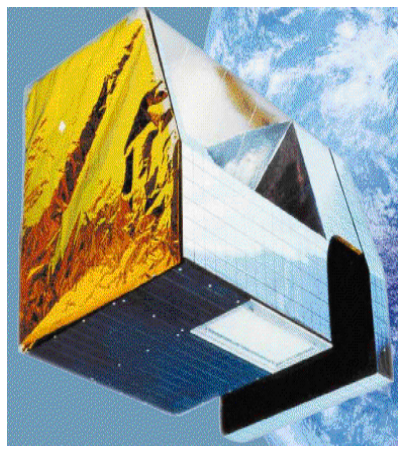
  – 0.4 km imaging and 0.8 km radiometer resolution
  – 22 spectral bands covering 0.4 to 12.5 μm
  – Automatic dual VNIR and triple DNB gains
  – Spectrally and radiometrically calibrated
  – EDR-dependent swath widths of 1700, 2000, and 3000 km



- Crosstrack InfraRed Sounder (CrIS)

  ITT Ft Wayne

  – 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



VIIRS Data Collection

Raytheon
Customer Success Is Our Mission

Development Sensor Highlights (Continued)

Raytheon
Customer Success Is Our Mission

- Advanced Technology Microwave Sounder (ATMS) - NASA

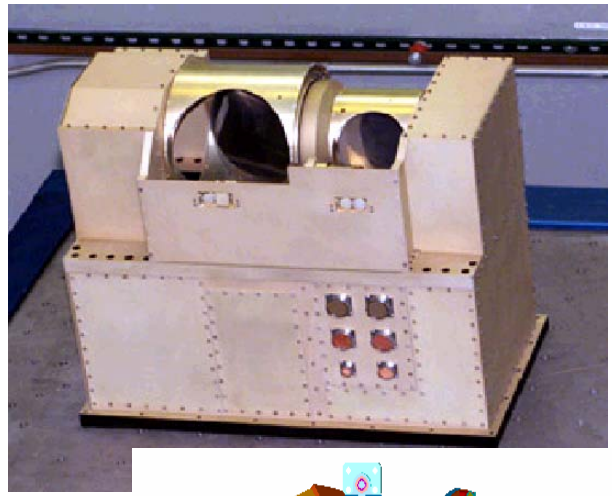
  Northrop Grumman Electronics

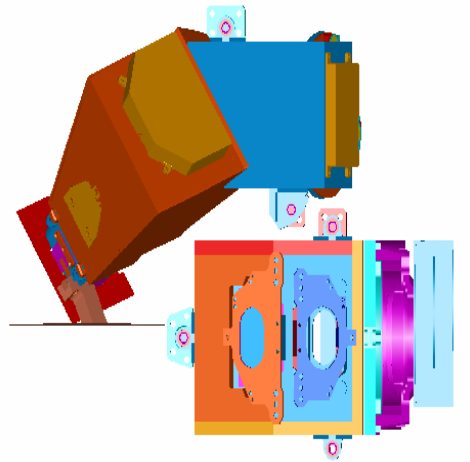
  – CrIS companion cross track scan
  – Profiling at 23, 50 to 57, 183 GHz
  – Surface measurements at 31.4, 88, 165 GHz
  – 1.1, 3.3, and 5.2 deg (SDRs resampled)
  – 2300 km swath width

- Ozone Mapping and Profiler Suite (OMPS)

  Ball Aerospace

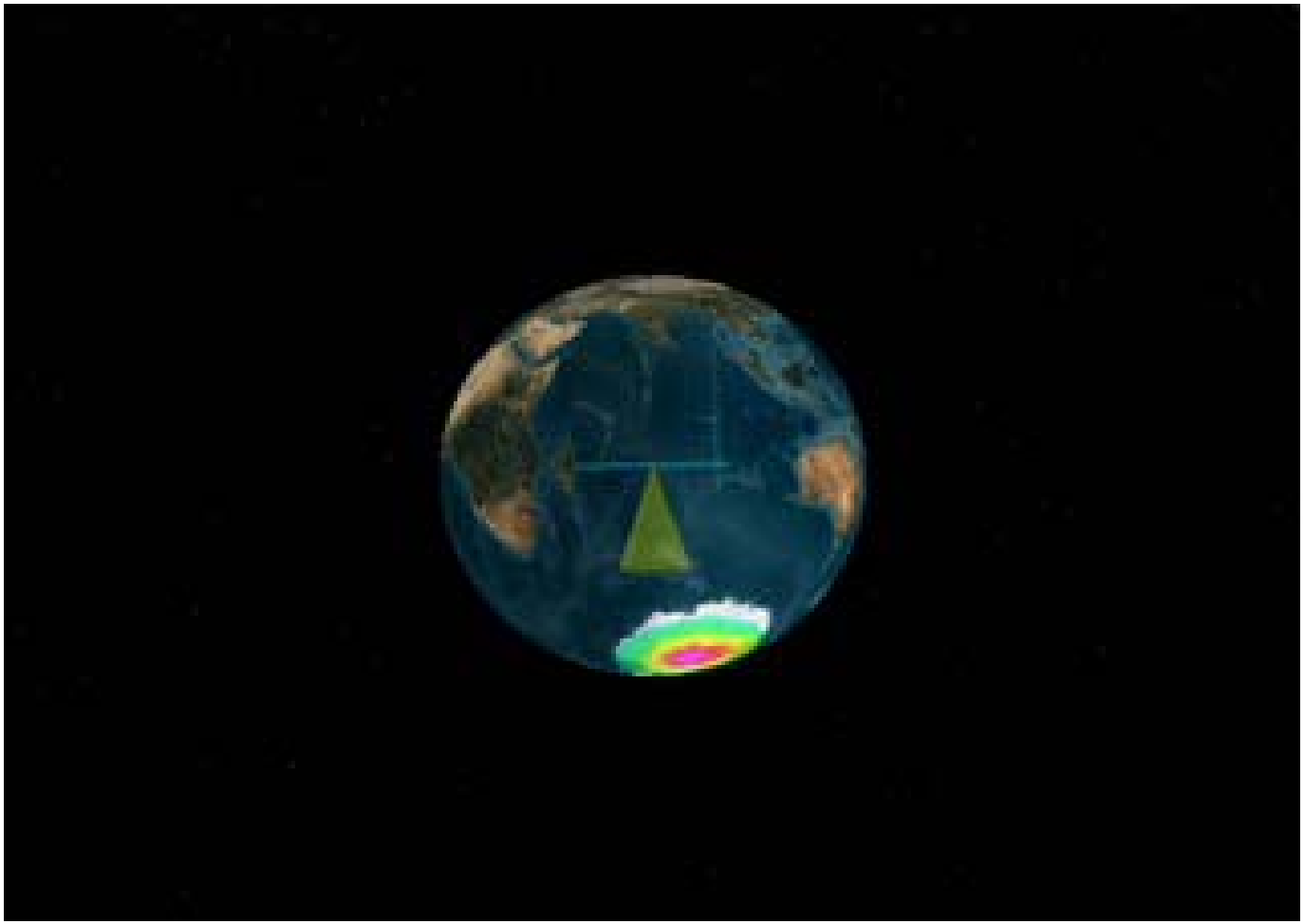
  – Total ozone column 300 to 380 nm with 1.0 nm resolution
  – Nadir ozone profile 250 to 310 nm with 1.0 nm resolution
  – Limb ozone profile 290 to 1000 nm with 2.4 to 54 nm resolution
  – Swath width of 2800 km for total column





