NOAA Update

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Agenda

- Satellites in support of NOAA's mission
- NESDIS budget
- Status of NOAA's space architecture
- NOAA Commercial Weather Data Pilot
- NOAA's future architecture planning
- NAS activity
  - ESAS Decadal Survey
  - Weather Act Section 301 study and Weather Decadal

Satellites in support of NOAA's mission

Supporting NOAA's Mission

NOAA is a science-based services agency engaged with the entire Earth system science enterprise.

NOAA's Top Four Priorities:

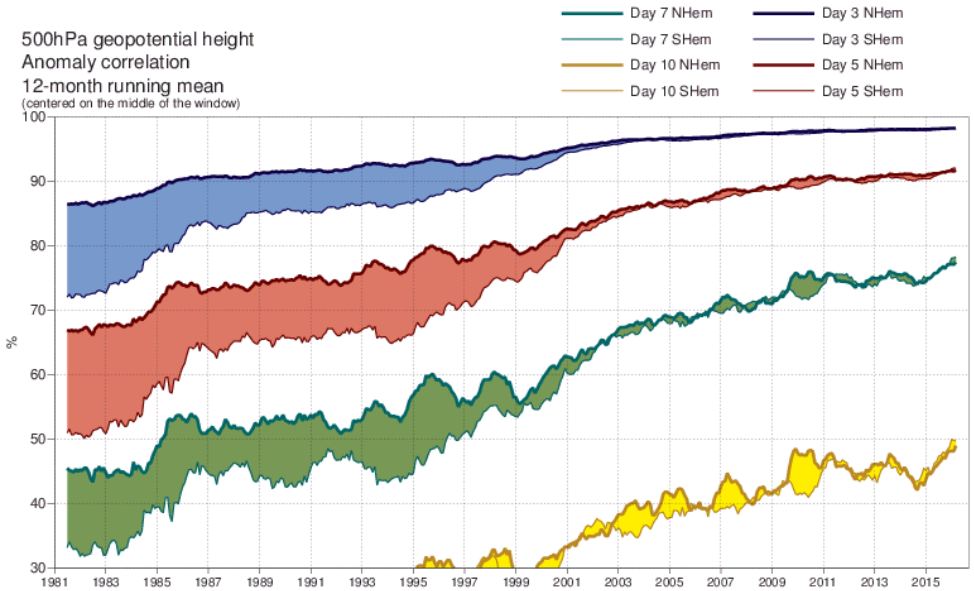
1. To provide information and services to make communities more resilient
2. To evolve the National Weather Service
3. To invest in observational infrastructure *50% of NOAA's Budget*
4. To achieve organizational excellence

NOAA/NESDIS Mission: Lives and Livelihoods

Significant Improvements in 3-7 day Weather forecasts

Improved NRT severe storm warnings & alerts

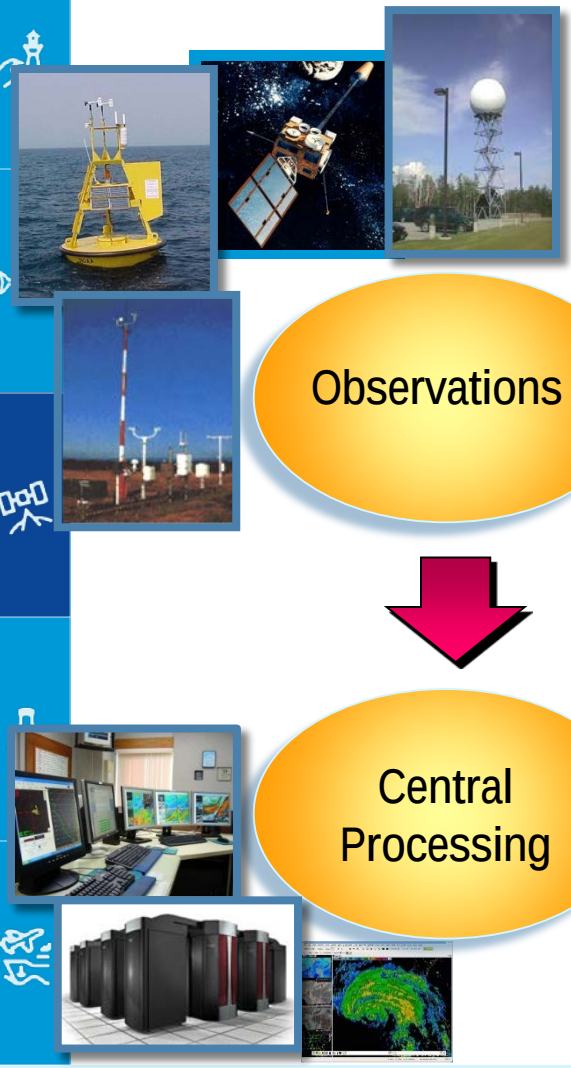
- 20% increase in hurricane track and intensity forecasts from 2010-2015



Companion Satellite Services

- SARSAT: >30,000 lives saved worldwide and >7,000 saved in the USA since the program start
- Argos Data Collection Services (A-DCS): 14,000 environmental platforms, almost 50% used by NOAA

The Continuous Cycle of Observations to Decisions and Back



NOAA NESDIS Budget

FY 2018 Omnibus: NESDIS Highlights

- NESDIS top line: $2.1B

- JPSS: $775.8M
- PFO: $419M
- GOES-R: $518.5M
- Space Weather Follow-on: $8.5M
- COSMIC-2/GNSS-RO: $6.1M
- CWDP: $6M

FY 2019 President's Budget: NESDIS Highlights

- NESDIS top line: $1.64B

- JPSS and PFO (combined into Polar Weather Satellites PPA): $878M (JPSS: $548M, PFO: $330M)
- GOES-R: $408.4M
- Space Weather Follow-on: $10M
- COSMIC-2/GNSS-RO: $5.9M
- CWDP: $3M

