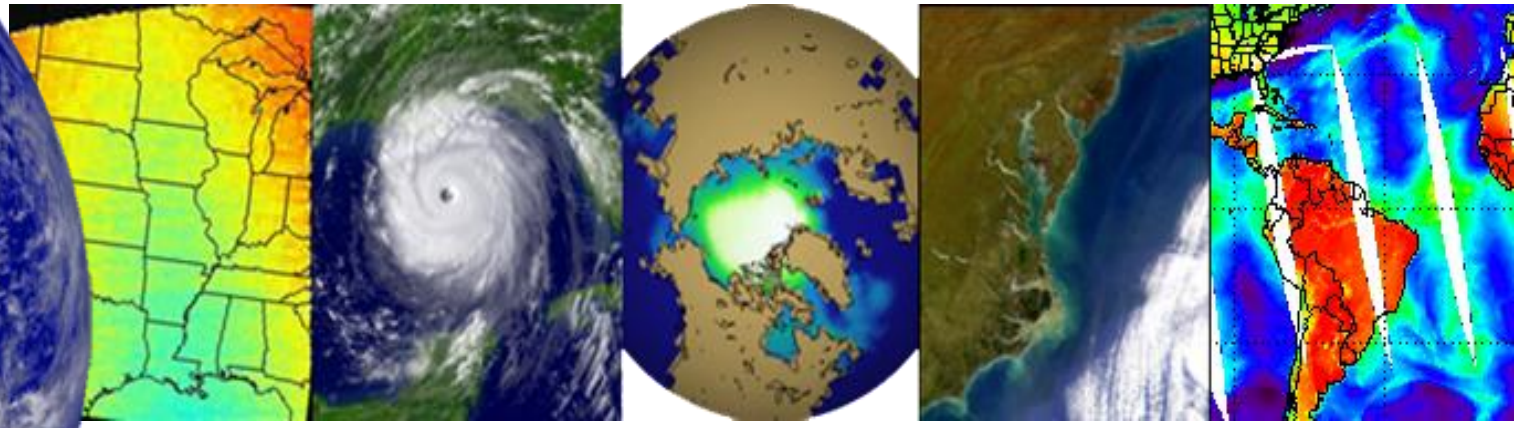
Scientific Guidance & Performance Assessment Tools to Support NOAA's Next-Gen Space Architecture Effort

(In pre-formulation and Formulation Phases)

Presented by Sid Boukabara
NESDIS Center for Satellite Applications
Center for Satellite Applications and Research
College Park, Maryland

Contributions by:
F. Gallagher (SAT co-chair), ASPEN and SAT teams (many to list)



Agenda

1. **Background: Importance of a Comprehensive Assessment**
2. **Systems performance Assessment Team (SAT)**
3. **SAT/ASPEN Tool:**
   Advanced Systems Performance Evaluation for NOAA
4. **Test Cases of ASPEN-Based Assessments (LEO and GEO)**
5. **Next Steps**

Background

- **NOAA/NESDIS in the pre-formulation phase of Next-Gen space architecture (LEO, GEO-XO: for Post JPSS and GOES) and the SpxW.**

- **Need Comprehensive Assessment (all users, all technology options):**
  - All applications Meteorology,Oceanography, Hydrology and Space Weather.
  - Comparative Assessment of all options (vs. single sensor impact assessment)
  - Technical and scientific (performance) factors are important. But so are programmatic, engineering, strategic factors: techn. maturity, cost, launch, etc
  - Value should be viewed from overall constellation perspective: ideally account for not only LEO, GEO, but also what's available from other sources (National, international, commercial Partners, ground & space).