OMPS Data Collection

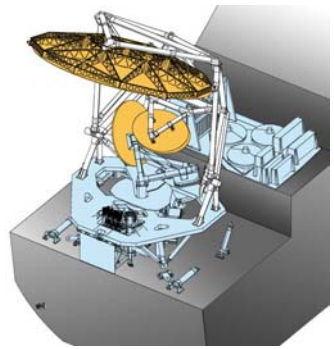
Raytheon
Customer Success Is Our Mission



Development Sensor Highlights (Continued)

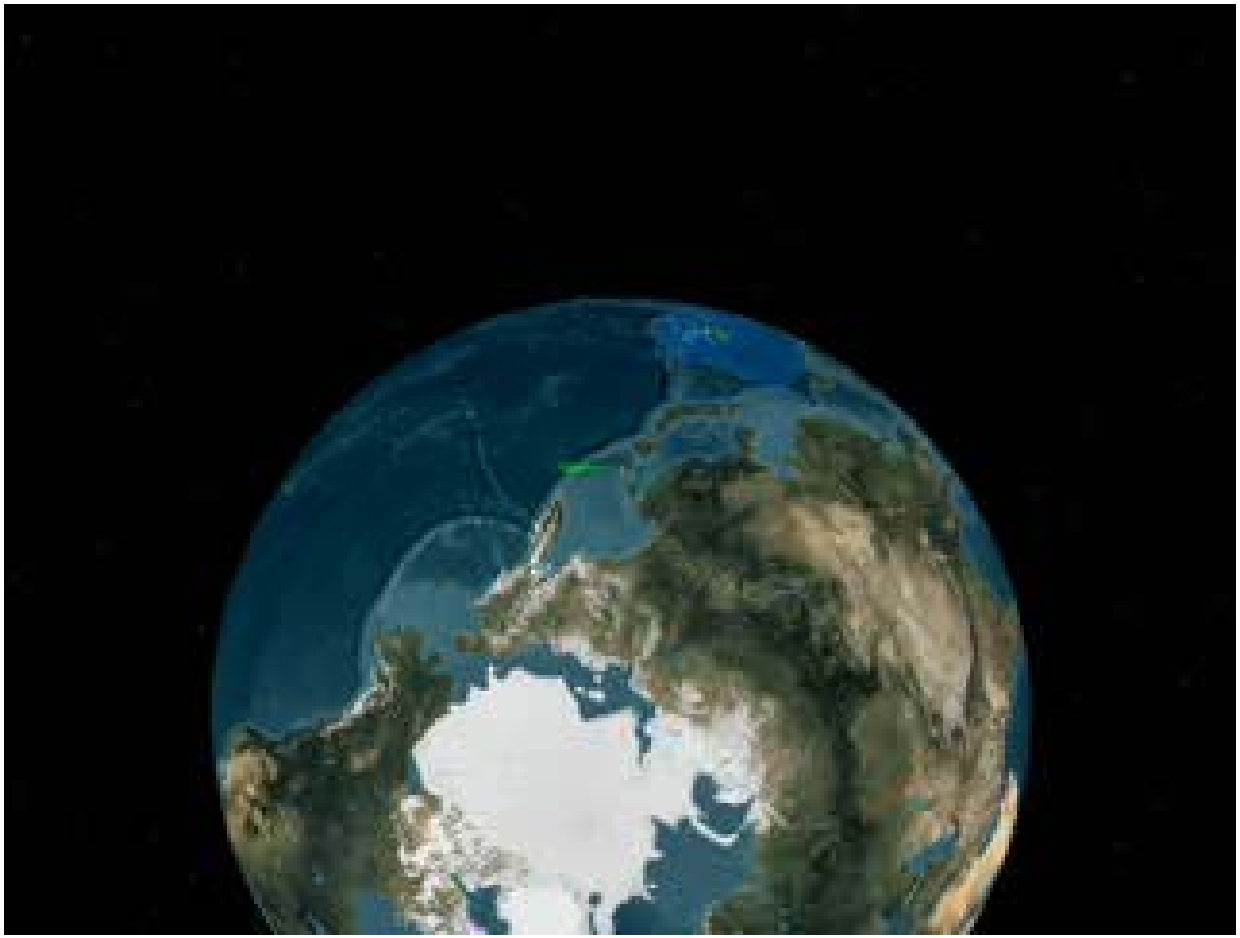
Raytheon
Customer Success Is Our Mission

