Science Advisory Board

Environmental Information Services Working Group (EISWG)

A NESDIS Observing System Backbone Framework

Members: Bill Gail (EISWG), Ilse Gayl (EISWG), Xubin Zeng (former EISWG)

15 Nov 2023

Purpose, Motivation, and Background

- NOAA's recent effort to explore commercial satellite data as alternative sources to data from dedicated NOAA satellites has raised important questions.
- Under what circumstances should NOAA maintain its own "backbone" systems even when acceptable commercial sources for those data are available? What characteristics should those backbone systems have?
- (The notion of a backbone was first introduced by the independent World Meteorological Organization International Radio Occultation Working Group (IROWG; https://irowg.org) for the case of RO data).

Process, Approach, and Applicability

- The study was initiated by EISWG in recognition of general interest in RO, but the subject evolved to the more general topic of observing system backbones based on needs identified by NOAA.
- The EISWG study team interviewed representatives from NOAA, WMO, European Centre for Medium-range Weather Forecasts (ECMWF), and commercial data providers.
- While this report reflects the initial charter to address NESDIS needs for spaceborne observations, the recommendations can be reasonably extended to address similar needs throughout NOAA.

KEY DEFINITION: An observational data element (ODE) is a *portion* of NOAA's observing system. An example is Radio Occultation.

F&R – "The Opportunity"

The backbone concept addresses an opportunity driven by the emergence of commercial satellite data:

- NOAA has a growing interest in using these "alternative-source" spaceborne observations [Finding 1]
- But, for various reasons, availability of alternative observations may not eliminate a need for NOAA to make similar observations. [Finding 2]
- When NOAA observations are still needed, the NOAA element can be referred to as a "backbone" and serve one or more functions [Finding 2]

RECOMMENDATION 1. NOAA should employ a backbone approach to integrating alternative-source observations [. . .] with the nature of that backbone determined through a process involving a formal decision and implementation framework.

F&R – "Backbone Framework" (Guideline 1)

FRAMEWORK GUIDELINE 1: Employ a data- and use-oriented systems approach

- Treat multiple data sources as part of a system, for which the role and contribution of each data source can be optimized across performance, cost, and risk. [Finding 3]
- Define the right performance metrics for this optimization associated with end use performance/effectiveness, cost, acquisition ease, and risk. [Finding 4]
- Data set stability and continuity is important for users. [Finding 5]

RECOMMENDATION 2. A process for defining and implementing a backbone should be data- and use-centric, not sensor- or platform-centric. It should treat all related observations as a system to be optimized across performance, cost, and risk.

F&R – "Backbone Framework" (Guideline 2)

FRAMEWORK GUIDELINE 2: Design the Backbone as an Enabler for All Related Data

- An essential part of the backbone role is to be an enabler, ensuring that the overall ODE is optimized and the alternative ODE contribution is maximized. [Finding 6]
- More than just ensuring a minimum number of observations, this concept can be broadened to reflect many important roles a backbone can perform. [Finding 7]
- Data stability is a desired characteristic for all end uses, and project funding stability is valued by providers. [Finding 8]

RECOMMENDATION 3. When employed, a backbone should be designed as an enabler for the overall ODE system.

F&R – "Backbone Framework" (Guideline 3)

FRAMEWORK GUIDELINE 3: Continuously Assess and Mitigate Risks of Alternative Data

- At this time, few or no sources of alternative spaceborne ODE have robust markets, presenting a risk. [Finding 9]
- Fundamental issues remain regarding alignment of NOAA and commercial interests, such as treatment of open data and international data sharing. [Finding 10]
- Government budgets for alternative data today are more volatile than for government-funded observation systems, presenting a risk. [Finding 11]

RECOMMENDATION 4. NOAA should define a continuous process to assess and mitigate risks to ongoing alternative-source data availability and access.

F&R – "Backbone Framework" (4)

A two-dimensional decision matrix can be used to assess backbone need and purpose

Backbone Role	Market Robustness Level (R=required, D=desirable)			
	Level 0	Level 1	Level 2	Level 3
1. Minimum Data Set				
2. Unaddressed Space/Time Regimes Data				
3. Anchor Data				
4. Calibration and Cross-Calibration Data				
5. Reference Standard Data				
6. Climate-Quality Data				
7. Data Continuity				
8. Observation Quality				
9. Observation Cost & Cost Risk				
10. Research Access to Data				
11. Equitable Data Availability				
12. Open data access				

We can define four levels of robustness:

- *Level 0.* No operationally capable alternative-source data suppliers, and evidence that a commercial market is unlikely.
- *Level 1.* No operationally capable alternative-source data suppliers, but some pre-operational suppliers exist with plans and even limited pilot or evaluation data.
- *Level 2.* One or several operationally capable alternative-source data suppliers. Some or all suppliers may not be able to meet all NOAA requirements. Supplier viability may be heavily dependent on government contracts, with limited non-government alternative buyers. Some risk that the supplier ecosystem will go away.
- *Level 3.* Multiple operationally capable alternative-source data suppliers and robust non-government alternative market. Most or all suppliers can meet all NOAA requirements.

F&R – RO Example

- RO presents a good example for applying the backbone framework. [Finding 12]

Example: RO Decision Matrix

Backbone Role	Market Robustness Level (R=required, D=desirable)			
	Level 0	Level 1	Level 2	Level 3
1. Minimum Data Set	R	R	R	-
2. Unaddressed Space/Time Regimes Data	R	R	R	-
3. Anchor Data	D	D	D	-
4. Calibration and Cross-Calibration Data	D	D	D	-
5. Reference Standard Data	R	R	D	D
6. Climate-Quality Data	R	R	D	-
7. Data Continuity	R	R	D	-
8. Observation Quality	R	R	D	-
9. Observation Cost & Cost Risk	R	R	D	-
10. Research Access to Data	R	R	D	-
11. Equitable Data Availability	R	R	D	-
12. Open data access	R	R	D	-

RECOMMENDATION 5. The backbone approach is applicable to RO, with important backbone roles apparently as yet unfulfilled by commercial providers, and NOAA should plan the RO element to include a backbone.