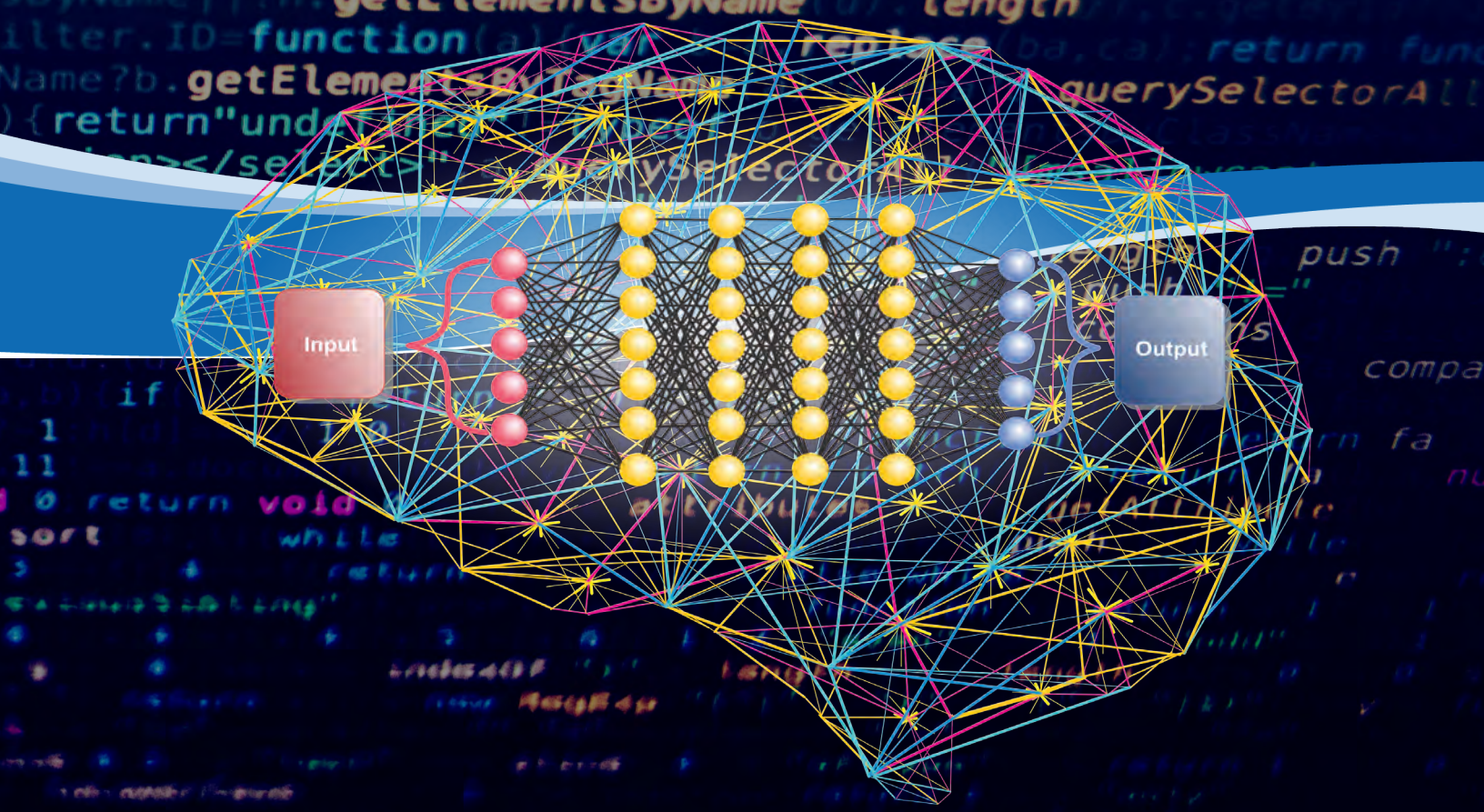
NOAA Artificial Intelligence Strategic Plan Workshop

One NOAA Approach for Next Generation Earth Science



NOAA Technical Memorandum NMFS-F/SPO-213
February 2021

NOAA Artificial Intelligence Strategic Plan Workshop

One NOAA Approach for Next Generation Earth Science

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CONTENTS

ACKNOWLEDGEMENTS

The overarching one NOAA approach of this NOAA Artificial Intelligence (AI) Strategic Plan Workshop to encourage synergy across the NOAA strategies is directly attributed to the leadership and support of the Deputy NOAA Administrator/Assistant Secretary of Commerce for Oceans and Atmosphere, Rear Admiral Timothy Gallaudet. Recognition for organizing the workshop is provided to William Michaels and Sid Boukabara, co-chairs of the NOAA AI Executive Committee, and to Jamese Sims. The NOAA AI Executive Committee members and the NOAA strategy leads, listed as co-authors of this workshop report, provided presentations and contributions during panel discussions and breakout sessions to stimulate productive discussions among the workshop participants. We are grateful to the workshop participants who provided invaluable expertise and balanced perspectives to developed the framework for the NOAA AI Strategic Plan. We are also thankful to Sarah Margolis, Chase Long, and Meredith Richardson who served as rapporteurs, and to Jason Philibotte, Catherine Chatfield, and Karene Sutherland who served as break-out session facilitators.

EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) has recently established strategic initiatives for applying emerging science and technology as actions to the recent guidance from the Administration and Congress, including the White House's Office of Science and Technology Policy (OSTP). The NOAA Artificial Intelligence (AI) Strategy is one of these initiatives in response to the Executive Order on Maintaining American Leadership in Artificial Intelligence. There are five goals of the NOAA AI Strategy:

Goal 1: Establish an efficient organizational structure and processes to advance AI across NOAA.

Goal 2: Advance AI research and innovation in support of NOAA's mission.

Goal3: Accelerate the transition of AI research to applications.

Goal 4: Strengthen and expand AI partnerships.

Goal 5: Promote AI proficiency in the workforce.

The purpose of this workshop, held during 27-28 February 2020, is to obtain well-balanced perspectives and recommendations from invited participants (i.e., leads of the NOAA Strategies on emerging science and technology, members of the NOAA AI Executive Committee, and invited experts) to establish the framework for drafting the actions of the NOAA AI Strategic Plan, and to establish a unified NOAA approach for coordinating the synergistic activities among the NOAA strategies on emerging science and technology. The first day of the workshop examined the objectives and synergy between the NOAA strategies. During the second day, participants proposed actions for drafting the NOAA AI Strategic Plan with consideration of how to coordinate the synergistic activities between the NOAA strategies. One of the key recommendations for the plan was to establish the NOAA Center for AI (NCAI) to facilitate awareness, coordination, and collaborations across NOAA and with its partners. The NCAI as a center of excellence would facilitate the acceleration of AI research and applications, establish a community of practice, and provide training resources to improve workforce proficiency in AI relevant disciplines.

The recommendations highlighted in this report will enhance awareness and coordination across the agency to accelerate AI research and applications, which will result in organizational and operational efficiencies to improve the delivery of high quality and timely scientific products and services to the public. For NOAA to sustain leadership in Earth system science, the fast pace of advancement necessitates diversity, collaboration, and workforce proficiency equipped with the technical and institutional support to leverage and apply AI to NOAA research and applications. This is a pivotal time for NOAA to embrace the rapidly evolving science and technology that will result in organizational and operational efficiencies, and coordination of the synergistic activities among the NOAA strategies will maintain NOAA's role as the world leader in environmental science in the upcoming years.

1 INTRODUCTION

1.1 BACKGROUND

The National Oceanic and Atmospheric Administration (NOAA) has established emerging science and technology strategies as actions to the recent guidance from the Administration and Congress, including the White House's Office of Science and Technology Policy (OSTP) FY21 Research and Development Letter[1], National Science and Technology Council (NSTC) report on Science and Technology for America's Oceans[2], and Executive Order on Maintaining American Leadership in Artificial Intelligence[3]. In February 2020, the finalized NOAA strategies on artificial intelligence (AI), uncrewed systems (UxS), 'omics, and cloud were announced[4]. In July 2020, the NOAA Data and Cloud Strategies were also announced[5]. These strategies will accelerate the NOAA mission to deliver high quality and timely scientific products and services. With recognition that there is considerable synergy across these strategies, the next step is to develop the strategic plans for these NOAA strategies. For these reasons, a workshop was held during 27-28 February 2020 to define the activities, resources, and oversight requirements of the NOAA AI Strategic Plan that takes into consideration the synergistic activities among these strategies as a unified NOAA approach.

1.2 TERMS OF REFERENCE FOR THE WORKSHOP (WILLIAM MICHAELS)

The goal of the workshop is to define the activities, requirements, and business case to develop the implementation plan of the NOAA AI Strategy[6]. Coordination across the NOAA strategies is necessary to make transformative improvements in NOAA's cross-functional mission requirements; therefore, invited expert representatives across the NOAA line offices (LOs) provided the necessary diverse and balanced perspectives during the workshop (Fig. 1.1). Day 1 of the workshop focused on the synergistic activities across the NOAA strategies, while Day 2 addressed the goals and objectives of the NOAA AI Strategy. The workshop presentations, break-out sessions, and panel discussions were designed to facilitate a unified approach in developing the NOAA AI Strategic Plan that optimizes coordination across the NOAA LOs and synergy among the NOAA strategies (Fig. 1.2). Further details on the terms of reference, agenda, and invited participants can be found in Appendices 12.1 and 12.2.

[1]White House Office of Science and Technology Policy FY21 Research and Development Letter, https://www.whitehouse.gov/wp-content/uploads/2019/08/FY-21-RD-Budget-Priorities.pdf

[2]White House National Science and Technology Council report on Science and Technology for America's Oceans: A Decadal Vision, https://www.federalregister.gov/documents/2018/06/28/2018-13926/science-and-technology-for-americas-oceans-a-decadal-vision

[3]White House Executive Order on Maintaining American Leadership in Artificial Intelligence, https://www.federalregister.gov/documents/2019/02/14/2019-02544/maintaining-american-leadership-in-artificial-intelligence

[4]NOAA news release on Strategies for Applying Emerging Science and Technology, https://www.noaa.gov/media-release/noaa-finalizes-strategies-for-applying-emerging-science-and-technology

[5]NOAA Research Council, NOAA Science and Technology Focus Areas, https://nrc.noaa.gov/NOAA-Science-Technology-Focus-Areas

[6]NOAA AI Strategy, https://nrc.noaa.gov/Portals/0/2020%20AI%20Strategy.pdf?ver=2020-09-17-150016-857

Figure 1.1. During the NOAA AI Strategic Plan Workshop held during 27-28 February 2020, workshop participation was composed of NOAA experts that included the leads of the NOAA strategies, members of the NOAA AI Executive Committee, and invited expert representatives across the NOAA line offices to ensure diverse and balanced perspectives.

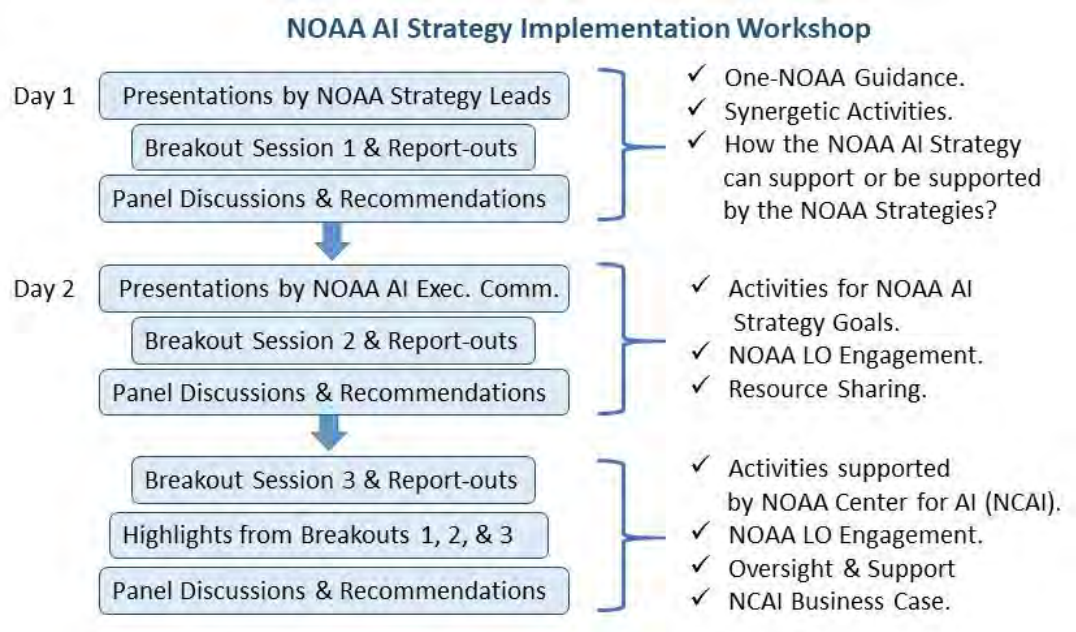


Figure 1.2. Workshop facilitation was designed to develop the framework for drafting the NOAA AI Strategic Plan that coordinates the synergistic activities across the NOAA strategies on emerging science and technology.

1.3 GUIDANCE ON NOAA STRATEGIC PLANS (TIMOTHY GALLAUDET)

The Deputy NOAA Administrator/Assistant Secretary of Commerce for Oceans and Atmosphere, Rear Admiral Timothy Gallaudet, provided the opening remarks and highlighted shared interests by the White House OSTP and Congress with NOAA's efforts to establish emerging science and technology strategies. The OSTP has plans to establish an interagency consortium for AI and develop AI technology for disaster relief. NOAA is well positioned to provide a lead role in these initiatives.

RDML Gallaudet offered to the workshop participants the question, what comprises a successful NOAA AI Strategic Plan Workshop? He suggested the success of this workshop will be determined by the workshop participants' suggestions on:

- Creating measurable actions with milestone dates, and assigning lead responsibilities for the actions of the NOAA AI Strategic Plan,
- Coordinating the synergistic activities across the NOAA strategies for organization efficiency,
- Designing a roadmap where the milestones produce accomplishments in the goal areas,
- Developing a business case with oversight and guidance in support of the NOAA LOs' requirements,
- Leveraging current NOAA processes, procedures, and timelines, and
- Prioritization process to guide NOAA's budget formulation for the NOAA strategies for applying emerging science and technologies.

Further emphasis was provided on the need to expand partnerships and build workforce proficiency across the NOAA strategies.

2 NOAA STRATEGIES AND SYNERGISTIC ACTIVITIES

The first day of the workshop was devoted to examining how the synergetic actions of the NOAA strategies on emerging science and technology can be leveraged to support or be supported by the NOAA AI Strategic Plan (Fig. 1.2). Summarized in this section, the Day 1 presentations provided the key synergistic activities that stimulated discussions during the breakout sessions and panel discussions.

2.1 NOAA ARTIFICIAL INTELLIGENCE STRATEGY (JAMESE SIMS)

Jamese Sims, special assistant to RDML Gallaudet, is assisting the NOAA AI Executive Committee co-chairs, William Michaels and Sid Boukabara, with the NOAA AI Strategy. On behalf of the NOAA AI Executive Committee, Jamese provided an overview of the NOAA AI Strategy (Fig. 2.1). The next step is to develop an implementation plan, with actions, that addresses the goals and objectives of the NOAA AI Strategy, and incorporates the synergistic activities across the other NOAA strategies to ensure organizational and operational efficiencies in support of the NOAA mission. This presentation can be found in Appendix 12.3, and further discussions on the activities of the NOAA AI Strategy are found in Section 5.

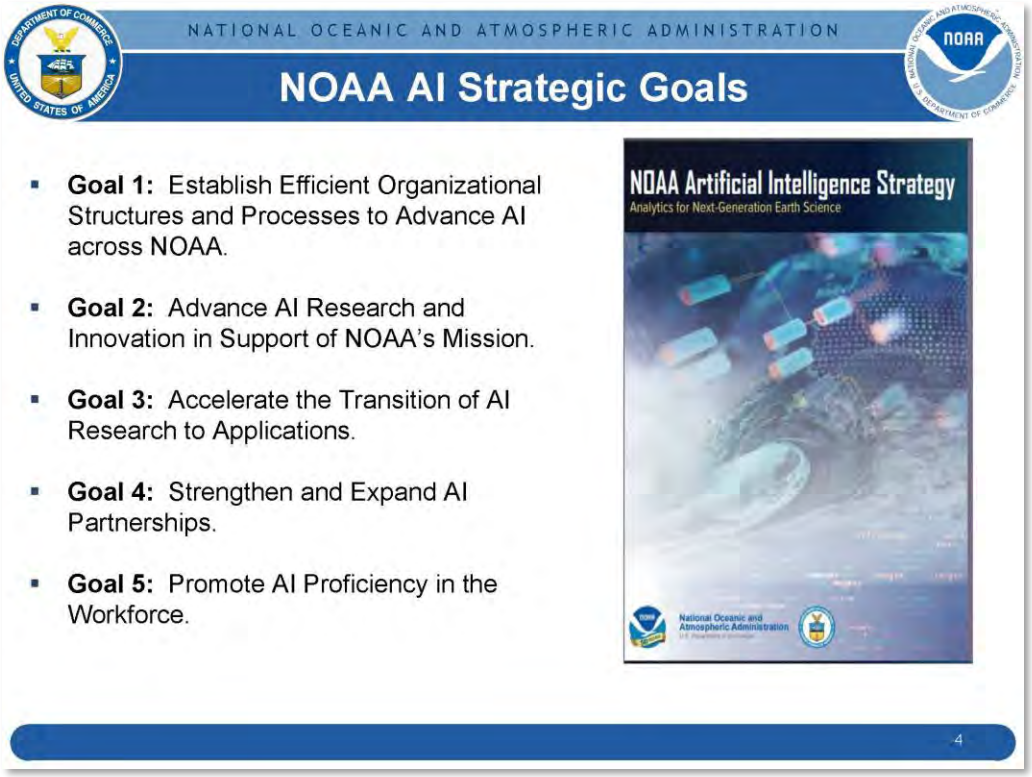
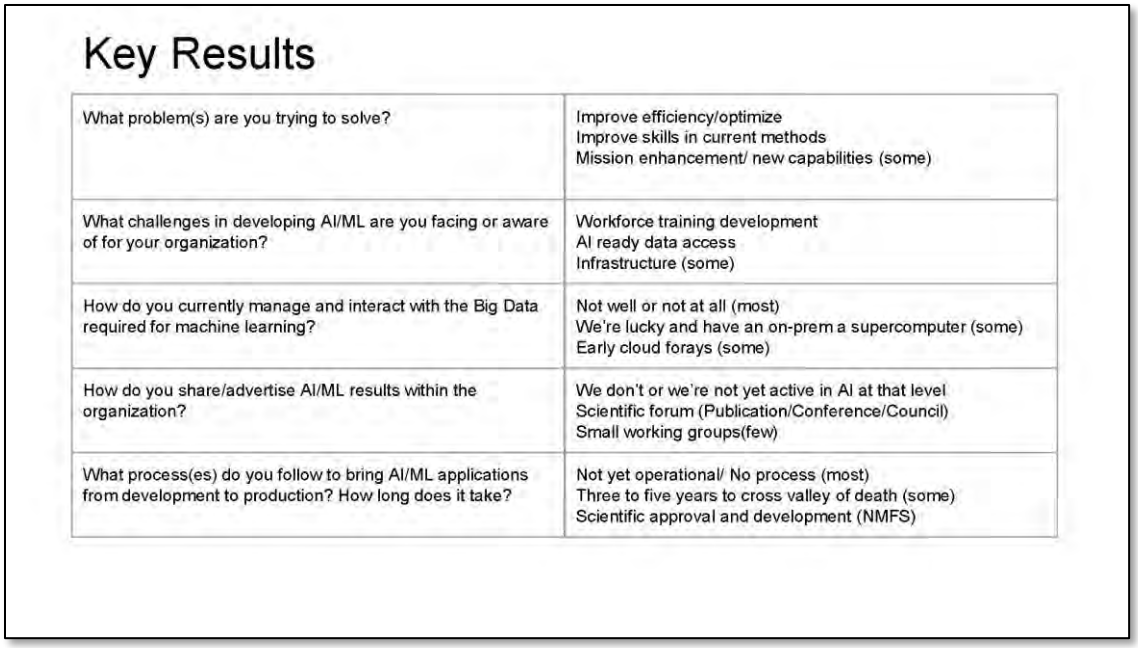


Figure 2.1. The goals of the NOAA Artificial Intelligence (AI) Strategy strives to transform NOAA's organizational and operational efficiencies in the application of AI technology that enhance the quality and timeliness of its scientific products and services.

2.2 NOAA AI Center (NCAI) Business Case (Eric Kihn, Sid Boukabara)

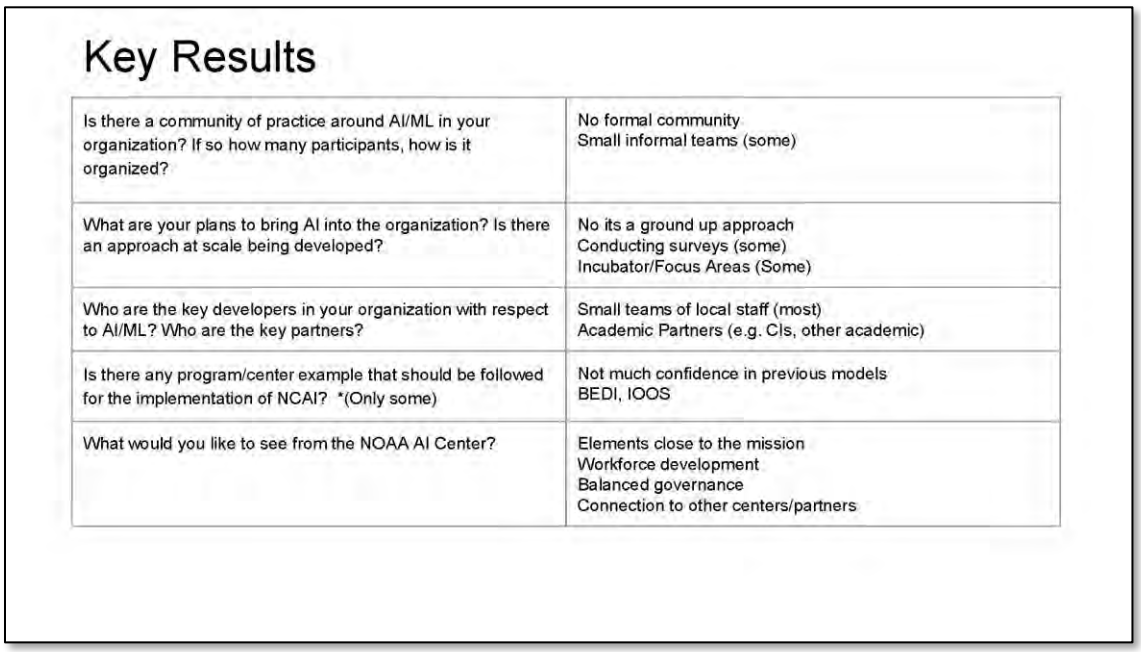
The NOAA National Centers for Environmental Information (NCEI) hosts and provides access to one of the most significant archives of earth, oceanic, atmospheric, and geophysical data. The first objective of the NOAA AI Strategy states the need to explore the establishment of a NOAA Center for AI (NCAI) to support the activities of its implementation plan. NCEI staff recently conducted interviews with members of the NOAA AI Executive Committee to understand the agency's challenges for implementing AI technology. The results of the interviews are summarized in Figures 2.2 and 2.3, and provide a foundation for workshop discussions on the NCAI business case (Section 8). The greatest challenge identified from the interviews is the need to support the elements for transitioning AI technology into operational efficiencies, and these elements can vary depending on the NOAA LO mission requirements for delivery of high-quality science. This requires balanced governance with NOAA LO representation, and some concern was expressed that evaluation of the various governance models will be needed. The NCAI business case should also focus on the need for improved coordination across the NOAA LOs to enhance AI-ready data access, workflow computing capabilities, promote workforce training, and expand partnerships. This presentation can be found in Appendix 12.4, and further discussions on developing the NCAI business case can be found in Section 8.



Key Results

What problem(s) are you trying to solve?	Improve efficiency/optimize Improve skills in current methods Mission enhancement/ new capabilities (some)
What challenges in developing AI/ML are you facing or aware of for your organization?	Workforce training development AI ready data access Infrastructure (some)
How do you currently manage and interact with the Big Data required for machine learning?	Not well or not at all (most) We're lucky and have an on-prem a supercomputer (some) Early cloud forays (some)
How do you share/advertise AI/ML results within the organization?	We don't or we're not yet active in AI at that level Scientific forum (Publication/Conference/Council) Small working groups(few)
What process(es) do you follow to bring AI/ML applications from development to production? How long does it take?	Not yet operational/ No process (most) Three to five years to cross valley of death (some) Scientific approval and development (NMFS)

Figure 2.2. Challenges for implementing AI technology within NOAA include the need for improved coordination for organizational efficiencies, workforce training, and transitioning AI into operations.



Key Results

Is there a community of practice around AI/ML in your organization? If so how many participants, how is it organized?	No formal community Small informal teams (some)
What are your plans to bring AI into the organization? Is there an approach at scale being developed?	No its a ground up approach Conducting surveys (some) Incubator/Focus Areas (Some)
Who are the key developers in your organization with respect to AI/ML? Who are the key partners?	Small teams of local staff (most) Academic Partners (e.g. CIs, other academic)
Is there any program/center example that should be followed for the implementation of NCAI? *(Only some)	Not much confidence in previous models BEDI, IOOS
What would you like to see from the NOAA AI Center?	Elements close to the mission Workforce development Balanced governance Connection to other centers/partners

Figure 2.3. The business case for implementing AI technology requires a ground-up approach with a balanced governance model to prioritize mission requirements, expand partnerships and build workforce proficiency.

2.3 NOAA Cloud Strategy (David Layton, Tony LaVoi)

The NOAA Cloud Strategy was presented by Dave Layton, who explained cloud computing will require a culture change in how NOAA manages its data enterprise. Agile and highly reliable cloud solutions are available, and by definition, cloud computing provides on-demand service with broad network access, resource pooling, rapid elasticity, and measured service. The NOAA Cloud Strategy provides a unified approach for migrating to the cloud driven by requirements and the business case, and the goals are presented in Figure 2.4. To establish a default architectural end-state for NOAA's cloud services will provide direct benefits in improving data access and analytical tools for NOAA's AI applications. Another synergistic activity includes promoting partnerships on the creation of cloud sandbox capabilities to enable AI innovations (Fig. 2.5). The cloud implementation roadmap is intended to be updated periodically to reflect the current status of initiatives in the roadmap. The roadmap will establish effective governance through a NOAA Cloud Committee, and coordination is recommended to support NOAA AI initiatives. The NOAA Office of the Chief Information Officer (OCIO) will conduct routine interviews with program managers of known cloud initiatives across NOAA LOs. This presentation can be found in Appendix 12.5.

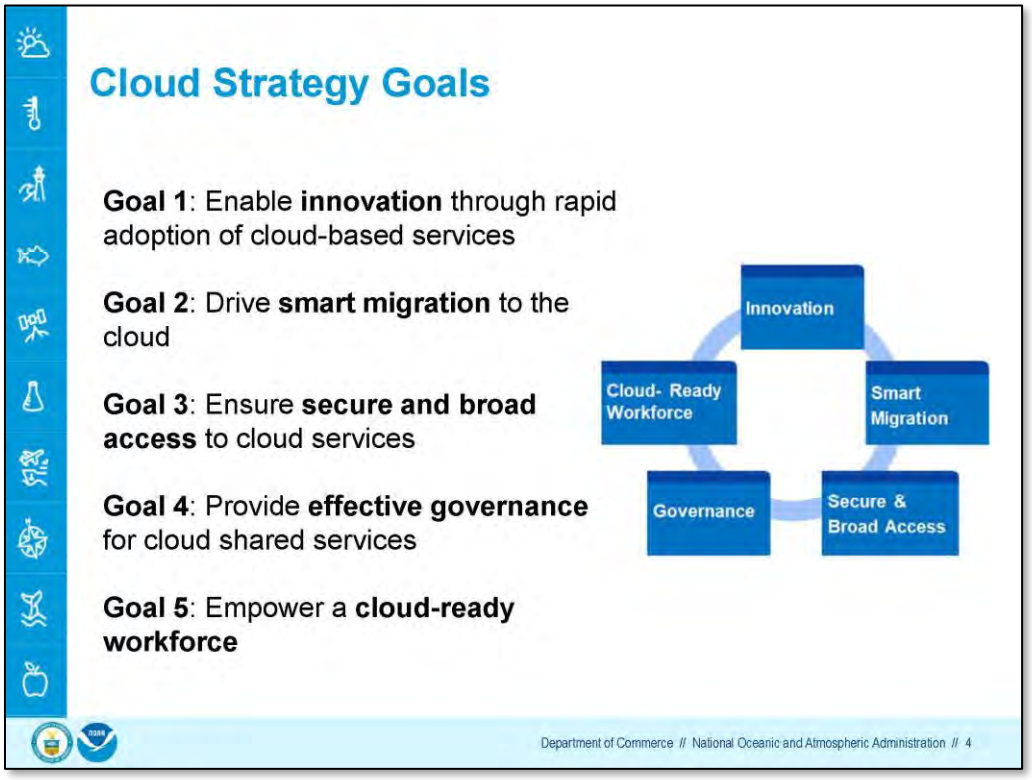


Figure 2.4. The NOAA Cloud Strategy will transform the NOAA data enterprise with smart data migration and cloud computing services based on NOAA mission requirements, best practices, and business case.

