OFFICE OF SCIENCE AND TECHNOLOGY POLICY

ACTION: Notice of Request for Information (RFI).

SUMMARY: The purpose of this Request for Information (RFI) is to solicit input from all interested parties regarding recommendations for the development of a National Plan for Civil Earth Observations ("National Plan"). The public input provided in response to this Notice will inform the Office of Science and Technology Policy (OSTP) as it works with Federal agencies and other stakeholders to develop this Plan.

DATES: Responses must be received by December 6, 2013 to be considered.

SUBMISSION: You may submit comments by any of the following methods.

- **Downloadable form:** To aid in information collection and analysis, OSTP encourages responses to be provided using this form. Please enter your responses in the fillable fields that follow the questions below.
- **Email:** OSTP encourages respondents to email the completed form, as an attachment, to earthobsplan@ostp.gov. Please include "National Plan for Civil Earth Observations" in the subject line of the message.
- **Fax:** (202) 456-6071.
- **Mail:** Office of Science and Technology Policy, 1650 Pennsylvania Avenue, NW, Washington, DC, 20504. Information submitted by postal mail should allow ample time for processing by security.

Response to this RFI is voluntary. Respondents need not reply to all questions listed. Each individual or institution is requested to only submit one response. Responses to this RFI, including the names of the authors and their institutional affiliations, if provided, may be posted on line. OSTP therefore requests that no business proprietary information, copyrighted information, or personally-identifiable information be submitted in response to this RFI. Given the public and governmental nature of the National Plan, OSTP deems it unnecessary to receive or to use business proprietary information in its development. Please note that the U.S. Government will not pay for response preparation, or for the use of any information contained in the response.

FOR FURTHER INFORMATION CONTACT:

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SUPPLEMENTARY INFORMATION:

Background

The U.S. Government is the world's largest single provider of civil environmental and Earth-system data. These data are derived from Earth observations collected by numerous Federal agencies and partners in support of their missions and are critical to the protection of human life and property; economic growth; national and homeland security; and scientific research. Because they are provided through public funding, these data are made freely accessible to the greatest extent possible to all users to advance human knowledge, to enable industry to provide value-added services, and for general public use.

Federal investments in Earth observation activities ensure that decision makers, businesses, first responders, farmers, and a wide array of other stakeholders have the information they need about climate and weather; natural hazards; land-use change; ecosystem health; water; natural resources; and other characteristics of the Earth system. Taken together, Earth observations provide the indispensable foundation for meeting the Federal Government's long-term sustainability objectives and advancing the Nation's societal, environmental, and economic well-being.

As the Nation's capacity to observe Earth systems has grown, however, so has the complexity of sustaining and coordinating civil Earth observation research, operations, and related activities. In October 2010, Congress charged the Director of OSTP to address this challenge by producing and routinely updating a strategic plan for civil Earth observations (see *National Aeronautics and Space Administration Authorization Act of 2010, Public Law 111-267, Section 702*).

Responding to Congress, in April 2013, OSTP released a National Strategy for Civil Earth Observations ("the National Strategy").

In April 2013, OSTP also re-chartered the U.S. Group on Earth Observations (USGEO) Subcommittee of the National Science and Technology Council's Committee on Environment, Natural Resources, and Sustainability. USGEO will carry out the National Strategy and support the formulation of the National Plan.

As requested by Congress, the National Plan is being developed by USGEO to advise Federal agencies on the Strategy's implementation through their investments in and operation of civil Earth observation systems. The Plan will provide a routine process, on a three-year cycle, for assessing the Nation's Earth observation investments; improving data management activities; and enhancing related interagency and international coordination. Through this approach, the Plan will seek to facilitate stable, continuous, and coordinated Earth observation capabilities for the benefit of society.

Congress also requested that development of the National Plan include a process for collecting external independent advisory input. OSTP is seeking such public advisory input through this RFI. The public input provided in response to this Notice will inform OSTP and USGEO as they work with Federal agencies and other stakeholders to develop the Plan.

Definitions and Descriptions

The term “**Earth observation**” refers to data and information products from Earth-observing systems and surveys.