- **Advocacy is important (to capture all arguments), but for the purpose of optimizing the value of the space constellation as a whole, rigorous, independent assessment should drive recommendations**

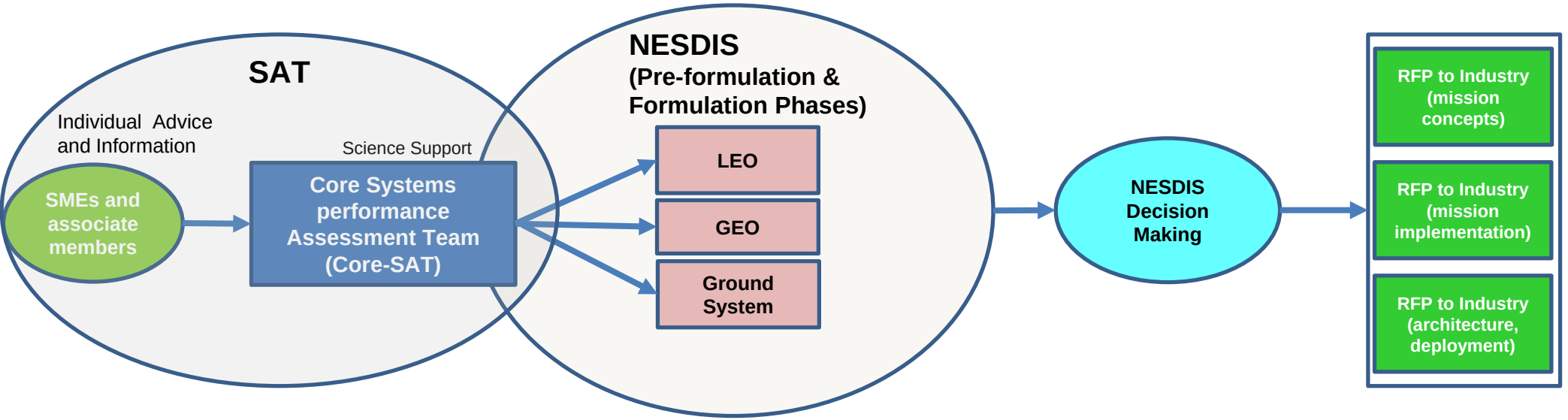
- **This led to: (1) SAT Establishment and (2) Development of ASPEN tool**

Agenda

1. **Background: Importance of a Comprehensive Assessment**
2. **Systems performance Assessment Team (SAT)**
3. **SAT/ASPEN Tool:**
   Advanced Systems Performance Evaluation for NOAA
4. **Test Cases of ASPEN-Based Assessments (LEO and GEO)**
5. **Next Steps**

Systems performance Assessment Team (SAT)

- SAT was established (in May 2019, ToR signed in May 2020) to provide authoritative scientific support and performance assessment
- SAT must have wide science expertise to be able to support different sensors categories: MW, IR, UV, Passive, Active, Lightning, SpWx,...
- 'A' is for Assessment, not Advocacy: Independent, fact-focused, Comprehensive, and 'Comparative' evaluation of value are all important for SAT