Status of NOAA's Space Architecture

NOAA's Flagship Satellites

- NOAA uses satellites to gather data to monitor and understand our dynamic planet
- The NOAA Satellite and Information Service (NESDIS) provides timely access to global environmental data from satellites and other sources to monitor and understand our dynamic Earth. We manage the Nation's operational environmental satellites and deliver data and information services such as Earth system monitoring and official assessments of the environment

JPSS*	GOES-R Series*
Provides Global coverage twice daily	Earth imager for enhanced weather, ocean, land and hazard products
Atmospheric temperature and moisture observations	Rapid coverage of global and focused areas
Tracks the health of the ozone layer and measures ozone in the atmosphere	Lightening Mapper
Night time imagery for polar viewing	Measures the space environment magnetic field

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NOAA's Satellite Program Status

GOES-R Series

- GOES-16 now operational as GOES-East
- GOES-S launched March 1, 2018
  - Now GOES-17, will become GOES-West after checkout later this year
- GOES-T KDP-D review completed

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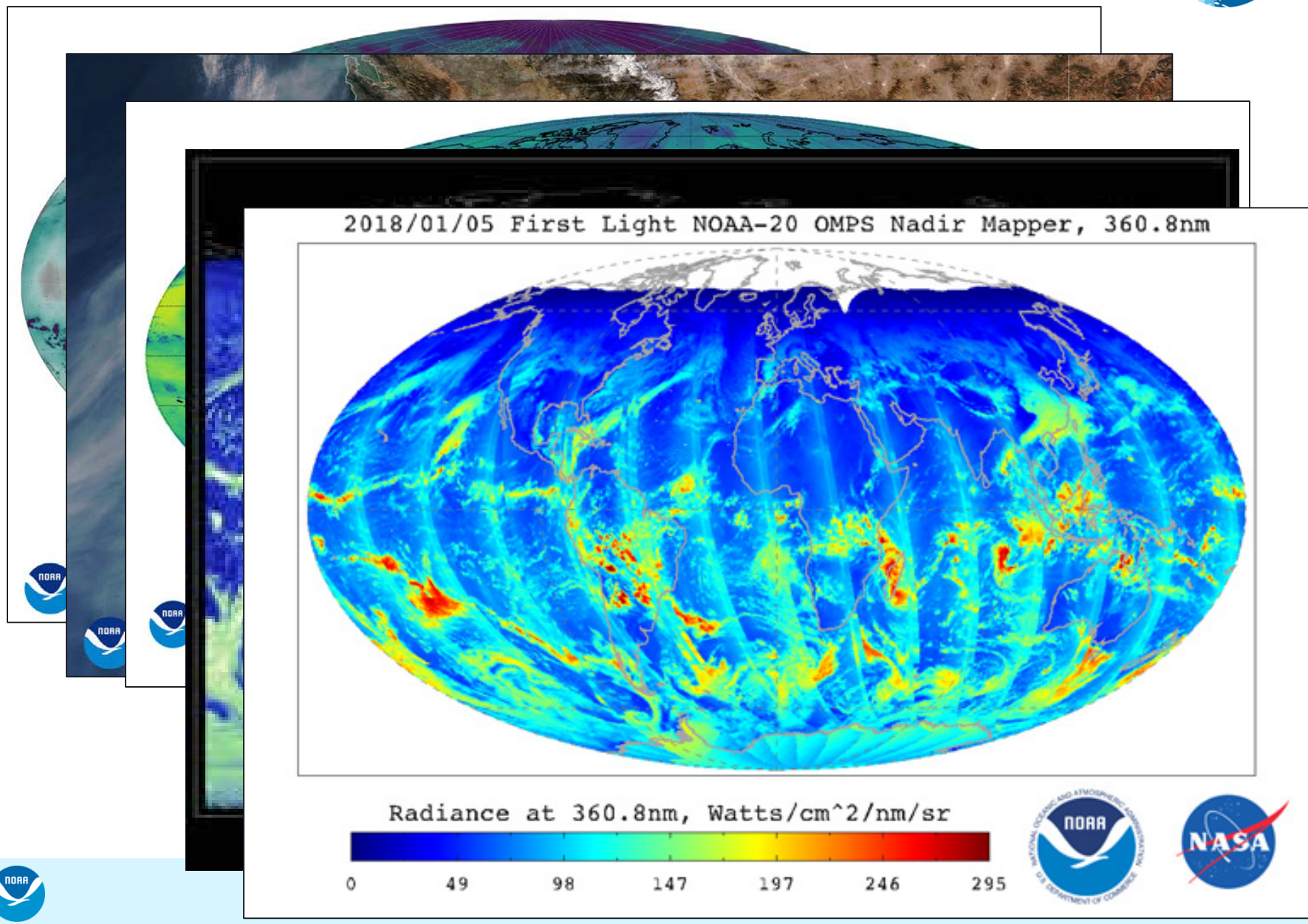
NOAA's Satellite Program Status

JPSS

- JPSS-1/NOAA-20:
  - Launched Nov 18, 2017
  - Satellite commissioning activities are progressing as planned
  - All instruments have returned first images
- JPSS-2:
  - Spacecraft Critical Design Review complete
  - NASA's RBI instrument will no longer be hosted on JPSS-2

