Satellite Task Force

Status Report
for NESDIS Satellite Programs

Preliminary Findings and Observations

(Subject to update as SATTF review with NOAA continues)

16 July 2012

Robert S. Winokur
Chair

Overview

- SATTF Terms of Reference
- Membership
- Process
- Bottom Line
- Key Observations and Findings
- Recommendations
- Way Forward

SATTF Terms of Reference
Charge

SATTF will: *"…recommend a way forward for NOAA's satellite program, starting with initial NESDIS recommendations and seeking a more affordable, flexible and robust satellite and services architecture…"*

SATTF Considerations

- **Long term sustainability of NOAA satellite programs (and gap risks)**
- **Current plans, including flight segment of JPSS-2 and the GO ES-T and beyond**
- **Ground segment, including data receipt, distribution and processing**
- **Cost estimates and the estimating methodology**
- **The National Space Policy call on NOAA for operational continuity**
- **Research and technology plans and investments by NASA and others**
- **System adaptability to accommodate changing technical and programmatic environments**
- **International collaborations and opportunities**
- **Collaborations and opportunities with DoD, NASA and the USGS**
- **Effective and enhanced use of academia and the private sector**
- **Feasibility, considering the anticipated difficulty in achieving needed future funding**
- **Flexibility to accommodate unpredictable future appropriations**

SATTF Members

- **Robert Winokur, Chair**
  - **Deputy and Technical Director (Acting Oceanographer of the Navy)**
  - **Oceanography, Space and MDA Division, Chief of Naval Operations**
- **Dolly Perkins, consultant**
  - **Former Deputy Center Director - Technical**
  - **NASA Goddard Space Flight Center**
- **Robert E. Gold**
  - **Space Department Chief Technologist**
  - **The Johns Hopkins University Applied Physics Laboratory (JHU/APL)**
- **Thomas C. Adang**
  - **Systems Director, The Aerospace Corporation**
  - **Department of Defense - Operationally Responsive Space (ORS) Office**
- **Michael D. Tanner**
  - **Acting Deputy Director, National Climatic Data Center**
- **Paul Menzel**
  - **Professor/Senior Scientist, University of Wisconsin**
  - **Formerly Chief Scientist, NESDIS STAR**
- **Diane Evans**
  - **Director, JPL Earth Science and Technology Directorate**
- **J. Marshall Shepherd, SAB Liaison**
  - **Department of Geography/Director, Atmospheric Sciences Program, University of Georgia**
- **David Hermreck, NESDIS Liaison**
  - **Senior Advisor, NESDIS Office of System's Development**

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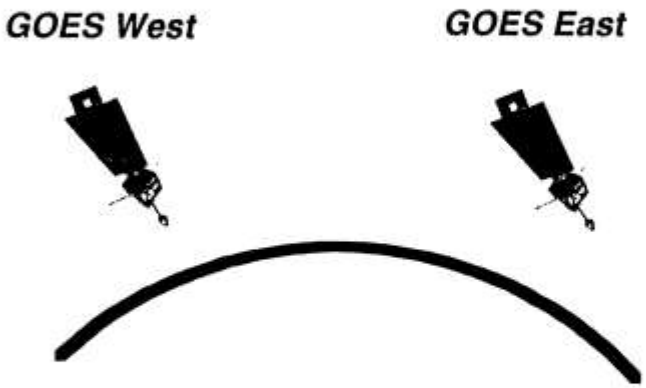
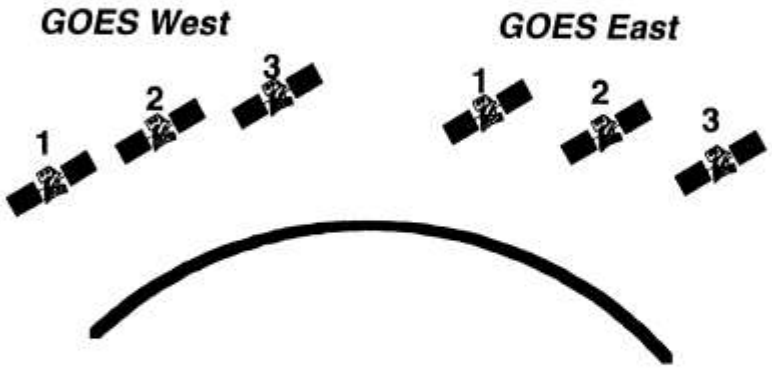
Satellite System Scope