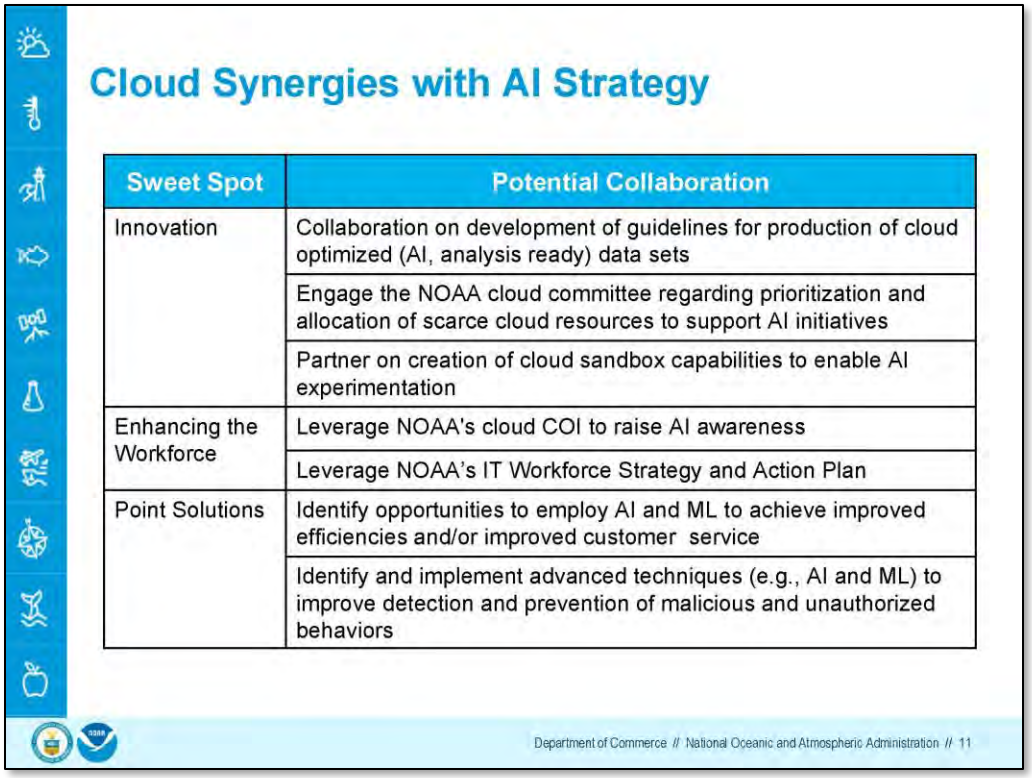


Figure 2.5. The NOAA Cloud Strategy will improve data accessibility and cloud computing services that supports NOAA's AI initiatives, and building partnerships to create cloud sandbox capabilities to enable AI innovation is recommended.

2.4 NOAA Data Strategy (Kim Valentine, Ed Kearns)

Kim Valentine presented the NOAA Data Strategy as a proactive approach to ensure NOAA is aligned and prepared to meet the new requirements of the Federal Data Strategy[7] and Evidence Act[8]. The NOAA Data Strategy will enable NOAA to improve mission delivery and steward resources, and accelerate the effective use of data by the agency, partners, and public. The goals of the NOAA Data Strategy will build a culture that values high quality data as an asset that is openly and widely accessible (Fig. 2.6). Data is the foundational cornerstone for each of the NOAA strategies, and emerging technologies have increased the volume of big data requiring more efficient data processing and analytical tools, such as the use of machine learning algorithms. The need to improve data quality and accessibility is synergistic for the NOAA strategies (Fig. 2.7). NOAA science is limited by the speed and ease of data access, and the NOAA Data and Cloud Strategies will need to leverage partnerships and stakeholder engagement to maximize NOAA data value to the nation. This presentation can be found in Appendix 12.6.

[7]Final Federal Data Strategy and 2020 Action Plan, https://strategy.data.gov/assets/docs/2020-federal-data-strategy-action-plan.pdf

[8]OMB Evidence Act guidance, https://www.whitehouse.gov/wp-content/uploads/2019/07/M-19-23.pdf

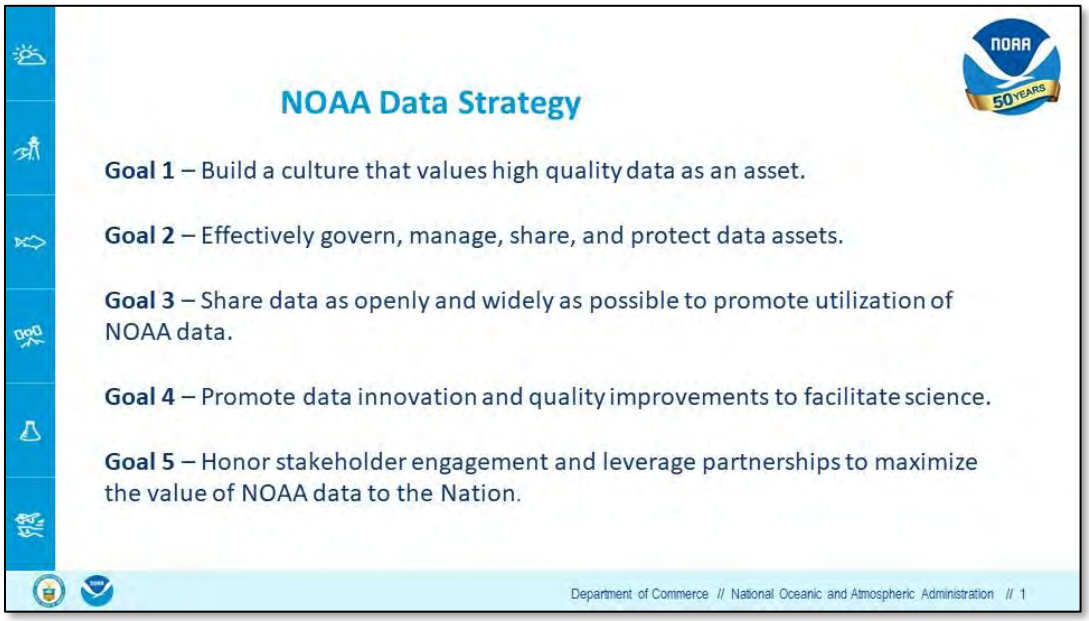


Figure 2.6. The NOAA Data Strategy strives to enable the agency's mission delivery and steward resources through improved accessibility and use of data by the agency, partners, and public.

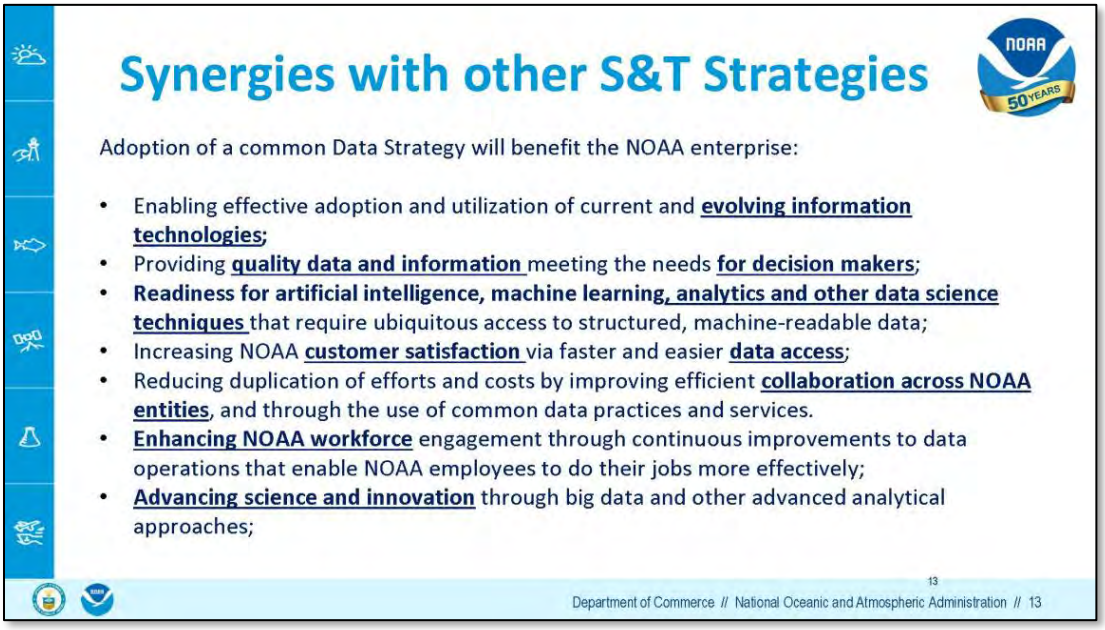


Figure 2.7. The NOAA data enterprise is the foundation for each of the NOAA strategies, and coordination across the NOAA entities is needed to enhance data quality, open access, analysis, and delivery of products.

2.5 NOAA Uncrewed Systems Strategy (Charly Alexander)

Charly Alexander began the presentation by acknowledging that each NOAA LO Assistant Administrator signed the approval of the NOAA strategies, and this buy-in across the agency shows strong institutional commitment. The purpose of the NOAA Uncrewed Systems (UxS) Strategy is to dramatically expand the collection and utilization of critical, high quality, and time-sensitive data by increasing the use and application of UxS technology. The NOAA Uncrewed Systems Strategy was previously referred to as the NOAA Unmanned Systems Strategy. UxS technology includes untethered platforms, sensor payloads, and communications that provide autonomous operations in support of NOAA's surveys and environmental observation infrastructure. The goals of NOAA UxS Strategy are similar to the NOAA AI Strategy, and address organizational efficiency, expand UxS research, accelerate UxS transition to applications, expand partnerships, and promote workforce proficiency (Fig. 2.8). UxS synergistic activities include data management, cloud computing, and analytics such as machine learning (Fig. 2.9), and the NOAA UxS operations are interdisciplinary, requiring close coordination across each NOAA strategy. The UxS Community Workshop planned later this year will identify implementation plan actions and need to expand partnerships and coordinate synergistic activities between the NOAA strategies. This presentation can be found in Appendix 12.7.

Figure 2.8. The NOAA UxS Strategy will improve organizational efficiency, expand UxS research, accelerate UxS transition to applications, expand partnerships, and promote workforce proficiency to dramatically expand the collection and utilization of critical, high quality, and time-sensitive data.

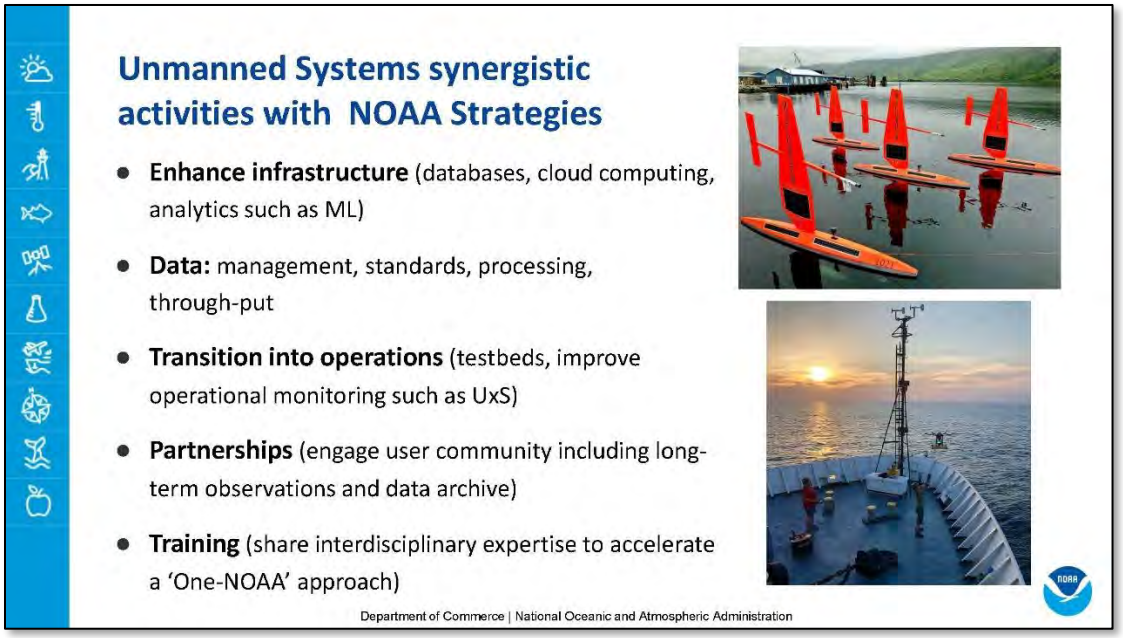


Figure 2.9. NOAA UxS operations are interdisciplinary, requiring close coordination across each NOAA Strategy, and synergistic activities include data management, cloud computing, and analytics such as machine learning to ensure effective UxS operations and timely delivery of scientific products.

2.6 NOAA 'OMICS STRATEGY (CISCO WERNER)

The NOAA 'Omics Strategy presented by Cisco Werner defined 'omics, also referred to as genomics, as a suite of advanced methods used to analyze material such as DNA, RNA, proteins, or metabolites. NOAA plans to integrate modern 'omics technologies across the agency, transforming its approach to biological investigations to accelerate scientific information for sustainable management of ecosystem resources for the benefit of people, communities, and economies. The next step is to develop the implementation plan that addresses each goal (Fig. 2.10), and to ensure coordination on the synergistic activities across the other NOAA strategies (Fig. 2.11). Similar to the other NOAA strategies, the need for cloud services for computing power and data storage infrastructure is a critical requirement for 'omics. This will enable the use of open-source tools, bioinformatic pipelines, and AI analytics, such as machine learning. The NOAA 'Omics Strategy will expand partnerships to advance research and applications across the agency, and there is a critical need to build 'omics expertise within the agency. This presentation can be found in Appendix 12.8.

Figure 2.10. The NOAA 'Omics Strategy will integrate modern 'omics technologies across the agency, transforming its approach to expand biological investigations to accelerate scientific information for sustainable management of ecosystem resources.

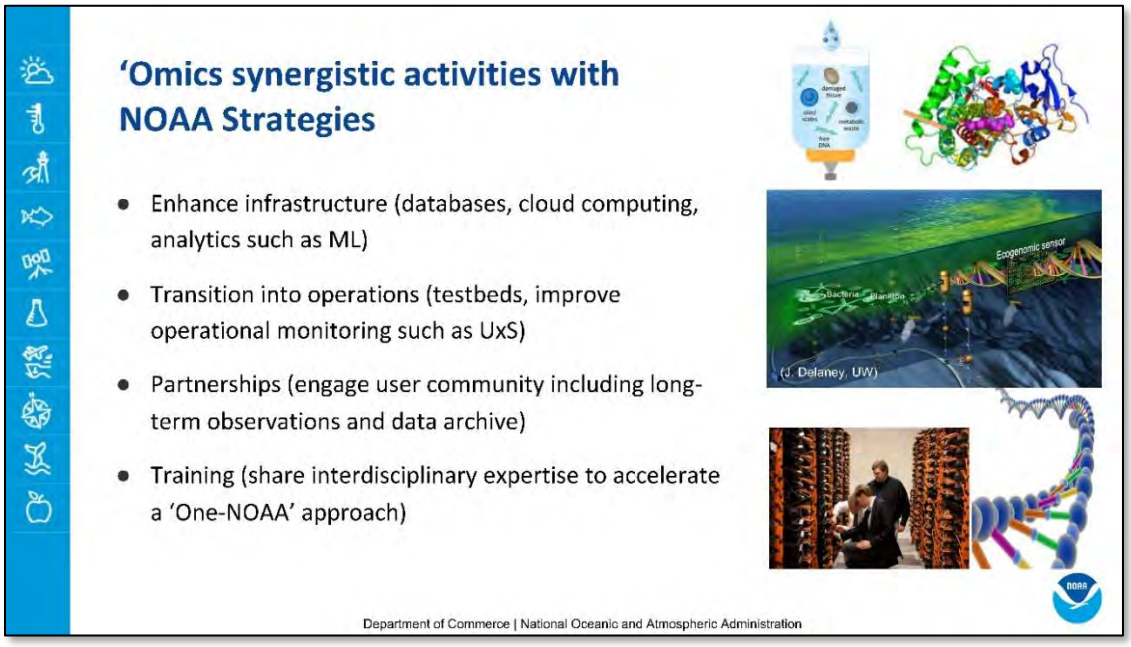


Figure 2.11. The NOAA 'Omics Strategy includes synergistic activities to improve cloud computing power and data storage, AI analytics, partnerships, and workforce proficiency to transition 'omics into operations.

2.7 NOAA EPIC STRATEGY (DANA CARLIS)

NOAA's Earth Prediction Innovation Center (EPIC) provides the opportunity to accelerate scientific research through sustained community engagement to produce the most accurate and reliable weather forecast modeling systems in the world (Fig. 2.12). The EPIC Strategy is an action resulting from the Weather Research and Forecasting Act of 2017[9]. The EPIC Community Workshop held in 2019 emphasized the importance of building external partnerships to advance NOAA's data and software infrastructure, including cloud-based, high-performance computing. EPIC facilitates continuous development of research and modeling to leverage process and prioritized investments, and improved coordination across the NOAA strategies is recommended to optimize synergy with the big data, cloud computing, and AI initiatives (Fig. 2.13). This presentation can be found in Appendix 12.9.

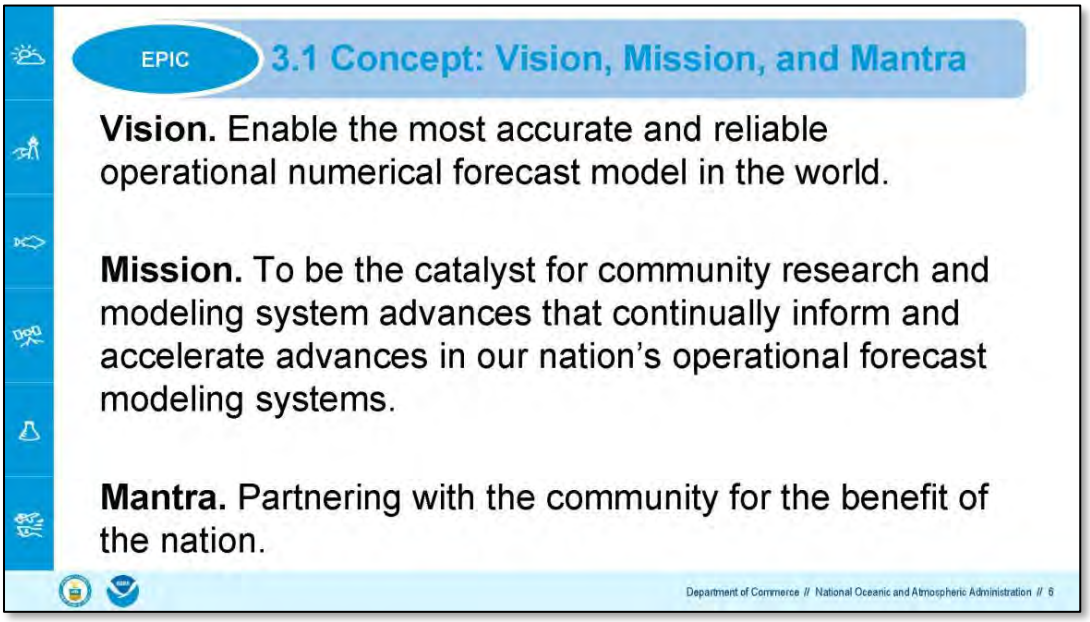


Figure 2.12. The NOAA Earth Prediction Innovation Center (EPIC) provides the opportunity to accelerate scientific research through sustained community engagement to produce the most accurate and reliable weather forecast modeling.

[9] Weather Research and Forecasting Act of 2017, https://www.congress.gov/bill/115th-congress/house-bill/353

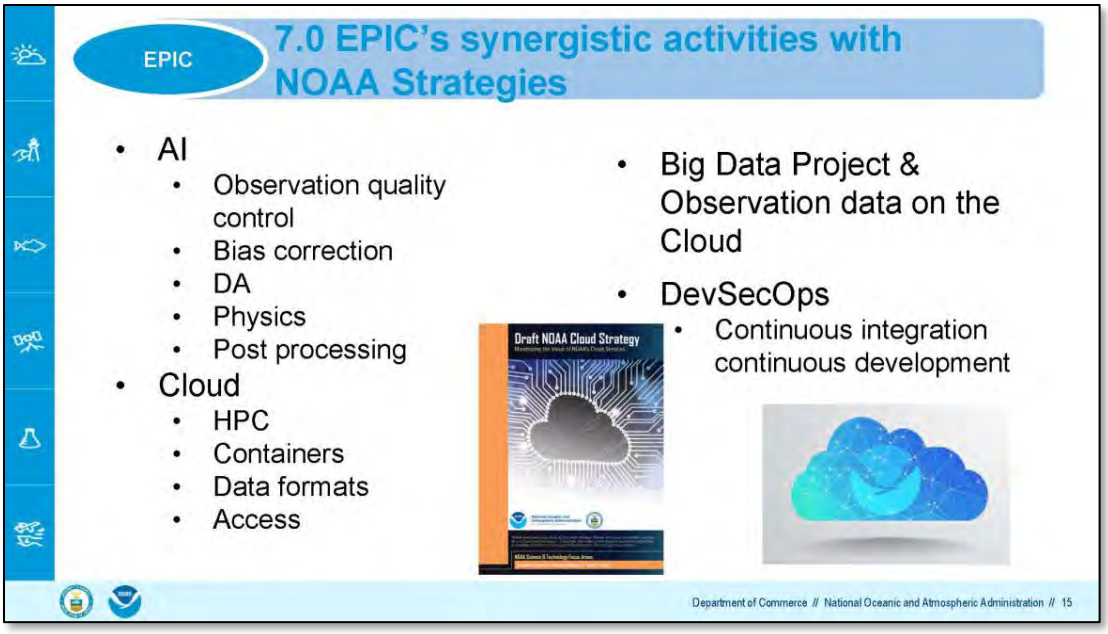


Figure 2.13. EPIC facilitates continuous development of research and modeling to leverage process and prioritized investments, and improved coordination across the NOAA Strategies is necessary to optimize synergy with the big data, cloud computing, and AI initiatives.

3 Panel Discussion 1: One NOAA Approach for NOAA Strategies

A panel discussion composed of the lead presenters on the NOAA strategies provided an opportunity for workshop participants (Appendix 12.2) to ask questions pertinent to the unified NOAA approach in coordination, shared resources, and budgetary guidance across the NOAA strategies. Each panelist provided an opening statement to begin discussions.

DaNa Carlis: What are the on-ramps and off-ramps in terms of the timelines for when these strategies need to come together? Collaborative discussions are needed at this time to better understand how the activities among the strategies fit together, especially at this time when the implementation plans are presently under development during the next couple of months. Furthermore, we need to include foresight about what the future could possibly be in the upcoming years. For example, how would the agency change if cloud became more cost-effective and it was no longer feasible to invest in on-premise servers? We need to begin thinking about the culture shift with more vision.

Cisco Werner: The world is changing ahead of us and we have a moving target. NOAA is undergoing a paradigm shift, and we need to pivot to figure out where to land with a moving target. Today, emerging science and technology is evolving more rapidly, while we have increasing uncertainty due to rapid changes in the ocean and atmospheric conditions. As we need to integrate across our sciences and strategies, we must also consider the workforce that needs to be trained and recruited into NOAA's new science direction.

Charly Alexander: Reinforcing our need to pivot, now is the time for the agency to implement a unified approach for the NOAA strategies. For example, the NOAA Data Strategy is a critical aspect for each

NOAA strategy and the foundation for NOAA as a science-based agency. These strategies are shifting the way NOAA operates and does science to achieve its mission. We must also examine how to better coordinate internally and with external partners.

Jamese Sims: The key is that we take a one NOAA approach to implementing the strategy. We have our own specific expertise, but we are connected across NOAA. We should not be limited only from a headquarters perspective. We need to think more broadly and collectively with input from the regional offices and science centers. In order to accomplish the objectives of the NOAA AI Strategy, the functions of the proposed NCAI will likely have centralized and distributed functions which need to be determined.

David Layton: Building on that notion of paradigm shifts, a keynote speaker at a recent cloud workshop stated, we need to lower the cost of curiosity. In other words, the speaker was encouraging us to think about how to remove barriers while accepting a reasonable level of risk. Innovation is constrained by a culture that rewards only accomplishments and provides no incentive for taking risk to obtain lessons learned. How can we change the culture to encourage experimentation and innovation? The NOAA Cloud Strategy is a good example of exploring options and lessons learning as cloud computing evolves rapidly.

Kim Valentine: Our data enterprise underlies all of these strategies, and changing the mindset is a struggle. In our community, we have devoted considerable time and effort over the years to make data accessible and documented. There are considerable barriers in data modernization because of constraints pertinent to the agency's mandates, policies, and partnerships. It will be challenging, and the organizational mindset will need to change to implement these NOAA strategies.

Eric Kihn: It is exciting to see the common threads, and the obvious one is data. The NOAA strategies will improve how data is collected, processed, and analyzed. This will require changes in the data enterprise infrastructure, shape a new workforce, and expand partnerships. Changing our culture to be agile is a challenge, yet a critical requirement as technology rapidly evolves. How do we become more adaptable and change culture to consider failure as important lessons learned? Coordination among the NOAA strategies will enable the more harvesting of our science.

Concluding recommendations from Day 1: The following question was discussed among the workshop participants and panelists:

- As we move forward with the strategies, how do we make sure that we continually promote the organic development at the research level and encourage innovation?

There was agreement that the strategies must support the research priorities at the field offices across the NOAA LOs, and this requires a transparent and agile process between the field and headquarters. While there is excitement about the benefits of the NOAA strategies to be realized, there is also caution to not create unnecessary bureaucracy that can stifle engagement from the field. We want an entity, such as the proposed NCAI, to serve as that conduit to support the mission and research priorities in the field. Institutional support does not mean control, rather it should enable rapid and agile advances in research. The proposed NCAI will also serve as a conduit for training. As we develop the NCAI business case, the combination of centralized and distributed functions with NOAA LO representation will need

to be determined. We need to enable the budgeting request process to support the necessary infrastructure to accelerate the efficiencies of emerging science and technology that people can use.

Another important question was presented:

- Building partnerships to enhance the agency's ability to utilize big data and cloud computing is foundational for the NOAA strategies; therefore, how do we remain agile and avoid vendor lock given the rapidly evolving technologies?

The NOAA Cloud Strategy has a set of principles to help guide decisions to optimize cloud investments. Ideally you want to be vendor agnostic. If the vendor has a great solution, then you develop the partnership; however, you always need an exit strategy before you make a commitment with a vendor. The NOAA data enterprise enables a deliberate and competitive strategy when expanding partnerships. The NOAA Cloud Strategy provides the example to not incrementally build out legacy infrastructure; instead, we need to look to a completely different end state as an option and to determine if the legacy/cloud is the right fit. There are different attitudes about the cloud, and the vendor neutrality aspect is important. The concept is for people to determine what their requirements are for cloud service, and not to prescribe a specific architecture for all of NOAA.

There was a discussion on the recent surge in using AI to conduct data assimilations using NOAA's large data set. It was stated that data are not truth, but rather approximations of a fluctuating environment. The importance of evaluating the assumptions and performance of models over time will remain a priority as the environment continues to change.

Discussions included the question:

- As we strive to improve workforce proficiency to transition emerging technologies into operational efficiencies, how do we recruit the needed expertise when the salaries are much higher in the private sector?

There was consensus among participants that our best investment is our existing workforce. While it is difficult to compete with salaries in the private sector, the existing professionals in NOAA are dedicated to its mission. Therefore, it is a wise investment to provide NOAA professionals the necessary leadership and academic training opportunities. While there is recognition that NOAA will need to recruit more engineers to transition emerging technologies into effective operations, our immediate need is to train our workforce and resolve institutional barriers that constrain our ability to work collaboratively with external expertise, which in turn builds expertise within our workforce. In part, this includes providing opportunities for external experts from national and international institutions to work alongside NOAA scientists, and sabbaticals to build our expertise from other agencies and industries. Scientific exchange at national and international conferences and workshops to promote collaborative research and remain current of the rapidly evolving technology are necessary. Shaping our workforce will consist of modifications to job descriptions and individual development plans. Support for cooperative institutions can also be directed to train our upcoming professionals through graduate research and undergraduate cooperative training programs. While there is priority placed on the NOAA strategies and other initiatives like Blue Economy, our workforce should be a much higher priority.