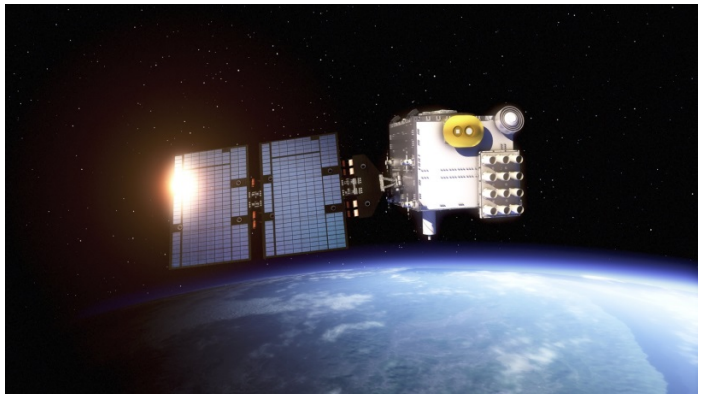
NOAA-20 “First Light” Images

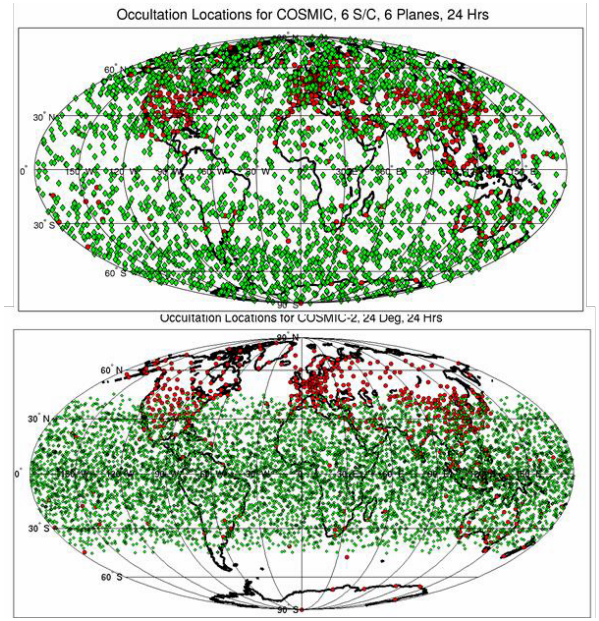


NOAA's Satellite Program Status

COSMIC-2

- COSMIC-2A will be launched this year (no earlier than June 13, 2018) by the Air Force on a Falcon Heavy
- The joint NOAA-Taiwan Executive Steering Committee decided not to exercise the option for COSMIC-2B
  - NOAA is examining ingest of RO data from Korea's Kompsat-5 and Spain's PAZ satellites





FORMOSAT-3 / COSMIC-1 6 spacecraft (72 degree)

FORMOSAT-7 / COSMIC-2A 6 spacecraft (24 degree)

NOAA’s Commercial Weather Data Pilot

Recent Guidance

Weather Research and Forecasting Innovation Act of 2017 discusses several NOAA commercial space activities

- Develop a strategy to enable the procurement of quality commercial weather data
- Pilot Program
  - Publish standards for space-based commercial weather data
  - Within 90 days, enter into at least one pilot contract with one or more private sector entities capable of providing data that meet published standards
  - Within 3 years, assess data's ability to meet standards and its impact to weather models
  - $6M per year authorized FY2017-FY2020
- If pilot demonstrates data can meet published standards, where appropriate, cost-effective, and feasible, obtain commercial weather data from private sector providers
- Continue to meet international meteorological agreements, including WMO Resolution 40
- Avoid unnecessary duplication between public and private sources of data

FY 2018 Omnibus: $6M for CWDP
FY 2019 President's Budget: $3M for CWDP

CWDP Round 1

- CWDP initiated with $3M in FY 2016
- NOAA identified radio occultation (RO) as initial data set for evaluation
- Roles:
  - NCAR/UCAR performing data processing and initial quality evaluation
  - Joint Center for Satellite Data Assimilation performing data validation and NWP model impact assessment
- Requirements set to enable maximum participation:
  - Requested 3-6 months of data in specified format
  - No minimum requirement for occultations per day, distribution of occultations around the globe, or secure real time data delivery
- Round 1 activities addressed processes for contract writing and initial evaluation
  - Round 1 does not address NESDIS processes for IT security, data rights and distribution, real time data ingest

CWDP Round 2

Overview:

CWDP Round 2 seeks to: extend the purchase of RO data from commercial vendors; perform a more comprehensive assessment of the value of commercial RO data; and develop NOAA systems readiness for future purchases of operational weather data from commercial sources.

This progress toward an operational data purchase is seen in three aspects of Round 2:

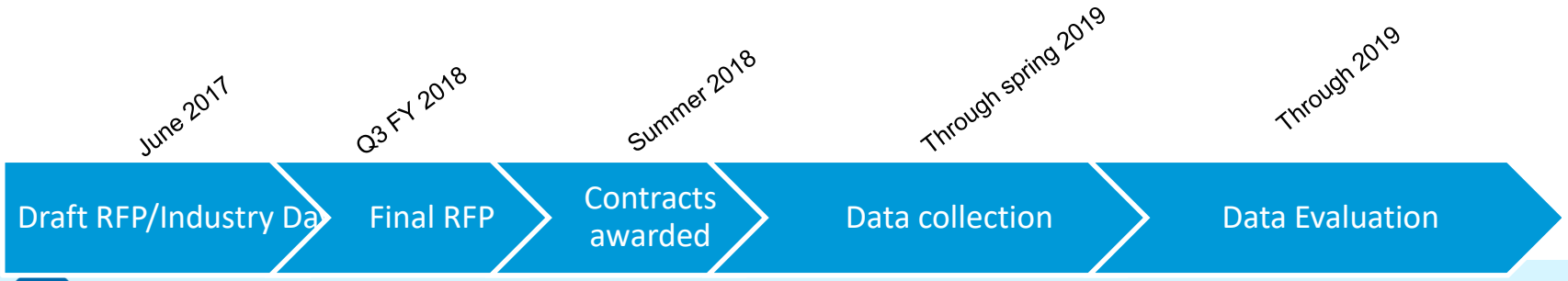
- Comprehensiveness of data requested and performance of seasonal impact assessment
- Increased emphasis on vendor validation approaches, a key enabler for level 2+ data purchase
- Operational features of data requested such as security, timeliness, and availability

Commercial Data Purchase Procedure	Round 1	Round 2
Contract Writing	X	X
Data quality assessment	X	X
Secure data ingest		X
Numerical weather prediction impact assessment		X
Data rights negotiation		X
Data archive		X
Operational attributes		X

CWDP Round 2

Round 2 budget and schedule:

- NOAA will use FY 2016 funds recouped from Round 1 contract modifications and FY 2017 funds ($5M) to execute Round 2
- Round 2 draft RFP released in May 2017
- Industry Day held in June 2017
- Based on the results of the June Industry Day discussions and additional market research, NOAA has determined that releasing an RFP in FY2017 is not in the best interests of the Government or the CWDP.
- NOAA anticipates releasing the Round 2 RFP early third quarter of FY2018.
- NOAA continues to pursue internal system readiness for future purchases of operational weather data.