- Conical Scanning Microwave Imager/Sounder (CMIS)
  Boeing Space Systems
  - 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



CMIS Data Collection

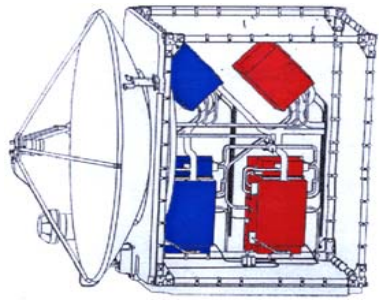
Raytheon
Customer Success Is Our Mission



Leverage Sensor Highlights

Raytheon
Customer Success Is Our Mission

- **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



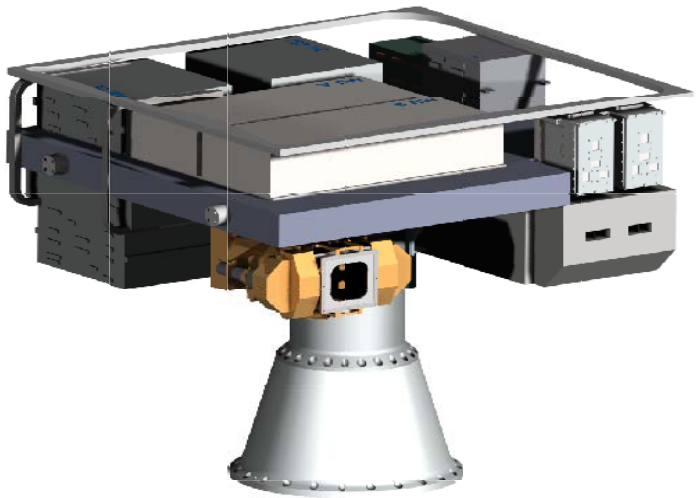
- **Earth's Radiation Budget Suite (ERBS)**
  Northrop Grumman Space Technology
  – Three spectral channels
  – Total radiation measurement 0.3 to 50 μm
  – Shortwave Vis and IR measurement 0.3 to 5 μm
  – Longwave IR measurement 8 to 12 μm

Leverage Sensor Highlights (Continued)

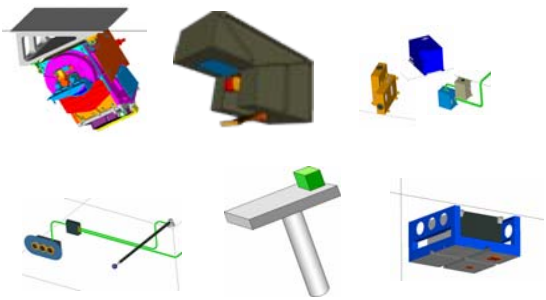
- **Total Solar Irradiance Sensor (TSIS)**

  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



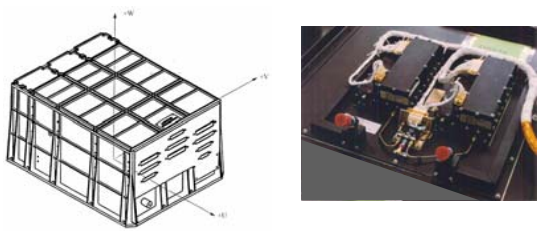
Highlights of Other Sensors



- **Space Environment Sensor Suite (SESS)**

  Ball Aerospace

  – Sensor suite collecting data on particles, fields, aurora, and ionosphere
  – Suite includes a UV disk imager (BATC), charged particle detectors (Amptek/U. of Chicago), thermal plasma sensors (UTD)
  – Will distribute suite on all 3 orbital planes



- Advanced Data Collection System (ADCS) and Search and Rescue Satellite-Aided Tracking (SARSAT)

  – "GFE" to NPOESS from France and China
  – ADCS supports global environmental applications
  – SARSAT collects distress beacon signals

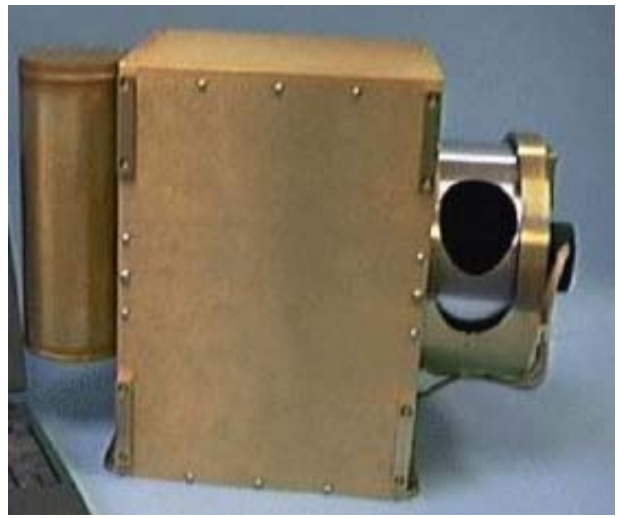
Highlights of Other Sensors (Continued)

Raytheon
Customer Success Is Our Mission

- **Aerosol Polarimetry Sensor (APS)**

  Raytheon Santa Barbara Remote Sensing

  – 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)