4 BUDGET UPDATE ON THE NOAA STRATEGIES (TIMOTHY GALLAUDET)

The NOAA UxS Strategy was our first effort which allowed for the initial FY2020 budget request for NOAA's Office of Marine and Aviation Operations (OMAO) to support UxS coordination and implementation. Not only did we get the FY2020 request of $4M, but we socialized it and built confidence with the Hill resulting in a $12.7M increase for UxS in FY2020. That is a real victory. Presently, the NOAA UxS Strategy team is working on their implementation plan. This team is addressing the challenge that the government will never have enough resources to match the private sector's ability to engineer technological advances. We are in the second age of technological innovations that was enabled by the government before, but now the private sector leads the innovations. For this reason, NOAA's efforts to expand its private-public partnerships is key to our success.

Presently, we are looking forward to another potential budget increase for the NOAA AI Strategy in FY2022 to mimic NOAA's UxS budget success. While the Department of Commerce (DOC) budget office is presently working with OMB, the FY2022 budget is not final yet. The efforts of this workshop will help establish the implementation plan, including the functions and infrastructure requirements of the NCAI. The NCAI will be the steward for the agency's repository for guidelines and best practices for AI-ready data, including training sets, algorithms, and tools. The NCAI will also serve as the central contact for promoting collaborations and partnerships. Strategically, we are appreciative of the recommendations from NOAA Observing Systems Council (NOSC). The NOSC is supportive of the NOAA AI Strategy, and our next step is to have the NOSC review and approve the NCAI business case. The NOSC wants to ensure program dollars are put to good use. Strategically, we are attentive to how the Department of Defense (DOD) and Department of Education (DOE) are proceeding with their efforts to establish AI centers. This is an exciting time for the NOAA Strategies to collectively transform the way our agency conducts its science for the socioeconomic benefit of our nation.

5 BREAKOUT SESSION 1: SYNERGISTIC ACTIVITIES ACROSS NOAA STRATEGIES

During Day 1 of the workshop, the first breakout session divided participants (Appendix 12.2) into three groups to identify the key synergistic activities that are interconnected between the NOAA strategies. For each breakout group, the participants were divided to ensure balanced perspectives and representation from each NOAA LOs. The break-out groups identified and prioritized the key synergistic activities across the NOAA strategies which are summarized in Table 5.1, and the following focus areas were discussed for improving coordination of the synergistic activities across the NOAA strategies for applying emerging science and technology:

Data and cloud services: The foundation for each of the NOAA strategies on emerging science and technology are the NOAA Data and Cloud Strategies. As NOAA increasingly expands the application of emerging science and technology, the volume of data will dramatically increase. Therefore, the top priority is to improve data access and dissemination to ensure high quality and timely scientific products and services. While the NOAA Data Strategy will build a culture that values high quality data as an asset that is openly and widely accessible, the NOAA Cloud Strategy will enhance on-demand data access and computing services with broad network access and resource pooling to provide the

necessary agility and measured service to accomplish the NOAA mission in a timely manner. Furthermore, these data and cloud initiatives can increase data access for the wider community for knowledge discovery, which provides added value to the NOAA data enterprise. It is recognized that an organizational culture shift will be required as NOAA collectively works to establish a default architectural end-state for NOAA's data and cloud services to improve data access and analytical tools for AI applications, and this should include promoting partnerships on the creation of data and cloud sandbox capabilities to enable AI innovations.

Governance: Each NOAA strategy addresses upfront in their Goal 1 the importance of establishing an oversight committee with equivalent NOAA LO representation, especially in regard to the prioritization and funding opportunities. Various governance models within NOAA were discussed, and there was agreement that the governance model should support the program integration and organizational culture shift required for implementing the strategic plans while avoiding unnecessary bureaucracy. For the NOAA AI Strategic Plan, governance will likely include an oversight committee composed of equivalent NOAA LO representation and the proposed NCAI. The NOAA approving body is yet to be determined, and it is recommended that a NOAA Science and Technology Synergy Committee be formed to ensure the synergistic activities of the NOAA strategies on emerging science and technology are coordinated as a unified approach.

Workforce development: There was agreement that enhancing workforce proficiencies for each NOAA strategy is a priority and is interconnected. Over the years, NOAA has prioritized training to advance its modeling capabilities. Today, NOAA needs to expand its training opportunities to include the priorities on the interdisciplinary nature of the NOAA strategies on emerging science and technologies. Through NOAA's cooperative agreements and centers of excellence, the agency will need to invest in its existing workforce and next generation of experts to remain proficient with emerging science and technology.

Leveraging partnerships: Expanding partnerships was a requirement across each NOAA strategy, and there is recognition that this needs to be improved at all levels within the agency. The NOAA LO organizational structure has created barriers for sharing resources; therefore, an organizational governance body or council is needed to support collaborative synergy across the NOAA strategies. Furthermore, NOAA will need to leverage private and academic partnership to benefit from the innovations of the rapidly evolving science and technology.

Research to operations: NOAA investments should be mission-driven and strive for operational efficiencies for timely delivery of the best scientific information available to serve the public. A common framework of shared resources would enhance the agency's ability to transition research to applications. Each strategy would benefit from utilizing testbeds and proving grounds to establish guidelines and frameworks to transition research into operations.

Table 5.1. The synergistic activities among the NOAA strategies on emerging science and technology were identified and ranked during the workshop breakout session 1.

Synergistic activities among the NOAA strategies	Ranked priority
Data and cloud services:	**18.6**
• Data and Cloud synergy for access and dissemination, shared computing	7.3
• Compute capacity (big data, cloud hosting, private partners)	3.6
• Cloud sandbox for AI	2.2
• Data synthesis, exploit big data	2.2
• R2X cloud-based applications for AI	1.2
• Resource sharing for Data/Cloud platforms	0.9
• Software sharing by NCAI	0.9
• Access to data characteristics (format, standards, storage stewards)	0.3
Governance:	**9.9**
• Leveraging lessons learned (e.g., EPIC)	3.1
• Program integration & culture change, joint program execution & prioritization	2.8
• Governance – What is the best model? Evaluate existing governance bodies	2.2
• Promote collaborations & funding across NOAA LOs	1.2
• Collaborations among NOAA strategies	0.6
Workforce development:	**7.9**
• Leverage NCAI for workforce development (technical & mgmt.)	4.8
• Training & shaping our future workforce, future position descriptions	3.1
Leveraging partnerships:	**8.0**
• Ensure external partners help define requirements, community engagement	3.1
• Leveraging private & academic partnerships	2.8
• Ease of access (acquisition/contracting) to industry	2.1
Research to operations:	**5.7**
• Common framework for research to applications	2.6
• Enable innovation & new capabilities	2.2
• Experimentation & proving grounds	0.6
• Optimize sensing strategies and automated operations (UxS)	0.3

Each break-out group addressed the following trigger questions:

- Which synergetic actions could support or be supported by the NOAA AI Strategic Plan?
- What resource-sharing opportunities across the NOAA LOs might exist for these synergistic actions?

Supportive actions for the NOAA AI Strategy: The NOAA Data and Cloud Strategies are considered to be foundational for the NOAA AI Strategic Plan. The ability to apply AI analytics requires a large database with machine readable metadata that is well described and allows an application programming interface. The NOAA Data Strategy will modernize the NOAA data enterprise to improve open access and use of AI analytical tools, while the NOAA Cloud Strategy will optimize the data architecture with cloud storage and cloud computing tools to integrate AI capabilities.

Actions supported by the NOAA AI Strategy: The application of AI, including machine learning (ML) analytics, supports each of the NOAA strategies and helps to address the NOAA big data challenge.

Presently, there are nearly 200 ongoing NOAA AI projects, and about half of these projects have applied AI to reduced data processing using ML automated detection and classification algorithms. Furthermore, AI analytics have improved NOAA's data assimilations and forecast modeling capabilities using the NOAA environmental data enterprise. Emerging technologies (i.e., remote sensing, atmospheric and oceanic observation systems, UxS, 'Omics, and Citizen Science) have dramatically increased the volume of environmental data collections, and AI analytics provides the means to process and analyze these data in a timelier manner in support of NOAA's cross-functional missions. Furthermore, AI will enhance knowledge discovery by the wider scientific community, thereby adding value to the NOAA data enterprise. A summary of ongoing NOAA AI projects can be found in Section 7.6.

6 PANEL DISCUSSION 2: LEVERAGING SYNERGISTIC ACTIVITIES

Day 1 of the workshop concluded with a panel discussion composed of the presenters of the above NOAA strategies. This session provided an opportunity for the panelists and participants to address concerns and provide recommendations on how the synergetic actions of the NOAA strategies can be collectively leveraged for the NOAA AI Strategic Plan. The questions for and responses from this panel discussion are as follows:

Bill Michaels: What are the greatest concerns you have for bringing these strategies together with respect to organizational efficiencies or inefficiencies?

Sid Boukabara: The organizational efficiencies can be realized through the synergy between the NOAA strategies. The biggest risk is to execute these strategic actions in stove-pipes instead of a collaborative approach. Perhaps we should have a pilot project with a common sandbox to demonstrate the efficiencies of bringing the synergistic activities of the NOAA Data, Cloud, and AI strategies together.

Kim Valentine: It's about communication. There are so many correlations and connections between these strategies, and we need to expand our communications like we're doing here today on the importance of coordinating these strategic synergies across NOAA LOs.

Dave Layton: I agree communication is key. There is a high risk of replicating our on-premise infrastructure in the cloud if we do not have a coordinated way forward. I would add, from the cloud perspective, follow the money. As the agency invests in the cloud, we will need to address questions on how best to provide this resource. How do we jointly fund and share a common infrastructure that we can more effectively utilize? Our agency's financial models are not organized to work collectively across NOAA LOs, so how do we jointly fund that common service?

Jamese Sims: This workshop has successfully begun communications between the leads of the NOAA strategies, and we need to continue these communications beyond this workshop. Monthly meetings between strategy leads has been beneficial to learn more on how best to coordinate the synergy. A key concern is how will the NOAA Strategic plans be executed collectively when many of the actions for each plan will be dependent on funds within each NOAA LO. The recommendations on the synergistic activities defined from this workshop and monthly meetings between the NOAA strategy leads must be delivered routinely to senior-level support to maintain the momentum for executing the implementation plans.

DaNa Carlis: We must define where we want to be ten years from now as it pertains to the way we do business. There's a lot of conversation around planning for that. For example, the cloud can be viewed as a disruptive technology today as we determine how best to migrate data to optimize cloud services. This will effectively transform the way we operate 10 years from now. There are good examples available for analyzing the cost-benefits.

Charly Alexander: An objective of the NOAA UxS Strategy emphasizes the need to improve data management for the large volumes of data collected from UxS technology; therefore, we need to take a fresh look at the service areas in NOAA to improve the efficiencies of data access and analytical tools to deliver timely products. This includes the need to train our workforce and improve how we interact with the private sector. The NOAA strategies will result in transformative changes during the next 10 years, and we need to gain the support of the agency's sponsors. This is best achieved by working together to reduce redundancy and improve operational efficiencies with coordination across the NOAA LOs.

Eric Kihn: This requires an organizational cultural change, and there is concern that NOAA is structured for LO success resulting in siloed projects. These strategies require each piece of NOAA to bring part of the solution. How do we change the governance to enable the culture shift to achieve that success? The technical piece takes care of itself, while the grand challenge is the organizational cultural shift needed to collectively implement the NOAA strategies as a unified NOAA approach.

Mashkoor Malik: There are ongoing AI projects that are stove-piped with incremental advances depending on individual project funding. Coordination across the NOAA LOs will potentially eliminate redundancy and optimize resources. The question is how will the AI applications be prioritized and funded? Is that a NOAA-wide decision or LO decision? How do we identify the low hanging fruit?

Eric Kihn: AI is already making advancements within the agency, and the two key components of Goal 1 in the NOAA AI Strategic Plan are to establish oversight with equivalent NOAA LO representation and to facilitate coordination through the NCAI. The NCAI will serve as the AI center of excellence for NOAA to enable a community of practice, increase awareness and access to best practices and tools, and provide training opportunities. The NCAI will also work closely with the NOAA Data and Cloud Strategies to develop a community of excellence around AI, and provide input to the NOAA AI Executive Committee (NAIEC) to help prioritize and identify the low hanging fruit.

Dave Layton: The cloud smart migration goal will develop tools and guidelines to facilitate transition of applications to the cloud and a business case template (best practice model) for moving to the cloud. One objective is to develop tools and guidelines to facilitate the transition of applications to the cloud. This includes identifying the characteristics of what you have today and what are the NOAA-wide distributed requirements in the upcoming years.

DaNa Carlis: Each NOAA strategy needs to provide an effective governance structure that is representative of the NOAA LOs with transparency and metrics. There are good examples in NOAA, like top-down oversight with tiger teams to define a pathway to transition applications into operational efficiencies. While our scientists only have so much time to engage in tiger teams, they have successfully provided senior leadership business cases for why we should invest in pilot projects. This can help leverage support and investment for the NOAA strategies.

Hendrik Tolman: For the past two decades, NOAA scientists have struggled to work with external collaborators outside of the NOAA firewall. If the NOAA data enterprise utilizes the cloud services, we will have a more collaborative environment and be a more captive customer with improved dissemination. Migrating to the cloud will occur incrementally during the next five years as we avoid disruptions to operations and optimize workflow for forecast modeling. This comes back to AI because cloud will give enhanced access to everybody, which will dramatically enable AI analytical capacity.

Bill Michaels: We can assume AI will be enabled in the cloud in the upcoming years, and cloud computing will be a huge paradigm shift for the cost model. NOAA and each of its science centers will need to prepare for this cost model, and I'm wondering, how much do we know about the developmental costs for migrating to the cloud? Another question is how do we develop the tools and guidelines to facilitate cloud-smart migration based on defined pathways to more efficient operations and applications?

Jebb Stewart: There is a lack of understanding of what it actually costs because we do not have experience for developing the cost model. We need to understand what a project of a certain scale should cost before submitting proposals.

Hendrik Tolman: The eye opener to me is the largest cost tends to be the data egress of the cloud.

Ed Kearn: Egress is exactly why NOAA did the Big Data Project. There is a misconception that people think the cloud is more expensive than our existing on-premise servers. The NOAA Big Data Program has conducted pilot studies that demonstrated the cost, including data egress, is actually less expensive. We have driven egress to zero on contract for the next 10 years. We need to eliminate the organizational obstacles to move forward with the cloud.

Bill Michaels: Some researchers need cloud storage and computing resources; however, they have run into administrative and bureaucratic barriers to utilize the cloud. On the other hand, other researchers like the control of having their data and computing resources on regional servers to meet the mandate-driven science requirements for that region. How do we move forward with modernizing our agency's data enterprise and use of cloud to enable requirements-based AI applications?

Eric Kihn: People on the ground are excited about AI. The bottom-level excitement says let's move forward with AI without the organizational barriers, and the top-level excitement asks how we can help. Emerging science and technology have dramatically increased the data volume and we need the AI tools to address the big data problem. The question is, how do we improve the organizational culture to move forward without creating additional bureaucracy?

Kim Valentine: Change often comes from the bottom up; therefore, training and recruiting workforce proficiencies with the required skill sets are critical for the implementation of the NOAA strategic plans.

Hendrik Tolman: We have experience drowning stuff in governance in the government, and defining the requirements from the solutions to decision support is a good approach. Presently, there are too many stove-piped initiatives and projects, and the NOAA strategic plans will enhance collaborative efforts across the NOAA LOs. There must be a balance with establishing a collective governance and decision process, while not creating a free-for-all.

Ben Richards: We've seen that no level can be less restrictive than the level above them, and it appears that each level chooses to be more restrictive to justify their existence. This can be restrictive to researchers doing their work. All levels must understand their job is to facilitate and not restrict.

Bill Michaels: Agree, each level must strive to support researchers to expedite the products and services of high integrity that support the agency's mission. Transitioning research and development into operational efficiencies is the valley of death that requires additional resources, and researchers can gain support by including the business case with cost-benefit analyses.

Dave Layton: The cost-benefit analysis is needed for migrating to the cloud. There needs to be a cost-modeling tool that evaluates current services cost with cloud services. In recent years with data center consolidation efforts, we attempted to identify operational costs. The results suggested cost savings were not the biggest benefit, but rather agility was the most important benefit.

Ed Kearn: You can do things in your own silo on the current system, while the Big Data Program has attempted to evaluate the cost-benefits of current systems compared to the cloud. Most managers treat labor as a sunk cost and do not get numbers on potential cost savings, so we tried to get at the cost savings just in dissemination alone. We gave up because we could not get the numbers out of the NOAA LOs, and some aspects of this are simply unknown. Our best guess is adopting the cloud can save the agency between $9M and $50M per year. Another observation is the fear that any cost savings could potentially disappear within a given NOAA LO budget.

Hendrik Tolman: The organizational culture change that will undoubtedly occur in the upcoming years due to emerging science and technology. While this can be disruptive, we have examples of cases with demonstrated benefits that speak louder than words. We need to improve communications to highlight the cases where collaborative efforts with partners have made a difference. Furthermore, the balance between focus and diversity of perspectives have also moved the cultural shift to more effective operations.

Ed Kearn: There is also a need to improve the efficiencies of the contractual acquisition process, and NOAA has been establishing the Other Transaction Acquisition (OTA) process which provides a more expedited process not constrained by the Federal Acquisition Regulations. The OTA will be evaluated in a new and satellite-focused initiative to enhance the NOAA architecture and data enterprise.

Bill Michaels: Today's discussions were informative on the synergistic activities among the NOAA strategies on emerging science and technology, and our vision for where NOAA needs to be strategically for the upcoming years. Tomorrow, we will discuss the actions of the NOAA AI Strategic Plan and which actions will support or be supported by these synergistic activities. This requires an organizational culture shift from an agency that is structured for LO success to one that collectively enhances operational efficiencies. The first day of the workshop is adjourned, and participants are invited to the workshop social event to continue discussions on how to proceed with tomorrow's workshop agenda and breakout sessions.

7 NOAA AI STRATEGY GOALS AND ACTIVITIES

The second day of the workshop focused on identifying actions of the NOAA AI Strategic Plan, including the business case for establishing the NOAA Center for AI. The synergistic activities identified from the first day will be incorporated into this framework.

7.1 GOAL 1: ORGANIZATIONAL STRUCTURE AND OVERSIGHT (FRANK INDIVIGLIO)

Similar to the other NOAA strategies, Goal 1 of the NOAA AI Strategy focuses on the organizational governance and supportive processes to execute actions of this plan. The Goal 1 presentation outlined five objectives (Fig. 7.1), and three key components of the proposed governance structure include:

- NOAA AI Executive Committee (NAIEC) composed of NOAA LO representation with well-balanced perspectives to provide oversight for the execution of the NOAA AI Strategic Plan.
- NOAA Center for AI (NCAI) to facilitate awareness and coordination of AI efforts across the agency. The NCAI will provide a centralized repository for guidelines on AI-ready data and tools, training resources to accelerate AI, and will build a community of practice across NOAA and with its partners.
- NOAA approving body, possibly the NOAA Research Council, for NAIEC recommendations and pertinent policy decisions of the NOAA AI Strategy. This approving body can also ensure coordination of the synergistic activities among the NOAA strategies for emerging science and technology.

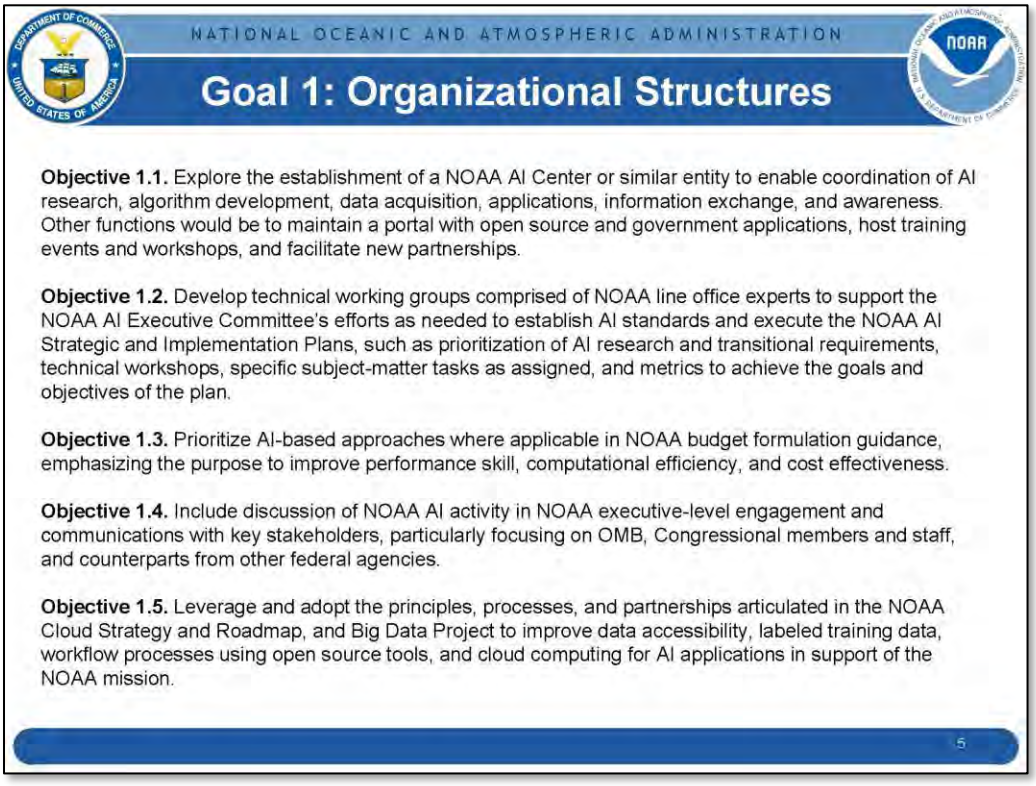


Figure 7.1. The objectives in Goal 1 of the NOAA AI Strategy address the requirements to establish efficient organizational structures and processes to advance AI applications across NOAA.

Further discussions will be needed on the need for technical input from the NOAA LOs, developing the business case for the NCAI, prioritization for budget formulation, communications with congressional subcommittees and external partners, and the supportive activities of the NOAA strategies. The NOAA data and cloud strategies are particularly important for enhancing data accessibility and workflow to enable AI applications. There is recognition that the other goals of the plan are highly dependent on the governance structure to be established. This presentation can be found in Appendix 12.10.

7.2 Goal 2: Accelerate AI Research and Development (V. Krasnopolsky)

There were five objectives presented for Goal 2 to advancing AI research and innovation across NOAA (Fig. 7.2). This goal includes a range of interdisciplinary research including development of algorithms and tools for applications such as data processing efficiencies with automated detection and classification toolkits, and improvements in data assimilation and predictive modeling. NOAA's investments in research and development of innovative AI approaches should be guided by a requirement-based process and the need to transition AI into operational efficiencies in support of the NOAA mission (Goal 3). Some discussion points were highlighted in preparation for today's breakout session (Fig. 7.3). The need to expand collaborations with other agencies and partnerships (Goal 4) and improve NOAA's workforce proficiencies (Goal 5) are at the core of the AI implementation activities to accelerate AI innovations in ecosystem and Earth system science. Refer to Appendix 12.11 for this presentation.

Figure 7.2. The objectives in Goal 2 of the NOAA AI Strategy address requirements to advance AI research and innovation in support of NOAA's mission.

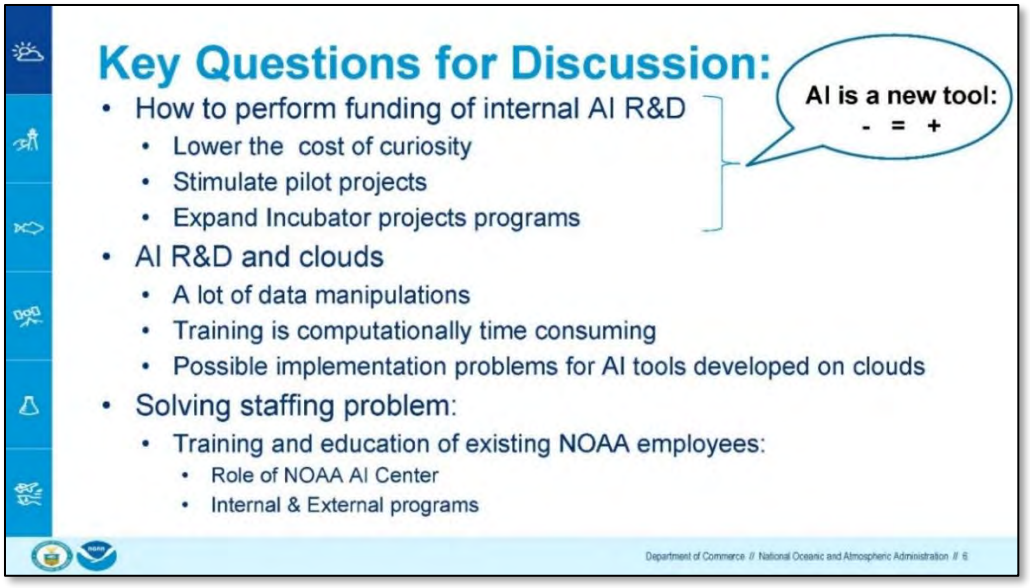


Figure 7.3. To advance AI research and development, there are key discussion points pertinent to the requirements for data and cloud services, promoting innovation, expanding partnerships, and improving workforce proficiency.

7.3 GOAL 3: TRANSITION AI RESEARCH TO OPERATIONS (HENDRIK TOLMAN)

An overview of the Goal 3 objectives was presented to prepare for breakout discussions on actions to enable rapid AI transition across NOAA as a unified approach in research to operations (Fig. 7.4). The evolving AI technology requires requirement-based holistic projects that are business-case driven, employ agile development, and apply evidence-based decision making. Scientific and technical standards for establishing AI-ready data and training procedures are necessary to validate the performance and assess bias of models to ensure delivery of high-quality and timely products for informed policy decisions. The formalized scientific, technical, and policy standards relevant to AI will need routine evaluation and updates to remain current with the rapidly evolving technology. Appropriate metrics should be established to monitor the progress and benefits of AI applications. NOAA should utilize testbeds and proving grounds to provide a mechanism to effectively evaluate research and standards for transition to operations. NOAA will need to establish or allocate budgets to leverage partnerships and accelerate the transition of AI research into operations. The last two objectives address the need to improve communications and transparency to promote the dissemination of reliable and trustworthy AI products. As a science-based agency, the top priority for NOAA is to maintain the integrity and credibility of the scientific products and services provided to the public. This presentation on Goal 3 can be found in Appendix 12.12.

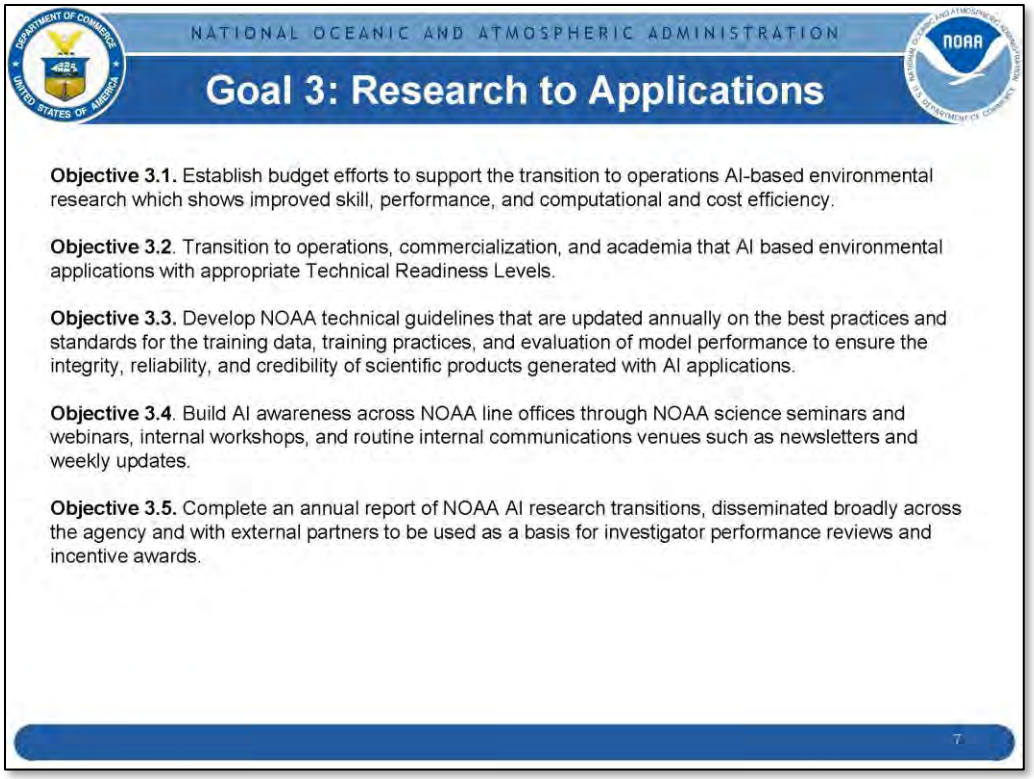


Figure 7.4. The objectives in Goal 3 of the NOAA AI Strategy address requirements to accelerate the transition of AI research to applications.