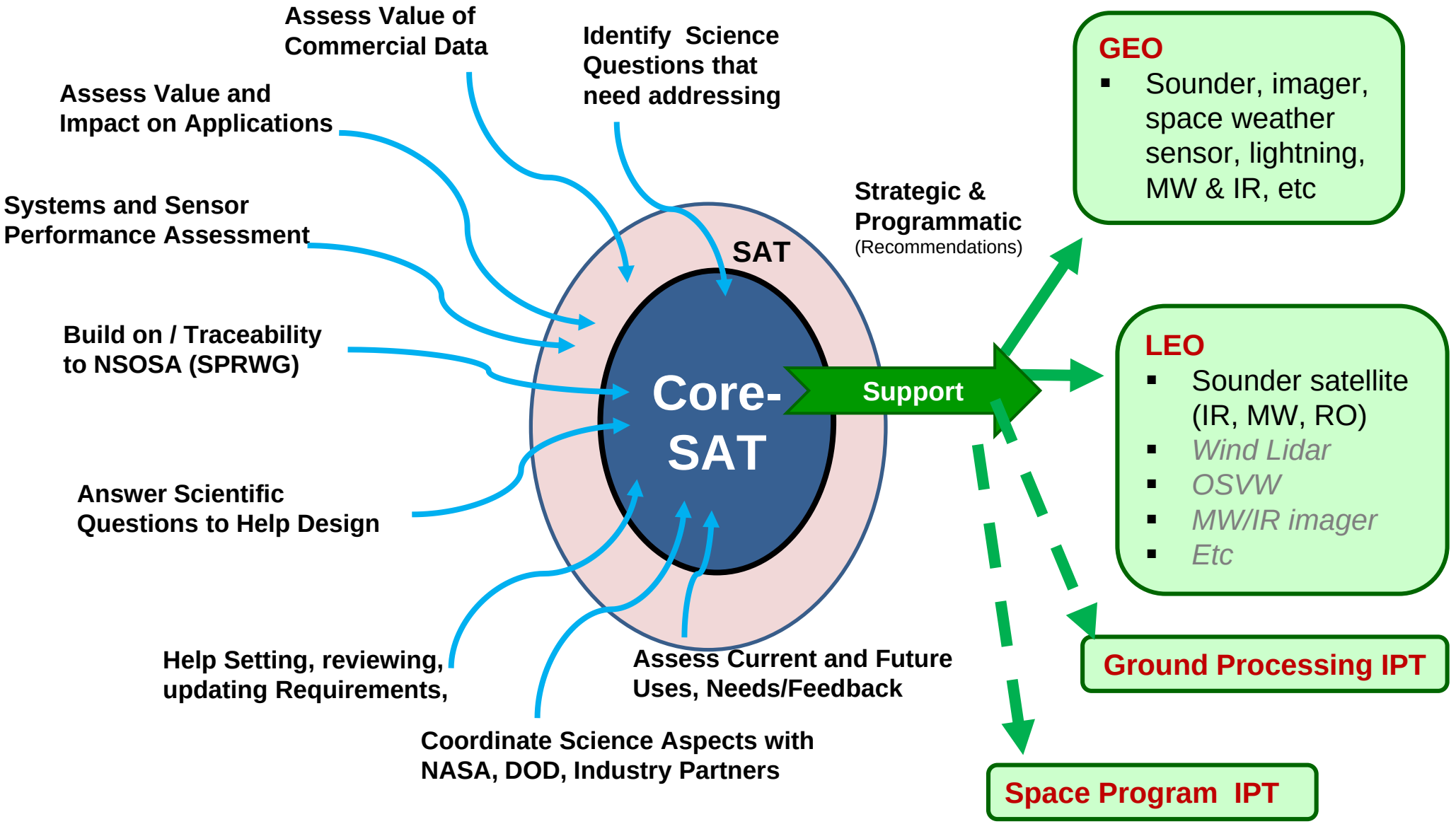


SAT: The Systems performance Assessment Team (SAT) is a technical team that has a diverse set of expertise in remote sensing, data assimilation, sensor design, impact assessment, constellation impacts, etc.

Role: To provide authoritative scientific and performance assessment support to NESDIS in its efforts to implement pre-phase A and formulation activities for the next generation of environmental remote sensing satellite programs.

Membership: Flexible Membership (Associate and Core SAT members). Users/stakehodlers participation critical.

Role and Scope of SAT (for Next-Gen Space Architecture Effort)