Key Challenges

Key challenges will continue to emerge, including those below, as NOAA continues to engage an evolving commercial sector.

- Price point stability/volatility, competition, and market demands
- Data licensing and tension between commercial interests at different points in the value chain
- Impact to partnerships, data sharing arrangements, and R&D
- Operational stability of data and user readiness
- Interagency coordination
- Validation lifecycle

NOAA’s future architecture planning

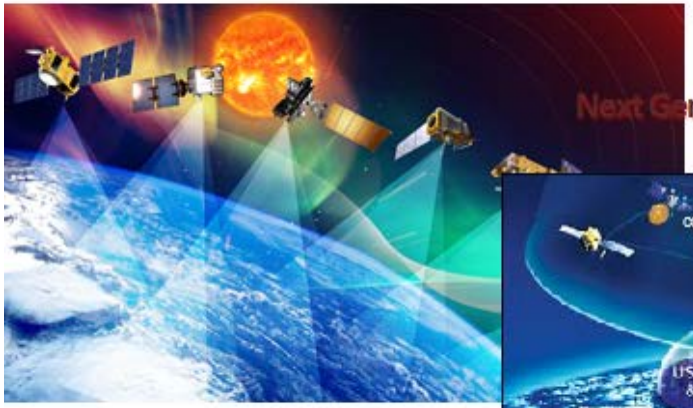
Dynamic Global Space-Based Observing System

Architecture of the Future

Develop a space-based observing system enterprise that is flexible, responsive to evolving technologies, and economically sustainable.

--FY15 NOAA Annual Guidance

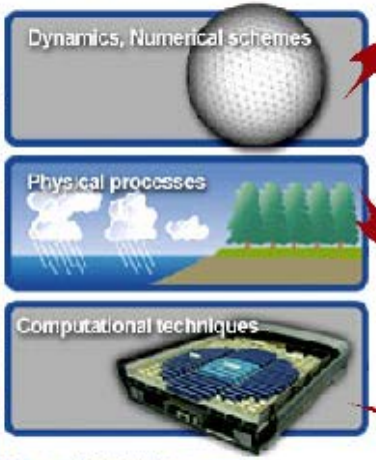
Global Earth Observing Satellite System

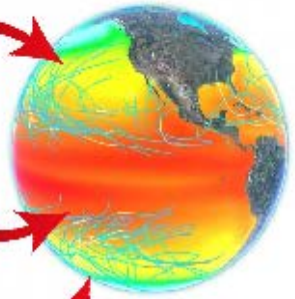


NESDIS & Satellite Partners

Next Generation Integrated & Adap Operations

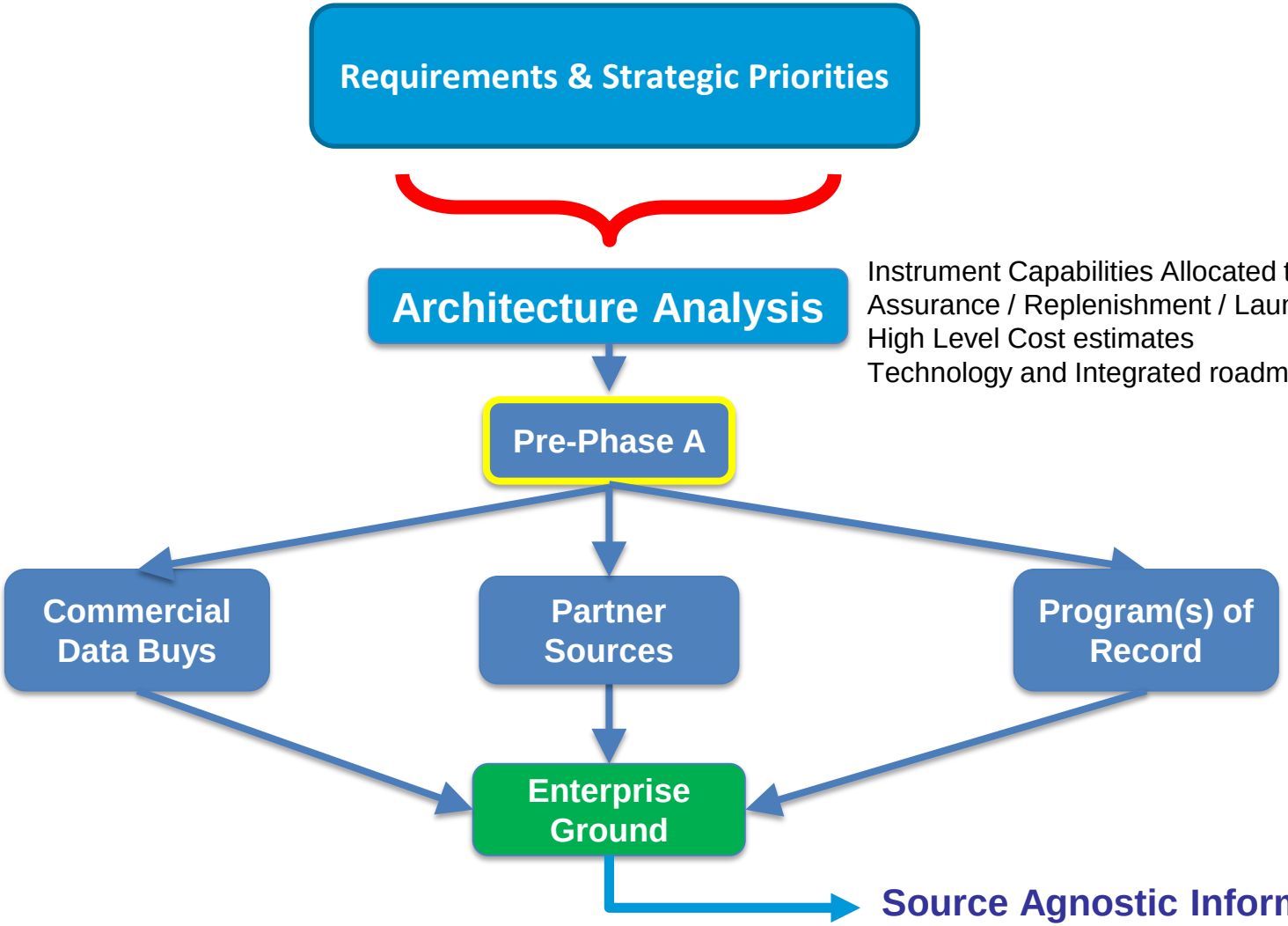
Integrated & Assimilated Operational Data Flow