7.4 GOAL 4: STRENGTHEN AND EXPAND AI PARTNERSHIPS (JEBB STEWART)

For today's discussions, there are six objectives proposed for Goal 4 to strengthen and expand NOAA partnerships for advancing AI research and development (Fig. 7.5). Partnerships serve as force multipliers to optimize resources and collaborations for scientific and technological exchange that keeps NOAA current in the evolving field of AI. Building partnerships across government, academic, industry, and research institutions both nationally and internationally is critical to effectively achieve many of the actions of this implementation plan. Equally important is partnering with the NOAA Data Strategy, NOAA Cloud Strategy, and NOAA Big Data Program to leverage data and cloud services that are foundational for enhancing AI-ready data access and workflows for AI analytics. As mentioned in Goal 1, the NCAI will have an important role in creating a community of practice that promotes innovation to collectively accelerate NOAA's capabilities in AI. The objectives of Goal 4 specially focus on NOAA policies that can help expand AI advancement through academic and private partnerships, as well as governmental cooperative agreements. During today's breakout sessions, we will need to discuss how best to utilize administrative mechanisms that can leverage joint expertise, optimize collaborative investments, and facilitate scientific and technical information exchange between NOAA LOs and other organizations. This presentation can be found in Appendix 12.13.

Figure 7.5. The objectives in Goal 4 of the NOAA AI Strategy address requirements to strengthen and expand partnerships to advance AI applications in support of the NOAA mission.

7.5 GOAL 5: PROMOTE AI PROFICIENCY IN THE WORKFORCE (GREG DUSEK)

An overarching theme across all objectives in Goal 5 (Fig. 7.6) was the recognition that there is a cost associated with providing good training, and that much of this work can be or should be directly supported by NCAI (Goal 1). Five of the objectives for Goal 5 address approaches to improve NOAA's existing workforce through on-line training, academic and professional training opportunities, and rotational assignments across NOAA LOs. The importance of identifying specific budget items focused on training and workforce development is essential, as is ensuring the NCAI has the right expertise to support on-line training and workshops to improve NOAA workforce proficiency in AI. Managers at the project level serve as a primary mechanism to encourage employee involvement and hands-on training opportunities in AI, and that training should be connected to mission priorities. This can also include collaborative opportunities with experts at academic and industry institutions. NCAI can assist with its efforts to establish a community of practice in AI. Furthermore, developing workforce proficiency is a common goal in each of the NOAA strategies on emerging science and technology, and training requirements may well be interdisciplinary and cross-cutting for these strategies. Lastly, there is an objective that prepares our future workforce in AI proficiency by working with the NOAA Office of Education (NOAA OE) to create student internships and encourage undergraduate and graduate students, including students from diverse backgrounds and underrepresented groups, to engage in AI research pertinent for addressing NOAA's gaps and priorities. This presentation can be found in Appendix 12.14.

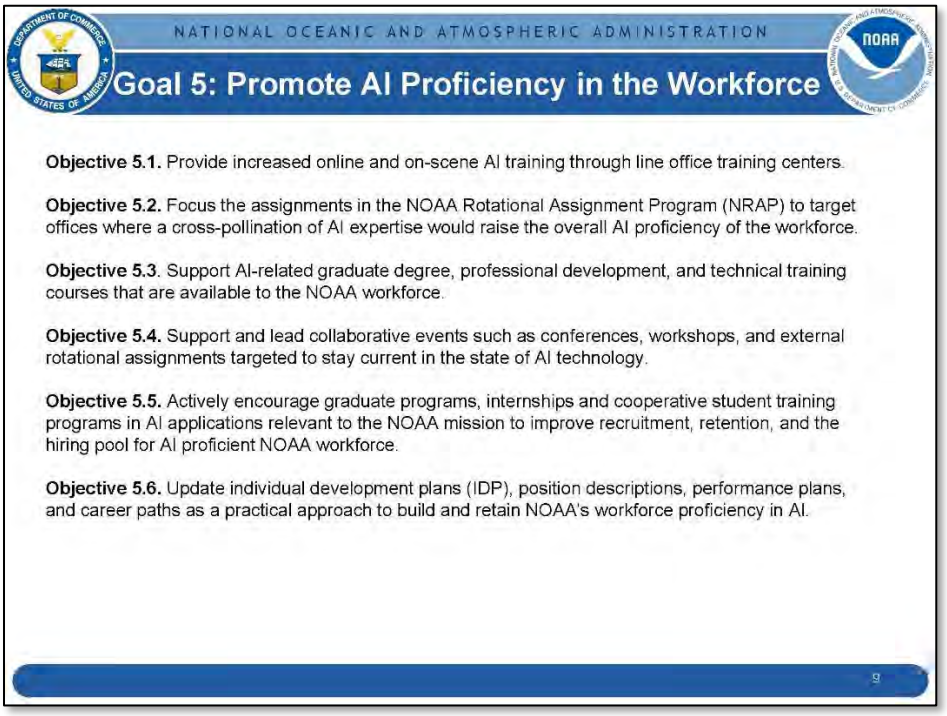


Figure 7.6. The objectives in Goal 5 of the NOAA AI Strategy address requirements to promote AI proficiency in the NOAA workforce.

7.6 SUMMARY OF NOAA AI DATA CALL (WILLIAM MICHAELS)

NOAA presently has about 190 ongoing AI projects as shown by a NOAA AI data call administered during February 2020. This NOAA data call provided information on existing AI project description, principal investigator, partnerships, anticipated budget requirements, and Technology Readiness Level (TRL). While the NOAA AI Data Call may not have captured all of NOAA's AI efforts, it provides useful information for drafting the NOAA AI Strategic Plan that can be useful for understanding priorities, gaps, and the level of support needed. This data call points to two drivers for NOAA's AI efforts; the need addresses the big data challenge by accelerating data processing with AI automated detection and classification, and ongoing efforts to improve data assimilations and forecast predictions (Fig. 5.1). NOAA AI projects also apply AI technology to a variety of data types found in NOAA's environmental data enterprise which highlights NOAA's interdisciplinary scientific leadership in ecosystem and Earth science (Fig. 5.2). Noteworthy is that about 25% of NOAA AI efforts have advanced to being fully operational (TRL 8 and 9) to provide higher quality and more timely scientific products and services (Fig. 5.3). Further efforts are needed to improve the tracking of the NOAA AI efforts and metrics, increase awareness and collaborations, and to optimize resource sharing. This presentation can be found in Appendix 12.15.

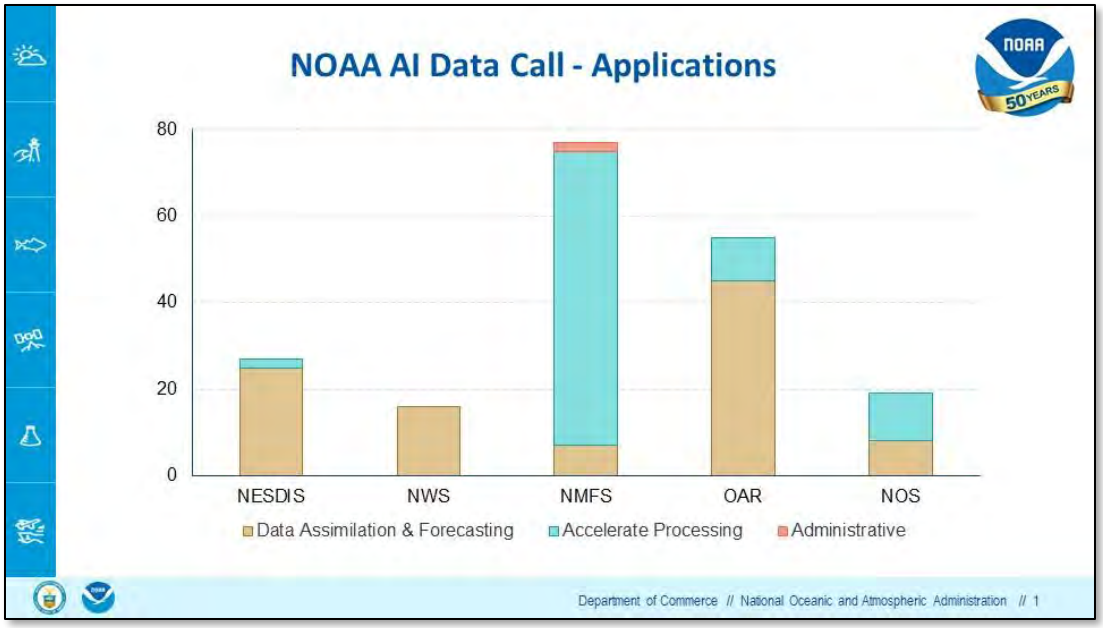


Figure 7.7. NOAA has made significant progress in the application of artificial intelligence (AI) and specifically machine learning (ML) analytics. There are two key drivers in NOAA's application of AI-ML; the need to improve data assimilation and forecast modeling, and need to accelerate the data processing of big data collected from emerging technologies.

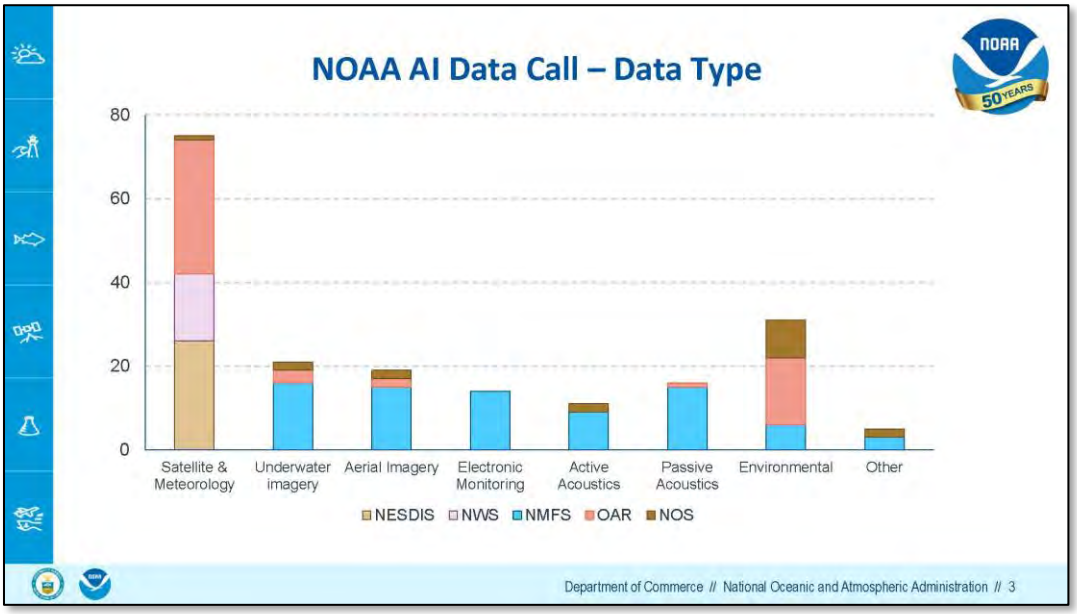


Figure 7.8. NOAA has applied AI-ML to a variety of environmental data, demonstrating its interdisciplinary research and operational capabilities in support of its cross-functional mission requirements.

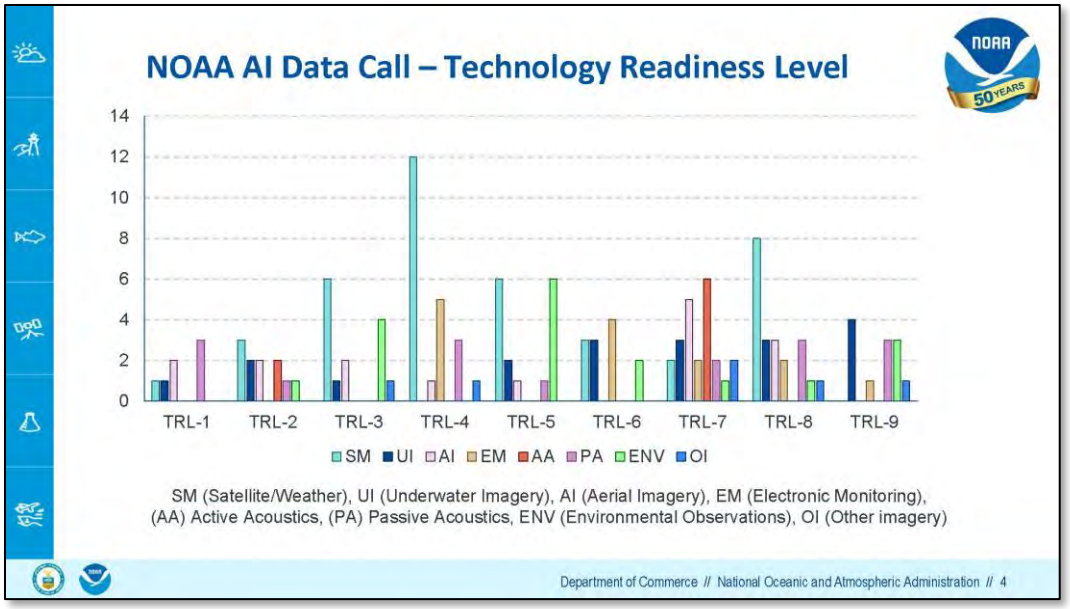


Figure 7.9. NOAA's efforts to apply AI-ML to its cross-functional mission requirements are at various Technology Readiness Levels (TRLs). Approximately 38% of the NOAA AI projects have reached the TRLs 1-4 which represent the research and development to proof of concept, and about 37% of the NOAA AI projects are in the TRLs 5-7 transitional phase before operationalizing AI technology. Approximately 25% of the NOAA AI projects have reached the TRLs 8-9, which is the final phase of bringing AI technology into routine operations.

8 Breakout Session 2: Actions for the NOAA AI Strategy

The second breakout was conducted during the morning of Day 2, and three breakout groups were tasked to identify the key actions and resource-sharing opportunities for each goal of the NOAA AI Strategy. Participants (Appendix 12.2) were divided into three breakout groups to ensure balanced perspectives and representation from the NOAA LOs. The following trigger questions guided the discussions for the breakout groups:

- What are the key actions for the objectives of each goal of the NOAA AI Strategy?
- Identify NOAA LOs' engagement for each of these key actions.
- What resource-sharing opportunities might exist across the NOAA LOs for key actions?

While discussing these questions, participants were asked to consider the synergistic activities of the NOAA strategies that were identified on Day 1. Upon completion of breakout session 2, participants were asked to prioritize the key actions across the goal areas (Tables 8.1 through 8.5). The leads of each breakout group provided the following report-outs of key actions, prioritization, and recommendations for developing the framework of the NOAA AI Strategic Plan.

8.1 BREAKOUT DISCUSSION ON ACTIONS FOR GOAL 1:

Participants discussed key actions for Goal 1, and considered the highest priority to define actions for NOAA executive-level engagement through the oversight of the NAIEC (Table 8.1). It was recommended to insert Objective 1.0 with the action to define the oversight role, terms of reference, and membership of the NOAA AI Executive Committee (NAIEC) as the first action in FY2021. The NAIEC membership should have equal representation from each NOAA LO to provide the necessary balance in perspectives to empower collaborative efforts across the agency. The next priority was to ensure governance included a mechanism to enable coordination of the synergistic activities across the NOAA strategies, especially for the NOAA Data and Cloud Strategies. This could be achieved by expanding the scope of the NOAA approving body, possibly the NOAA Research Council, and to establish a NOAA science and technology synergy committee that communicates routinely. There was considerable discussion on how to establish the prioritization process with the NAIEC that equally evaluates the priorities and gaps of each NOAA LO. This process will likely require technical input from experts from each NOAA LO; therefore, discussions included the need to define the terms of reference for a NOAA AI working group. There are different approaches to meet this requirement; establish a working group of volunteer experts from each NOAA LO to address technical tasks as needed, and embedded representative experts for each NOAA LO within the NCAI. There was consensus that establishing the NCAI was essential for the success of the NOAA AI Strategic Plan as specified in Objective 1.1. The NCAI will serve as the focal point of the plan to improve AI awareness and coordination across the agency. Priority was placed on the NCAI facilitation role to serve as a repository for guidelines on AI-ready data and tools, workforce training, and to establish a community of practice across NOAA and with external partners. The NCAI can also play an important role in leveraging principles and partnerships with the NOAA Data and Cloud Strategies.

Table 8.1. Key actions for Goal 1 objectives for the NOAA AI Strategic Plan were identified and prioritized during the workshop breakout session 2. *It was also recommended that an objective be added to define the oversight role of the NOAA AI Executive Committee.

Key actions for the NOAA AI Strategic Plan	Ranked Priority
Goal 1. Establish efficient organizational structures and processes:	
1.0. Recommend adding an objective for the NOAA AI Executive Committee oversight	*
1.1. Explore the establishment of a NOAA Center of AI (NCAI)…	**4.1**
• Repository to increase accessibility for AI-ready data, tools, and guidelines	3.8
• Facilitate partnership and cooperative agreement opportunities	0.3
1.2. Develop technical working groups… NOAA line office experts… Executive Comm.	**4.0**
• Expert NOAA LO representation to identify AI requirements and gaps	3.1
• Determine terms of reference for AI transitional activities	0.9
1.3. Prioritize AI-based approaches… in budget formulation guidance…	**4.5**
• Prioritization process for budgetary formulation	4.5
1.4. Include discussion of NOAA AI activities in NOAA executive-level engagement…	**8.9**
• Governance structure and oversight, and evaluate examples in good governance	8.9
1.5. Leverage principles and partnerships in NOAA cloud and data strategies	**6.5**
• Shared training data and evaluate examples of data sets	5.3
• Define requirements for data standardization and processes	1.2

8.2 BREAKOUT DISCUSSION ON ACTIONS FOR GOAL 2:

There was recognition that many NOAA scientists are presently engaged in AI research, as indicated by the recent data call (section 7.6), and the NOAA AI Strategic Plan will accelerate these ongoing efforts by leveraging the agency's expertise, partnerships, and resources. Therefore, much of the discussion on Goal 2 was interconnected to the need to transition AI research into operations (Goal 3), expand partnerships (Goal 4), and build workforce proficiency in AI (Goal 5). Top priority for Goal 2 was the need to identify and coordinate testbed and proving grounds to evaluate algorithms and model performance, establish best practices, and to benefit from lessons learned for transitioning research into operations (Table 8.2). Presently, most ongoing AI research projects are funded incrementally with specific programs, and there is a need to establish NOAA-wide funding to support more collaborative testbed and proving ground opportunities. The second priority for Goal 2 is to establish a requirement-based process to leverage available assets, expertise, and resources. This should include prioritization and gap analyses, and a roadmap that transitions AI research into operations. This is closely linked to the need to build expertise within NOAA through scientific exchange, rotational assignments, and training (to be discussed in Goal 5). The acceleration of AI research and development requires expansion of partnerships across NOAA LOs and with external partners (Goal 4), and pertinent discussions included topics such as clarity on intellectual property at the beginning of collaborative agreements, support for scientific exchange and rotational assignments, and accessibility to data and trustable training data.

Table 8.2. Key actions for Goal 2 objectives for the NOAA AI Strategic Plan were identified and prioritized during the workshop breakout session 2.

Key actions for the NOAA AI Strategic Plan	Ranked Priority
Goal 2. Advance AI research and innovation:	
2.1. Establish a requirement-based process to ensure AI research leverages…	**5.3**
• Identify current AI research priorities and capabilities	3.1
• Develop AI roadmap and standards for transitioning research to operations	1.9
• Evaluate advertisements and marketing comparisons	0.3
2.2. Prioritize AI-based approaches and support in NOAA federal research funding…	**0.7**
• Streamline process for establishing partnerships	0.6
• Establish liaisons with other agencies	0.1
2.3. Establish an annual research and development prize competition series…	0.2
• Identify paths and opportunities for prize competitions	0.1
• Data mining for knowledge discovery by the science community	0.1
2.4. Evaluate and execute various testbeds and proving grounds…	**8.9**
• Provide guidance and direction for testbeds and proving grounds	5.0
• Identify use cases for lessons learned	3.5
• Validation and verification guidelines for model performance and uncertainty	0.4
2.5. Encourage every prospectus for NOAA Cooperative Institutes (CIs)…	**5.0**
• Provide direction for AI research with NOAA academic agreements (e.g., CIs, CSCs)	5.0

8.3 BREAKOUT DISCUSSION ON ACTIONS FOR GOAL 3:

Environmental research is often supported with individual project funding, yet transitioning research into beneficial operational efficiencies tends to require additional funds, which is why the transition phase is often referred to as the "valley of death." For this reason, participants ranked the need to establish a budget to transition AI research to operations as the most important action among all the Goals (Table 8.3). This includes transitioning and maintenance costs to fully realize the benefits of operationalizing innovations, and leveraging public-private partnerships. There was considerable discussion on whether this requirement can be covered by a NOAA-wide budget or a need to leverage NOAA LO funding. The matrix program model might be an approach to leverage NOAA LO funds, and it was suggested the NOAA Coral Reef Conservation Program model might be a good example. There was recognition of other mechanisms at the NOAA LO level, such as Program Change Summary, which often has better success in receiving funds. The agency should explore options for leveraging interagency funding opportunities. The second priority for Goal 3 was to address aspects of transitioning AI into operations, such as the prioritization, gap analysis, business case and metrics for defining success up-front to help prioritize wise investments. Always start with the end in mind to ensure a successful operational outcome. Existing testbeds can serve as an approach for evaluating success, and should be linked to programmatic decisions. The focus should include a number of diverse tools for the right business models, with guidelines and standards. This will need interdisciplinary teams with different stakeholders that work together from research to operations. There will be rapid change in AI technology, so being agile is important. There will need to be balance with support for maintenance and upgrades for existing toolkits, while remaining agile to benefit from new advances in technology.

Table 8.3. Key actions for Goal 3 objectives for the NOAA AI Strategic Plan were identified and prioritized during the workshop breakout session 2.

Key activities of the NOAA AI Strategic Plan	Ranked Priority
Goal 3. Accelerate the transition of AI research to applications:	
3.1. Establish budget efforts to support the transition to operations…	**18.8**
• Leverage NOAA LO budget initiatives	7.0
• Establish NOAA-wide budget initiatives	6.9
• Define success and operational outcome up-front	4.6
• Leverage existing interagency funding opportunities	0.3
3.2. Transition to operations, commercialization, and academia…	**12.7**
• Evaluate and transition existing testbeds	5.8
• Support transition to operations and commercialization	2.8
• Define metrics (e.g., Readiness Levels)	1.2
• Define business case and governance support	2.0
• Standardization and maintain agility for rapidly evolving science and technology	0.9
3.3. Develop NOAA technical guidelines and standards…	**4.0**
• Define guidelines, and determine who defines guidelines (e.g., NCAI, EDMC)	3.0
• Evaluate gaps to guide research and development	1.0
3.4. Build AI awareness across NOAA line offices…	**0.5**
• Workshops, training, and seminars for scientific exchange	0.4
• Improve awareness and communications (NCAI)	0.1
3.5. Complete an annual report of NOAA AI research transitions…	0.1
• Disseminate annual report to inform NOAA LO on progress, gaps, and priorities	0.1

8.4 BREAKOUT DISCUSSION ON ACTIONS FOR GOAL 4:

The breakout group on Goal 4 agreed on the priority to expand and formalize cooperative agreements among the NOAA LOs and with external partners to accelerate AI research and applications in support of the NOAA mission (Table 8.4). Discussion focused on the actions to formalize partnerships at all levels for accelerating NOAA's mission-driven AI research and applications, including:

- Support collaborative AI research and rotational assignments across NOAA LOs.
- Identify liaisons to prioritize AI in NOPP project proposals.
- Work with NSF institutes to expand collaborative AI efforts with research institutions.
- Formalize public-private partnerships, using mechanisms such as CRADA and SBIR grants, and enhance contract opportunities (e.g., streamlined Other Transaction Authority process).
- Update NOAA agreements with Cooperative Institutions (CIs) and Cooperative Science Centers (CSCs) to expand academic AI research programs, fellowships, and scholarships.
- Support and engage in international scientific exchange and collaborations on AI applications.
- Increase formal cooperative agreements with interagency partners (e.g., DOD, DOI, DOE, DHS), including engagement with policy and advisory committees on AI, such as congressional and White House subcommittees (e.g., NSTC).

For building trusting partnerships, there must be good understanding and agreement of the value drivers between NOAA and its partners. NOAA has devoted considerable investment to transfer its research and expertise for commercialization (e.g., SBIRs); however, NOAA must ensure its investments help to transition AI research to operational efficiencies in support of the NOAA mission.

Table 8.4. Key actions for Goal 4 objectives for the NOAA AI Strategic Plan were identified and prioritized during the workshop breakout session 2.

Key activities of the NOAA AI Strategic Plan	Ranked Priority
Goal 4. Strengthen and expand AI partnerships:	
4.1. Prioritize AI-based environmental research in… NOPP project proposals…	**1.0**
• Engage NOPP liaison for collaborative AI research and development	1.0
4.2. Expand partnerships in AI-based environmental research with the academic…	**12.6**
• Expand academic partnerships in AI (e.g., NOAA CIs and CSCs)	9.2
• Support partnerships in data and cloud services infrastructure	2.8
• Request AI announcement in fellowship programs	0.6
4.3. Work with the NSF's National AI Research Institute…	0.1
4.4. Increase the number of formal cooperative agreements… interagency…	**1.6**
• Engage internal NOAA line offices and expand interagency agreements	1.6
4.5. Formalize new public-private partnerships…	**29.3**
• Improve accessibility of data and tools through partnerships	12.1
• Mission focused engagement with end-users and stakeholders	5.7
• Document process to expand public-private interactions (e.g., CRADAs, SBIRs)	5.2
• Utilize NCAI to build community of practice to expand partnership opportunities	3.9
• International agreements for collaborations and sharing expertise	1.5
• Partner with foundations and philanthropic groups	0.9
4.6. Provide innovative and substantive contributions to policy…	0.1

8.5 BREAKOUT DISCUSSION ON ACTIONS FOR GOAL 5:

NOAA's greatest asset is its workforce, so supporting the training of its dedicated professionals to build the agency's proficiency in AI is clearly a wise investment. An overarching theme across all objectives in Goal 5 (Fig. 7.6) was the recognition that there is a cost associated with providing AI relevant training, and some of the training can be facilitated by NCAI through online training, workshops, and seminars. A number of NOAA training programs were identified that could be utilized to build the agency's workforce proficiency in AI, such as cooperative agreements with academic and private institutions, scientific exchange, and rotational assignments (Table 8.5). Objective 5.1 to support online and on-scene AI training for the NOAA workforce is closely linked with Goal 1 to establish the NCAI to facilitate training opportunities. The importance of identifying specific budget items focused on training and workforce development is essential, as is ensuring the NCAI has the right expertise to support training for the NOAA LOs. To aid with this, it was proposed that the NCAI should have rotating experts from the NOAA LOs who would spend a portion of their time assisting with training while performing cutting-edge AI research. Another suggestion for the NCAI is to fund exploratory research within NOAA (e.g., NOAA High Performance Computing and Communications Incubator Program). This can support AI development, and serve as a primary mechanism to encourage employee involvement and hands-on training opportunities.

Table 8.5. Key actions for Goal 5 objectives for the NOAA AI Strategic Plan were identified and prioritized during the workshop breakout session 2.

Key activities of the NOAA AI Strategic Plan	Ranked Priority
Goal 5. Promote AI proficiency in the workforce:	
5.1. Provide increased online and on-scene AI training…	**14.5**
• Learning Center with curated on-line AI courses	6.5
• Create budget for AI training	3.8
• Training to build proficiency in creating AI-ready data and test sets	2.0
• NOAA AI seminars and training workshops	1.6
• Broad and focused AI relevant training for scientists, managers, and leaders	0.6
• Build knowledge-based analytical tools	0.1
• Hire expertise to develop and administer AI relevant training	0.1
5.2. Focus the assignments in the NOAA Rotational Assignment Program (NRAP)…	**2.5**
• Create collaborative and competitive assignments	1.9
• Promote rotational assignments to build and share AI expertise across NOAA LOs	0.6
5.3. Support AI-related graduate degree, professional development…	0.1
5.4. Support and lead collaborative events such as conferences, workshops…	**8.1**
• Host AI workshops at science and technology conferences for scientific exchange	6.2
• Collaborative AI training workshops	1.9
5.5. Encourage graduate programs, internships, and cooperative student training…	**5.4**
• Fund research and development	4.8
• Target undergraduate students via cooperative training programs	0.6
5.6. Update individual development plans, position descriptions…	0.1
• Individual development plans to build AI proficiency, and update job descriptions	0.1

There was agreement that investments in workforce training must be aligned with the agency's mission priorities, and NCAI can help to assess what AI skills and capabilities already exist within NOAA and a gap analysis can determine where additional skills are needed. The interdisciplinary aspects of AI training will be interconnected with the other NOAA strategies on emerging science and technology (e.g., data, cloud, UxS, 'omics). As NCAI builds a community of practice, training opportunities supported by experts in academia and industry can be explored to support these cross-functional mission priorities. Each NOAA LO should support professional development for their dedicated workforce through individual development plans, graduate-level training, rotational assignments, and scientific exchange. A proposal was made to utilize external "sabbaticals" and "visiting scholar" programs for exchange with academia or industry, where NOAA employees can benefit from the expertise in these sectors. Scientific exchange through active engagement in scientific conferences and workshops is an excellent approach to build proficiencies through collaborative research and to remain current with the evolving science and technologies. As specified in Objective 5.4 and Goal 4, the CI and CSC agreements are important for training the agency's next generation of professionals; therefore, NCAI should coordinate with the NOAA Office of Education to ensure language related to AI is included in existing CI and CSC programs. These programs should mentor both graduate and undergraduate students, and it is also recommended we investigate starting a new internship program focused on AI.