“**Observing systems**” refers to one or more sensing elements that directly or indirectly collect observations of the Earth, measure environmental parameters, or survey biological or other Earth resources (land surface, biosphere, solid Earth, atmosphere, and oceans).

“**Sensing elements**” may be deployed as individual sensors or in constellations or networks, and may include instrumentation or human elements.

“**Observing system platforms**” may be mobile or fixed and are space-based, airborne, terrestrial, freshwater, or marine-based. Observing systems increasingly consist of integrated platforms that support remotely sensed, *in-situ*, and human observations.

Assessing the Benefits of U.S. Civil Earth Observation Systems

To assist decision-makers at all levels of society, the U.S. Government intends to routinely assess its wide range of civil Earth observation systems according to the ability of those systems to provide relevant data and information about the following Societal Benefit Areas (SBAs):

1. Agriculture and Forestry
2. Biodiversity
3. Climate
4. Disasters
5. Ecosystems (Terrestrial and Freshwater)
6. Energy and Mineral Resources
7. Human Health
8. Ocean and Coastal Resources and Ecosystems
9. Space Weather
10. Transportation
11. Water Resources
12. Weather

The U.S. Government also intends to consider how current and future reference measurements (*e.g.*, bathymetry, geodesy, geolocation, topography) can enable improved observations and information delivery.

To address measurement needs in the SBAs, the U.S. Government operates a wide range of atmospheric, oceanic, and terrestrial observing systems. These systems are designed to provide: (a) sustained observations supporting the delivery of services, (b) sustained observations for research, or (c) experimental observations to address specific scientific questions, further technological innovation, or improve services.

Questions to Inform Development of the National Plan

Name (optional): Umesh Ketkar

Position (optional): Program Manager, Remote Sensing Programs, Advanced Space and Intelligence Systems

Institution (optional): The Boeing Company

Through this RFI, OSTP seeks responses to the following questions:

1. Are the 12 SBAs listed above sufficiently comprehensive?

The 12 Societal Benefit Areas listed above thoroughly encompass the very broad range of objectives met by Earth observation systems. All aspects of the Earth's observable geological, biological, environmental, and man-made attributes are addressed in sufficient detail. The list provides a careful breakdown of how observation data can enhance our knowledge of what is happening on and to the Earth as well as what has happened previously or what might happen in the future. In addition, Space Weather goes beyond terrestrial observation to provide a deeper understanding of how external influences are affecting our planet.

   a. Should additional SBAs be considered?

While the list is quite comprehensive, the addition of Archeology, either as an additional SBA or an add-on to an existing SBA, would add to the completeness. Earth Observation has proven beneficial in both locating and understanding archaeological sites. Of greatest importance is discovering previously unknown sites, such as roads, towns, and ancient cities that have been covered by soil or sediment. In some cases, the suspected presence of hidden archaeological structures can be inferred by the indirect effects on vegetation, soil (including relative soil moisture), hydrology, and subtle topography differences. In these indirect cases, there can be benefit in surveying a large area from a distance in order to observe patterns (such as road networks, city walls, and two outlines) and subtle relative differences across the scene. Increased hyperspectral data collection (with improved combinations of spatial and spectral sampling) may offer great benefit to these indirect explorations. More direct archaeological exploration can be made by Earth observations modes (sensor phenomenologies) that can penetrate vegetation, soil, and sediment. In the future, these more direct modes should have increasing value in archaeological exploration. Ground penetrating radar has already proven quite useful, but other modalities may also have benefit.

   b. Should any SBA be eliminated?

No.

2. Are there alternative methods for categorizing Earth observations that would help the U.S. Government routinely evaluate the sufficiency of Earth observation systems?

There are multiple ways that Earth Observation data could be categorized. One approach could be to group data by intended use:

a) sustained observations supporting the delivery of services
b) sustained observations for research
c) experimental observations to address specific scientific questions, further technological innovation, or improve services.

While this approach may appear to simplify prioritization between competing objectives (e.g., services vs. research), it suffers from the drawback that a single observation system or method may easily start off as an experimental system, be found useful for research, and then eventually become a standard service that is provided to the nation and industry.