Examples of SAT Activities

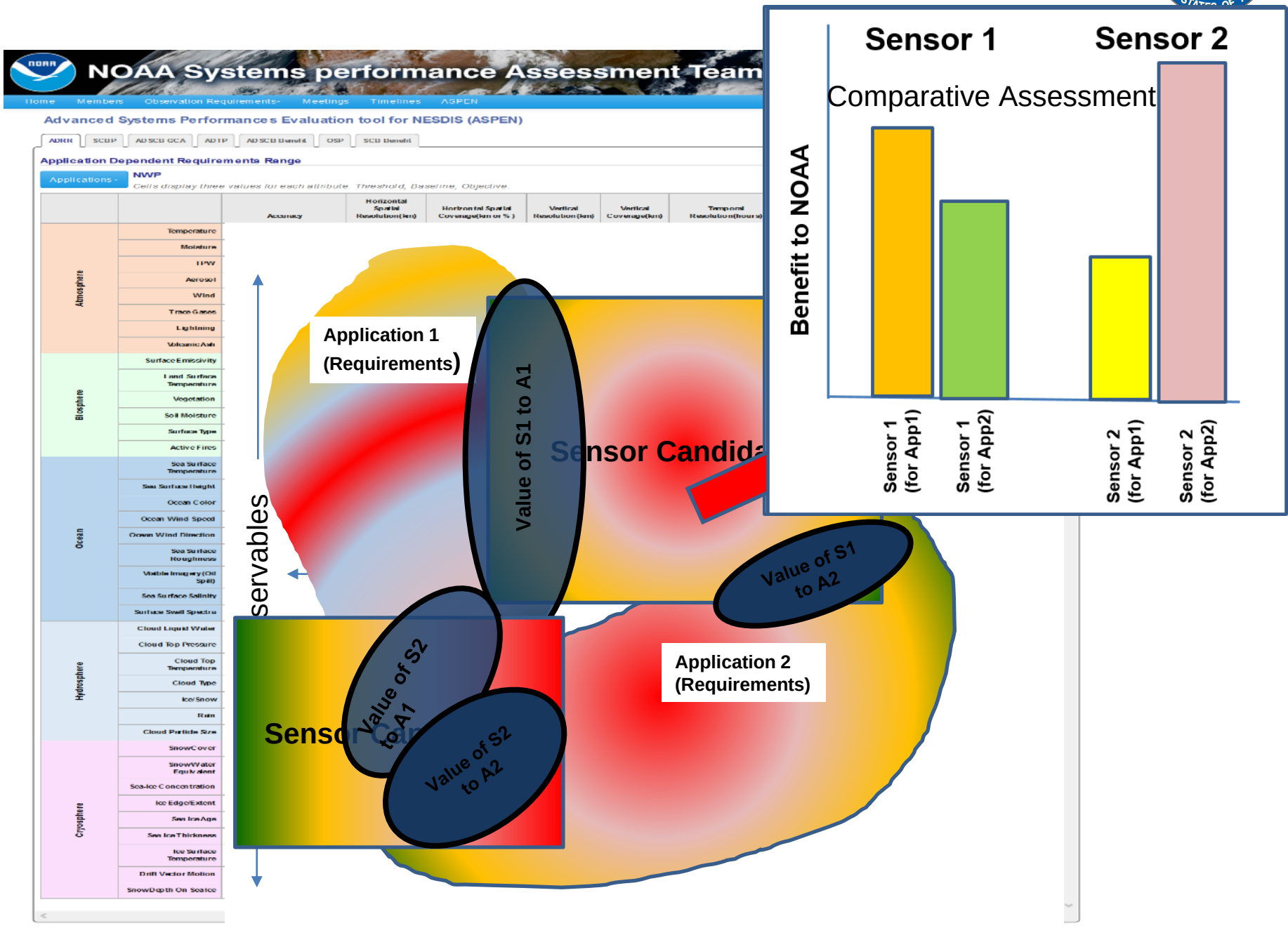
- **Providing guidance on the Design of MW and IR sensors (linking performances to Sensor characteristics)**
- **Providing guidance on Value of IR SW band in NWP (as a mitigation to LW band potential loss)**
- **Providing recommendations on the potential complementarity of WSF-M for NOAA Applications**
- **Providing recommendations regarding the impact on losing legacy sensors on NOAA's global NWP**
- **Guidance on acceptability of disaggregating (or need to collocate) MW and IR sensors, for global NWP.**
- **Upcoming Focus areas:**

  - Recommendation on sounding Quality vs Quantity importance (for smallsats)
  - Etc.

Agenda

1. **Background: Importance of a Comprehensive Assessment**
2. **Systems performance Assessment Team (SAT)**
3. **SAT/ASPEN Tool:**
   Advanced Systems Performance Evaluation for NOAA
4. **Test Cases of ASPEN-Based Assessments (LEO and GEO)**
5. **Next Steps**

ASPEN Concept



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Advanced Systems Performance Evaluation for NOAA (ASPEN)

Principle:

Assessing whether Current and/or Future Sensors and Constellations Can Meet NOAA Observational Needs

Why is this Important:

- **Decision-Making Support Tool** (Space Architecture decisions (GEO-XO, LEO, etc), Commercial Data Buys values/criteria, Data Partnership Value assessment, Etc)
- **Risk Assessment & Full Awareness of Decision Impacts** (What is the impact of the decision we make on users?, What gaps (in observables) are we tolerating? What Potential capability Overlaps are there?)