9 BREAKOUT SESSION 3: NOAA CENTER FOR AI (NCAI) BUSINESS CASE

The final breakout session of the workshop was conducted during the afternoon of Day 2. The workshop participants (Appendix 12.2) were divided into three break-out groups to identify the responsibilities, infrastructure requirements, and business case for the NCAI to support the actions of the NOAA AI Strategic Plan. Each breakout group was comprised of balanced perspectives from each NOAA LO, and tasked to address the following trigger questions:

- How should the NCAI support the actions and requirements of the NOAA AI Strategy Plan and synergistic activities of the other NOAA strategies?
- What type of infrastructure and NOAA LOs engagement are needed for the NCAI?

The breakout session leads presented lists of key recommendations, and the participants ranked the lists generated from the breakouts. The ranked results from breakout session 3 (Table 9.1), and the key recommendations are summarized in the following categories.

NCAI as a service: A crucial organizational objective of the NOAA AI Strategic Plan is to establish the NCAI to enable coordination of AI research and applications among the NOAA LOs (Objective 1.1). Since NCEI has experience as NOAA's largest repository of environmental data, it is recommended that the NCAI reside at the NCEI. Participants considered a high priority for the NCAI was to improve awareness, engagement, and knowledge sharing among the NOAA LOs and external partners (Table 9.1). Further discussions on NCAI's role in developing a community of practice and training will be discussed in the upcoming categories. The NCAI should be established as a service while minimizing bureaucracy, and can also be supportive to the other NOAA strategies, especially in regard to the NOAA Data and Cloud Strategies.

Table 9.1. Key business case activities for the NOAA Center of AI (NCAI) identified during breakout session 3.

Priorities for NCAI business case	Ranked Priority
NCAI as a service:	**21.8**
• Communicate NOAA LO priorities for external engagement and knowledge sharing	10.5
• NCAI as a service and minimize unnecessary bureaucracy	8.6
• Define and facilitate coordination across NOAA LOs	1.0
• Facilitate synergy for NOAA strategies on emerging science and technology	1.6
• Coordinate grant processes to accelerate AI research and applications	0.1
Facilitation of training:	**24.7**
• Rotate AI experts across NOAA LOs for NCAI support and collaborative research	5.5
• Programmatic coordination of workforce training across NOAA LOs	4.8
• Create and make available AI-relevant training courses and resources	4.4
• Establish an AI help desk	3.2
• AI internship programs with academic and industry institutions	2.4
• Fund AI incubator projects for training activities	2.3
• Gap analysis to define AI proficiency skill requirements	2.1
Prioritization process:	**20.3**
• Engage in gap analysis and provide recommendations to resolve gaps	12.1
• Communicate priorities (bottom-up vs. top-down) for NOAA LO research goals	3.1
• Provide input to NAIEC for prioritization for internal and external funding	1.8
• Assist with defining metrics and desired benefits	3.1
• Facilitate grand challenges	0.1
• Define scale and size to meet objectives	0.1
Coordination to transition research into operations:	**15.1**
• Facilitate testbed and sand-box opportunities	5.8
• Provide annual report on matching research to operational priorities	3.2
• Define end-to-end research to commercialization (data call, toolbox, end-product)	2.7
• Provide pilot toolbox with infrastructure resources	2.2
• Facilitate end-user requirements	1.2
Community of practice for partnerships:	**11.0**
• Coordinate with NOAA Office of Education to establish CI and CSC agreements for AI	2.6
• Leverage external partnership opportunities	2.6
• Engage in interagency coordination with other AI centers	2.4
• Create metrics for partnership value	1.2
• Document and track existing partnerships, and expand partnerships	1.0
• Broker between NOAA LOs and stakeholders	1.0
• Establish CRADAs and contracts to expand public-private AI partnerships	0.1
• Engagement expertise across NOAA LOs in defining standards and best practices	0.1
Advance AI research:	**4.3**
• Facilitate innovative research	3.0
• Coordinate basic AI user research	1.3
Data services:	**2.1**
• Provide resources for developing AI-ready data and training set repository	2.0
• Communications to increase awareness and coordination of shared data services	0.1

Facilitation of training: To be included in Goal 5, the top priority was to establish the NCAI as a center for AI excellence by facilitation of AI relevant training (Table 9.1). The NCAI should work with the NOAA LOs to evaluate available AI expertise and conduct a gap analysis to direct development of its AI training program. This program should include on-line courses, hands-on workshops, and facilitation of scientific change opportunities for NOAA LOs and external partners. The NCAI facilitates communications and establishes a list of resources including the dissemination of guidelines on best practices for AI research. NOAA researchers would benefit by establishing an AI help desk. NCAI can also coordinate with NOAA rotational assignments at the NCAI to share expertise and with external partners to gain expertise to expand NOAA's workforce proficiency in AI.

Prioritization process: There were discussions about how priorities will be defined for the NOAA LOs. While the NAIEC and NOAA approving body will have a role in decisions related to priorities, the NOAA LOs will define and negotiate their priorities. The NOAA LOs need to define their priorities for transitioning AI research to operations, and the upstream and downstream communications within each NOAA LO is necessary to document emerging capabilities and needs. NAIEC will work with the NCAI (Objective 1.1) and technical working group (Objective 1.2) to solicit feedback from the NOAA LOs on their priorities and gaps. This process can be enabled through the NCAI's role to improve awareness, guidelines, and communications across the NOAA LOs and its partners. NCAI can administer data calls, conduct gap analysis, and open communications across the NOAA LOs to understand who is engaged in AI research and how they can collaborate with those transitioning AI into operations.

Coordination to transitioning research into operations: Supportive of Goal 3, the NCAI can play an important role to evaluate and match ongoing AI research to operations across the NOAA LOs, and disseminate an annual report summarizing pertinent progress and recommendations. NCAI can also help to facilitate sandbox and testbed opportunities, and coordinate engagement in pilot toolbox efforts with data and cloud infrastructure resources. Pertinent to both Goals 3 and 4, the NCAI can help to define end-to-end research for commercialization as well as end-products in support of the NOAA mission.

Community of practice for partnerships: There was consensus that the NCAI would play an important role for Goal 4 to develop a community of practice for AI across the NOAA LOs (Table 9.1). This community of practice would include tracking and building relationships with external partners (e.g., interagency, academic, private, and international institutions), including the synergistic activities of the NOAA strategies on emerging science and technologies. Improving awareness on public-private partnership opportunities (e.g., CRADAs, SBIRs, and contracts) and partnership value metrics is another priority for building a community of practice.

Advance AI research: Pertinent to the community of practice, it was recommended that NCAI explores ways to engage the end-users with collaborative AI research to ensure effective transition and desired end-products. Presently, many of the ongoing AI projects are stove-piped. For this reason, the NCAI can improve awareness and collaborative opportunities across the agency for organizational efficiencies.

Data services: NCAI can help to increase awareness and coordination of shared data and cloud resources supporting the scalability of AI, while recognizing some degree of separation will be needed between the IT, data-centric, and AI-centric infrastructure.

10 PANEL DISCUSSION 3: CONCLUDING SESSION

During the two-day workshop, contributions of the NOAA strategy leads and participants successfully identified key actions and synergistic activities through the presentations, breakout sessions, and discussions. During this closing panel discussion, the participants were tasked to ask the panel some difficult questions of concern that may exist for drafting the NOAA AI Strategic Plan.

Bill Michaels: In two sentences, we ask the participants to present the panel with questions of what you are most concerned about.

Frank Indiviglio: It is clear the NCAI is a central component of the organizational structure of the NOAA AI Strategy, and it will be supporting many aspects of each Goal. However, one could argue that it is still not clear how the NCAI will be supporting the AI priorities across the NOAA LO missions.

Eric Kihn: The NCAI will communicate among the NOAA LOs to assess priorities and gaps, develop a community of practice within the agency and with its partners, and facilitate collaborative efforts for rapid adoption and acceleration of AI in our organization. Additionally, we will remain current and agile to take advantage of the evolving AI technology. We do not want to end up 15 years behind industry like we presently are with adopting cloud.

Jebb Stewart: Where is the value of the NOAA AI Strategic Plan and why do we need the NCAI when I can already conduct AI research in my program?

Ben Richards: Yes, many of us are already conducting AI research and some have transitioned AI into more effective operations at a large cost. Unfortunately, most AI projects to date are stove-piped which is very inefficient. The intent of the NCAI and the implementation plan is to improve awareness, foster collaborations, and more effectively utilize shared resources to eliminate redundancy. This collective approach is a force-multiplier for success.

Greg Dusek: Each of the NOAA line offices are already doing training at some level, and so why should we centralize training resources at the NCAI?

Hendrik Tolman: Yes, the NOAA LOs have a responsibility to train their workforce to remain current and proficient in the sciences and technologies. During this workshop, participants clearly identified the priority to address the need to improve workforce proficiency in AI and why do it six times if you can do it once through a centralized resource center.

Hendrik Tolman: Every time we have a hard problem to address, we put together another organizational structure which can result in unnecessary top-heavy bureaucracy. Why would the proposal to establish the NCAI be different?

Jebb Stewart: NOAA is the most science-based organization in the government and has the largest environmental data enterprise in the world. To remain competitive, NOAA must embrace innovation through workforce proficiency and collaborative partnerships. We must avoid the pitfalls of designing a center that serves mainly a single NOAA LO. The cost-effective solution is to improve awareness, collaboration, and shared resources through a center of AI excellence. Note that other government agencies are planning a similar approach, and NOAA is positioned to be a leader in AI.

Sid Boukabara: Agree, we must avoid the pitfalls in the design of a center by leveraging what exists already, centralizing what makes sense collectively for NOAA LOs, and improving awareness and opportunities through a community of practice. We can also work closely and learn with other agencies.

Bill Michaels: This is a pivotal time where emerging science and technology is rapidly changing the way we do business, and NOAA needs to adopt an organizational culture shift to optimize its resources for operational efficiencies. Modernizing its data enterprise to utilize cloud computing and AI analytics has already demonstrated efficiencies in timely delivery of higher quality products and services. There are presently about 200 ongoing AI projects, but most are isolated efforts with duplication of effort. The implementation plan and the NCAI are necessary for this organizational culture shift to achieve organizational and operational efficiencies.

Kim Valentine: If there was no funding to support the NCAI, then how can we enable the NOAA AI Strategic Plan through a decentralized initiative?

Eric Kihn: The NCAI as a center of AI excellence to improve awareness and facilitate AI efforts through centralized resources is the critical component of the plan, and we need a NOAA executive council to support this. While we are making incremental progress with siloed projects, some may believe we can continue to make progress without top-down investment and organization. However, the agency is clearly behind the outside community with the emerging science and technology in terms of investment, organizational support, and workforce proficiency. I would say we are doing less today for the American taxpayer by not embracing AI.

Charly Alexander: We need to be prepared for the question, is it better for NOAA to simply outsource emerging science and technology?

DaNa Carlis: In some situations, we are outsourcing. For example, Congress is mandating that funding for the EPIC initiative is used for external collaborations and software engineering functions to assist NOAA with building the best numerical weather system in the world. However, we do not outsource our science. As a science-based agency with mandates, NOAA must support its workforce proficiency to analyze, interpret, and deliver its scientific products to a high standard of integrity and credibility.

Hendrik Tolman: If you outsource to industry, they strive to deliver for the profit margin. On the other hand, NOAA has a mission to serve the public with the best available scientific information. The NOAA AI Strategic Plan will expand public-private partnerships, and improve its organizational efficiencies including workforce proficiency to meet mission requirements.

Bill Michaels: In the closing statement, appreciation is extended to the NOAA strategy leads and invited participants who have contributed to the success of the workshop. On behalf of the participants, we are thankful for the leadership and support of the Deputy NOAA Administrator/Assistant Secretary of Commerce for Oceans and Atmosphere, Rear Admiral Timothy Gallaudet. During the upcoming months, the results of this workshop will provide the framework for drafting the actions for the NOAA AI Strategic Plan. Furthermore, the workshop also identified the need to coordinate the synergistic activities of the NOAA strategies on emerging science and technology. The meeting is adjourned.

11 CONCLUSION

Key actions were identified for developing a framework to draft the NOAA AI Strategic Plan, and some of these actions included the need to coordinate the synergistic activities across the NOAA strategies (i.e., Data, Cloud, AI, UxS, 'Omics, Citizen Science) on emerging science and technology. The invited participants representing the NOAA LOs provided the leadership, technical knowledge, and well-balanced perspectives for developing this framework, and included members of the NOAA AI Executive Committee, leads for the NOAA strategies, and invited experts from each NOAA LO. The opening statement of the Deputy NOAA Administrator and lead for these NOAA strategies, Rear Admiral Timothy Gallaudet, emphasized that we are in the second age of technology that was initially enabled by government agencies, but now innovation is led by the private sector. Therefore, building the agency's partnerships and workforce proficiency is key. NOAA is a science-based agency with the largest environmental data enterprise in the world and has the most mandates for environmental stewardship of any federal agency. Therefore, NOAA has a responsibility to embrace these strategic initiatives on emerging science and technologies to effectively serve the public and remain a world leader in Earth science.

To accomplish organizational and operational efficiencies with the AI applications, the top priority is to establish the necessary governance to effectively execute the actions of the NOAA AI Strategic Plan and ensure synergy among the NOAA strategies. The Goal 1 recommendations pertinent to this priority include:

- The NAIEC should consist of balanced representation from each NOAA LO to effectively serve as the oversight committee for executing the actions of the implementation plan.
- The NCAI should be supported to serve as NOAA's center of excellence for facilitating awareness, coordination, and collaborations to accelerate AI research and applications across the NOAA LOs. Funding is needed to support the NCAI distributed functions to build a community of practice supporting the NOAA LO mission priorities, while establishing centralized resources for guidelines on AI-ready data, analytical tools, and training to build the agency's workforce proficiency in AI.
- The NOAA approving council (e.g., possibly the NOAA Research Council) is needed for approval of recommendations and policies pertinent to the NOAA AI Strategic Plan, and expanded terms of reference to ensure synergy across each of the NOAA strategies on emerging science and technology for organizational efficiency. It is further recommended that a NOAA Science and Technology Synergy Committee be established to ensure coordination and organizational efficiencies of the synergistic activities among these NOAA strategies.
- Recommendations also included the need for a national working group to provide AI expertise from the NOAA LOs to assist the NAIEC and NCAI, as needed, with tracking progress, priorities, and gap analysis across the agency. This could be accomplished by a combination of approaches such as expert volunteers from the NOAA LOs, rotational assignments, and/or distributed positions among the NOAA LOs that are supported by the NCAI depending on funding.

Throughout this report, there are several recommendations for each goal of the NOAA AI Strategic Plan. A key recommendation applicable to each goal is that NOAA's investments in AI must be requirement-based in support of the agency's cross-functional mission priorities. In other words, decisions to invest in AI research should be driven by the need to transition developments into more

efficient operations and desired end-products for the end-users. Associated with this is the recognition that existing organizational barriers need to be removed to encourage innovation while accepting a reasonable level of risk. NOAA is undergoing a paradigm shift, and we need to pivot to the rapidly evolving technology.

Common to each of the NOAA strategies, recommendations were provided for Goal 4 to expand collaborative partnerships across the NOAA LOs and with external partnerships. Building a community of practice is a force-multiplier for transitioning emerging science and technology into organizational and operational efficiencies. The NOAA Data and Cloud Strategies are considered foundational for the NOAA strategies, while the NOAA AI Strategy provides the computational tools, such as machine learning algorithms, to effectively address the big data challenge of the dramatic increase in data collections from the emerging technologies. The NOAA LOs must collectively work together to share expertise and resources, and to determine how best to expand public-private partnerships. An important take home message is the need to build trusting relationships with partners, while avoiding vendor lock so the agency can remain agile in the rapidly evolving technologies.

The NOAA workforce, composed of professionals with diverse backgrounds and experiences, serves as our most valued asset. Clearly, the best investment is to train NOAA's dedicated workforce to integrate AI and other relevant disciplines in emerging science and technology. The recommended actions for Goal 5 are deliberate steps that demand a diverse and inclusive workforce to reflect, understand, and respond to the varied communities and stakeholders that NOAA serves. Participants provided recommendations to expand the scope of existing NOAA training programs (e.g., CIs, CSCs, fellowships) to build existing and future workforce proficiencies. Furthermore, the NCAI can also serve as a center to provide on-line and on-scene training for AI and other relevant disciplines, such as data science and cloud computing tools. Rotational assignments and scientific change at national and international scientific forums can contribute to build collaborations and workforce proficiency.

This workshop has successfully begun communications between the leads of the NOAA strategies on emerging science and technology, and we need to continue these communications beyond this workshop. The NOAA AI Executive Committee will complete the NOAA AI Strategic Plan in the upcoming months, while the NOAA strategy leads will communicate on the benefits of coordinating synergistic activities as they develop their implementation plans.

The framework and recommendations from this workshop will help to establish the unified NOAA approach in the development of the NOAA AI Strategic Plan in coordination with the other NOAA strategies on emerging science and technology, and NOAA is committed to maintain the momentum for executing the implementation plans to maintaining NOAA as a world leader in atmospheric and oceanic science.

12 APPENDICES

APPENDIX 12.1. WORKSHOP TERMS OF REFERENCE AND AGENDA.

NOAA AI Strategic Plan Workshop

Civic Center, Fenton Room, 8525 Fenton Street, Silver Spring, MD 20910

February 27-28, 2020

Terms of Reference

The primary focus of this workshop will be to develop the framework of "The NOAA AI Strategic Plan." The workshop presentations, break-out sessions, and panel discussions will address the actions, NOAA Line Office (LOs) engagement, and business case to achieve the objectives for each goal of the NOAA AI Strategy:

Goal 1. Establish an efficient organizational structure and processes to advance AI across NOAA.

Goal 2. Advance AI research and innovation in support of the NOAA mission.

Goal 3. Accelerate the transition of AI research to operational capabilities.

Goal 4. Strengthen and expand AI partnerships.

Goal 5. Promote AI proficiency in the workforce.

The workshop will also evaluate the synergy between the NOAA Data, Cloud, Uncrewed Systems (UxS), and 'Omics strategies to determine how the NOAA AI Strategic Plan can be supported or support the NOAA strategies. The NOAA strategies are available at:

https://www.noaa.gov/media-release/noaa-releases-new-strategies-to-apply-emerging-science-and-technology

Coordination across the NOAA strategies is necessary to make transformative improvements in NOAA's cross-functional mission requirements; therefore, the presentations, break-out sessions, and panel discussions (refer to the agenda, guidance for presentations, and trigger questions) are designed to provide recommendations on developing the NOAA AI Strategic Plan that optimizes coordination among the NOAA LOs and synergy across the NOAA strategies. Furthermore, the success of the workshop is highly dependent on the diverse, balanced and inclusive perspectives from expert representatives across each NOAA line office (refer to the list of invited participants).

It is important to note that this is an internal workshop for NOAA invited participants, and the 2nd NOAA AI Workshop during April 20-24 will be the venue for NOAA and private sector to address partnerships;

https://www.star.nesdis.noaa.gov/star/meeting_2020AIWorkshop.php

Agenda and Trigger Questions

<u>Day 1, Thursday February 27</u>: The objective for Day 1 is consensus building on the synergetic actions of the NOAA strategies that can be mutually leveraged for the NOAA AI Strategic Plan.

08:30	Coffee	
09:00	Welcome, terms of reference, facilitation, introductions	Bill Michaels, facilitators
09:15	Guidance for NOAA strategies and implementation plans, and FY22 budget update.	RDML Timothy Gallaudet

Day 1 Guidance for NOAA strategies presentations: The Leads for each NOAA Strategy (i.e., AI, Cloud, Data, UxS, 'Omics, and EPIC) will provide a brief overview of the goals and objectives, and then conclude with key synergetic activities can support or be supported by the NOAA AI Strategic Plan. The intent is to stimulate discussions for break-out sessions and panel discussions.

09:30	NOAA AI Strategy Overview	Jamese Sims
09:45	NOAA AI Center Business Case	Sid Boukabara, Eric Kihn
10:00	Break	
10:15	NOAA Cloud Strategy Overview	Dave Layton, Tony Lavoi
10:30	NOAA Data Strategy Overview	Ed Kearns, Kim Valentine
10:45	NOAA UxS Strategy Overview	Charly Alexander
11:00	NOAA 'Omics Strategy Overview	Cisco Werner
11:15	NOAA EPIC Strategy Overview	DaNa Carlis
11:30	**Panel Discussion 1:** The panel will address questions on the above presentations from the participants, and discuss the 'One NOAA' approach and FY22 budget request.	RDML Timothy Gallaudet (Panel Chair); Leads from the NOAA strategies.
12:00	Lunch	

Day 1 Guidance for Break-out Session 1: Participants will be divided into break-out groups to identify the key actions that are interconnected between the NOAA strategies, and which synergetic actions should support or be supported by the NOAA AI Strategic Plan. Each break-out group will address the following three trigger questions:

13:20	**Break-out Session 1:** Each break-out group will address: **(1a).** What key objectives and actions between the NOAA strategies are interconnected? **(1b).** Which synergetic actions could support or be supported by the NOAA AI Strategic Plan?	The lead from each break-out group will summarize the key recommendations for the following report-outs and address questions during panel discussions.

	(1c). What resource-sharing opportunities across the NOAA LOs might exist for these synergetic actions?	
14:40	Report-out from lead of each break-out group	Break-out group leads
15:00	Break	
15:20	**Panel Discussion 2:** Recommendations on how the synergetic actions of the NOAA strategies can collectively leveraged for the NOAA AI Strategic Plan.	RDML Timothy Gallaudet (Panel Chair); Leads from the NOAA strategies.
16:00	Day 1 closing remarks & Day 2 recommendations	Bill Michaels
16:10	Adjourn	
16:15	NOAA strategies social to be held at the Silver Strings Restaurant, 8630 Colesville Rd., Silver Spring, MD 20910	Invited participants

Day 2, Friday February 28: The overarching objective for Day 2 is to establish consensus among the NOAA LOs representation and define the next steps for drafting the actions and NOAA LOs engagement for the NOAA AI Strategic Plan, and to include the synergetic actions that can support or be supported by the NOAA strategies.

08:30	Coffee	
09:00	NOAA AI Strategic Plan – Next Steps	RDML Timothy Gallaudet

Day 2 Guidance on presentations of NOAA AI Strategy Goals: Selected NOAA AI Executive Committee members will briefly highlight key actions for each NOAA AI Strategy Goal to encourage balanced perspectives and discussions for consensus building during the following break-out session.

09:10	NOAA AI Strategic Plan – Goal 1: Organizational structure and oversight	Frank Indiviglio
09:20	NOAA AI Strategic Plan – Goal 2: AI research	Vladimir Krasnopolsky
09:30	NOAA AI Strategic Plan – Goal 3: Transition of AI	Hendrik Tolman
09:40	NOAA AI Strategic Plan – Goal 4: AI partnerships	Jebb Stewart
09:50	NOAA AI Strategic Plan – Goal 5: Workforce proficiency	Greg Dusek
10:00	Summary of NOAA AI Data Call	Bill Michaels
10:10	Break	

Day 2 Guidance for Break-out Session 2: Participants will be divided into break-out groups to identify the key actions and NOAA LO engagement for the objectives of each goal of the NOAA AI Strategy, and the following three trigger questions will guide each break-out group:

10:30	**Break-out Session 2:** Each break-out group will address: **(2a).** What are the key actions for the objectives of each goal NOAA AI Strategy Goal? **(2b).** Identify NOAA LOs engagement for each of these key actions? **(2c).** What resource-sharing opportunities might exist across the NOAA LOs for key actions?	The lead from each break-out group will summarize the key recommendations for the following report-outs and address questions during panel discussions.
12:00	Lunch	
13:20	Report-out from lead of each break-out group	Break-out group leads

Day 2 Guidance for Break-out Session 3: Participants will be divided into break-out groups to identify the responsibilities, infrastructure requirements, and oversight of the NOAA Center for AI (NCAI) to support the key actions of the NOAA AI Strategic Plan, and the following three trigger questions will guide each break-out group:

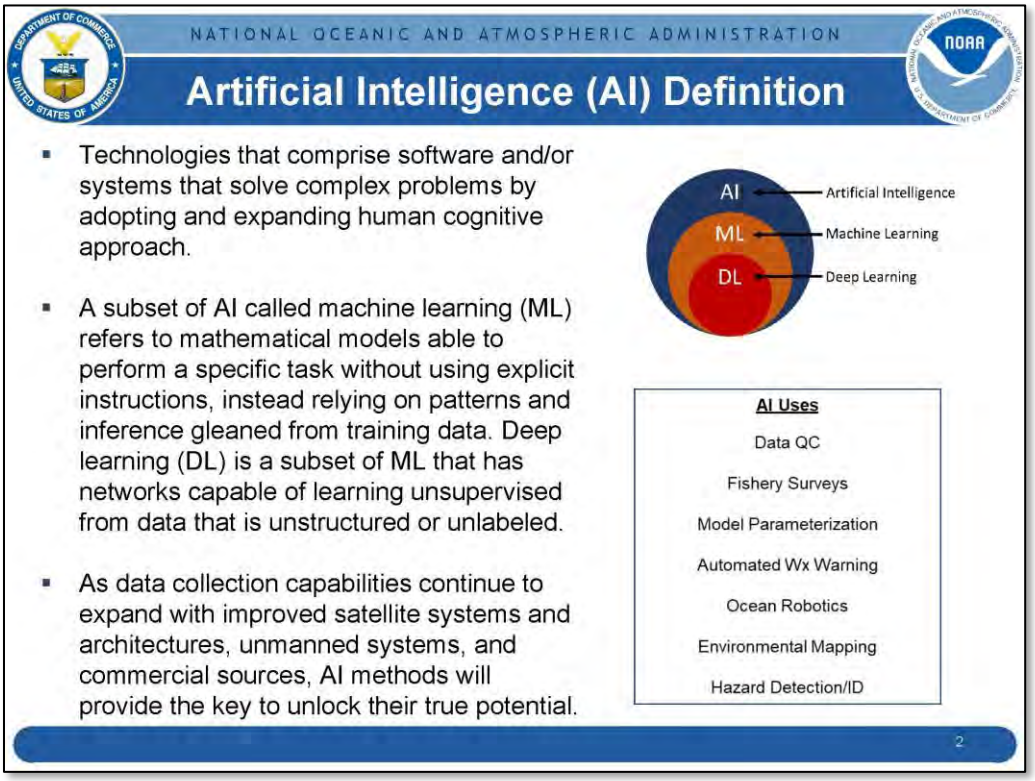
13:40	**Break-out Session 3:** Each break-out group will address: **(3a).** How should the NOAA Center for AI (NCAI) support the actions and requirements of the NOAA AI Strategic Plan and other NOAA strategies? **(3b).** What type of infrastructure and NOAA LOs engagement are needed for the NOAA Center for AI? **(3c).** What are the oversight recommendations for the NOAA AI Strategic Plan?	The lead from each break-out group will summarize the key recommendations for the following report-outs and address questions during panel discussions.
15:00	Break	
15:20	Report-out from lead of each break-out group	Break-out group leads
15:40	Summary of Break-out Session 1 recommendations	Bill Michaels
15:50	Summary of Break-out Session 2 recommendations	Jamese Sims
16:00	Summary of Break-out Session 3 recommendations	Sid Boukabara
16:10	**Panel Discussion 3:** Concluding discussions and recommendations for drafting the actions, NOAA LOs engagement, and business case of the NOAA AI Strategic Plan.	RDML Timothy Gallaudet (Panel Chair); Presenters on the goals and key activities of the NOAA AI Strategy.
16:50	Closing statement	RDML Timothy Gallaudet
17:00	Adjourn	

APPENDIX 12.2. PARTICIPANT LIST.

The NOAA AI Strategic Plan Workshop was to the following invited participants to provide well balanced perspectives and expertise from each NOAA line office and NOAA strategies. Members of the NOAA AI Executive Committee are indicated by the asterisk.