Another approach would be to categorize by method of collection:

a) space-based sensors
b) airborne sensors
c) terrestrial sensors
d) freshwater, or marine-based sensors
e) human observations

This approach could allow easier categorization of activities into "programs of record". However, there appear to be at least two drawbacks. The first is that this categorization approach will tend to instantiate and propagate individual programs and activities regardless of whether they are accomplishing the desired results. Another difficulty is that this type of segregation may lead to "stovepipe" platform-centric solutions, rather than complementary systems that work together to gather desired information and data.

We believe a useful approach would be to:

1. First focus on the desired societal benefit
2. Next, examine which spectral regime (Visible and Reflective Infrared Remote Sensing, Thermal Infrared Remote Sensing, or Microwave Remote Sensing) can best be used to gather useful data with regards to each benefit area. Research and analysis have determined that certain wavelengths and detection systems are best for viewing different materials and phenomenon.
3. Next, examine the state of current observation systems with regard to that spectral regime, and rate them for sufficiency or adequacy. Note that this sufficiency rating could be related to current services, to research or to experiments
4. Finally, define how to address gaps in the most cost-effective manner. Note that this assessment of alternatives could lead to any number of solutions, from acquisition of new systems, to greater reliance on existing commercial data sources, or anything in between.

A sample table with this categorization system is shown below.

Societal Benefit Area	Spectral regimes	Current systems	Sufficiency rating	Gap mitigation approach
agriculture and forestry				
biodiversity				
climate change				
natural disasters				
terrestrial and freshwater ecosystems				
energy and mineral resources				
environmental factors				
ocean and coastal resources				
space weather				
transportation				
water resource management				
weather forecasting				

The benefits of this tiered approach are many fold. First, it allows direct categorization and prioritization among societal benefit areas. It then allows a scientific assessment of the best means to observe and detect phenomenology related to each area, along with an assessment of sufficiency of currently existing systems and methods. And then finally, assessment and evaluation can be performed to find the most cost-effective means to address any resulting gaps.

This platform-agnostic categorization approach should provide a means to focus often-scarce resources on addressing gaps related to the most important societal benefits.

3. What management, procurement, development, and operational approaches should the U.S. Government employ to adequately support sustained observations for services, sustained observations for research, and experimental observations? What is the best ratio of support among these three areas?

Refer to responses for items 4, 7 and 11 for discussions of approaches that the U.S. Government should employ in the areas of commercial remotes sensing, public-private partnership, acquisition management, and organization.

4. How should the U.S. Government ensure the continuity of key Earth observations, and for which data streams (*e.g.*, weather forecasting, land surface change analysis, sea level monitoring, climate-change research)?

Agreement on a long term strategy for Earth observation, as documented in the National Strategy for Civil Earth Observations (April 2013), is an excellent first step to ensuring data continuity. An update of the documented National Plan every three years is suggested in the Strategy, but more frequent monitoring and adjustment may be needed to both the Plan and the Strategy to accommodate changing national needs, capabilities and budget priorities. Risk management should also be a key part of the National Plan and periodic re-assessment of risks and mitigation plans should be performed on a regular basis. As the National Plan is developed, it is probable that cooperation across Federal agencies and with foreign and commercial entities may add new risks of new data gaps. Risks to data continuity will most likely be when space asset development gets delayed, assets or launches fail, or when planned systems get defunded. Refer to the NOAA NESDIS Independent Review Team Report from July 2012 as an example. Most of these risks can be mitigated through development of a rapid access to space capability such as that undertaken through the Operationally Responsive Space (ORS) initiative. Similarly, rapid access for airborne assets should be developed. Programs related to rapid access should be funded to help mitigate these risks.

It is recommended that the U.S. Government (USG) consider increasing its use of commercial assets for Earth observation to ensure continuity for all data streams. This private-public model has already been demonstrated with DigitalGlobe and its sale of imagery data to the Government. It allows private companies to bear the costs of asset development and operations, rather than the USG. In addition, the gradual commercialization of Earth remote sensing should be understood to have societal benefit itself. In particular, space-based remote sensing has long been seen as the next major viable commercialization of space, has been supported by several USG efforts over multiple administrations, and is now showing great promise. For these businesses to succeed, however, it is imperative that the USG support them through data purchases. It is anticipated that more private companies will develop systems for electro-optical imaging as well as other phenomenologies such as radar and hyperspectral imaging in the near future.