Integrated Operational Requirements Document (IORD) Example

Raytheon
Customer Success Is Our Mission

Atmospheric Vertical Temperature Profile

Highly accurate measurement of the vertical distribution of temperature in the atmosphere in layers from the surface to 0.01 mb

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size		
1. Clear, nadir	18.5 km	1 km
2. Clear, worst case	100 km	1 km
3. Cloudy, nadir	40 km	1 km
4. Cloudy, worst case	50 km	1 km
b. Vertical Reporting Interval		
1. Surface to 850 mb	20 mb	10 mb
2. 850 to 300 mb	50 mb	10 mb
3. 300 to 100 mb	25 mb	10 mb
4. 100 to 10 mb	20 mb	10 mb
5. 10 to 1 mb	2 mb	1 mb
6. 1 to 0.1 mb	0.2 mb	0.1 mb
7. 0.1 to 0.01 mb	0.02 mb	.01 mb
c. Mapping Accuracy	5 km	0.5 km
d. Measurement Uncertainty (expressed as error in layer average temperature)**		0.5 K
Clear:		
1. Surface to 300 mb*	**1.6 K per 1 km layer**	
2. 300 mb to 30 mb	1.5 K per 3 km layer	
3. 30 mb to 1 mb	1.5 K per 5 km layer	
4. 1 mb to 0.01 mb	3.5 K per 5 km layer	
Cloudy:		
5. Surface to 700 mb*	**2.5 K per 1 km layer**	
6. 700 mb to 300 mb	1.5 K per 1 km layer	
7. 300 mb to 30 mb	1.5 K per 3 km layer	
8. 30 mb to 1 mb	1.5 K per 5 km layer	
9. 1 mb to 0.01 mb	3.5 K per 5 km layer	
e. Latency	156 minutes	15 minutes
f. Refresh	6 hours	3 hours
g. Long-Term Stability***		
1. Trop. Mean	0.05 K	0.03 K
2. Strat. Mean	0.10 K	0.05 K

Major Applications

1) Initialization of Numerical Weather Prediction Models

2) Complementary data for derivation of moisture/pressure profiles and cloud properties

Iterative, Disciplined Requirements Process Ensures Users Needs are Met

Program Schedule

2002 A&O Contract Award

2003 NPP Delta Critical Design Review

2005 NPOESS ΔPreliminary Design Review

2007 NPOESS Critical Design Review
NPP Ground Readiness

2008 NPP Launch (TBR)

2009 NPOESS Ground Readiness

2010 NPOESS C1 Launch (TBR)

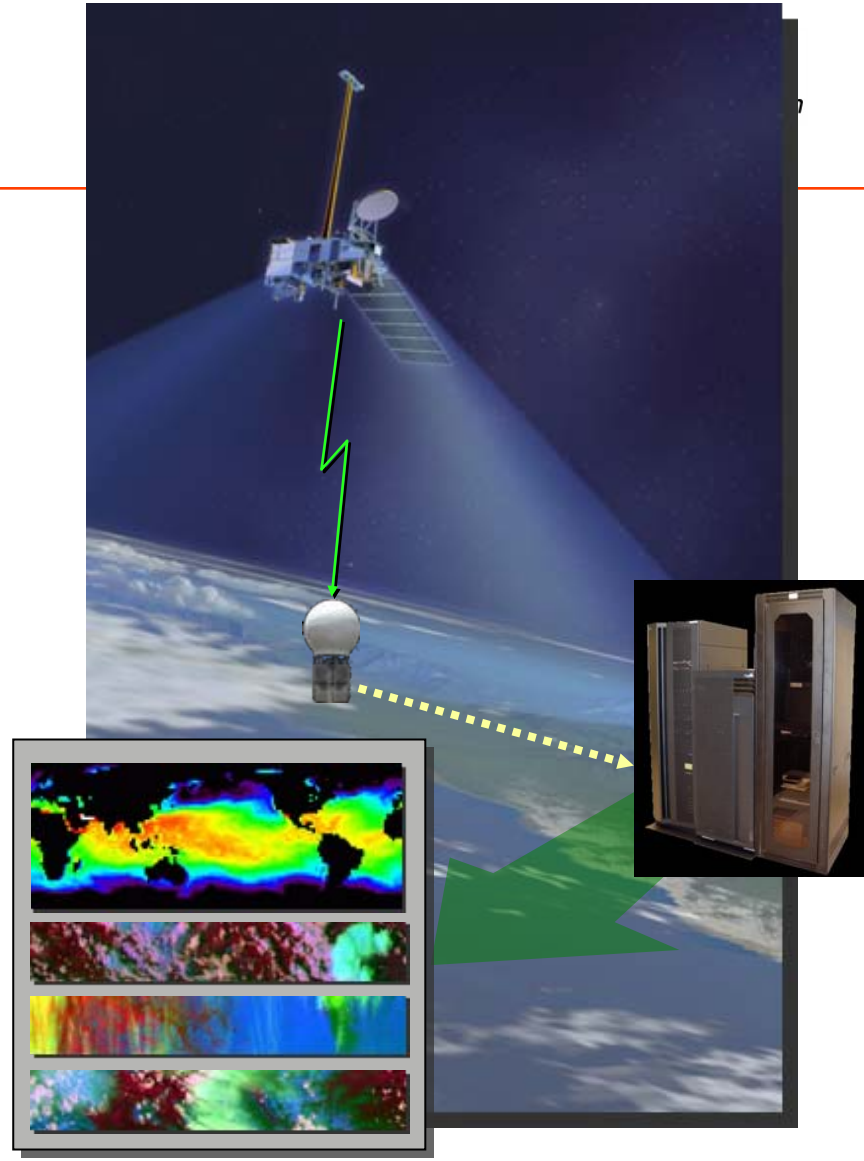
2011 NPOESS C2 Launch (TBR)
Field Terminal Segment Readiness
Initial Operational Capability