- Includes polar and geostationary
- Applications include weather, climate, space weather and oceans
- Key sensors include imaging, sounding and altimetry
- Large multi-sensor satellites
- Constellations of smaller satellites with specific sensors
- Ground segment

Satellite Architecture Concept

Consolidated vs. Distributed GOES Architecture





Consolidated Architecture

- Current Architecture
- Multiple critical payloads per S/C

Distributed Architecture

- Future architecture option
- One primary payload per S/C
  - Imager
  - Infrared Sounder
  - Microwave Sounder

SATTF Process

- Met in person and via teleconference calls:
  - 14 March, 19-20 June 2012 (face-2-face)
  - 4, 30 April, 7 June 2012 (telcon)
- Presented interim report to SAB – 5 April, 2012
- Reviewed NESDIS general plans for space architecture development including:
  - Requirements analysis and results
  - Space segment: status, plans and alternative analysis
  - Ground segment: status, workshop results and enterprise approach
- Examined Space System Alternative Approaches
  - DoD Operationally Responsive Space (ORS)
  - NAS smallsat “meeting of experts”

Caveat

- The findings and observations presented in this report are preliminary and will be updated based on feedback from the SAB and additional updates and reviews with NESDIS as the SATTF prepares the final report by October 2012

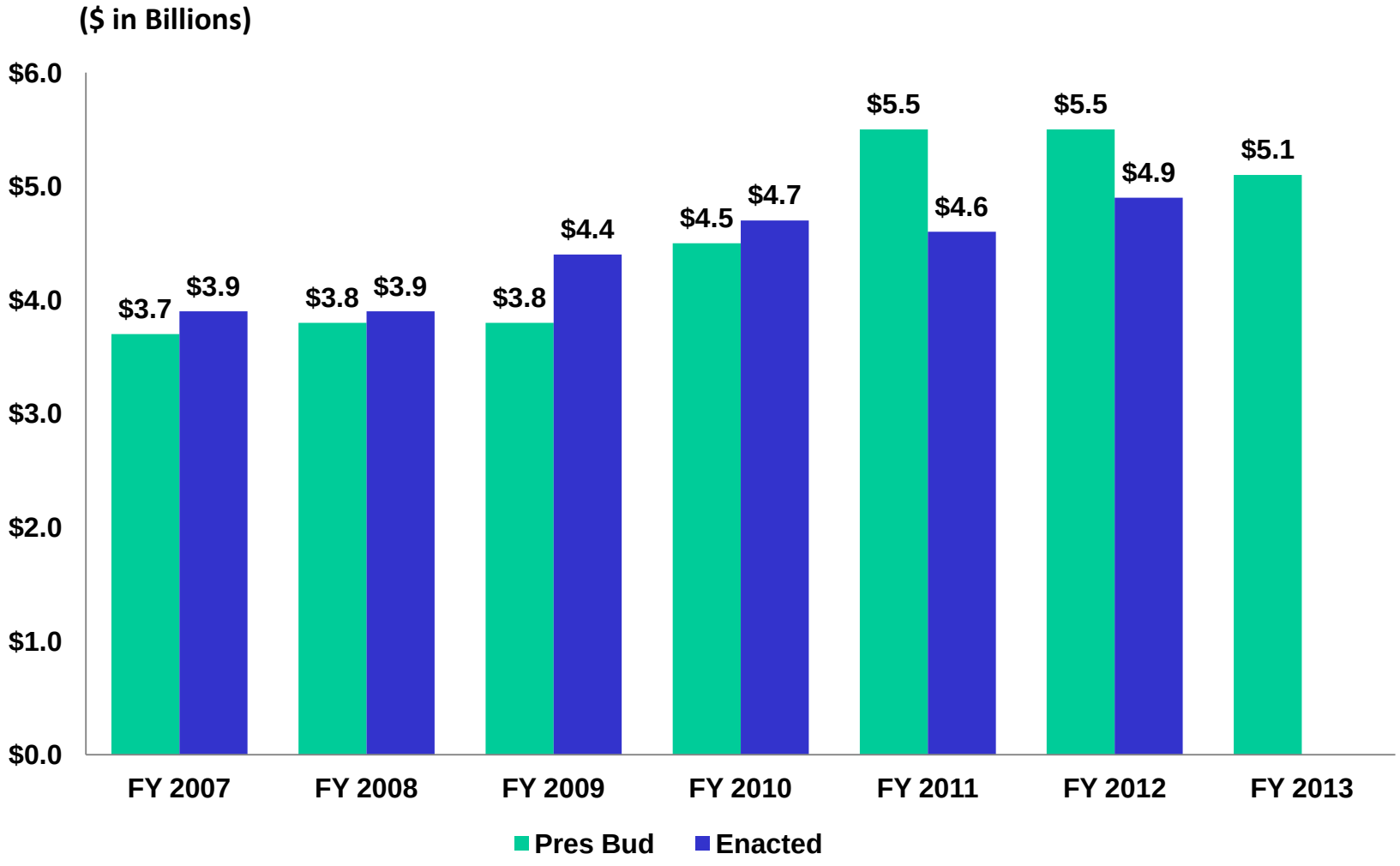
Bottom Line Up Front

- NOAA budget for currently planned space systems appears to be unsustainable
  - Today's fiscal environment could very well lead NOAA to increase risk or decrease scope – maintain high impact capability
  - Constrained fiscal environment will require prioritization of threshold space-based observational requirements
- NOAA is to be commended for taking steps to prepare a future satellite system architecture
  - Additional effort and continued commitment is required toward meeting that goal building on the progress to date.
- NOAA needs a total systems approach to satellite architecture
  - NOAA is in a position to undertake this as they now have sole responsibility for JPSS and GOES
- NOAA needs to find a pathway to develop affordable, flexible and robust alternatives to address the budget challenge
  - NOAA needs to expand the spectrum of alternatives identified and assessed using common measures of merit