RDML Timothy Gallaudet*	NOAA strategies, Lead, USEC, Deputy NOAA Administrator	Leads for NOAA strategies
Jamese Sims	NOAA AI Strategy, Co-Lead/ASOA AI Special Assistant OFCM	
Charly Alexander*	NOAA UxS Strategy, Lead, USEC/OMAO	
Cisco Werner*	NOAA 'Omics Strategy, Lead, NMFS	
Tony LaVoi	NOAA Cloud Strategy, Lead, OCIO	
David Layton	NOAA Cloud Strategy, Chair, OCIO	
Ed Kearns*	NOAA Big Data Program, Lead, OCIO	
Kim Valentine	NOAA Data Strategy, Chair, NOS	
DaNa Carlis	NOAA EPIC Strategy, Chair, OAR	
Bill Michaels*	NOAA AI Executive Committee, Chair, NMFS	NMFS representation
Ben Richards	NMFS expert representative	
Nichole 'Niki' Rossi	NMFS expert representative	
Frank Parrish	NMFS expert representative	
Sid Boukabara*	NOAA AI Executive Committee, Co-chair, NESDIS	NESDIS representation
Eric Kihn	NESDIS expert representative	
Kevin Garrett	NESDIS expert representative	
Alek Krautmann	NESDIS expert representative	
Vladimir Krasnopolsky*	NOAA AI Executive Committee, NWS Representative	NWS representation
Hendrik Tolman*	NOAA AI Executive Committee, NWS Representative	
Mark Miller	NWS expert representative	
Stephan Smith	NWS expert representative	
Greg Dusek*	NOAA AI Executive Committee, NOS Representative	NOS representation
Neil Weston*	NOAA AI Executive Committee, NOS Representative	
Mark Osler	NOS expert representative	
Hassan Moustahfid	NOS expert representative	
Jebb Stewart*	NOAA AI Executive Committee, OAR Representative	OAR representation
Mashkoor Malik*	NOAA AI Executive Committee, OAR Representative	
Venkatramani 'Balaji' Balaji	OAR expert representative (represents NOAA AI Executive Committee member, Venkatachala 'Ram' Ramaswamy*)	
Frank Indiviglio*	NOAA AI Executive Committee, OAR Representative	
John McDonough*	NOAA AI Executive Committee, OMAO Representative	OMAO representation
Robert Nadeau	NOAA External Affairs, USEC	Other NOAA representation and facilitators
Chase Long	Rapporteur, NOAA Data Strategy, NOS	
Sarah Margolis	Rapporteur, NOAA/NMFS Data Modernization	
Meredith Richardson	Rapporteur, NOAA Data Strategy, OS	
Derek Hanson	NOAA General Counsel, USEC	
Catherine Chatfield	NOAA Facilitators	
Karene Sutherland	NOAA Facilitators	
Jason Philibotte	NOAA Facilitators	

APPENDIX 12.3. NOAA AI STRATEGY OVERVIEW (J. SIMS)



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA AI Strategy

Strategic Drivers:

White House
- AI Executive Order
- NSTC AI R&D Strategic Plan

Congress
- Weather Act
- CENOTE Act

NOAA
- EPIC & Space Innovation
- Blue Economy

Vision:

Through the NOAA AI Strategy, expansion of Artificial Intelligence is accelerated across the entire agency to make transformative improvements in NOAA mission performance and cost effectiveness.

Purpose:

To dramatically expand the application of AI in NOAA's mission areas in order to achieve transformational improvements in performance, skill, computational efficiency, and cost effectiveness.

3

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA AI Strategic Goals

- **Goal 1:** Establish Efficient Organizational Structures and Processes to Advance AI across NOAA.
- **Goal 2:** Advance AI Research and Innovation in Support of NOAA's Mission.
- **Goal 3:** Accelerate the Transition of AI Research to Applications.
- **Goal 4:** Strengthen and Expand AI Partnerships.
- **Goal 5:** Promote AI Proficiency in the Workforce.

4

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Goal 1: Organizational Structures

Objective 1.1. Explore the establishment of a NOAA AI Center or similar entity to enable coordination of AI research, algorithm development, data acquisition, applications, information exchange, and awareness. Other functions would be to maintain a portal with open source and government applications, host training events and workshops, and facilitate new partnerships.

Objective 1.2. Develop technical working groups comprised of NOAA line office experts to support the NOAA AI Executive Committee's efforts as needed to establish AI standards and execute the NOAA AI Strategic and Implementation Plans, such as prioritization of AI research and transitional requirements, technical workshops, specific subject-matter tasks as assigned, and metrics to achieve the goals and objectives of the plan.

Objective 1.3. Prioritize AI-based approaches where applicable in NOAA budget formulation guidance, emphasizing the purpose to improve performance skill, computational efficiency, and cost effectiveness.

Objective 1.4. Include discussion of NOAA AI activity in NOAA executive-level engagement and communications with key stakeholders, particularly focusing on OMB, Congressional members and staff, and counterparts from other federal agencies.

Objective 1.5. Leverage and adopt the principles, processes, and partnerships articulated in the NOAA Cloud Strategy and Roadmap, and Big Data Project to improve data accessibility, labeled training data, workflow processes using open source tools, and cloud computing for AI applications in support of the NOAA mission.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Goal 2: Research and Development

Objective 2.1. Establish a requirement-based process to ensure AI research leverages the best available assets and expertise in support of the NOAA mission and to continually evaluate ongoing AI R&D to capitalize on rapidly evolving AI technology.

Objective 2.2. Prioritize AI-based approaches and support in NOAA research federal funding opportunities (FFO), requests for proposals (RFPs), and research grants to promote collaborative AI research and maintain an awareness of the rapidly evolving AI technology in areas relevant for NOAA mission.

Objective 2.3. Establish an annual research and development prize competition series for AI applications in environmental science, to include separate categories for data processing efficiencies, automated detection and classification toolkits, improvements in data assimilation and predictive modeling, and other organizational efficiencies using AI.

Objective 2.4. Evaluate and execute various testbed and proving grounds approaches across NOAA to expand AI research, develop best practices and training data, improve algorithms, and evaluate model performance in support of advancing the NOAA mission. NOAA testbeds and proving grounds play an important role in pre-operational evaluation of new developments performed by NOAA and university scientists.

Objective 2.5. Encourage every prospectus for NOAA Cooperative Institutes (CIs) and Cooperative Science Centers (CSC's) to develop metrics that track yearly increases in AI research and applications.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Goal 3: Research to Applications

Objective 3.1. Establish budget efforts to support the transition to operations AI-based environmental research which shows improved skill, performance, and computational and cost efficiency.

Objective 3.2. Transition to operations, commercialization, and academia that AI based environmental applications with appropriate Technical Readiness Levels.

Objective 3.3. Develop NOAA technical guidelines that are updated annually on the best practices and standards for the training data, training practices, and evaluation of model performance to ensure the integrity, reliability, and credibility of scientific products generated with AI applications.

Objective 3.4. Build AI awareness across NOAA line offices through NOAA science seminars and webinars, internal workshops, and routine internal communications venues such as newsletters and weekly updates.

Objective 3.5. Complete an annual report of NOAA AI research transitions, disseminated broadly across the agency and with external partners to be used as a basis for investigator performance reviews and incentive awards.

7

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Goal 4: Expand AI Partnerships

Objective 4.1. Prioritize AI-based environmental research in National Oceanographic Partnership Program (NOPP) project proposals and selection.

Objective 4.2. Expand partnerships in AI-based environmental research with the academic and research community, including CIs and institutions that host NOAA EPP/MSI, Nancy Foster, Hollings, John Knauss, Pathways, and Margaret Davidson scholars, fellows, and interns.

Objective 4.3. Work with the NSF's National Artificial Intelligence Research Institutes to collaborate with appropriate institutes on AI R&D.

Objective 4.4. Increase the number of formal cooperative agreements on AI-based environmental research and applications with interagency and international partners, including DOD, DOI, DOE, and DHS.

Objective 4.5. Formalize new public-private partnerships through established mechanisms such as Cooperative Research and Development Agreements (CRADAs) and Small Businesses Innovative Research (SBIR) grants.

Objective 4.6. Provide innovative and substantive contributions to the policy and advisory committees such as the National Science and Technology Council (NSTC) Select Committee on AI, and engage its experts in scientific exchange during national and international conferences, workshops, and other opportunities.

8

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Goal 5: Promote AI Proficiency in the Workforce

Objective 5.1. Provide increased online and on-scene AI training through line office training centers.

Objective 5.2. Focus the assignments in the NOAA Rotational Assignment Program (NRAP) to target offices where a cross-pollination of AI expertise would raise the overall AI proficiency of the workforce.

Objective 5.3. Support AI-related graduate degree, professional development, and technical training courses that are available to the NOAA workforce.

Objective 5.4. Support and lead collaborative events such as conferences, workshops, and external rotational assignments targeted to stay current in the state of AI technology.

Objective 5.5. Actively encourage graduate programs, internships and cooperative student training programs in AI applications relevant to the NOAA mission to improve recruitment, retention, and the hiring pool for AI proficient NOAA workforce.

Objective 5.6. Update individual development plans (IDP), position descriptions, performance plans, and career paths as a practical approach to build and retain NOAA's workforce proficiency in AI.

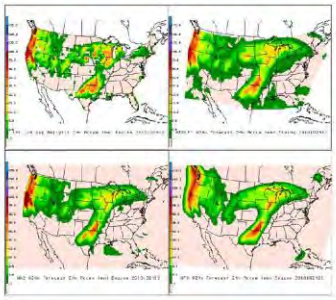
9

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA AI Strategy Next Steps

Implementation Plan Development and Next Steps:

- ✓ Completed AI data call and analysis of AI requirements across NOAA LOs, including synergic operational efficiencies with the other NOAA Strategies (Currently under analysis)
- Conduct a two day NOAA Implementation Plan Development Workshop (Feb 27-28)
- Conduct the 2nd Workshop on Leveraging Artificial Intelligence for Earth Systems Prediction (April 21-24)
- Develop and distribute the NOAA AI Implementation Plan



10

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Synergy with NOAA Science and Technology Strategies

Organizational Structure: Advance coordination of AI methods, develop repositories and datasets, as well as best practices

Research to Applications: Enhance AI solutions to advance NOAA's research to operational applications in all mission areas.

Partnerships: Increase and leverage commercial and academic partnerships for research and applications.

Training: Train the current and future NOAA workforce to use AI methods efficiently within the organization.

A I

UxS

OMICS

Cloud + Big Data + EPIC

11

APPENDIX 12.4. NOAA CENTER FOR AI BUSINESS CASE (E. KIHN, S. BOURKABARA)

NOAA Center for AI - Business Case

Status Report
Kihn/Boukabara

NCAI Business Case Development

	Interview Status
National Ocean Service	
Greg Dusek, COOP	Completed, Friday 2/7
Neil Weston, OCS	Completed, Thursday 2/6
NOAA Fisheries	
William Michaels, OST/NMFS	Completed, Monday 2/3
Cisco Werner, OAA	Completed, Thursday 2/13
National Weather Service	
Hendrik Tolman, OSTI	Completed , Thursday 2/20
Vladimir Krasnopolsky, EMC	Completed, Thursday 2/6
NESDIS	
Sid Boukabara, STAR	Completed, Wednesday 2/12
OAR	
Frank Indiviglio, OCIO	Completed, Tuesday 2/18
Mashkoor Malik, OER	Completed, Thursday 2/6
V. 'Ram' Ramaswamy, GFDL	Completed, Thursday 2/20
Jebb Stewart, ESRL	
OMAO	
Charly Alexander	Completed, Thursday 2/13
John McDonough, PPMD	Completed, Tuesday 2/11
NOAA Office of the CIO	
Ed Kearns	Completed, Tuesday 2/11

1. Completed draft 19 page implementation plan
2. Distilled it into a 2 pager
3. Developed AI questions
4. Interviewed all AI executive committee members

The team:

- Stephanie Herring
- Brian Meyer
- David Fischman
- Douglas Rao
- Jebb Stewart
- Kenneth S. Casey
- Huai-min Zhang
- Jennifer Fulford (production support)

NCAI Questions

1) Why are you looking into ML/AI? What problem(s) are you trying to solve?
2) What challenges in developing AI/ML are you facing or aware of for your organization?
3) How do you currently manage and interact with the Big Data required for machine learning?
4) How do you share/advertise AI/ML results within the organization?
5) What process(es) do you follow to bring AI/ML applications from development to production? How long does it take?
6) Is there a community of practice around AI/ML in your organization? If so how many participants, how is it organized?
7) What are your plans to bring AI into the organization? Is there an approach at scale being developed?
8) Is there any program/center example that may be followed by the implementation of NCAI?
9) Who else would be good to contact regarding the AI Center in your line?
10) What would you like to see from the NOAA AI Center

Key Results

What problem(s) are you trying to solve?	Improve efficiency/optimize Improve skills in current methods Mission enhancement/ new capabilities (some)
What challenges in developing AI/ML are you facing or aware of for your organization?	Workforce training development AI ready data access Infrastructure (some)
How do you currently manage and interact with the Big Data required for machine learning?	Not well or not at all (most) We're lucky and have an on-prem a supercomputer (some) Early cloud forays (some)
How do you share/advertise AI/ML results within the organization?	We don't or we're not yet active in AI at that level Scientific forum (Publication/Conference/Council) Small working groups(few)
What process(es) do you follow to bring AI/ML applications from development to production? How long does it take?	Not yet operational/ No process (most) Three to five years to cross valley of death (some) Scientific approval and development (NMFS)

Key Results

Is there a community of practice around AI/ML in your organization? If so how many participants, how is it organized?	No formal community Small informal teams (some)
What are your plans to bring AI into the organization? Is there an approach at scale being developed?	No its a ground up approach Conducting surveys (some) Incubator/Focus Areas (Some)
Who are the key developers in your organization with respect to AI/ML? Who are the key partners?	Small teams of local staff (most) Academic Partners (e.g. CIs, other academic)
Is there any program/center example that should be followed for the implementation of NCAI? *(Only some)	Not much confidence in previous models BEDI, IOOS
What would you like to see from the NOAA AI Center?	Elements close to the mission Workforce development Balanced governance Connection to other centers/partners

Principle Discussion Points

- Should there be an NCAI (timing/value)?
- Given the functionality above, what are centralized and distributed functions?
- Are there other models NCAI should follow (Governance/Funding/Operation)?
- What role would an NCAI play in training/staffing?
- Minimal commercial engagement (funding)?
- Is AI a science task, IT task, or whole new thing?

APPENDIX 12.5. NOAA CLOUD STRATEGY OVERVIEW (D. LAYTON, T. LAVOI)

Cloud Definition and Challenges

Federal Cloud Computing (Cloud Smart) definition:

"Notwithstanding the term's common usage, the term "cloud" is most accurately applied to those solutions that exhibit five essential characteristics of cloud computing, as defined by NIST:

- On-demand service
- Broad network access
- Resource pooling
- Rapid elasticity, and
- Measured service."

Primary Challenge

Fully realizing the potential of the cloud requires changing behaviors and culture (its not a technology challenge!)

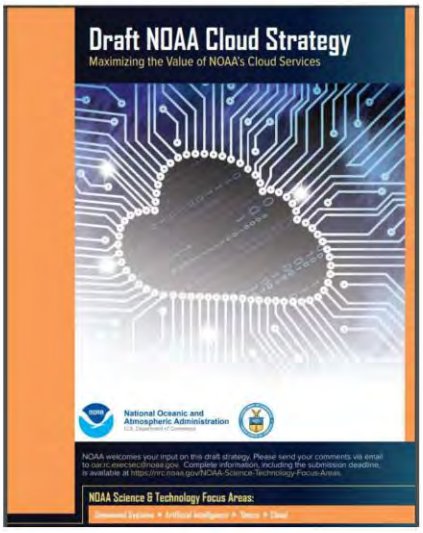
NOAA Cloud Strategy

Maximizing the Value of NOAA's Cloud Services

David Layton
NOAA Office of the CIO

The Cloud Strategy was developed as an FY19 CIO Council Priority, with support from Line Office detailees and OCIO/CDO staff.

The strategy team thanks the NOAA CIO Council for sponsorship and guidance, numerous NOAA-wide committees and working groups for input, as well as recommendations received during the public comment period.



Strategy's Vision

NOAA uses an accessible, scalable, secure, flexible, agile, cost-effective, efficient, highly reliable, and integrated suite of cloud computing products and services to fulfill its mission. Cloud solutions are driven by requirements and the business case, with the default solution being a brokered commercial, multi-cloud, multi-tenant cloud.

Strategy's Purpose

- Provide a unified approach for migrating to the cloud
- Establish a default architectural end-state for NOAA's cloud services
- Promote a smart transition based on requirements, business cases and best practices
- Enable broad sharing of solutions

Cloud Strategy Goals

Goal 1: Enable **innovation** through rapid adoption of cloud-based services

Goal 2: Drive **smart migration** to the cloud

Goal 3: Ensure **secure and broad access** to cloud services

Goal 4: Provide **effective governance** for cloud shared services

Goal 5: Empower a **cloud-ready workforce**

Goal 1 – Enable Innovation

Objective 1.1 **– Cloud Sandbox Capability**
Establish a self-service capability for users to rapidly access or provision a secure exploratory cloud environment.

Objective 1.2 **– Products, Services & Customer Experience**
Identify opportunities to use AI and ML to modernize and improve NOAA products, services, and customer experience.

Objective 1.3 **– Novel Approaches for Cloud Adoption**
Identify and promote novel approaches to encourage innovation using cloud technologies, to include leveraging agile principles and a continuous learning culture.

Objective 1.4 **– Cloud Optimized & AI Ready File Formats**
Establish clear and actionable guidelines for producing NOAA data in cloud-optimized and AI ready file formats.

Goal 2 –Smart Migration

Objective 2.1 **–Implementation Roadmap**
Develop a NOAA cloud transition roadmap that promotes collaborative solutions and aligns with the NOAA Science & Technology (S&T) and Data strategy implementation plans.

Objective 2.2 **– Guidance and Tools**
Develop guidance and tools to facilitate cloud transition planning. Such guidance includes but is not limited to templates for cloud business cases, models to estimate migration and hosting costs, and best practices to prevent cost overruns.

Objective 2.3 **– Transparency**
Provide enhanced transparency to promote trust and encourage collaboration on enterprise cloud solutions.

Objective 2.4 **– Efficient Data Dissemination**
Leverage shared infrastructure and partnerships to reduce data dissemination and egress costs.

Objective 2.5 **– Cloud Success Teams**
Establish Cloud Success Team(s) to assist NOAA programs with developing and executing cloud adoption/migration plans.

Objective 2.6 **– Software Reuse and Collaboration**
Establish an efficient framework and toolset for sharing and reusing software across NOAA and its collaborators.

Goal 3 –Secure and Broad Access

***Objective 3.1* –Cloud Access Security Platform**
Identify and onboard NOAA Cloud Service Providers into a cloud access security platform.

***Objective 3.2* – Advanced Techniques to Mitigate Cyber Threats**
Identify and implement advanced techniques such as AI and ML to improve detection and prevention of malicious and unauthorized behaviors.

***Objective 3.3* – SaaS Hosting Environment**
Establish an accredited system boundary to house SaaS applications used by NOAA.

***Objective 3.4* – System Boundary Guidance**
Provide guidance for defining information system boundaries when programs are leveraging cloud services.

***Objective 3.5* – Common/Shared Cloud Services**
Identify and establish common services for cloud use. Common services include procurement, networking, authentication, security assessment, and security monitoring services.

Goal 4 – Effective Governance

***Objective 4.1* – Continuous & Measurable Customer Experience Improvements**
Develop and implement procedures to govern enterprise cloud services. Procedures ensure continuous and measurable customer experience improvements.

***Objective 4.2* – NOAA Cloud Committee**
Establish a NOAA Cloud Committee to support governance and coordinate effective use of cloud services. The Committee will ensure alignment of planned cloud activities with the NOAA Cloud Strategy, as well the NOAA Data and S&T strategies.

Goal 5 – Cloud Enabled Workforce

Objective 5.1 – Cloud Expertise

Invest in and develop NOAA's cloud expertise. Employ traditional and innovative development approaches and methods.

Objective 5.2 – Cloud Community of Interest

Establish a cloud Community of Interest (COI) to share cloud knowledge, lessons learned and best practices NOAA-wide.

Objective 5.3 – Partnership to Expand Talent

Expand NOAA's cloud talent pool by creating partnerships with other governmental organizations, academia, non-profit organizations, and the private sector.

Objective 5.4 – Competency Based Standards

Develop NOAA-wide competency based standards for cloud knowledge, skills, and abilities.

Objective 5.5 – Attract Talent

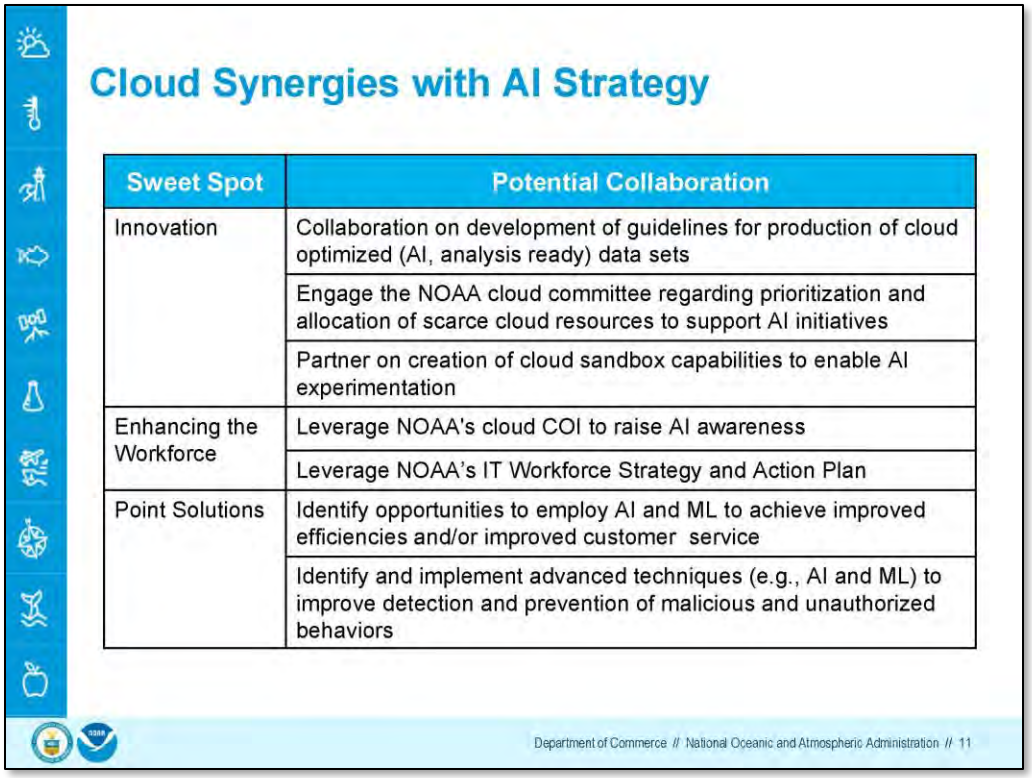
Attract a cloud-proficient IT workforce by creating a mobile-friendly workplace that embraces emerging technology. Balance rapid adoption of new technology, worker mobility, and security.

Next Steps

Milestone	Action
March 2	CIO Council decisional vote to approve cloud objectives
NLT March 6	Revise strategy to incorporate approved objectives, for dissemination to NOSC, NEP, NEC for review and comment
Week of March 9	Commence virtual reviews with NOSC, NEP and NEC, using the same process and turnaround times followed by the other S&T strategies

Implementation Roadmap Plan

- Version 1 published on Jan 27
- Initiated an NRAP project to develop the next version and recommend
  - An efficient and sustainable process to refresh the roadmap over time
  - A collaborative platform to host the roadmap for ease of access and use.
- Engage the new NOAA Cloud Committee as a primary cloud roadmap stakeholder


Cloud Synergies with AI Strategy
Sweet Spot
Potential Collaboration
Innovation
Collaboration on development of guidelines for production of cloud optimized (AI, analysis ready) data sets
Engage the NOAA cloud committee regarding prioritization and allocation of scarce cloud resources to support AI initiatives
Partner on creation of cloud sandbox capabilities to enable AI experimentation
Enhancing the Workforce
Leverage NOAA's cloud COI to raise AI awareness
Leverage NOAA's IT Workforce Strategy and Action Plan
Point Solutions
Identify opportunities to employ AI and ML to achieve improved efficiencies and/or improved customer service
Identify and implement advanced techniques (e.g., AI and ML) to improve detection and prevention of malicious and unauthorized behaviors
Department of Commerce // National Oceanic and Atmospheric Administration // 11

APPENDIX 12.6. NOAA DATA STRATEGY OVERVIEW (K. VALENTINE, E. KEARNS)

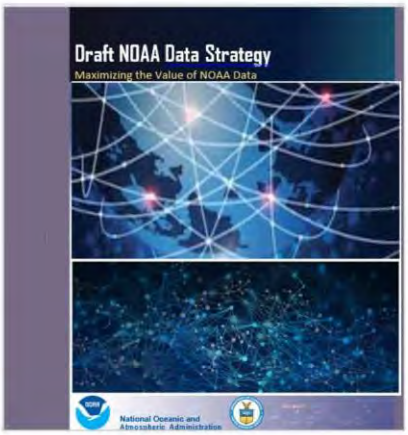
NOAA Data Strategy

Maximizing the Value of NOAA Data

Kim Valentine (NOS/OACIO)

The NOAA Data Strategy was developed as a proactive approach to ensure the Agency was aligned and prepared to meet the new requirements coming from the Federal Data Strategy, the President's Management Agenda, CAP Goal 2, "Leveraging Data As a Strategic Asset."

The Data Strategy was initiated by the NOAA Chief Data Officer, with in-kind support from the NOAA Environmental Data Committee, and executive sponsorship by the NOSC and CIO Council.



Definition & Benefits

Evidence Act:

"Data" means all data collected or produced by NOAA line, staff and corporate services offices. This includes environmental, program and statistical data, as well as mission-support data including administrative, financial, performance, and workforce data.

Benefits:

The NOAA Data Strategy will accelerate the effective use of data by the agency, partners, and the public; it will enable NOAA to improve mission delivery and steward resources while ensuring data security, privacy, and confidentiality.

Legislative Drivers

New Federal Data Landscape

- Federal Data Strategy
- M-19-23 Evidence Act (Phase 1)
- Information Quality Guidelines
- A-130; A-16

- Exec Order on AI (2019)
- Geospatial Data Act (2018)
- Evidence Act (2019)

President's Management Agenda

- Cross Agency Priority Goals: Data, IT, Spending Data, Improper Payments Data, Shared Services

Strategic Drivers

NOAA Unmanned Systems Strategy

NOAA Artificial Intelligence Strategy

NOAA 'Omics Strategy

Draft NOAA Cloud Strategy

Key Components

Vision:
Data are fully leveraged inside and outside NOAA to create mission value, improve government efficiency and effectiveness, and provide quality services for the public.

Purpose:
The NOAA Data Strategy promotes the effective use of data by the agency, its partners, and the public.

Goal 1 – Build a culture that values high quality data as an asset.

Objective 1.1 Create a reporting and coordination structure throughout NOAA's Line and Staff Offices

Objective 1.2 Ensure that enterprise data governance, security, management and stewardship are represented to facilitate effective data-driven decisions and investments

Goal 2 – Effectively govern, manage, share, and protect data assets.

Objective 2.1. Establish a diverse Data Governance Body that has: a) oversight of NOAA's collective data operations, b) the authority to collectively govern how NOAA's data assets are managed, and c) provides strategic guidance for NOAA's Line Offices and Staff Offices relevant to their data and related activities, including Program Management, Acquisition, and IT review boards.

Objective 2.2. The Data Governance Body should revise and maintain existing NOAA data policies (e.g. NAO 212-15, EDM Framework) to keep pace with the rapidly changing data community.

Objective 2.3. The Data Governance Body should facilitate the NOAA-wide use of common services to support NOAA data throughout the Data Lifecycle. [All S&T Strategies]

Goal 3 – Share data as openly and widely as possible to promote utilization of NOAA data.

Objective 3.1. Develop a NOAA Open Data Plan, a Data Security Plan, and a collective Concept of Operations that describes how NOAA's data can and will be shared appropriately inside NOAA, with other Federal agencies, with NOAA's partners, and with the general public.

Objective 3.2. Develop and maintain a comprehensive data inventory that accounts for all data assets collected by, under the control or direction of, or maintained by NOAA.

Goal 4 – Promote data innovation and quality improvements to facilitate science.

Objective 4.1. Establish a NOAA Data Architecture to facilitate alignment of NOAA's data and information systems to support NOAA's mission, science and innovation. [Cloud Strategy]

Objective 4.2. Create a NOAA-wide workforce development plan, including training opportunities, to allow NOAA employees to take full advantage of the available information and data science technologies in support of NOAA's missions. [All S&T Strategies]

Goal 5 – Honor stakeholder engagement and leverage partnerships to maximize the value of NOAA data to the Nation.