Scientifically/technically:

- **It is quantitative:** Can Assess (1) Overall ability of sensors/constellation to measure environment (OSSE-NC), and (2) degree of satisfaction of Observational needs/requirements, (3) Value
- **Detailed:** E.g. spatial/vertical resolution, temporal refresh, spatial coverage, etc are all assessed
- **Comprehensive:** all applications: Ocean, Weather, Land,.. and users needs –forecasters,..
- **Complementary to OSE/OSSE and FSOI:** these could Calibrate ASPEN:
- **Fast, Transparent, Traceable:** 1- sensitivity, 2- what if scenarios, 3- uncertainty

ASPEN methodology

Unit of measure

ASPEN STEPS:

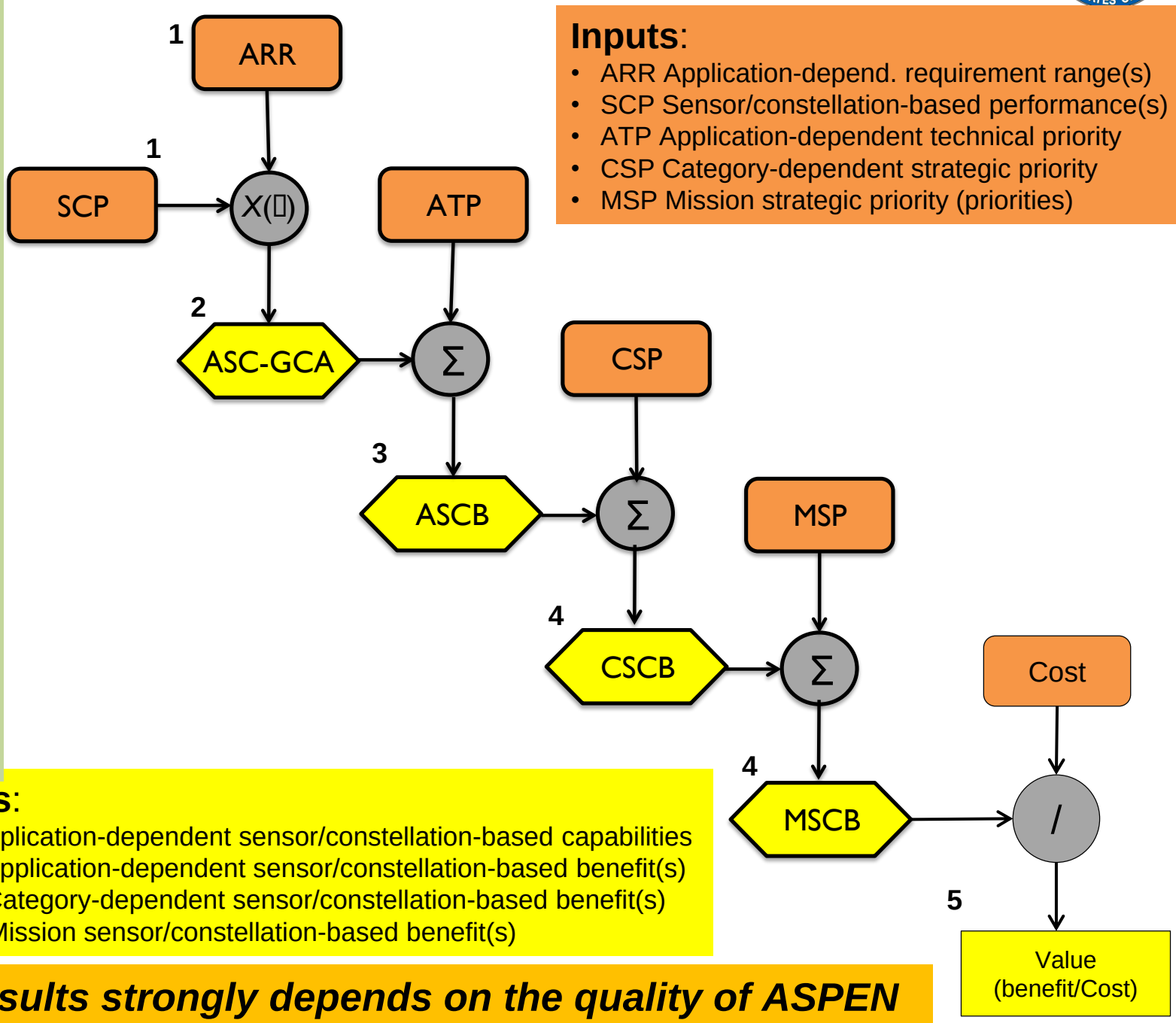
1- Collect sensor capabilities, application requirements and application priorities through **expert elicitation**.