2013 NPOESS C3 Launch

2015 NPOESS C4 Launch

2017 NPOESS C5 Launch

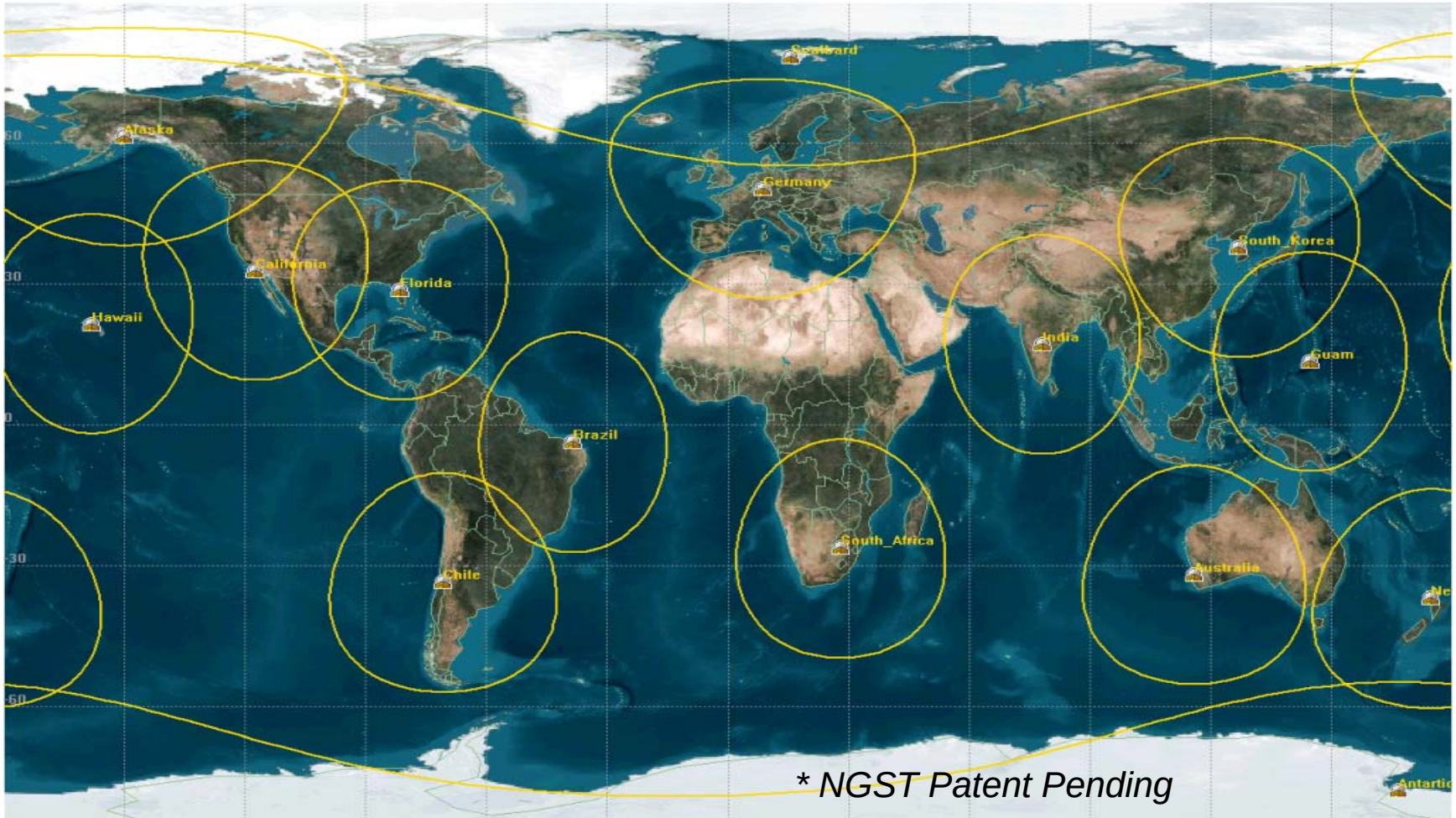
2020 End of Program



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

SafetyNet*– The Key to Low Data Latency and High Data Availability

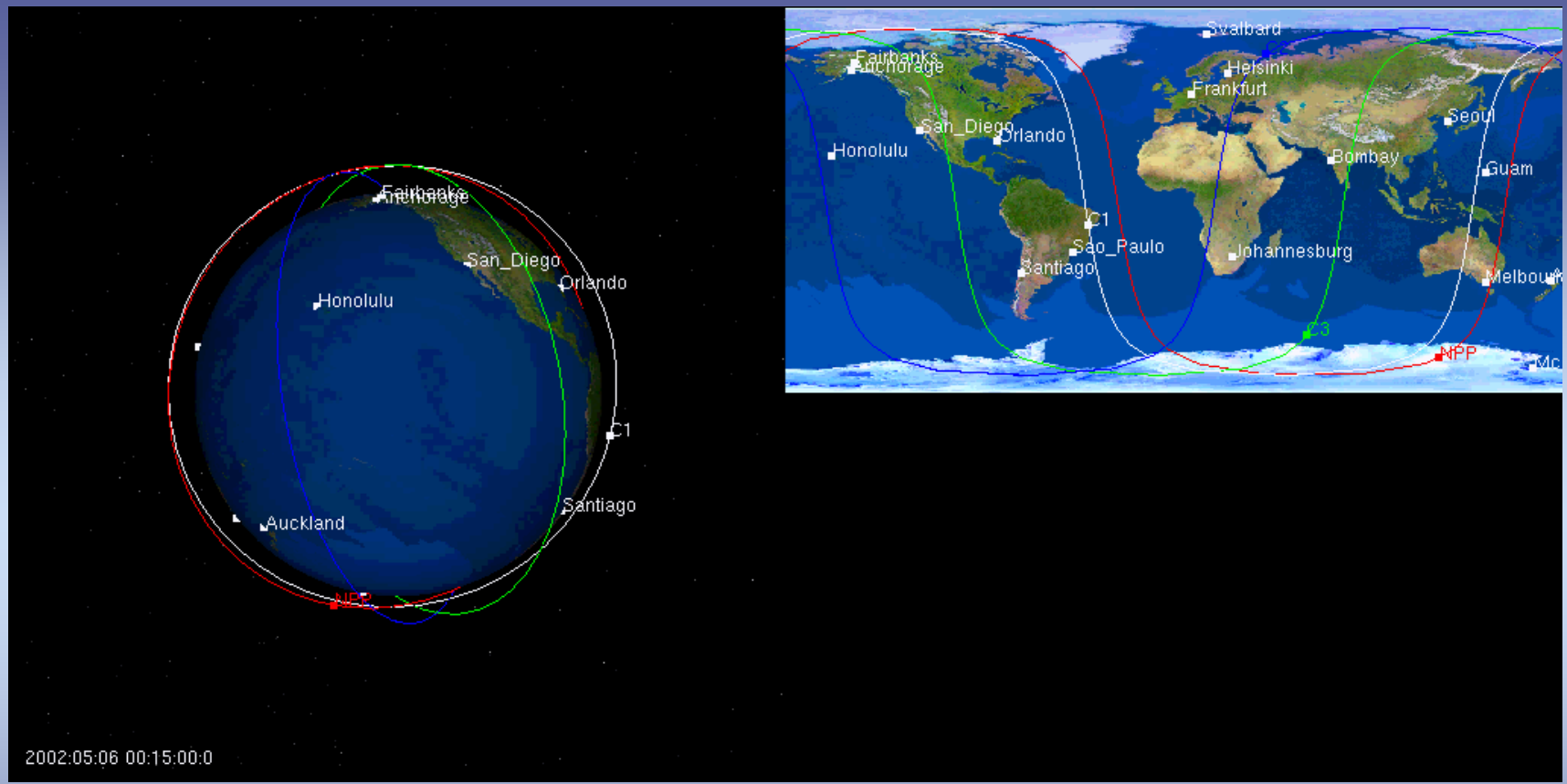
Raytheon
Customer Success Is Our Mission



More than 75% of NPOESS Data Products at the Nation's Weather Centrals within 15 min.....95% in under 30 min