Objective 5.1. Establish partnerships to enable effective and wide scaling of access to NOAA's data, the provision of expertise that supports the wider understanding of those data, and the effective use of NOAA information products by all. [All S&T Strategies]

Objective 5.2. Engage with NOAA's stakeholders to ensure that NOAA receives ongoing expert and timely feedback on NOAA's data practices, especially as they relate to the use of NOAA's data in the research and commercial sectors. [All S&T Strategies]

Next Steps

Timeline & Status:

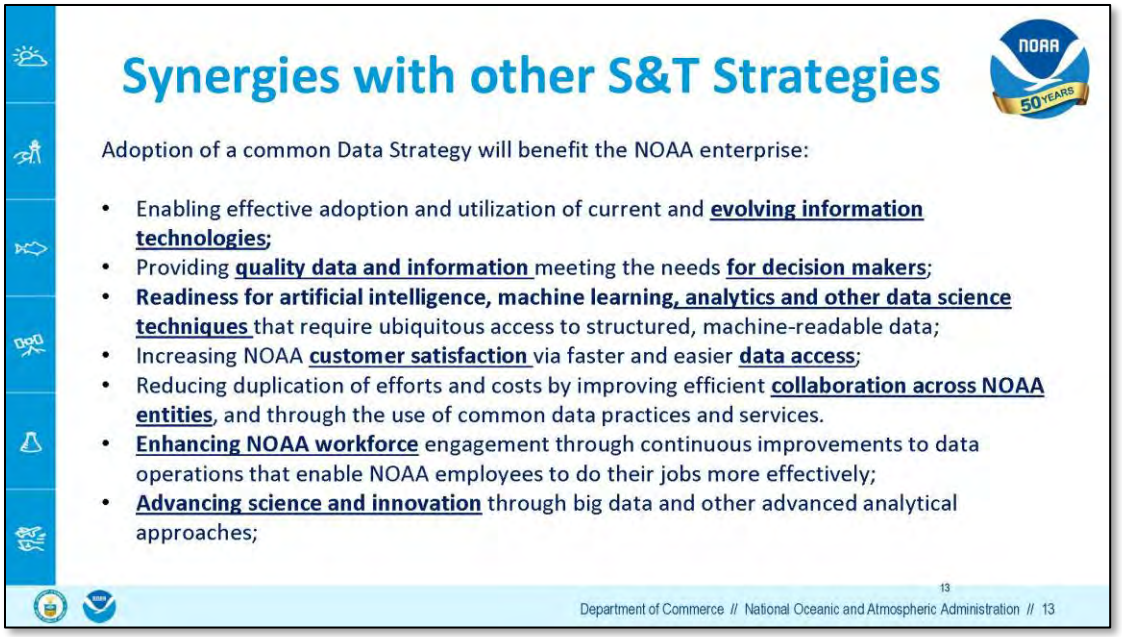
- March: Data Strategy Team working to adjudicate recent feedback (NOSC, CIO Council, etc.)
- April: Present revised draft Strategy for final review and approval

Synergies with other S&T Strategies

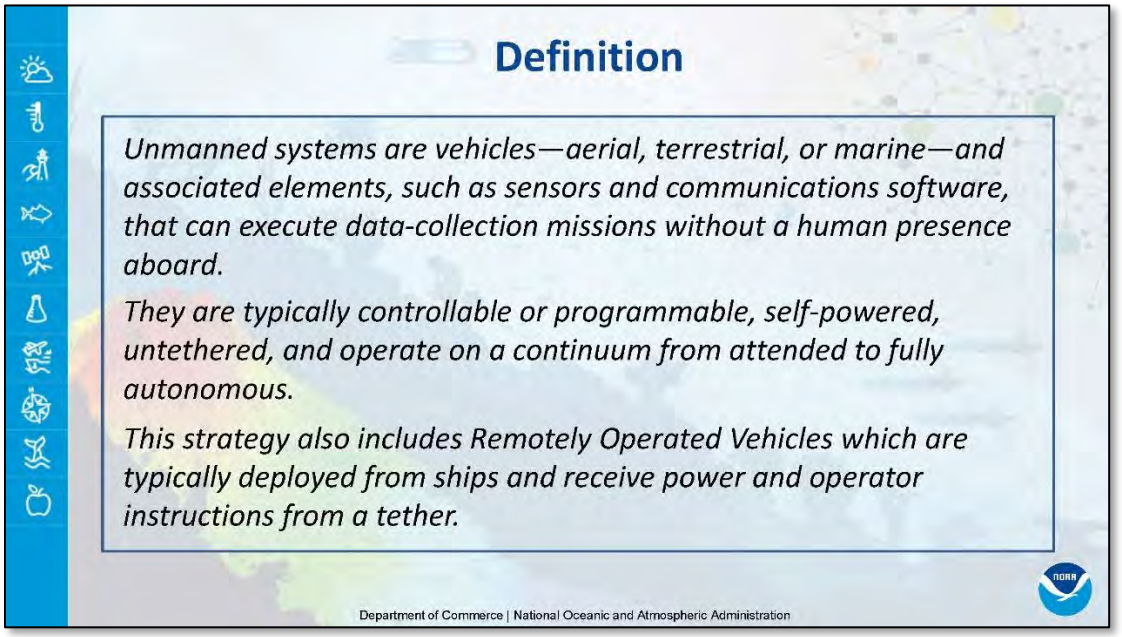
The Data Strategy lays the foundation for the other strategies.

Science is limited by the speed and ease of data access.

Data is the tree upon which all the shiny ornaments depend.


Synergies with other S&T Strategies
NOAA
50 YEARS
Adoption of a common Data Strategy will benefit the NOAA enterprise:
• Enabling effective adoption and utilization of current and evolving information technologies;
• Providing quality data and information meeting the needs for decision makers;
• Readiness for artificial intelligence, machine learning, analytics and other data science techniques that require ubiquitous access to structured, machine-readable data;
• Increasing NOAA customer satisfaction via faster and easier data access;
• Reducing duplication of efforts and costs by improving efficient collaboration across NOAA entities, and through the use of common data practices and services.
• Enhancing NOAA workforce engagement through continuous improvements to data operations that enable NOAA employees to do their jobs more effectively;
• Advancing science and innovation through big data and other advanced analytical approaches;
13
Department of Commerce // National Oceanic and Atmospheric Administration // 13

APPENDIX 12.7. NOAA UNCREWED SYSTEMS STRATEGY OVERVIEW (C. ALEXANDER).



Benefits

The recent rapid expansion in availability of UxS, fueled in part by NOAA scientists and discoveries, has brought **a corresponding increase in their innovative use as a force multiplier** for many NOAA programs - augmenting data collection often **at lower cost, increased safety, and reduced risk**, especially in remote or extreme environments.

Examples include hydrographic and habitat mapping, ocean exploration, marine mammal and fishery stock assessments, emergency response, and at-sea observations that improve forecasting of extreme events, such as harmful algal blooms and hypoxia.

VISION

NOAA is the national and global leader in UxS operations that support science, public safety, and security.

PURPOSE

To dramatically expand the collection and utilization of critical, high accuracy, and time-sensitive data by increasing the application and use of unmanned aircraft and marine systems (together, "unmanned systems" or "UxS") **in every NOAA mission area** to improve the quality and timeliness of NOAA science, products, and services.

NOAA Unmanned Systems Strategy Goals

Goal 1: **Coordinate and Support UxS Operations at an Enterprise Level.**

Goal 2: **Expand UxS Applications Across NOAA's Mission Portfolio.**

Goal 3: **Accelerate Transition of UxS Research to Applications.**

Goal 4: **Strengthen and Expand UxS Partnerships.**

Goal 5: **Promote Workforce Proficiency in UxS Use and Operations.**

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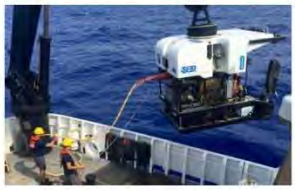
Goal 1: Support UxS Operations at an Enterprise Level

Objective 1.1.
Establish an Effective and Adaptive Organizational Structure.

Objective 1.2.
Identify and Deliver Priority Core Services Including Cybersecurity, Training, and Acquisition.

Objective 1.3.
Implement an Innovative, Robust, and Encompassing UxS Data Enterprise.

Goal 2: Expand UxS Applications Across NOAA's Mission Portfolio.



Objective 2.1.

Establish A Requirements-Based Process to Prioritize UxS Operational Applications and Use.

Objective 2.2.

Establish a Thriving UxS Community of Practice at NOAA.

Objective 2.3.

Objective 2.3. Institutionalize Operational Applications Through Formal Concepts of Operations.

Goal 3: Accelerate Transition of UxS Research to Applications.*

Objective 3.1.

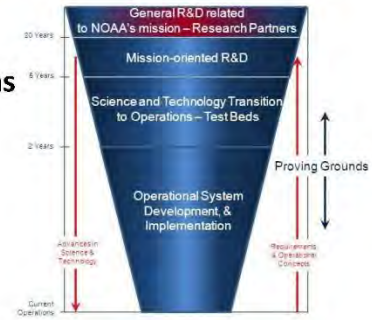
Identify and Prioritize Candidate UxS Platforms for NOAA Use.

Objective 3.2.

Develop Transition Plans With Operational Partners.

Objective 3.3.

Conduct Systematic Testing and Evaluation to Ensure High Performance.



NOAA Research & Development Funnel

* *The UxS Strategy is inclusive of "R2X" considerations, i.e., Research to Operations, to Applications, and to Commercialization, as well as the feedback to Research. As such, the UxS Strategy is meant to consider the full R2X2R feedback of activities.*

Goal 4: **Strengthen and Expand UxS Partnerships.**

Objective 4.1.

Increasingly Leverage Interagency Integration.

Objective 4.2.

Reinforce Cooperation With Academia.

Objective 4.3.

Dramatically Grow Partnerships With the Private Sector.

Goal 5: **Promote Workforce Proficiency in UxS Use and Operations.**

Objective 5.1.

Expand Recruiting Efforts to Showcase NOAA UxS Activities.

Objective 5.2.

Establish Formal Training and Certification.

Objective 5.3.

Include NOAA UxS Assignments as a Retention Tool.

NEXT STEPS AND IMPLEMENTATION PLAN process/timeline

February - **Plan Process Initiated: with initial Planning/Process/Assignments Meetings** (divide into Goal/Objective Teams)

Late Arpil - **NOAA UxS Imp. Plan Workshop** (1.5-2 days, in person, DC area)

Mid-Late May - **Draft Implementation Plan, v1.0**

Late July - **Community Workshop on Draft Plan** (1.5-2 days, DC area with Stakeholders)

September - **v2.0 of Implementation Plan for NOAA review**

October - **Final UxS 5 Year Implementation Plan** (roll-out at OCEANS 2020, Biloxi, MS)

NEXT STEPS AND IMPLEMENTATION PLAN writing team

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4. **John Crofts**, NOAA Fisheries/SWFSC
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6. **Michael Gallagher**, NOAA Fisheries/S&T
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9. **CDR Paul Hemmick**, OMAO/AOC-UAS
10. **Philip Hoffman**, OAR/OER
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Unmanned Systems synergistic activities with NOAA Strategies

- **Enhance infrastructure** (databases, cloud computing, analytics such as ML)
- **Data:** management, standards, processing, through-put
- **Transition into operations** (testbeds, improve operational monitoring such as UxS)
- **Partnerships** (engage user community including long-term observations and data archive)
- **Training** (share interdisciplinary expertise to accelerate a 'One-NOAA' approach)

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Unmanned Systems Strategy Team

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Martha McCoy
Derek Hanson
Frank Sprtel

NOAA Legislative Affairs
Bryan Cole

NOAA Office of the CIO
James Jones

APPENDIX 12.8. NOAA 'OMICS STRATEGY OVERVIEW (C. WERNER).

NOAA 'Omics Strategy

Strategic Application of Transformational Tools

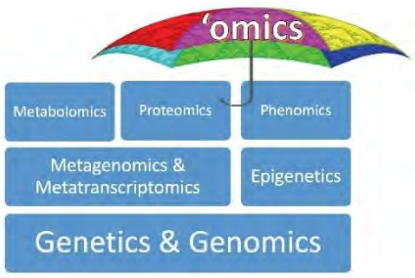
Cisco Werner[1], Kelly Goodwin[2], Mark Strom[3] & Jeanette Davis[4]

[1]NOAA NMFS
[2]Atlantic Oceanographic & Meteorological Laboratories, NOAA OAR
[3]Northwest Fisheries Science Center, NOAA NMFS
[4]Office of Policy, NOAA NMFS

The 'Omics Strategy was developed in collaboration with members of the NOAA 'Omics Task Force. We also thank recommendations received during the public comment period and from NOAA's Research Council.

'Omics Definition and Benefits

- A suite of advanced methods used to analyze material such as DNA, RNA, proteins, or metabolites.
- These tools that have revolutionized biological study, with benefits applied to medicine, agriculture, and other industries.
- NOAA is using these tools to understand how to sustain and grow the benefits we receive from our oceans and Great Lakes.



STRATEGY'S VISION

NOAA will integrate modern 'omics technologies across the agency, transforming its approach to biological investigation and accelerating sustainable management of ecosystem resources for the benefit of people, communities, and economies.

STRATEGY'S PURPOSE

Integrating 'omics tools into research and operations to deliver timelier products and services to benefit society. The strategy process helps ensure deliberate and transparent investment in 'omics technologies to meet mission priorities.

'Omics Strategy Goals

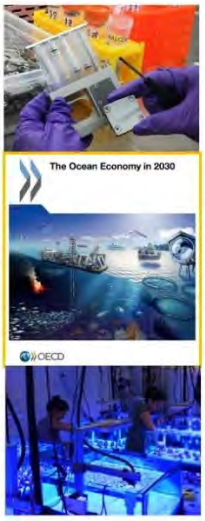
Goal 1: Enhance **infrastructure** to meet the analytical demands of 'omics data.

Goal 2: Execute 'omics **research** targeted to support and advance the U.S. Blue Economy.

Goal 3: Accelerate **transition** of 'omics research into operations.

Goal 4: Expand **partnerships** to advance 'omics research and applications across the agency.

Goal 5: Promote **workforce proficiency** in 'omics.



Goal 1 – Enhance Infrastructure

Objective 1.1. **LABS, SHIPS, AND VEHICLES**

Provide adequate laboratory space in facilities and ships to collect, process, and store samples for 'omics analyses, and increasingly leverage UxS (unmanned systems) for data collection (**see UxS Strategy**)

Objective 1.2. **COMPUTING POWER and STORAGE**

Procure the analytical and computational infrastructure needed to generate, analyze, and manage massive 'omics data sets, and increasingly leverage the commercial cloud for computation and data storage (**see Cloud Strategy**).

Objective 1.3. **BIOINFORMATICS and DATABASES for 'OMICS TIME SERIES**

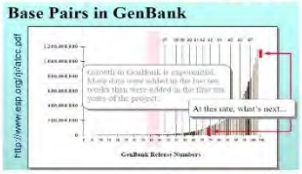
Expand the databases that identify genetic sequences and develop bioinformatics tools needed to manage and interpret time series data, including impacts of large scale environmental change through biodiversity monitoring.

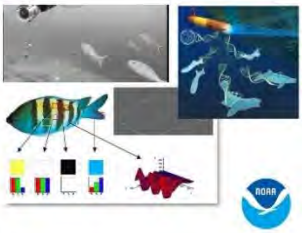
Objective 1.4. **SHARED REPOSITORIES**

Create a central repository to share protocols, standards, and house bioinformatics pipelines to support a community of practice across laboratories and programs.

Objective 1.5. **MACHINE LEARNING (ML) AND AI**

Leverage computational approaches such as ML and AI (**see AI Strategy**) to help interpret genetic variation and recognize relationships with environmental data.





Goal 2 – Research to Support US Blue Economy

Objective 2.1. **BIO-SURVEILLANCE**

Improve detecting and monitoring of harmful algal blooms, toxins, pathogens, and invasive species to protect health and coastal economies.

Objective 2.2. **SEAFOOD FORENSICS**

Support consumer protection and sustainable fishing practices by using genetic analysis to identify fraudulent and illegally sourced seafood products.

Objective 2.3. **SUSTAINABLE AQUACULTURE**

Foster the development of aquaculture by using 'omics to optimize animal health, yield, and product characteristics while supporting safe and sustainable farming practices.

Objective 2.4. **FISHERIES, PROTECTED RESOURCES, FOOD WEBS**

Sustain fisheries resources and protect vulnerable species using 'omics to increase the breadth, depth, and throughput of information used to evaluate target populations' structure and distribution, generate indices of abundance, and characterize the food webs that support them.

Objective 2.5. **BIODIVERSITY AND BIOPROSPECTING**

Advance the exploration of biodiversity and bioprospecting to discover natural products that may have medical or other commercial value, and provide international leadership in the use of marine genetic resources while protecting biodiversity.

Goal 3 – Accelerate transition of 'omics research into operations

Objective 3.1. **UNDERSTAND AND FULFILL MISSION REQUIREMENTS**

Conduct field trials to define operational requirements, calibrate 'omics approaches with traditional methodologies, and clarify design specifications to accelerate production of validated approaches.

Objective 3.2. **STANDARDIZATION, INTEROPERABLE AND AVAILABLE DATA**

Promote a unified approach to sample and metadata collection, sample processing, and data deposition in publicly searchable archives to promote interoperability and time series establishment.

Objective 3.3. **INDICATORS AND ACTIONABLE EVIDENCE**

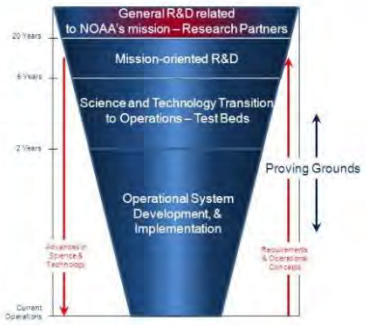
Develop and integrate 'omics ecosystem indicators into reports, models, and forecasts to benefit seafood safety, public health, and economic protection.

Objective 3.4. **COMBINE TECHNOLOGIES TO HASTEN SUCCESS**

Combine 'omics with existing and emerging technologies to synergize the strengths of individual approaches and thus hasten the innovation of operations.

Objective 3.5. **UTILIZE R2X PROCESS**

Develop transition plans with NOAA Line Office Transition Managers (LOTMs) to outline steps for technology transfer and provide incentives and support for 'omics R2X.



NOAA Research & Development Funnel

Goal 4 – Expand partnerships to advance 'omics research and applications across the agency.

Objective 4.1. **INTERNAL COMMUNICATION AND CHAMPIONSHIP**

Establish a NOAA 'Omics Executive Committee, chaired by the Chief Scientist, to guide the 'Omics Working Group (OWG) to share information opportunities, and promote the priorities outlined in this strategy across the agency.

Objective 4.2. **ENGAGE USER COMMUNITIES**

Engage existing national and international groups working to enhance 'omics technology improvement, standardization, long-term observations, and data and sample archival.

Objective 4.3. **INTERAGENCY FUNDING OPPORTUNITIES**

Prioritize 'omics research in existing interagency funding opportunities to advance 'omics research and development.

Objective 4.4. **NATIONAL AND INTERNATIONAL ENGAGEMENT**

Foster coordinated and collaborative projects across agencies and internationally to advance 'omics applications.

Objective 4.5. **TECHNOLOGY TRANSFER PARTNERSHIPS**

Build and sustain partnerships with the private and academic sectors using existing vehicles to encourage engagement with federal 'omics research and development and to increase the potential for commercialization.

Goal 5 – Promote Workforce Proficiency in 'Omics

Objective 5.1. **NEEDS ASSESSMENT**

Conduct a baseline needs assessment to inform goal implementation.

Objective 5.2. **TRAINING**

Provide training for 'omics data collection and bioinformatics analysis to increase expertise within the current workforce.

Objective 5.3. **RECRUITMENT**

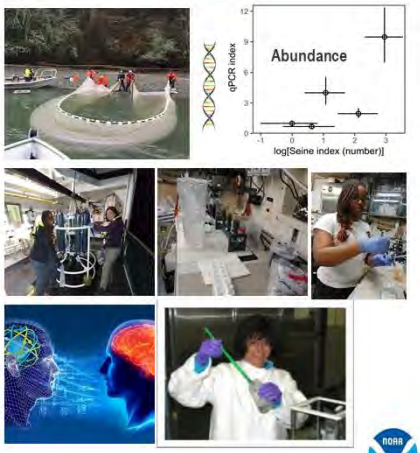
Recruit and retain information technology (IT) professionals and scientists with bioinformatics expertise to address current gaps in the ability to analyze and provide biological or environmental context to sequence data.

Objective 5.4. **DEVELOPMENT OPPORTUNITIES**

Develop opportunities for job details in laboratory facilities to provide career development for staff, interns, and fellows, and to promote 'omics projects and data integration.

Objective 5.5. **SHARE EXPERTISE**

Focus assignments in the NOAA Rotational Assignment Program (NRAP) to target offices where a cross-pollination of 'omics expertise would raise overall proficiency.



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NEXT STEPS AND IMPLEMENTATION PLAN

- NOAA is committed to continued development and implementation of 'omics technologies to address complex challenges across its multiple missions.
- The NOAA **'Omics Strategy** identifies goals and objectives to develop the proficiency, projects, and partnerships needed to integrate 'omics into mission areas to promote a sustainable ocean economy.
- A NOAA 'Omics **Implementation Plan** will further detail how the investment areas described in this strategy will be accomplished.

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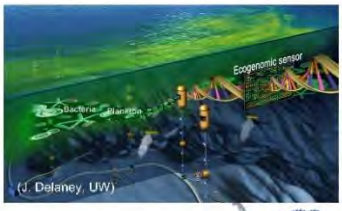
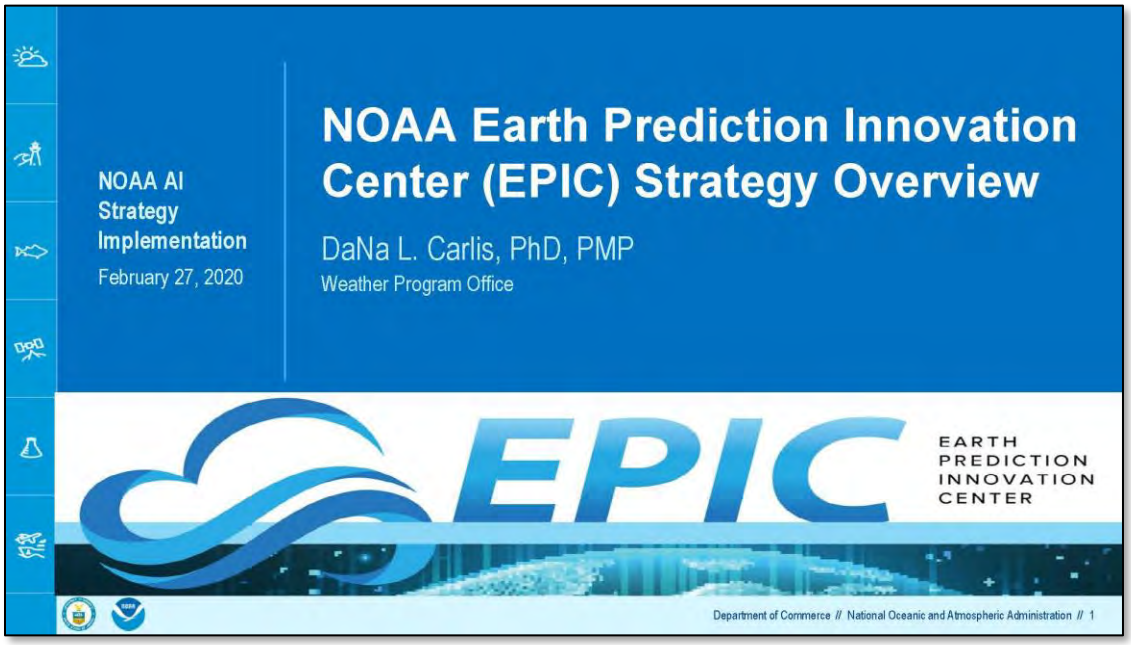
'Omics synergistic activities with NOAA Strategies

- Enhance infrastructure (databases, cloud computing, analytics such as ML)
- Transition into operations (testbeds, improve operational monitoring such as UxS)
- Partnerships (engage user community including long-term observations and data archive)
- Training (share interdisciplinary expertise to accelerate a 'One-NOAA' approach)



APPENDIX 12.9. NOAA EPIC STRATEGY OVERVIEW (D. CARLIS).



EPIC

1.0 Why is EPIC needed?

1.1 The Opportunity
To accelerate scientific research and modeling contributions through continuous and sustained community engagement to produce the most accurate and reliable operational modeling systems in the world.

1.2 The Community Requests
2019 EPIC Community Workshop

1.3 The Legislative Mandates
The Weather Research and Forecasting Innovation Act of 2017
National Integrated Drought Information System Reauthorization Act of 2018
FY2020 Appropriation (P.L. 116-93 and explanatory statement)

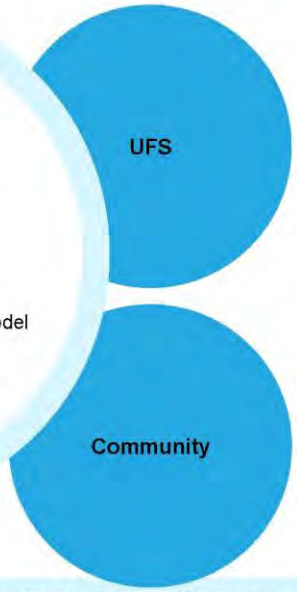
1.4 The Executive Mandates
NOAA's FY2020 Blue Book
Memorandum on Fiscal Year 2021 Administration Research and Development Budget Priorities

2.0 What EPIC isn't

EPIC IS a virtual center that leverages resources to better coordinate the weather research and modeling community to continually inform and accelerate advances in our nation's operational forecast model systems. In the near term, this means that EPIC's initial focus is on global components of the Unified Forecast System.

EPIC IS NOT free user access to high-performance computing and parallel processing; containerization beyond the community integrated development environment; the Unified Forecast System.

What EPIC is….
Development environment
Code manager
Cloud-ready code
Observations/tools
Community support
Community engagement
Roadmap for research and model priorities
Later: Additional components



3.0 How will EPIC work?

From the requests and mandates, the following concepts and approaches emerge to realize the full potential of EPIC.

EPIC

3.1 Concept: Vision, Mission, and Mantra

Vision. Enable the most accurate and reliable operational numerical forecast model in the world.

Mission. To be the catalyst for community research and modeling system advances that continually inform and accelerate advances in our nation's operational forecast modeling systems.

Mantra. Partnering with the community for the benefit of the nation.

EPIC

3.2 Approaches, Practices, and Scenarios

Collaborating with integrity and trust across our community.

Posing the problems rather than defining solutions.

Leveraging existing objective evaluation processes and agreed-upon metrics.

Pursuing realistic near-term wins with attribution for everyone.

Co-developing research and modeling.

EPIC

3.2 Approaches, Practices, and Scenarios

3.2.1 External Engagement and Community

3.2.2 Software Engineers*

3.2.3 Software Infrastructure*

3.2.4 User-Support Services*

3.2.5 Cloud-based High Performance Computing

3.2.6 Scientific Innovation

3.2.7 Management and Planning

**contracted services*

EPIC

4.0 How will EPIC succeed?

4.1 Accurate and reliable operational models: EPIC will partner with NOAA to continually update and provide accurate, efficient, and advanced operational models that are a seamless, best-in-class system of software and hardware.

4.2 Community contributions to operational modeling systems: make EPIC the most community-accessible and user-friendly system in the world so that everyone benefits from collective advancements.

4.3 Community engagement: engagement is the opportunity to share and learn from each other.

EPIC

4.1 Accurate and reliable operational models

Objective 1.1 // Co-develop research and models.

Objective 1.2 // Prioritize code.

Objective 1.3 // Leverage assets.

Objective 1.4 // Increase understanding.

Objective 1.5 // Leverage observational data.

Objective 1.6 // Partner.

EPIC 4.2 Community contributions to operational modeling systems

Objective 2.1 // Ensure that operational priorities are addressed.

Objective 2.2 // Catalyze engagement.

Objective 2.3 // Inspire outcomes.

EPIC 4.3 Community engagement

Objective 3.1 // Accelerate contributions.

Objective 3.2 // Document community engagement plan.

Objective 3.3 // Document governance structure.

Objective 3.4 // Align programs and funding opportunities.

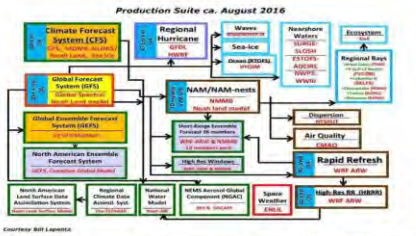
Objective 3.5 // Communicate EPIC's importance.

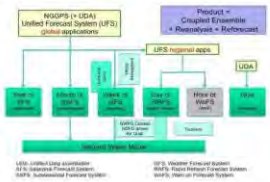
Objective 3.6 // Learn continually.

Objective 3.7 // Build and maintain trust.

EPIC 5.0 The EPIC way forward

Just as **EPIC facilitates** and supports the agile and **continuous development** of research and modeling, this strategic plan will be continually developed and updated to leverage progress and **prioritize new investments.** Watch for **early successes** as measured in code utilization and GitHub forking, and later successes measured in increased skill scores from code **improvements to operational modeling systems**.