The USG should also re-assess its policies for commercialization (as discussed in responses to items 9 and 11), identify ways to promote commercial development of these systems and ways to share costs with private companies, and avoid acting as a competitor or deterrent when commercial ventures are prepared to enter a portion of the remote sensing marketplace and attempt to satisfy both commercial and governmental needs. This can be a delicate consideration that will require that Earth observation programs across the USG be monitored closely and adjusted when needed to avoid stymieing or thwarting commercial investment and the development of commercial markets. While there is often great benefit to many of these government programs, it should also be understood that they can sometimes act as a barrier to entry for some commercial ventures, and that timing can be critical. In the coming years there will be occasions when it is appropriate for the USG to switch from platform operator and data distributor to a customer (e.g., collection tasking and data purchasing) for some types of Earth observation data.

5. Are there scientific and technological advances that the U.S. Government should consider integrating into its portfolio of systems that will make Earth observations more efficient, accurate, or economical? If so, please elaborate.

Current and near-term advances in commercial space-based remote sensing offer potentially significant cost improvements over existing architectures. Affordable, electro-optical small spacecraft deployed in constellations of large quantities – such as the various concepts being developed by Skybox, Boeing and others– should be considered as an alternative architecture for Earth observation missions. Launched in multiples across a range of launch vehicles, including the cost-efficient Space X Falcon 9, this approach allows for greater flexibility and improved cost efficiency. These smallsat-based systems can disaggregate (or distribute payload sensors from a single platform to multiple smaller platforms) mission functions (such as, Earth observation modes /sensors or collection capacity) allowing for faster and more affordable development periods within a program. Different payload sensors and phenomenology can be integrated into a common system with shared spacecraft bus and communication architectures. Lower individual spacecraft costs – and intentionally fast cycle life - can allow for greater risk and reliability tolerance. In addition, payload enhancements can be made incrementally on successive deployments allowing for sensor technology insertions in a timely manner. Economies of scale, enabled by large numbers of common spacecraft platforms, reduce overall program costs.

Integrated ground-based processing of mission data collected across the constellation, as well as legacy and other cooperative systems, bring together multiple sensor systems that can provide a more nuanced and timely view of any event impacting a SBA. Internal coordination of mission tasking through tipping and cueing mechanisms can bring multiple sensors into view to address sudden events like earthquakes, nuclear accidents or oil-spills. Advances in computing power and technology can be gracefully inserted within a ground system in an efficient and timely manner. As this architecture develops, it can improve compatibility with the objectives of the Global Earth Observation System of Systems (GEOSS) data structure for information sharing.

Other advances in space-based systems can allow for greater spectral capability and accuracy. High accuracy hyperspectral imaging systems can provide additional spectral bandwidth and precision to address several SBAs. An application example is complementing the 90-m coastal hyperspectral data collected by NASA’s HICO mission with a 5-m class resolution. Other concepts include improved digital elevation mapping using higher resolution tandem radar spacecraft than currently provided by Germany’s TanDEM-X.

6. How can the U.S. Government improve the spatial and temporal resolution, sample density, and geographic coverage of its Earth observation networks with cost-effective, innovative new approaches?

Improvement to spatial resolution in Earth observation networks for U.S. Government imaging assets is limited by technology and dissemination restrictions. For NOAA licensing of commercial space remote sensors the currently allowed spatial resolution is no less than 0.5 meters. In order to improve spatial resolution for Earth observation the policies on spatial resolution should be re-assessed, particularly if the U.S. Government will rely on commercial assets for its data.

Disaggregation (or distribute payload sensors from a single spacecraft to multiple smaller spacecraft) is probably the most effective means to achieving improvements in Earth observation temporal resolution and geographic coverage. The advantage of splitting up large satellites into smaller ones is that it can improve geographic coverage and revisit times. Geographic coverage is also highly dependent on the imager swath (or geographic collection) size. Each mission must be analyzed to determine the optimal quantity of platforms, orbit profiles, and spatial resolution to achieve desired time to revisit and Earth coverage.