NESDIS FY 2013 BUDGET: $2,041.4 million

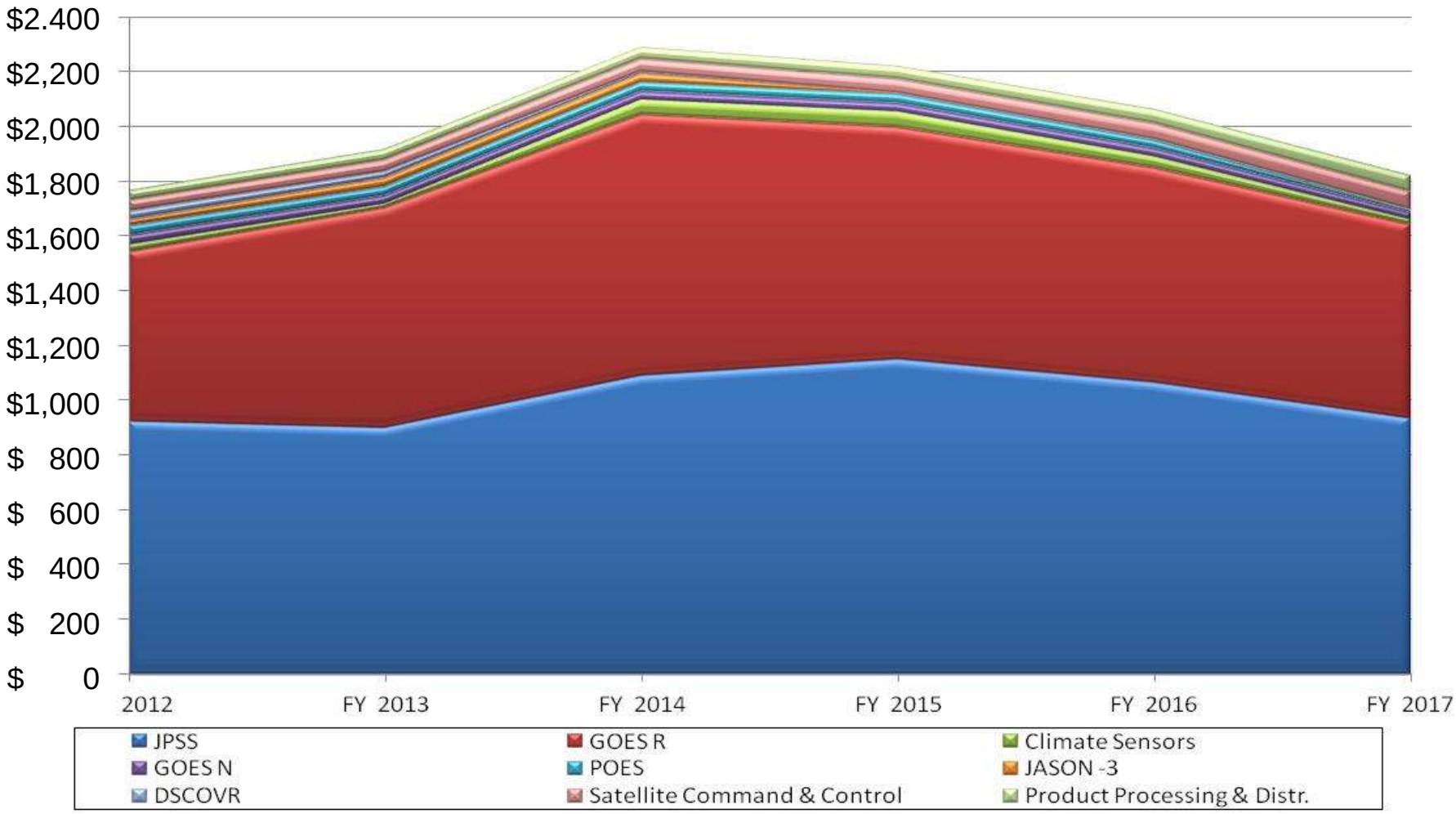
- Contains funding for major systems: JPSS and GOES-R
- Continues the development of the Jason-3 satellite in partnership with EUMETSAT and CNES to provide continuity of precise measurements of sea surface heights (i.e., altimetry)
- Continues DSCOVR
- Funds NOAA's data centers within NESDIS
- Sustains satellite operations
- Provides additional resources for the processing and distribution of environmental data from the Suomi-NPP Mission to be used for operational weather forecasting

NOAA Budget Trend – (FY 2007 to FY 2013)



NESDIS Satellite

Acquisitions, Operations, and Distribution- Current Programs Only
FY 2012-2017 Funding Profile ($M)



Data Source: FY 12: FY12 Conference Mark (ORF & PAC), FY 13-17: FY 13 OMB Submission profiles (PAC), FY 13-17: Included NASA 2010 Indices Inflationary Factors (ORF)

National Space Policy Guidance to NOAA

- National Space Policy Revised 6-28-10
- NOAA shall:
  - Transition mature research and development Earth observation satellite to long-term operations.
  - Use international partnerships to help sustain and enhance weather, climate, ocean and coastal observations from space.
  - Be responsible for the requirements, funding, acquisition, and operation of civil operational environmental satellites in support of weather forecasting, climate monitoring, ocean and coastal observations, space weather forecasting.
  - Primarily use NASA as the acquisition agent
  - Provide for the regulation and licensing of the operation of commercial sector remote sensing systems.

Strategic Guidance

NOAA Next Generation Strategic Plan, Dec. 2010

- Objective: Accurate and reliable data from sustained and integrated Earth observing systems. (NGSP p. 31)
  - NOAA will advance the development of next-generation satellites to serve future space-based observations and provide data continuity, launch and operate environmental observation satellites;
  - NOAA will assimilate and fully exploit the observations data from the next-generation of polar and geostationary satellites, space weather observing systems
  - NOAA will pre-plan the transition of research observing platforms to operations
  - NOAA will maintain strong partnerships with domestic and foreign partners through agreements to share expertise, instrumentation, data, data processing, and related costs.