Raytheon
Customer Success Is Our Mission

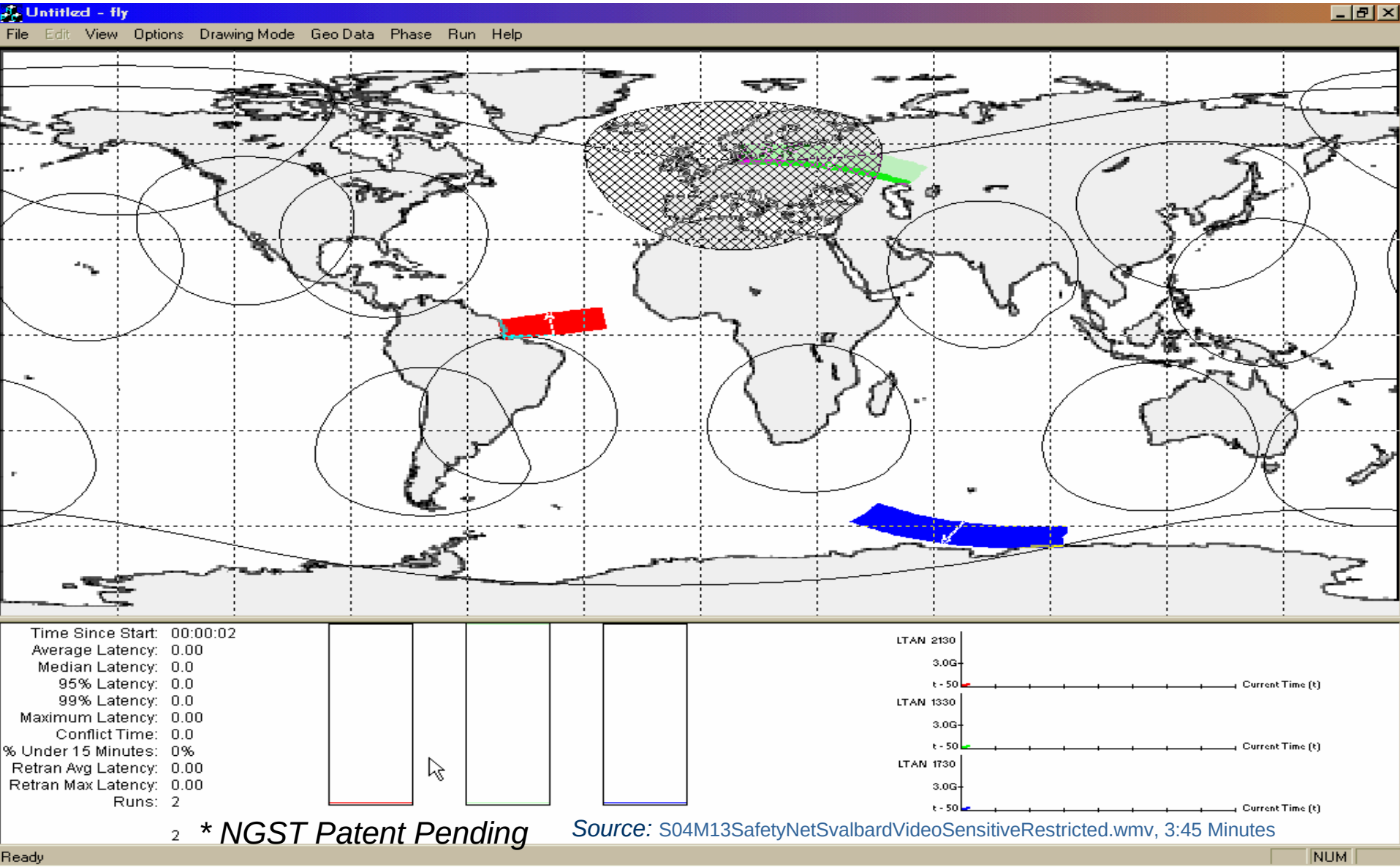
NPOESS SafetyNet* Design



** NGST Patent Pending*

Raytheon
Customer Success Is Our Mission

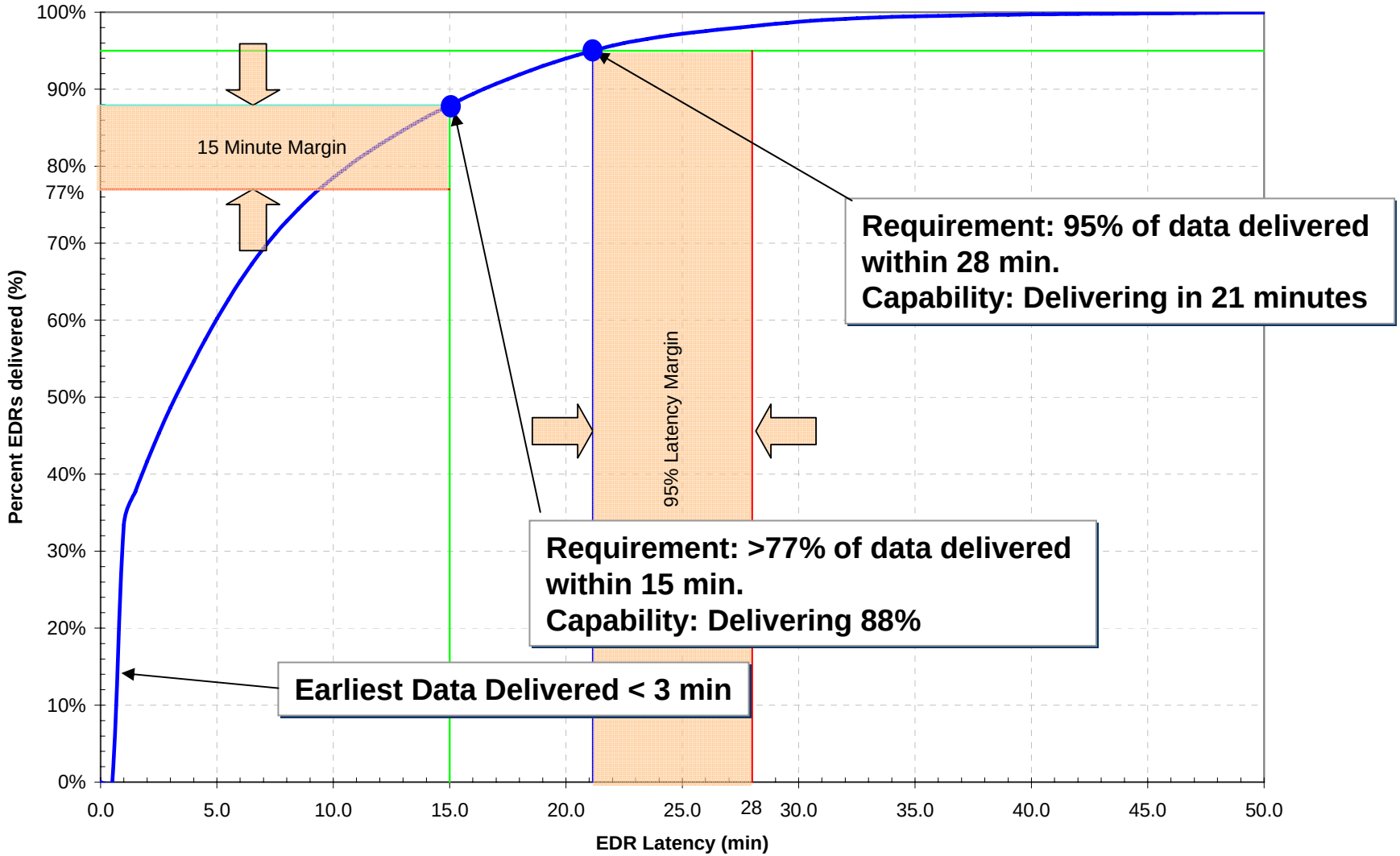
NPOESS Data Retrieval Via SafetyNet*



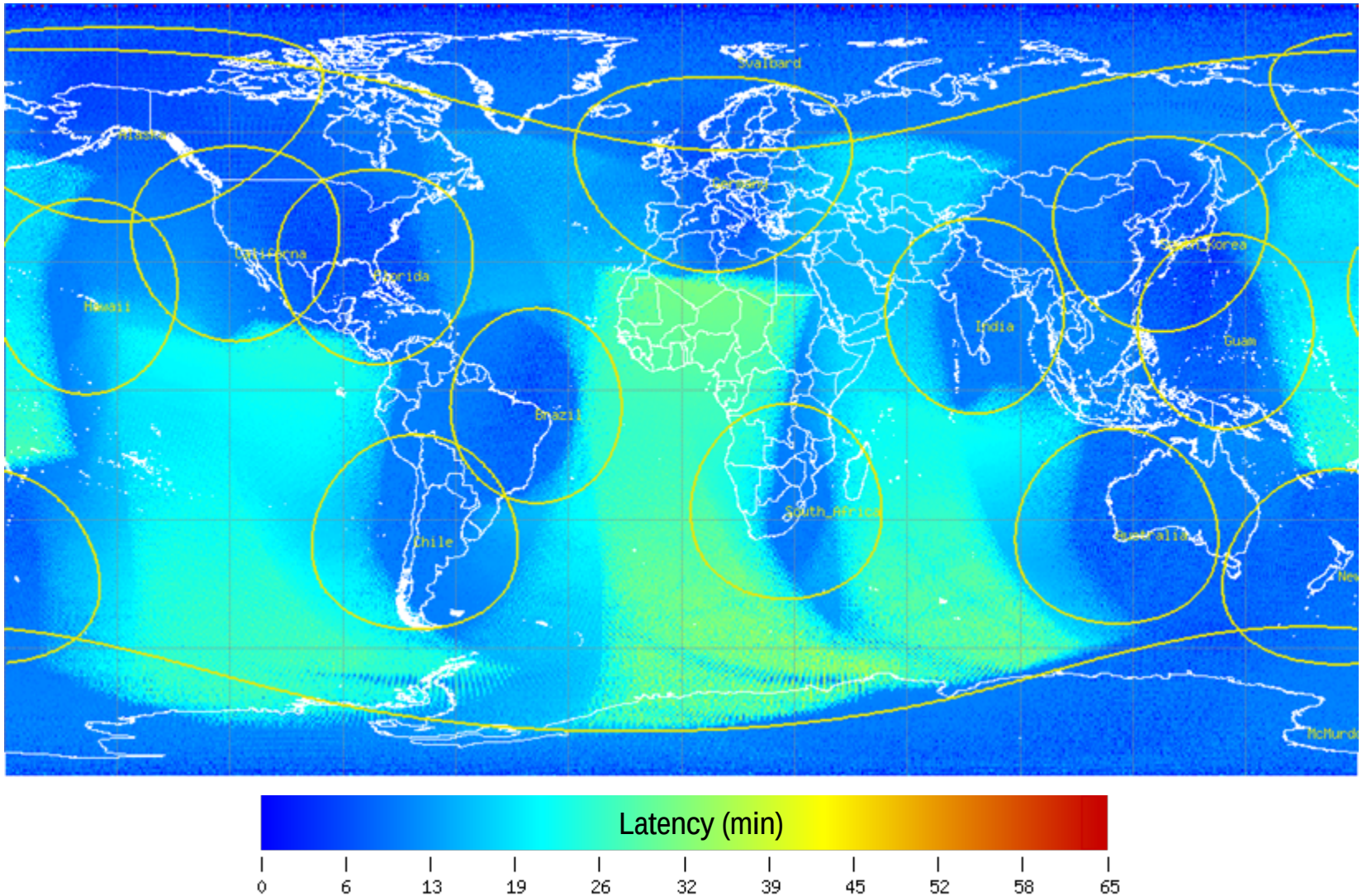
2 * *NGST Patent Pending*

Source: S04M13SafetyNetSvalbardVideoSensitiveRestricted.wmv, 3:45 Minutes

NPOESS EDR Processing Timeline



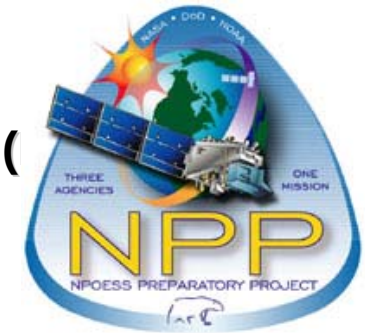
Global 95% Data Latency



NPOESS Preparatory Project (NPP) Joint IPO-NASA Risk Reduction Demo

Raytheon
Customer Success Is Our Mission

- NPP Spacecraft contract awarded to Ball Aerospace – May 2002
- Instrument Risk Reduction