To achieve improvements in spectral sampling density, also called spectral resolution, the government should consider using hyperspectral imagers. Hyperspectral sensors offer increased flexibility of data analysis in the reflective bands for the same collection costs as the multispectral sensors. Such sensors have been successfully demonstrated on airborne and space platforms. These arrays provide greater spectral resolution and content than typical multi-spectral sensors, allowing users to perform additional science for societal benefit areas.

For example, over the last 4 decades Landsat has maintained an emphasis on broad area coverage and moderate spatial resolution while only gradually increasing spectral coverage by adding more carefully chosen spectral bands. Existing commercial technology now allows broad area moderate spatial resolution land remote sensing to evolve from the historical multispectral imaging (MSI) approach to hyperspectral imaging (HSI), at least in the reflective VNIR-SWIR regime. The technology for HSI sensing, data processing, and analysis has matured significantly in the last decade. These sensors are now in steady production and available at commodity pricing. Utilization of airborne hyperspectral imaging systems for commercial, science, and government uses has become more common, but there should be great value in a space-based HSI system with greater area coverage, improved spatial resolution, and better revisit, and collection efficiency (cost-effectiveness) than current airborne or space-based HSI Earth observing systems. Such a system could be an evolution (replacement) or adjunct to the current Landsat program.

Imaging with a hyperspectral sensor provides much greater information content than the traditional multi-spectral band and offers advantages of: 1) collection of explicit spectra, rather than under-sampled spectra, 2) detection of many more materials, 3) sub-pixel detection of materials, 4) determination of multiple constituents within a pixel, 5) a greater variety of scientific uses, not limited to heritage Earth imaging bands that were aimed at particular applications, 6) more refined crop identification and indicators of vegetation stress and senescence, and 7) better soil and mineral identification. A hyperspectral system would enable the data collection to support exploitation in many of societal benefits areas.

7. Are there management or organizational improvements that the U.S. Government should consider that will make Earth observation more efficient or economical?

The current model for acquiring and managing Earth Observation systems appears to have areas of overlap between multiple government agencies (e.g., NOAA, NASA, USGS, EPA), and also within single agencies and associated organizations (e.g., NASA-Goddard, NASA-Marshall, JPL).

This overlap can lead to confusion, to competing priorities, and in the worst-case to “turf battles” across organizations. We believe it would be helpful to define clear organizational charters for the primary agencies and organizations involved in Earth Observation.

For example, separate agencies could be given leadership in the following areas:

1. System requirements: Focus on use of scientific analysis, climate models and research to map from Societal Benefit Areas to derivation of specific operational requirements necessary for individual systems
2. Acquisition: Manage system development & delivery into Operations
3. Operations: Tasking, planning, data processing, exploitation and delivery of data

A model similar to this is used for National Technical Means programs, where there is a division of responsibilities similar between the Directorate of National Intelligence (DNI), the National Reconnaissance Office (NRO) and the National Geospatial Intelligence Agency (NGA). Though no organizational model is perfect at addressing all problems & issues, this approach has seemed to work over the years at producing quality products and cutting-edge technologies.

Another major consideration is the acquisition model used for the space portion of the Earth Observation program. Over the last few years, government agencies ranging from NRO to the Air Force have experienced good results with movement towards a commercial-like acquisition model. Patterned after the model used by long-standing commercial organizations such as Intelsat, Inmarsat and SES, this model relies on significantly less interaction and oversight by the government team. The system requirements are still fully specified, so this is not a return to the acquisition models tried in the late 90's. It is simply recognition of the fact that the space industry now has long experience, and has developed robust engineering, manufacturing and mission assurance practices. The commercial-like acquisition model usually couples reduced oversight with fixed-price contracting, so that industry has more autonomy to operate, while the government is protected from any resulting cost issues.