General Observations

- NOAA/NESDIS leaders clearly stated a prioritized programmatic criteria for establishing an alternative space-based architecture (cost, schedule, level of performance)
- NOAA/NESDIS is commended for establishing an effective process to demonstrate the ability to prioritize needs for space-based observations.
- NESDIS developed options for future ground system architectures and alternative JPSS variants
- NESDIS has taken a big step toward defining an Enterprise Ground System
- The SATTF recognizes the significant challenge inherent in developing satellite architectural alternatives

Specific Observations: Requirements

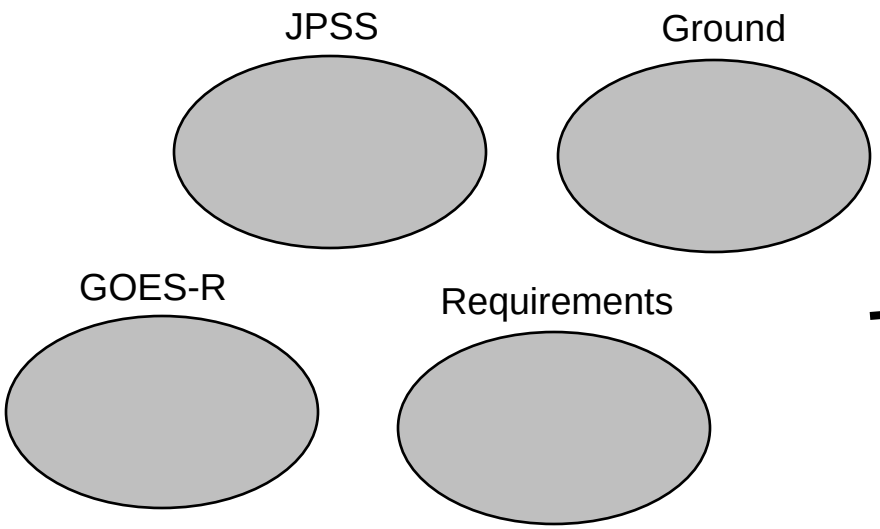
- Requirements prioritization is incomplete
  - What is most important; e.g.: Weather, Climate or Space Weather?
  - NOAA needs to establish a prioritized list of threshold space-based observational requirements
    - There is not an agreement on the baseline required for NOAA operational continuity for satellite observations to maintain high impact capability
    - What are the minimum capabilities required to sustain weather forecasting at today's level? Future capability?
  - Need capability of assessing impact to outcomes from removing specific observations
- Unclear linkages between the NOAA space-based observational requirements process and the external user community
- Unclear linkages between NOAA satellite requirements and dependence on National and international partners?

Specific Observations:
Systems Engineering

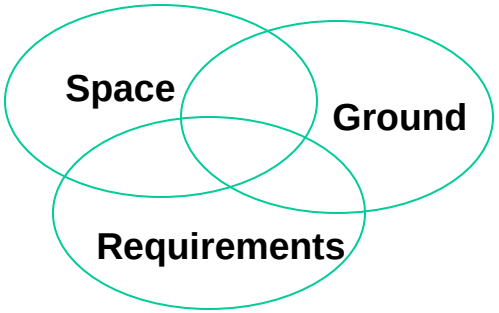
- Needs an integrated and comprehensive approach
  - Initial approach to satellite architecture design was fragmented (separate space and ground architecture studies) with no apparent link to a systems-level design nor clear link to a streamlined requirements process
- Needs an integrated approach to a space-based observational strategy, including teaming with national and international partners
  - Did not see a constellation management plan
- Needs a systems engineering function that addresses the link from goals, to architectures, to concepts of operation, to individual system development and finally to delivery of the integrated systems across the organization

Systems Engineering Approach

Current Planning



Needed



Specific Observations: Alternative Architectures

- A spectrum of alternative space-based architectures have not been examined to date
  - These include varying orbits, mixed instruments, hosted payloads, partners, and sensors on distributed satellites
  - DoD's Operationally Responsive Space office provides one model for rapid response, lower capability alternatives
- The Aerospace study did a good job of evaluating JPSS 2-based alternatives from the JPSS-1 baseline
  - The study used a budget-based approach
  - The study was a first step in looking at a distributed system; however, it was too narrow
  - Alternatives not based on the existing configuration may be more affordable and still meet the threshold requirements