NOAA NWS/OAR & NESDIS & Partners

NOAA's Future Space Architecture Planning



NAS Activities

ESAS 2017 Decadal Survey

- NOAA is grateful for the work of the Steering Committee and Panels to produce this report
- Many of the recommendations in the report for both NASA and NOAA will benefit NOAA's operational mission
  - NOAA will continue to work with NASA on a framework that will leverage each agencies' strengths to benefit both agencies' missions
  - The "Incubator" and "Venture Continuity" lines recommended for NASA have potential to benefit NOAA
  - NOAA is interested in many of the observation objectives recommended to NASA
  - NOAA appreciates the need to continue to work with our international partners and the commercial sector to make use of their data and capabilities
- NOAA is working to synthesize our architecture analysis with the Decadal results for consistency and areas where the Decadal recommendations can inform examination of our areas of interest going forward

Weather Act Section 301 study

(A) IN GENERAL.—Under an agreement between the Under Secretary and the National Academy of Sciences under this subsection, the National Academy of Sciences shall conduct a study on matters concerning future satellite data needs.

(B) ELEMENTS.—In conducting the study under subparagraph (A), the National Academy of Sciences shall—

(i) develop recommendations on how to make the data portfolio of the Administration more robust and cost-effective;

(ii) assess the costs and benefits of moving toward a constellation of many small satellites, standardizing satellite bus design, relying more on the purchasing of data, or acquiring data from other sources or methods;

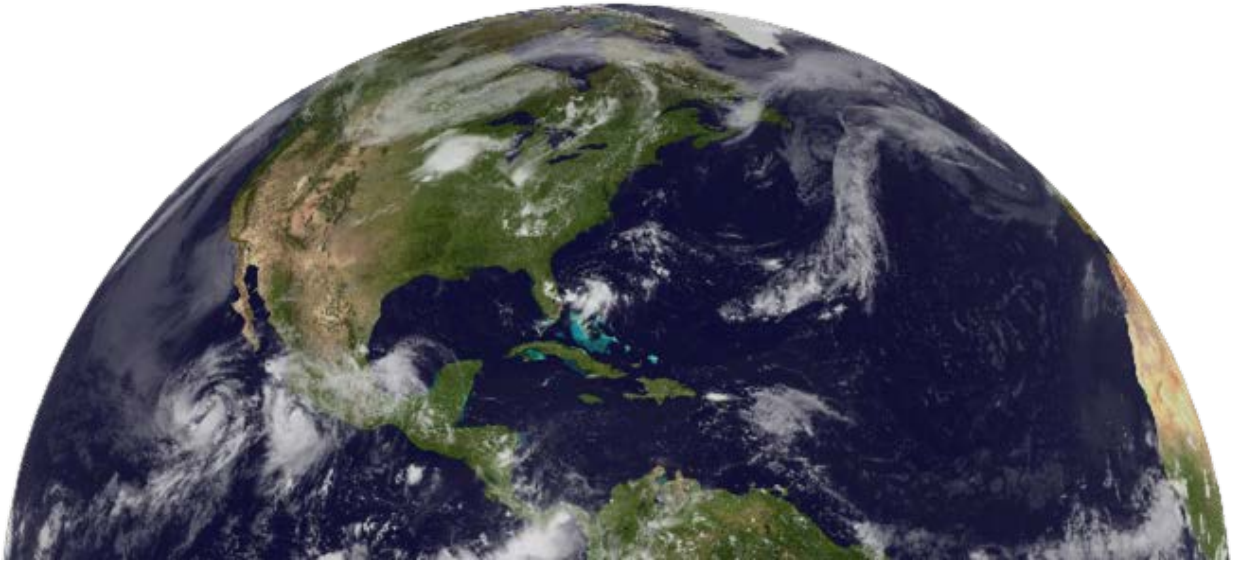
(iii) identify the environmental observations that are essential to the performance of weather models, based on an assessment of Federal, academic, and private sector weather research, and the cost of obtaining the environmental data;

(iv) identify environmental observations that improve the quality of operational and research weather models in effect on the day before the date of enactment of this Act;

(v) identify and prioritize new environmental observations that could contribute to existing and future weather models; and

(vi) develop recommendations on a portfolio of environmental observations that balances essential, quality-improving, and new data, private and nonprivate sources, and space-based and Earth-based sources.