2- Normalize the sensor capabilities by the application requirements.

3- Calculate the benefit of the sensor to the application as a weighted average.

4- Combine benefits for categories of application or for all of NOAA. Then for overall NOAA mission

5- Calculate "values" as benefits divided by sensor costs.



Inputs:
- ARR Application-depend. requirement range(s)
- SCP Sensor/constellation-based performance(s)
- ATP Application-dependent technical priority
- CSP Category-dependent strategic priority
- MSP Mission strategic priority (priorities)

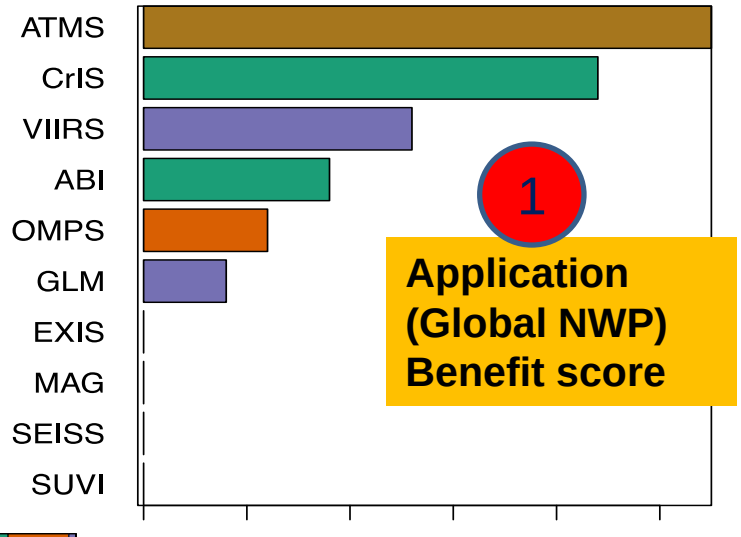
Outputs:
- GCA Application-dependent sensor/constellation-based capabilities
- ASCB Application-dependent sensor/constellation-based benefit(s)
- CSCB Category-dependent sensor/constellation-based benefit(s)
- MSCB Mission sensor/constellation-based benefit(s)

Quality of ASPEN results strongly depends on the quality of ASPEN inputs — sensor capabilities, application requirements, priorities.