Aerospace Concept Design Center Analysis

Cost Summary by Segment

Legend

C1: JPSS-1 baseline Payload Suite
C2: JPSS-1 Imagers only: VIIRS, A-DCS
C2a: JPSS-1 Imagers, VIIRS (Reduced), A-DCS
C2tech: JPSS-1 Imagers , New Technology
C2x: JPSS-1 Imagers, X-band comm vs. Ka
C3: JPSS-1 Sounders only: CrIS, ATMS
C4: Climate Sat: CERES, TSIS, OMPS
C5: CrIS - Design with payload: CrIS

	C1	C2	C2a	C2T	C2x	C3	C4	C5
OGC	$76	$38	$32	$38	$36	$31	$25	$21
Fee	$273	$136	$125	$138	$130	$113	$92	$78
Launch	$84	$77	$74	$77	$76	$76	$76	$75
Ground	$0	$0	$0	$0	$0	$0	$0	$0
Space	$2,254	$1,109	$937	$1,124	$1,061	$915	$739	$624

Specific Observations: Ground

- Commend NESDIS for conducting an analysis of alternatives and embarking on a study for the Enterprise Ground System approach
- Implementation of an enterprise approach to the ground system architecture has potential for cost savings because of the integrated systems approach
  - NOAA is now in the position to undertake this as they now have sole responsibility for JPSS, GOES-R and legacy systems
  - Support pursuit of near-term cost-savings activities, such as increased automation of the ground system
  - Implementing the Enterprise Ground System approach in a manner that will result in cost savings will be challenging
- The relationship between the ground and space segment architectures is unclear
- Ultimate implementation of the enterprise ground system is dependent upon clear expression of the long-term vision and required next steps

Specific Observations:
Policy

- Severe budget cuts could dictate less capable satellites, leading to major policy implications, such as:
  - Meeting National Space Policy responsibility
  - Impacts on international commitments
  - Impact on non-NOAA users
- “National” relationship is not clear in NOAA requirements.
- Alternative architectures could lead to International Traffic in Arms Regulations (ITAR) challenges
- NOAA management commitment required to pursue alternative architectures, given potential hard choices and their repercussions

Specific Observations:
Budget

- NOAA budget for currently programmed space systems may be unsustainable in today's fiscal environment
- Given the foreseeable future funding profile, NOAA will be challenged to deliver the same level of capability as today
- NOAA needs to be prepared for budget shortfalls given uncertainty in fiscal future
- JPSS-2 alternative architectures provides an opportunity for minimizing the cuts in capability while responding to a budget shortfall
- Reliability of international partners, given developing economic conditions may falter requiring risk management

Specific Observations:
Risk

- Moving towards an alternative architecture, such as a distributed system, involves both risks and benefits
- Alternative architectures require a tailored risk management plan that defines levels of risk for different types of missions
- Operational continuity and constellation reconstitution continues to be a significant risk
- No plan has been seen that mitigates gap risks nor deals with tailored risk management
- A distributed system may help mitigate budget risk
- Quick Reaction capability can help mitigate catastrophic failures, relatively quickly and at managed cost

Specific Observations:
Satellite Enterprise Top Risks

- The SATTF take note of NOAA's characterization of satellite enterprise risks
- Two risks are noted as "High Likelihood" and "High Consequence":
  - Environmental Observations Continuity
  - Budget Availability and Stability
- The SATTF also notes (and questions) Risk Item #5, "Space System Architectural Robustness," which is shown as both Medium Likelihood and Medium Consequence

Recommendations - 1

- Establish a prioritized list of threshold space-based observational requirements
- Create a Chief Systems Engineering function
  - Needed to address the end-to-end link from goals, to architectures, to concepts of operation, to individual system development and finally to delivery of the integrated systems across the organization
- Assess affordable architectures that include large multi-sensor satellite systems and alternative distributed systems, or a hybrid.
  - DoD's Operationally Responsive Space office provides one model for rapid response, lower capability alternatives, especially for observational reconstitution in the case of single instrument failures
  - Building alternative architectures is not easy and requires organizational commitment and budget and programmatic flexibility

Recommendations - 2

- Develop a tailored overarching risk-management plan consistent with alternative architectural decisions
- Develop a cost-capped implementation plan for a NOAA Enterprise Ground System building on recently completed study and analysis of alternatives
- Develop an integrated master schedule addressing the entire satellite system architecture
- Coordinate with stakeholders, including National and International stakeholders, with respect to prioritization of requirements and architectural tradeoffs.