Thank you

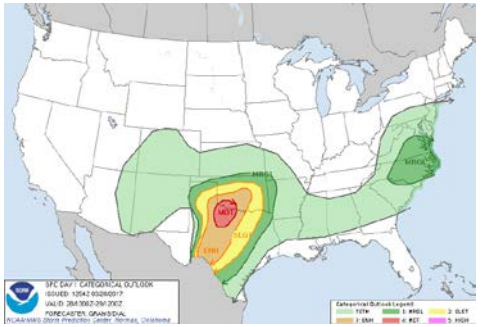


Round 1/Round 2 Spec Comparison

Requirement	Round #1 (RFQ)	Round #2 (Draft RFP)
Data latency	Minimum monthly deliveries required.	Minimum weekly deliveries required; options for vendors to demonstrate low-latency downlink and processing.
Data Rights and Sharing	Only within entities performing specific CWDP analysis.	Rights for non-operational analysis and retention, and sharing with U.S. agencies and international partners.
Radio Occultation data	No minimum amount required. Specific periods of consecutive data, open loop required.	$\geq$500 RO per 24 hrs, up to 6 months total consecutive data. $\geq$1 RO covering $\geq$90% of all 500km² surface areas, repeated every 15 days. [TBR]
Ionospheric data	Not requested.	POD data able to derive Total Electron Content (TEC); options for electron density, S4 and σΦ derived product files.
Concurrent RO/POD/Attitude data	Attitude data required, and closed-loop POD corresponding to RO dataset.	POD and attitude data concurrent with RO data required; minimum 50% POD duty-cycle and 60 minute arcs required.
GNSS Tracking data	No requirement on tracking data quality. Dual-frequency required.	Requires 4 GNSS satellites in Field of View during POD, 95% of the time.
Derived bending angles and profiles	Not requested.	Requested as an option. Onboard clock steering information required, to ensure accurate angle/profile derivation.

NSOSA Study Background

- **NOAA Satellite Observing Systems Architecture (NSOSA) study is examining the space segment architecture decisions for space systems post GOES-R/S/T/U and JPSS-1/2/3/4**
  - *Which observation functions should be allocated to which orbits?*
  - *Should we retain the legacy architecture or seek major change?*
  - *Which observation functions should be improved?*
- **Primarily addressing NOAA operational needs**
  - *Observations that result in warnings, watches, baseline weather and space weather forecasts, and ocean or fisheries actions*



- **Scoped to NOAA systems, with a backdrop of partner contributions and relationships**
- **Intended to result in Pre-Phase-A program activities**