Agenda

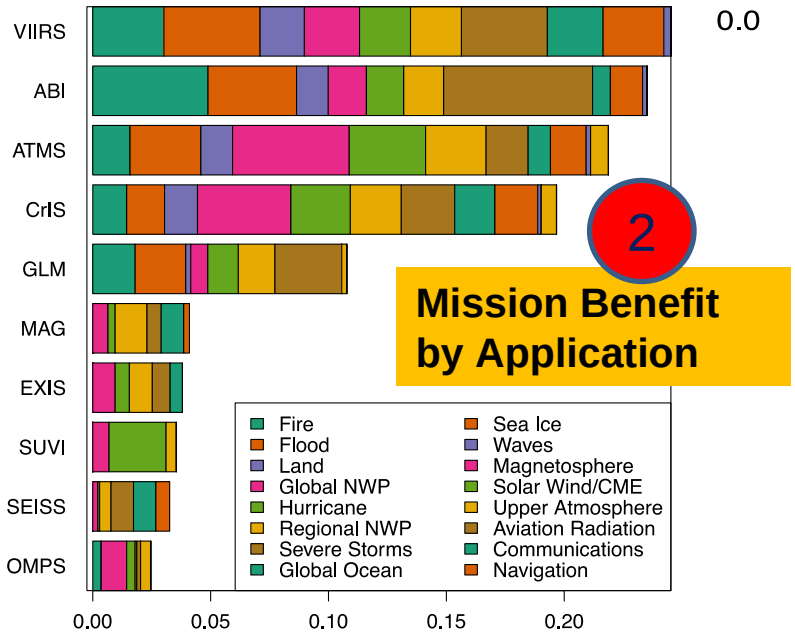
1. **Background: Importance of a Comprehensive Assessment**
2. **Systems performance Assessment Team (SAT)**
3. **SAT/ASPEN Tool:**
   Advanced Systems Performance Evaluation for NOAA
4. **Test Cases of ASPEN-Based Assessments (LEO and GEO)**
5. **Next Steps**

Sensors Assessment & Ranking (Benefit & Value to NOAA)