  - Early delivery / instrument-level test / system-level integration and test
    - VIIRS - Vis/IR Imager Radiometer Suite (IPO)
    - CrIS - Cross-track IR Sounder (IPO)
    - ATMS - Advanced Technology Microwave Sounder (
    - OMPS – Ozone Mapping and Profile Suite (IPO)
  - Provides lessons learned and allows time for any required modifications before NPOESS first launch
- Ground System Risk Reduction
  - Early delivery and test of a subset of NPOESS-like ground system elements
  - Early User Evaluation of NPOESS data products
  - Provides algorithms / instrument verification and opportunities for instrument calibration / validation prior to first NPOESS launch
  - Allows for algorithm modification prior to first NPOESS launch
- Continuity of data for NASA's EOS Terra/Aqua/Aura missions



Recent NPP Spacecraft Photographs within BATC High Bay

Raytheon
Customer Success Is Our Mission

Additional NPOESS Articles On-Line

Raytheon
Customer Success Is Our Mission

- There is an NPOESS article in every issue from Jan 2004 through May 2005 (see archives).

  http://www.eomonline.com/currentissues.html

- There are two other sites that might be of interest to students:

1. The official government web site for NPOESS
   http://www.npoess.noaa.gov

2. The official NASA web site for NPP
   http://jointmission.gsfc.nasa.gov/

National Polar-orbiting Operational Environmental Satellite System

Raytheon
Customer Success Is Our Mission