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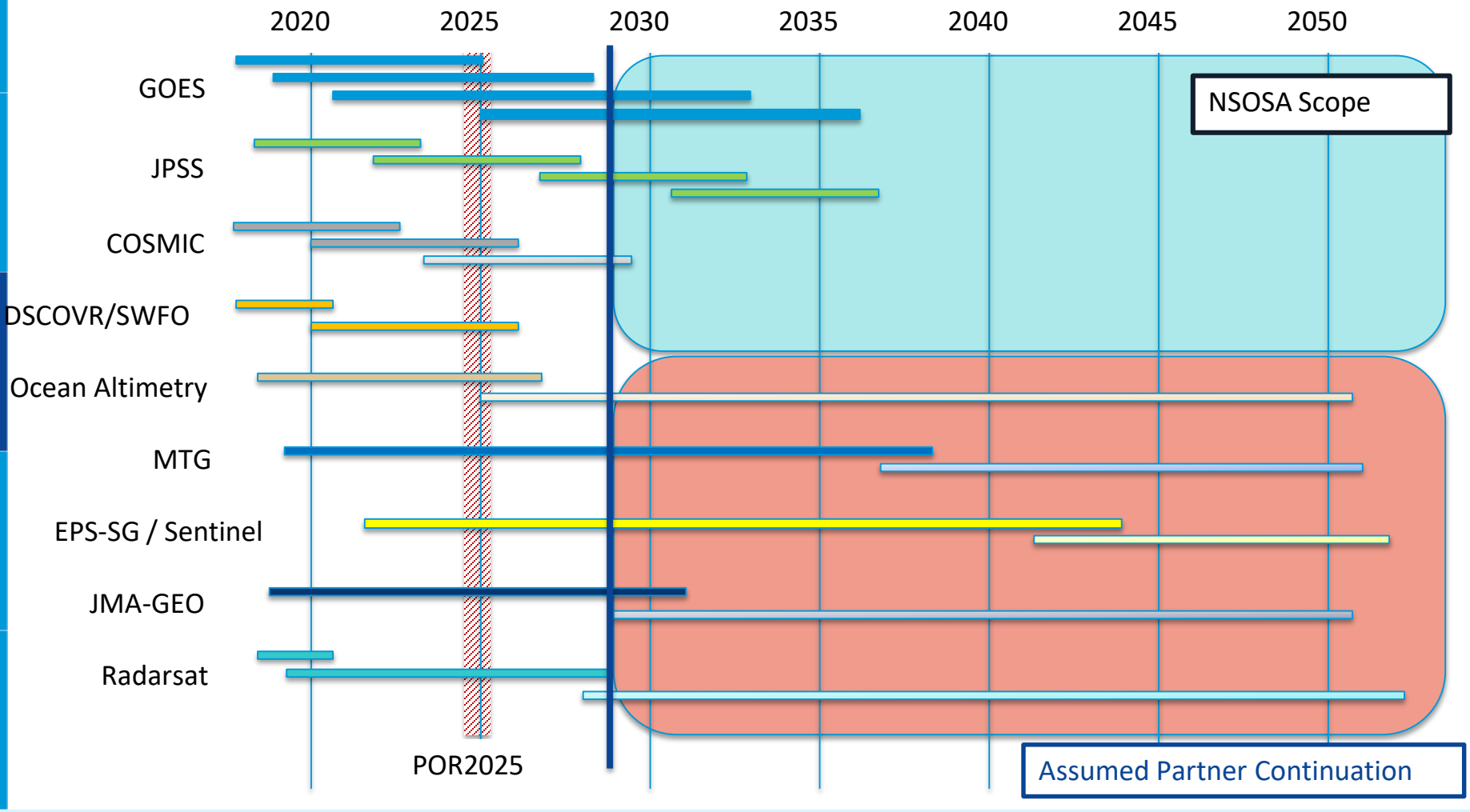
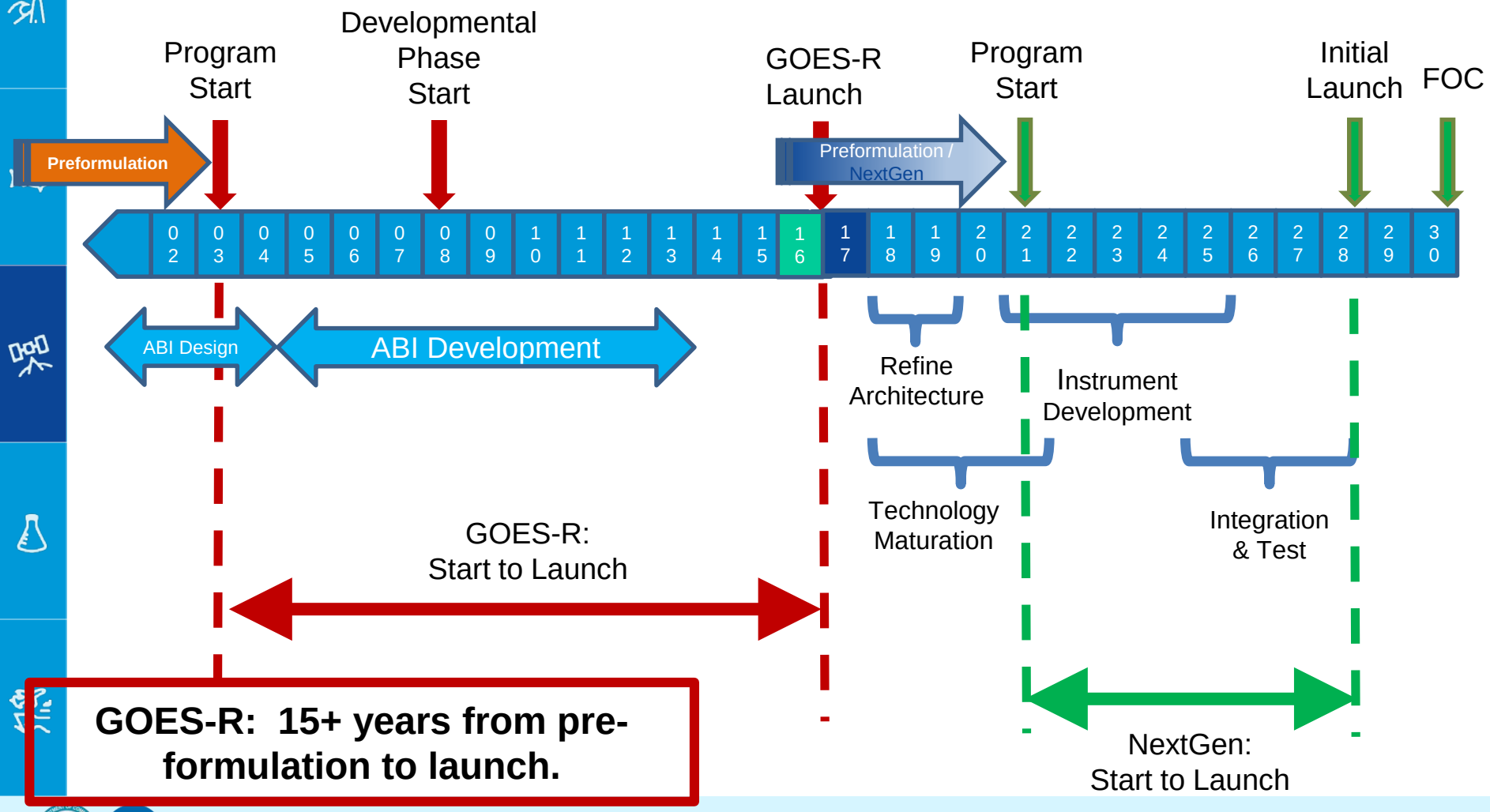
Baseline and Timing



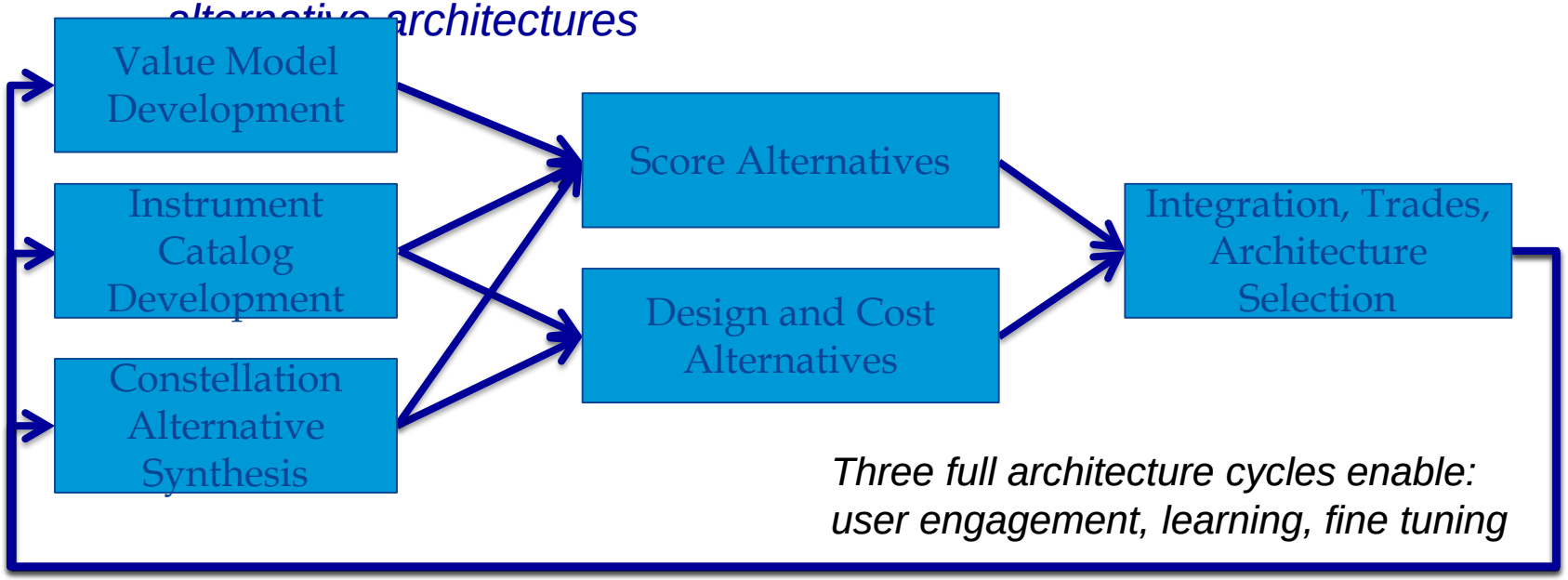
Why Start Now?