Way Forward Schedule
SATTF Next Steps

- Update the “Preliminary Findings and Observations” based on:
  - SAB comments: hold telecon – July/August 2012
  - Continued dialog with NOAA
- Face-to-face meeting – September 2012
  - Receive updates from NOAA
  - Draft written report
- Release draft report for public comment – Oct 2012
- Final Report to SAB – November 2012


NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Questions?

Backup

SATTF Terms of Reference

"NOAA's Satellite and Information Service (NESDIS) is facing unprecedented budget challenges with substantial appropriation shortfalls and future budget outlooks that are inconsistent with current plans. These challenges are threatening service gaps in core services, loss of important remote sensing resources (e.g., the QuikSCAT ocean vector winds mission) and impairment of NOAA's ability to take full advantage of new NASA and international satellite resources."

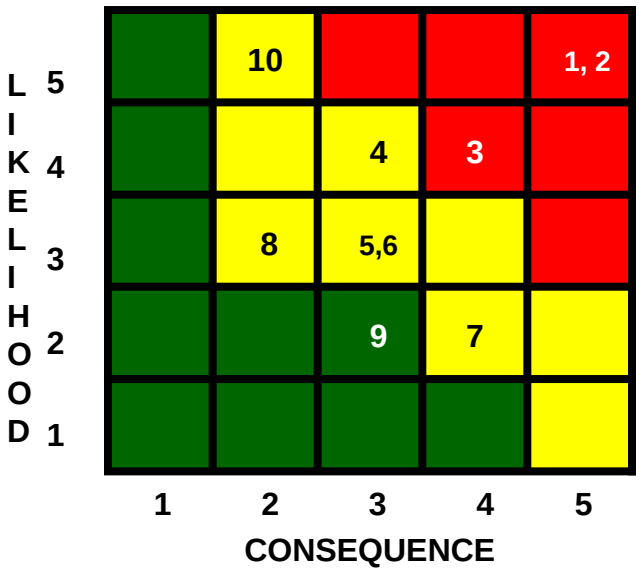
SATTF TOR, p. 1

NESDIS FY 2013 BUDGET: $2,041.4 million

- FY 2013 Budget provides $2,041.4M for NESDIS, a $163.6M (8.8%) increase over the FY 2012 Spend Plan. Includes $162.0M for Program Changes and $1.5M for Inflationary adjustments.
- This request supports the priorities of the Administration, Department of Commerce and NOAA. In meeting these priorities, the FY 2013 President's Budget:
  - Ensures the continued development of the Joint Polar Satellite System (JPSS), NOAA's next generation polar satellite.
  - Provides the necessary resources for the Geostationary Operational Environmental Satellite R-Series to maintain an October 2015 launch date for GOES-R.
  - Continues the development of the DSCOVR space weather satellite which will provide warnings of solar storms that could affect critical infrastructure and human health.

Satellite Enterprise Top Risks

April 12, 2011



Criticality	L & C Trend	Approach
High	↓ Improving	M - Mitigate
Med	↑ Worsening	W - Watch
Low	→ Unchanged	A - Accept
	NEW	R - Research

Rank	Trend	Title	Handling Strategy	LIKELY	Consequence
1	↑	Environmental Observations Continuity	M	5	5
2	↑	Budget Availability & Stability	M	5	5
3	↑	Launch Services	R	4	4
4	↑	Industrial Base	W	4	3
5	→	Space System Architecture Robustness	R	3	3
6	→	Spectrum Management	R/M	3	3
7	↓	Operational Readiness	M	2	4
8	→	Ground System Architecture Robustness	W	3	2
9	↑	International Partnerships	M	2	3
10	→	NOAA Workforce	M	5	2

NESDIS Supplementary Input

to

SATTF Preliminary Observations

Linkage to External User Community

Supplementary input for: ***Specific Observations: Requirements***

- Unclear linkages between the NOAA space-based observational requirements process and the external user community

Supplementary input for: ***Specific Observations: Policy***

- "National" relationship is not clear in NOAA requirements.