In the coming years there will be occasions when it is appropriate for the USG to switch from platform operator and data distributor to a customer (e.g., collection tasking and data purchasing) for some types of Earth observation data. These decisions should be made one at a time, in a timely manner, as commercial ventures indicate readiness to take satisfy the needs of both civil and commercial applications in particular areas of the remote sensing market. The USG needs to be sensitive to both its potential as a promoter of commercialization but also its potential for being an obstacle to commercialization (as explained in Response to Item 4) and should actively seek to avoid the latter.

Hosted payloads and ridesharing are other opportunities for cost reduction that can be considered on a program-by-program and launch-by-launch basis.

As a policy matter, easing of restrictions on the use of foreign launch vehicles is needed to help improve launch costs. This will have two major benefits. First, it will help promote commercialization of Earth observation by reducing the cost, a key sensitivity for commercial ventures. Second, this will allow the U.S. Government to off-load more Earth observation requirements to these commercial ventures. As a practical matter, the great majority of commercial launches now have a strong foreign launch involvement for economical reasons, and current US Government restrictions on commercial class space vehicles are excessive and costly.

In the "Enhance Capabilities for Assured Access to Space" section of the National Space Policy of the United States of America, 28 June 2010, it states "United States access to space depends in the first instance on launch capabilities. United States Government payloads shall be launched on vehicles manufactured in the United States unless exempted by the National Security Advisor and the Assistant to the President for Science and Technology and Director of the Office of Science and Technology Policy, consistent with established interagency standards and coordination guidelines." Although the current National Space Policy generally advocates for commercialization, it requires presidential exception for launch of commercial items on foreign launch vehicles. This creates potential barriers to hosted payload and commercial opportunities. In the case of hosted payload, the host vehicle will most likely plan to launch on foreign launch vehicle (~100% of commercial satellites are launched on foreign launch providers. And the low cost launch is a key enable in commercial-like cost savings. This policy should be relaxed to allow for foreign launch of commercially classed items.

8. Can advances in information and data management technologies enable coordinated observing and the integration of observations from multiple U.S. Government Earth observation platforms?

Yes. Observing the same area of interest (piece of Earth, terrain or water) with different sensor modalities has great value, as different phenomenologies become apparent and bring greater understanding. Repeated observations of the same area, whether by the same or different sensors, increase the understanding of both cyclical dynamic processes and long-term change. In past decades there may have been a preference for periodic coverage by the same sensor with the same geometry, in order to avoid processing and analytical difficulties. This was a tenet of some "data continuity" requirements in the Landsat program and other aspects of the Global Change Initiative and Mission to Planet Earth. However, modern processing and analytical techniques now allow much better accommodation of multiple collects from different geometries, different sensors, and even different geometries. One valuable analytical technique becoming more common is to arrange a series of collection over an area of interest in time ordered sequence in order to more clearly understand change. Other techniques allow fusion of data from different collects. Cost-effective and flexible COTS processing and analysis tools now allow much better handling, comparison, and joint analysis of diverse data sets.

Physical characteristics that drive collection phenomena, such as sun angle, illumination, and revisit time, are important considerations to enable integration of data across different platforms but establishing a reference grid or geographic coordinates is all that is required. Modern analytic tools allow direct analysis and comparison of data with different sensor footprints as long as there is some scene overlap. It is possible to use multiple "before" and multiple "after" images to analyze changes in a large area. Today's state of the art imaging systems often deal with this added complexity in geospatial production and imagery analysis activities for U.S. Government and commercial customers. Somewhat different geometries (e.g., slightly off-nadir line of sight to a given ground point) can also be accommodated using these modern techniques. In a sense, coverage's and footprints can be virtualized via a robust data archive and continuing collection.

Developments in cloud computing now allow seamless access to data distributed in multiple locations such as would be expected with Earth observation data from different U.S. Government agencies and international partners. Using a web-based tool and service oriented architecture, users could query and view data from these different locations for different platforms, times and sensor types. The challenges of coordinating this observation data from multiple sources can be met in large part through establishment of data standards as indicated in the Strategy (April 2013). New sensors typically require some new metadata, and sometimes other added data complexities. But a deliberate effort to reduce the propagation of unnecessary formats and data complexity, and instead conform to current and evolving popular standards (whether international, civil, or commercial), will help to remove barriers for all potential users.