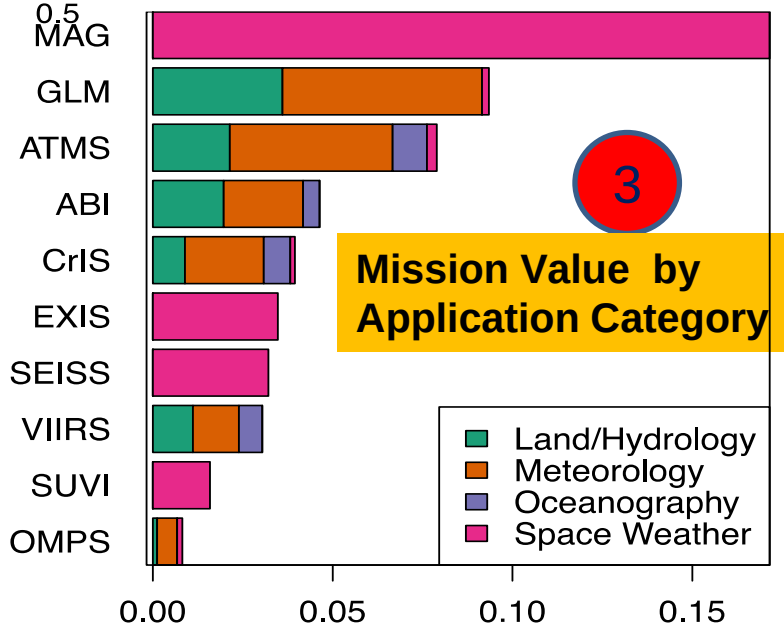
1

Application (Global NWP) Benefit score



2

Mission Benefit by Application



3

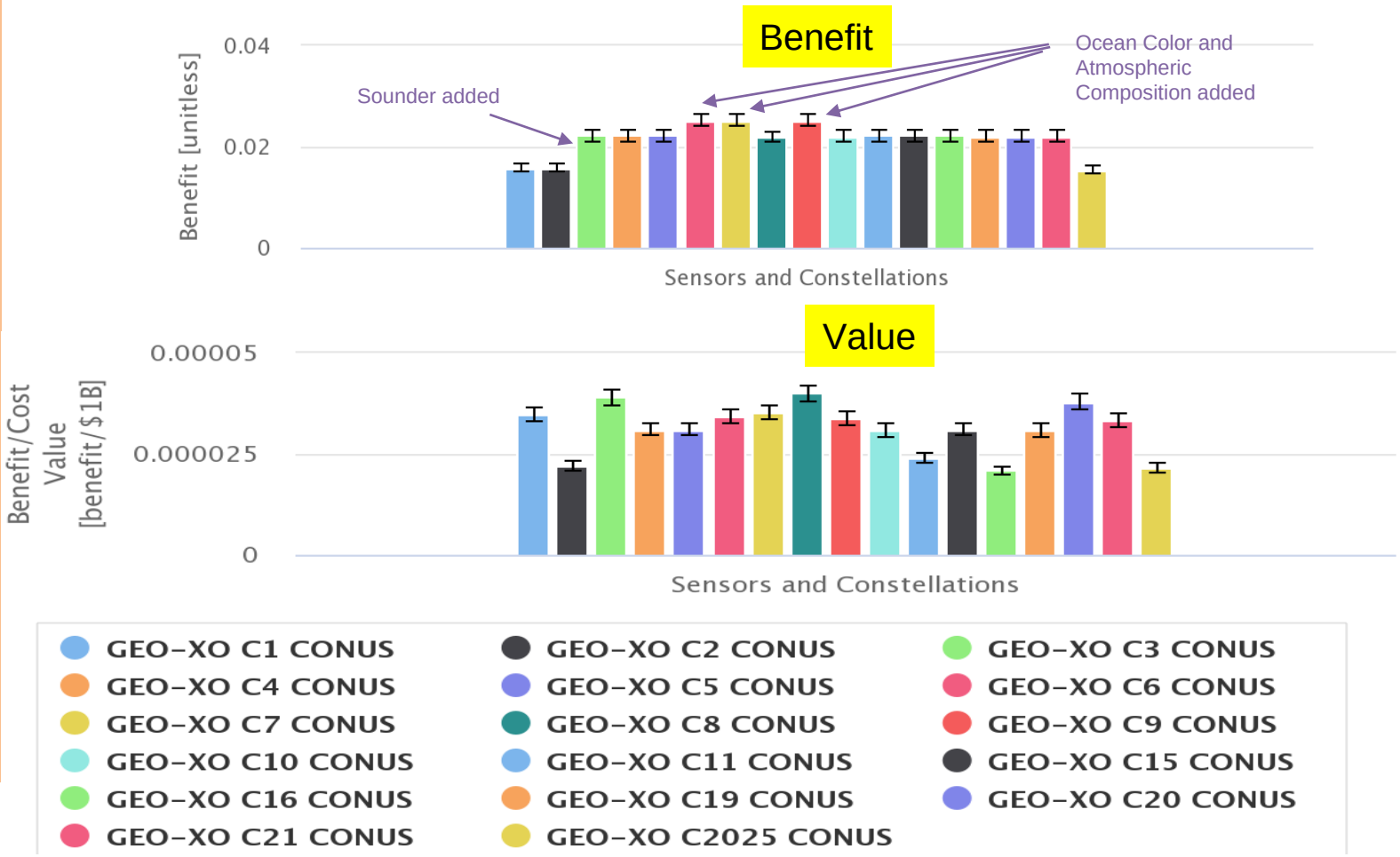
Mission Value by Application Category

Examples of ranked benefits (left) and Values (benefit/cost) of several sensors, as assessed against the overall NOAA mission requirements (MSC). These are stratified by individual applications and/or categories of applications.

GEO-XO Constellations Assessment

- Comparison of 17constellations
- CONUS View for constellations
- Applications selected: Fire, GNWP, Hurricane, Severe Storms, Coast Water Quality
- Rolled up to NOAA Mission-level benefit

Assessment of 17 constellations (CONUS View)



ASPEN allows to assess several configurations of constellations (with mixture of Sounder, Ocean color, Atmospheric composition, with and without Polar constellations, etc)

Summary & Next Steps

- **SAT aims at being an *Independent* and *Objective* Assessment mechanism: provides science recommendations to NESDIS based on mature, established facts, for sound decision-making**
- **ASPEN is a NESDIS-wide assessment tool support Next-gen space effort: account for LEO, GEO, SpxW, Nat. and Internat. Partners, Commercial (Space & Ground) Assets**
- **Specifically, ASPEN will be used to:**

  - **Continue Support the GEO-XO space architecture**
  - **Support BAA Studies Evaluation (LEO and GEO)**
  - **Support LEO Studies Architecture:** ***Evaluation of trade space of: Sensors choice, Designs, Constellations, etc***
  - **Support Space Weather Architecture**
  - **Support Commercial data buys *(deal value assessment?)***
  - ***Partnership Data Value Assessment***
  - ***Etc***