- NOAA's Next Generation Strategic Plan (http://www.ppi.noaa.gov/ngsp/)
  - Incorporate top-level NOAA goals
    - Four goals: Weather, Climate, Oceans & Coasts
    - Societal outcomes are derived from NOAA goals and assessed by NOAA line offices
    - Satellite requirements derive from other NOAA line offices, each of whom has established relationships with the external user community. NESDIS does not have a generalized external liaison role, to minimize confusion with responsible NOAA line office.
    - NOAA's Program Planning and Integration office (PPI) leads organization wide planning and priority setting, based on priorities delegated from leadership.
- The NOAA Observing System Council (NOSC) requirements process is focused on documenting and validating NOAA's platform-independent observational requirements which reference external partners for programs
- Office of the Federal Coordinator for Meteorology (OFCM, administratively part of NOAA) – Coordinates all federal interests related to weather
- Office of Science and Technology Policy (OSTP)
  - National Earth Observation (NEO) Task Force assessing government-wide missions and impacts of observing systems
  - NOAA/TPIO is a key participant

Interdependence with National/International Partners

Strategy is to leverage international partnership – with a force multiplier effect – for partners to capitalize on each others strengths

Supplementary input for: **Specific Observations: Requirements**
- Unclear linkages between NOAA satellite requirements and dependence on National and international partners

Supplementary input for: **Specific Observations: Systems Engineering**
- Needs an integrated approach to a space-based observational strategy, including teaming with national and international partners
  - Did not see a constellation management plan

- Bilateral and Multilateral Agreements (related to satellites)
  - NOAA has many International bilateral agreements
  - NOAA participates in many International multilateral agreements
- Coordination Group for Meteorological Satellites (CGMS)
  - Harmonizes meteorological satellite mission parameters (such as orbits, sensors, data formats and downlink frequencies).
  - Identifies potential gaps and advances contingency measures
  - Is engaging development of Architecture for Climate Monitoring from Space with CEOS, WMO, and others
- Committee on Earth Observation Satellites (CEOS)
  - International partnerships addressing key observational gaps
  - Bridges multiple GEO Societal Benefit Areas
  - CEOS has seven “Virtual Constellations” providing synergistic observations which are more reliable and comprehensive than individual contributions
- Group on Earth Observations (GEO)
  - Coordinates societal-benefit-level needs for Earth observations and related analyses
  - U.S. is GEO Co-chair and NOAA is an active participant

Long-term Architecture

Spectrum of space-based architectures

Supplementary input for: **Specific Observations: Alternative Architectures**

"A spectrum of alternative space-based architectures have not been examined to date

- These include varying orbits, mixed instruments, hosted payloads, partners, and sensors on distributed satellites"

- NOAA has done many targeted technology studies in recent years
- Historically, NOAA's space-based architecture has been GOES & POES
- A study from the National Research Council (NRC) is being considered that will take a fresh and comprehensive look at NOAA's future satellite architecture
  - A long-term orientation, sensitive to but not constrained by current austerity
  - To assess missions as delegated by the National Space Policy
  - To consider ground infrastructure and data processing
  - To include: varying orbits, mixed instruments, hosted payloads, partners, and sensors on distributed satellites
  - Consider NOAA/NESDIS actions needed to maintain the architecture
- The **NOAA Satellite Observations Continuity Survey** provides an assessment of NOAA's baseline current, planned and future satellite programs. The satellite survey also includes a gaps assessment and risk mitigation analysis with recommended solutions (ie: entering into International Partnerships, seeking Commercial Partnering opportunities) for both the Legacy (Geostationary, Polar) and the Continuity (Radar Altimetry, Solar Wind, High Fidelity Atmospheric) Programs.