In conclusion, the US Government can help facilitate beneficial utilization of data for civil, research, and commercial purposes by 1) ensuring efficient easy timely access to as much Earth observing data as possible; and 2) enforcing standards and consistency in data formats.

9. What policies and procedures should the U.S. Government consider to ensure that its Earth observation data and information products are fully discoverable, accessible, and useable?

Federal agencies conduct a wide range of Earth observations, generating vast amounts of diverse data. For this data to be available for consumption requires a management method that is broadly applicable across heterogeneous platforms, yet capable of being tailored to specific needs.

As discussed in Item 8 above, utilization of broadly recognized data format standards (rather than the propagation of too many new ones) will help make products more discoverable, accessible, and usable by a larger group of users.

The Data-Management Framework detailed in the National Strategy for Civil Earth Observations (April 2013) is a clear and comprehensive approach to ensuring Earth observation data and its associated information products are fully discoverable, accessible, and useable. The framework focuses on utilizing an open, integrated, and harmonized data architecture across all Federal agencies. It establishes a common data life-cycle process, basic operating principles which agencies can tailor as required, and standards for data development, documentation, and exchange. Among many other things, the framework provides guidance for how agencies should leverage the power of web-based, service-oriented architecture (SOA) and interoperability connections. Furthermore, an emphasis on constant and consistent evaluation of the framework and processes encourages Federal agencies to be proactive and forward-thinking with their data management roadmaps. This framework could lead to improved timeliness of data dissemination, more useable data for all agencies, reduced operating costs, better interoperability, and more increased data innovation.

While the National Strategy only addresses Federal agencies, expanding the data-management architecture and practices to commercial entities would provide even more opportunity for improved access and use. Several considerations, including the NOAA licensing and ITAR restrictions would need to be addressed prior to any commercial agreements.

10. Are there policies or technological advances that the U.S. Government should consider to enhance access to Earth observation data while also reducing management redundancies across Federal agencies?

See Items 9 and 11 for discussion on the need for policy changes that ease restrictions on foreign space launch vehicles.

11. What types of public-private partnerships should the U.S. Government consider to address current gaps in Earth observation data coverage and enhance the full and open exchange of Earth observation data for national and global applications?

Historically, the government has specified and acquired platforms or systems. A worthwhile alternative to consider is for the government to instead acquire types of data or services. If the government were to specify the types of data desired for Earth Observation, industry could perform trades to determine the most cost-effective means to provide that data.

As an example, consider a case where the government determines that there is utility in hyperspectral data in the Visible and Reflective Infrared spectral range. The traditional approach would be for the government to release an RFP to procure satellites hosting sensors capable of producing that data. The government would then perform the trades on whether to have dedicated ("free flyer") spacecraft, or to aggregate multiple missions onto a single host spacecraft. The government would have to decide how often to field replenishment systems, which launch vehicle to procure, how to transport the data back to Earth and then perform data processing, and a multitude of other detailed decisions.

An alternative approach would be for the government to simply specify key parameters (e.g., spectral range and resolution, signal-to-noise ratio, spatial resolution, swath width, revisit rate). Industry would be free to offer solutions ranging from dedicated spacecraft, to a fleet of small disaggregated vehicles. The government's needs could be bundled with similar commercial requirements to allow private business cases to close, and thus provide the government a more cost-effective solution.

The key to making this approach work is for the government to commit to long-term service-level agreements or data-level agreements. Then as long as specified quality parameters are met, private industry can have confidence in ongoing revenue. This in turn will incentivize private industry to make the capital investments necessary to fund satellite construction.

The government will benefit by being able to have flat, predictable funding profiles (without the large peaks that typically characterize space acquisition). This is also likely to lead to greater innovation, both in the technology as well as in the financing and business model.

An additional significant benefit is that since the government is simply purchasing data, it can be free to share that data with allied governments, or with universities, or with a host of other possible public/private consortiums. This model will almost certainly result in more open data exchange and greater collaboration and sharing among the global community.

12. What types of interagency and international agreements can and should be pursued for these same purposes?

No response is submitted for this question.