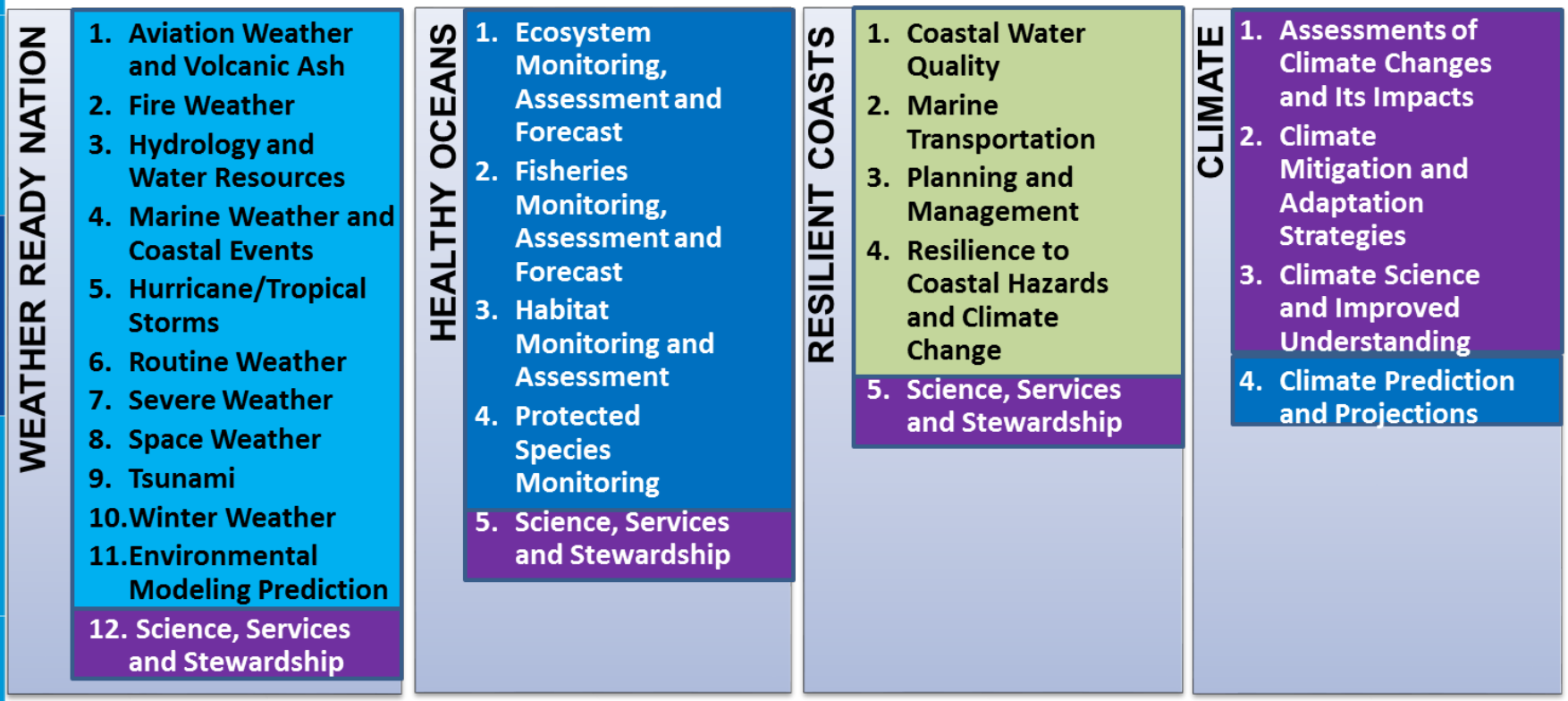
GOES-R: 15+ years from pre-formulation to launch.

NSOSA Study Approach

- **Study is organized into 3 major lines of effort built around 3 major design cycles**
  - *Three Lines: Value Model, Instrument Catalog, Constellation Synthesis*
  - *Each design cycle does complete, end-to-end designs of multiple alternative architectures*



Observation Requirements are Driven by NOAA Mission Service Areas



NSOSA Study Explored a Wide Range of Architecture Options

- ***Examined nearly 100 observing system architecture options, considering the anticipated environment in the 2030 timeframe***
  - *Developed a catalog of nearly 100 instrument concepts based on projected capabilities in the 2030 time frame*
  - *Observing Points – LEO, MEO, GEO, tundra, Deep space Lagrange point (L1, L5)*
  - *Flight configurations—large satellites, small satellites, disaggregated architectures, hosted payloads*
  - *Commercial technology, data, and services based on input from industry*
  - *Planned international partner contributions*

- ***The Options considered different balances of:***
  - *Sustainable cost*
  - *Mission benefit or system performance*
  - *Risk (acquisition, launch failure, market/vendor uncertainty)*

The study considers options from expanding legacy systems to radical alternatives

Example Future Constellation