GitHub

EPIC 6.0 EPIC Next steps

- Release Request for Proposals (RFP)
- Governance Documents
- Implementation Plan
- Communications Strategy
- Graphics and visualizations
- UFS medium-range weather release
- UFS tutorials, workshops, hackathons
- Procurement of cloud resources

UFS
UNIFIED FORECAST SYSTEM

7.0 EPIC's synergistic activities with NOAA Strategies

- AI
  - Observation quality control
  - Bias correction
  - DA
  - Physics
  - Post processing
- Cloud
  - HPC
  - Containers
  - Data formats
  - Access
- Big Data Project & Observation data on the Cloud
- DevSecOps
  - Continuous integration continuous development

EPIC EARTH PREDICTION INNOVATION CENTER

THANK YOU!

EPIC

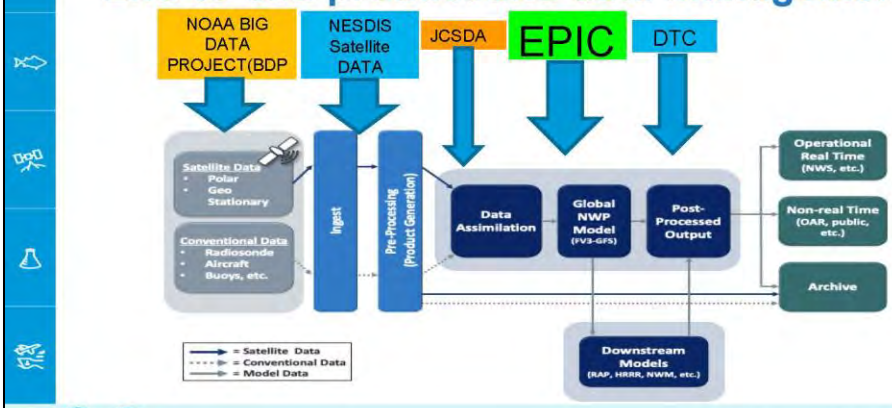
EARTH PREDICTION INNOVATION CENTER

BACKUP SLIDES

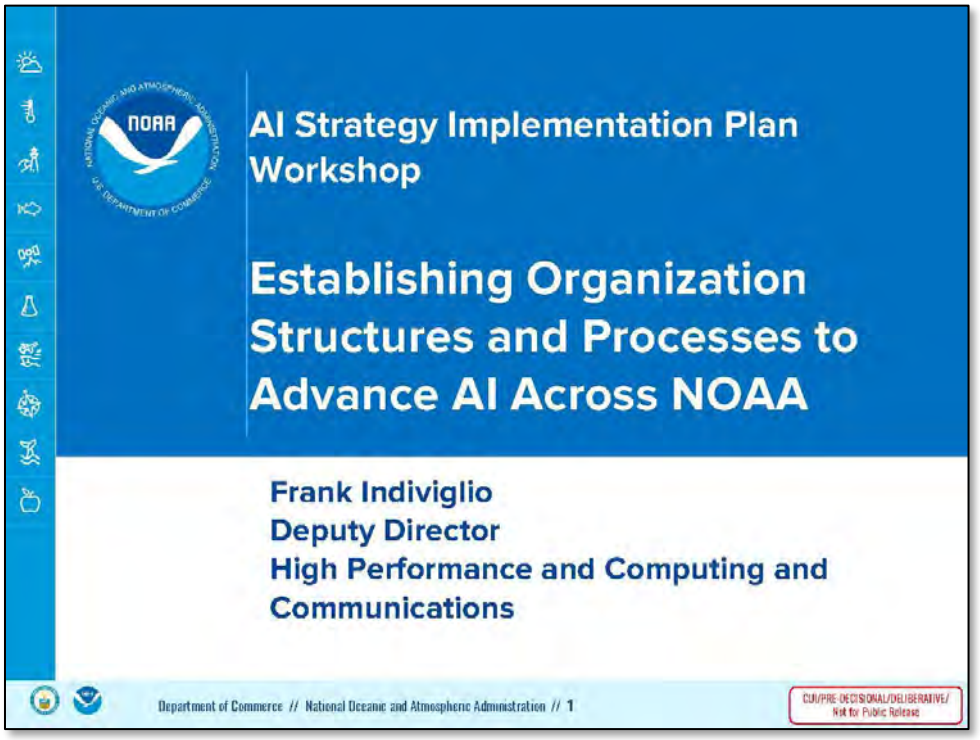
EPIC

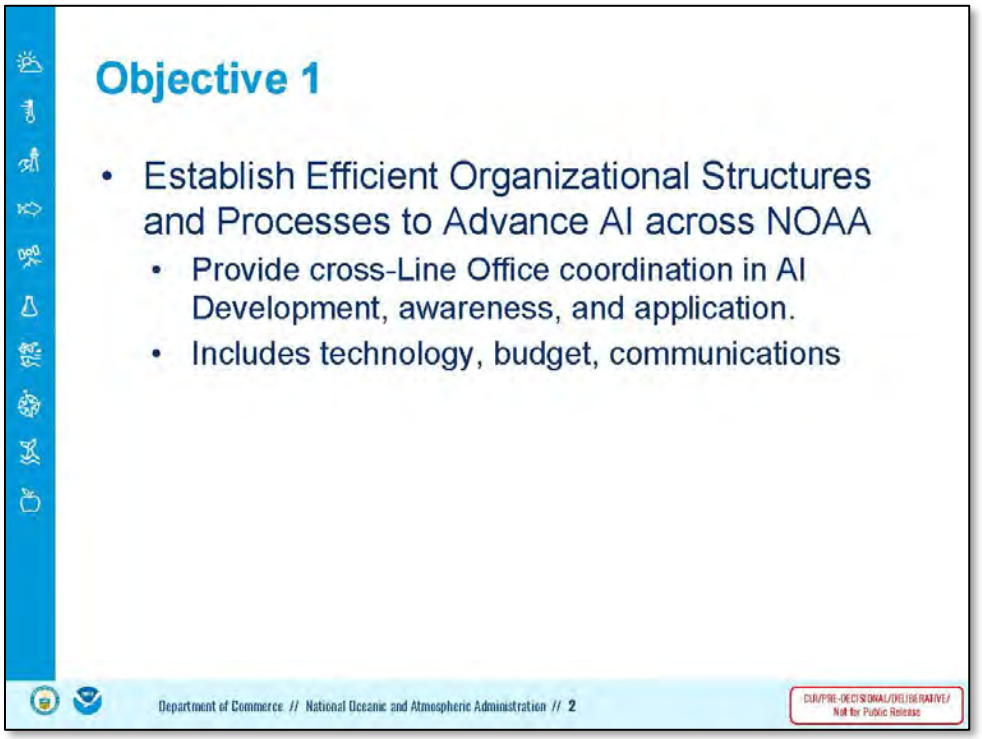
EPIC Connects Forecast Process

End-to-end product and data management



APPENDIX 12.10. NOAA AI STRATEGY – GOAL 1 (F. INDIVIGLIO).





Objective 1.1

- Establish the NOAA center for AI
  - Coordinate R&D, Communications
  - Host training and workshops
  - Facilitate new partnerships
  - Open source and application repository

Objective 1.2

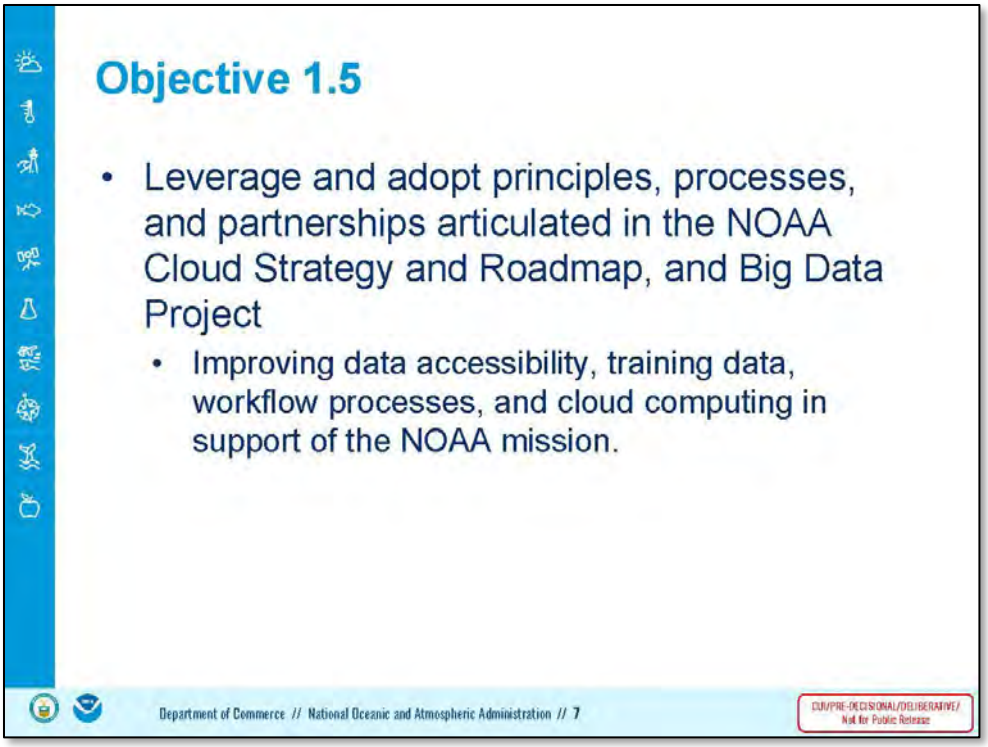
- Develop working groups of cross-Line Office expertise to develop and execute implementation plans
  - Prioritization of Research Activities
  - Workshops
  - Develop Metrics to measure progress and need

Objective 1.3

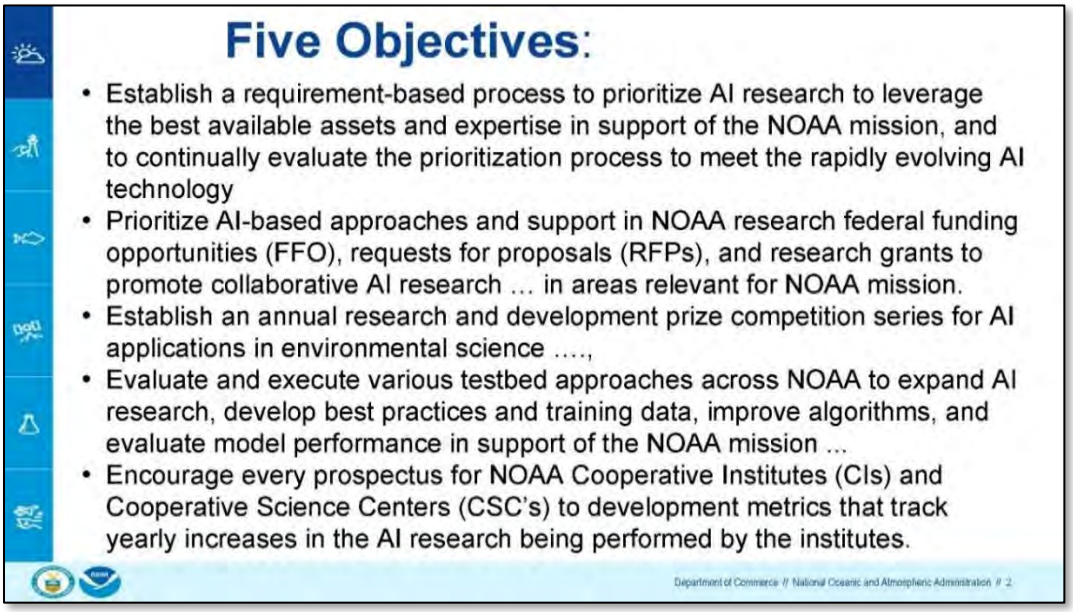
- Prioritize AI-based approaches in NOAA budget formulation
  - Performance/Skill
  - Computational efficiency
  - Cost Effectiveness

Objective 1.4

- Include discussion of NOAA AI activity in NOAA executive level engagement and communications with key stakeholders.
  - OMB
  - Congressional Staff
  - Federal Agencies


Objective 1.5
• Leverage and adopt principles, processes, and partnerships articulated in the NOAA Cloud Strategy and Roadmap, and Big Data Project
• Improving data accessibility, training data, workflow processes, and cloud computing in support of the NOAA mission.
Department of Commerce // National Oceanic and Atmospheric Administration // 7
DUVPRE-DECISIONAL/DELIBERATIVE/
Not for Public Release

APPENDIX 12.11. NOAA AI STRATEGY – GOAL 2 (V. KRASNOPOLSKY).

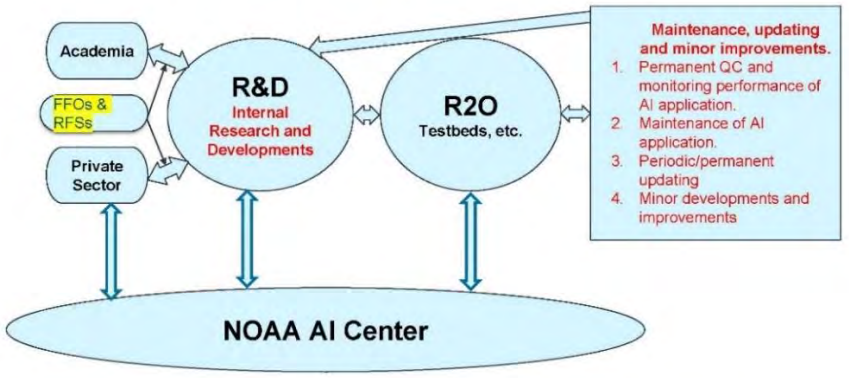


For Implementation of Goal 2, the Key Priority - Building Infrastructure for AI R&D > R2O > O2R > R2O

- ***Major assumptions:***

1. AI Infrastructure may be similar to existing infrastructures, supporting other major NOAA research tools like statistical modeling tools, numerical weather prediction models, etc.
2. AI Infrastructure must be comprehensive - include all chains of AI R&D life cycle

AI R&D Life Cycle



AI Infrastructure have to be supported by sufficient amount of employees

1. Finding new employees with AI experience is difficult now.
2. **Reeducation and retraining of existing employees:**
   - NOAA AI Center
   - Taking courses at Universities (e.g., UMD)
   - Mentoring (internal) programs
   - "Sabbatical" (external) programs

Key Questions for Discussion:

- How to perform funding of internal AI R&D
  - Lower the cost of curiosity
  - Stimulate pilot projects
  - Expand Incubator projects programs
- AI R&D and clouds
  - A lot of data manipulations
  - Training is computationally time consuming
  - Possible implementation problems for AI tools developed on clouds
- Solving staffing problem:
  - Training and education of existing NOAA employees:
    - Role of NOAA AI Center
    - Internal & External programs

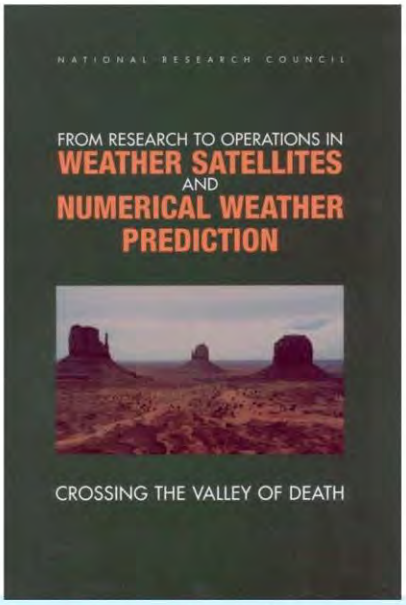
AI is a new tool:
- = +

APPENDIX 12.12. NOAA AI STRATEGY – GOAL 3 (H. TOLMAN).

R2X: not a new problem

- 2000 NAS report with two foci:
  - Operational modeling (EMC)
  - Satellite data (NESDIS)
- 15 recommendations
- 13.5 implemented
- Organizations benefitted, but Valley of Death remained unchanged

	Recommendation (2000)	Preset Status (2017)
1	Implement a development, testing, and integration facility at EMC	Better resources within EMC, adding DTC, GMTB, testbeds and OPG
2	Support critical EMC staff through base funding	Greatly improved by 2010, may be eroding now.
3	Co-locating EMC with other appropriate institutions.	Move from WWB to NCWCP (University of Maryland), Summer 2012
4	Broad NWS plan for technology infusion	NWS modernization, one-NOAA HPC, SENA project
5	EMC should actively participate in the USWRP	Moving from in-house mesoscale models to WRF
6	EMC needs to collaborate with NSF and ONR on oceans	Navy HYCOM models implemented at EMC, HYCOM-MOM merging ongoing
7	NCEP and EMC should institutionalize the R2O process	"Glass half full"



NOAA moving to Readiness Levels

NAO 216-115A: RESEARCH AND DEVELOPMENT IN NOAA

- .08 **Readiness Levels (RLs):** A systematic project metric or measurement system that supports assessments of the maturity of R&D projects for transition from research to operation, application, commercial product or service, or other use and allows the consistent comparison of maturity between different types of R&D projects. (Note: NOAA's RL's are similar to Technology Readiness Levels developed by NASA (Mankins, 1995) and embody the same concept for quantifying the maturity of research). A program may include projects at different RLs depending on the goals of each project. Inventions may be generated at any RL. NOAA's Policy on Research and Development Transitions can be found in NAO 216-105B.

RLs defined in NAO 216-115a

There are nine RLs as follows:

a. RL 1: Basic research, experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications (OECD, 2015);
b. RL 2: Applied research, original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving specific and predetermined objectives (OECD, 2015);
c. RL 3: Proof-of-concept for system, process, product, service or tool; this can be considered an early phase of experimental development; feasibility studies may be included;
d. RL 4: Successful evaluation of system, subsystem, process, product, service or tool in laboratory or other experimental environment; this can be considered an intermediate phase of development;
e. RL 5: Successful evaluation of system, subsystem process, product, service or tool in relevant environment through testing and prototyping; this can be considered the final stage of development before demonstration begins;
f. RL 6: Demonstration of prototype system, subsystem, process, product, service or tool in relevant or test environment (potential demonstrated);
g. RL 7: Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system).
h. RL 8: Finalized system, process, product, service or tool tested, and shown to operate or function as expected within user's environment; user training and documentation completed; operator or user approval given;
1. RL 9: System, process, product, service or tool deployed and used routinely.

RLs defined in NAO 216-115a

RL	Description
1	Basic research
2	Applied research
3	Proof of concept
4	Experimental eval.
5	Relevant eval.
6	Test demonstration
7	Prototype system
8	Finalized system
9	Operations

Modeling example

- RL6: Test demonstration
  - From concept to product
- RL7: Prototype:
  - All relevant elements are active
  - Environment looks like operations
- RL8: Finalized
  - Tested and proven
  - Documented
  - In final form
  - All that needs to be done is a handoff …..

R2O that works

- O2R2O with research and operations using the same tools ("X2R2X")
  - Reduces transition time by factor 5
  - Enabling partnerships as force multipliers
    - NOAA ops, NOAA R&D, gov., academia, industry, ….
- Balanced agility
  - Code development highly agile, application updates recognize stability needed by stakeholders
- Balanced diversity
  - Unified infrastructure with diverse science components = focused resources and diversity

Implications for AI

- Standardize tools between "R" and "X" ….
  - #1 accelerator of transitions
- Define AI making a disctinction between tools and outcomes and ….
- Define RLs
  - NAO allows for AI specific defintion of RL
  - Needs to be tailored to type of AI considered
- Education: "AI needs to be redone every time"
- And …. breakout session ….

APPENDIX 12.13. NOAA AI STRATEGY – GOAL 4 (J. STEWART).

Goal 4: Strengthen and Expand AI Partnerships

Cooperative partnerships serve as force multipliers to optimize resources and effort, and the scientific and technological exchange keeps NOAA current in the rapidly evolving field of AI. Partnerships in AI-based environmental applications are already creating a community of practice that is sparking innovation and has the opportunity to accelerate tremendous advances in NOAA's capabilities

Goal 4: Strengthen and Expand AI Partnerships

Objectives (Highlights)

1. Prioritize AI-based environmental research in National Oceanographic Partnership Program (NOPP) project proposals and selection.
2. Expand partnerships in AI-based environmental research with the academic and research community, including CIs and institutions that host NOAA EPP/MSI, Nancy Foster, Hollings, John Knauss, Pathways, and Margaret Davidson scholars, fellows, and interns.

Key Actions: The who, what, and how to make this happen

Goal 4: Strengthen and Expand AI Partnerships

Objectives (Highlights)

3. Work with the NSF's National Artificial Intelligence Research Institutes to collaborate with appropriate institutes on AI R&D.
4. Increase the number of formal cooperative agreements on AI-based environmental research and applications with interagency and international partners, including DOD, DOI, DOE, and DHS.

Goal 4: Strengthen and Expand AI Partnerships

Objectives (Highlights)

5. Formalize new public-private partnerships through established mechanisms such as Cooperative Research and Development Agreements (CRADAs) and Small Businesses Innovative Research (SBIR) grants.
6. Provide innovative and substantive contributions to the policy and advisory committees such as the National Science and Technology Council (NSTC) Select Committee on AI, and engage its experts in scientific exchange during national and international conferences, workshops, and other opportunities.

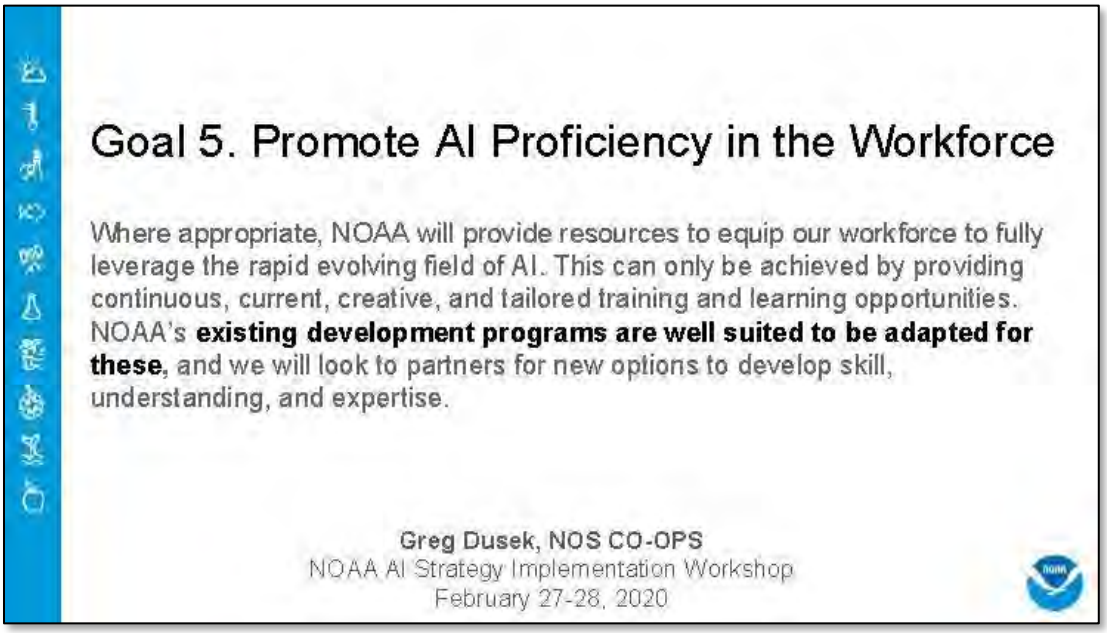
Goal 4: Strengthen and Expand AI Partnerships

Key Action: Prioritize AI in our partnerships across all line offices

Questions for Discussion:

- How do we handle Intellectual Property?
- Related to Goal 3. R2X with partners - it is a two way street
- To what degree can we streamline agreements?
  - Involve General Council Early
- Government and International partnerships - DOE, DOD, top down, bottom up, both?
- NOAA Center for AI serve as an interface to partners, how?

APPENDIX 12.14. NOAA AI STRATEGY – GOAL 5 (G. DUSEK).



Objective 5.2. Focus the assignments in the NOAA Rotational Assignment Program (NRAP) to target offices where a cross-pollination of AI expertise would raise the overall AI proficiency of the workforce.

NOS CO-OPS NRAP Starting April 1
Applying AI to Coastal Oceanographic Data

Objective 5.3. Support AI-related graduate degree, professional development, and technical training courses that are available to the NOAA workforce.

NOAA Advanced Education Programs

coursera

ILLINOIS — Master of Computer Science — University of Illinois

Master of Applied Data Science — University of Michigan

Master of Machine Learning and Data Science — Imperial College London

Objective 5.4. Support and lead collaborative events such as conferences, workshops, and external rotational assignments targeted to stay current in the state of AI technology.

Objective 5.5. Actively encourage graduate programs, internships and cooperative student training programs in AI applications relevant to the NOAA mission to improve recruitment, retention, and the hiring pool for AI proficient NOAA workforce.

Ernest F. Hollings Undergraduate Scholarship

José E. Serrano Educational Partnership Program with Minority Serving Institutions

COOPERATIVE INSTITUTES
National Oceanic and Atmospheric Administration

Objective 5.6. Update individual development plans (IDP), position descriptions, performance plans, and career paths as a practical approach to build and retain NOAA's workforce proficiency in AI.

NOAA Mentoring Program

Top Career Paths in
Machine Learning

APPENDIX 12.15. NOAA AI DATA CALL SUMMARY (W. MICHAELS).

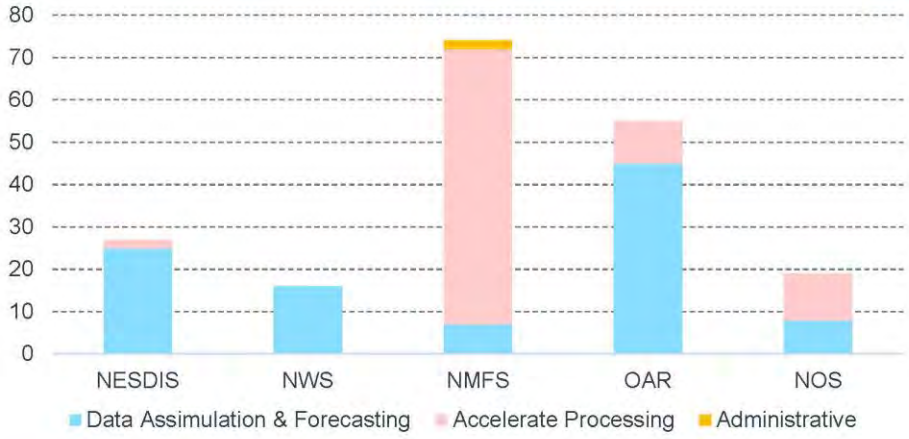
NOAA AI Data Call

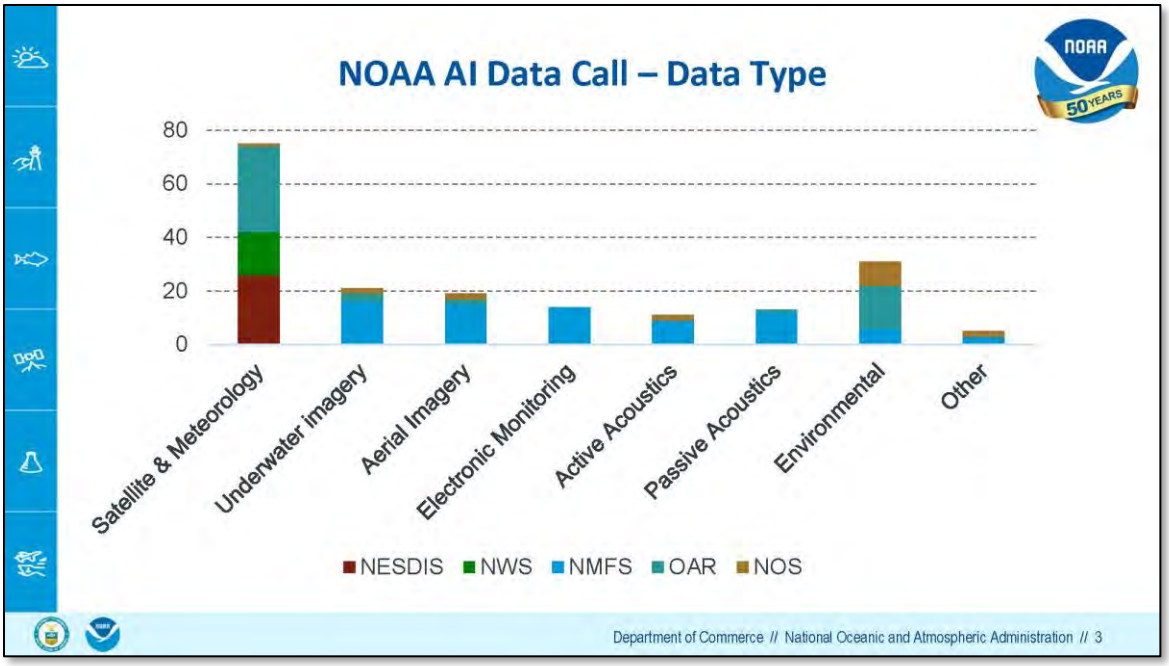
William Michaels
(Co-Chair, NOAA AI Executive Committee)

The NOAA Artificial Intelligence (AI) Data Call during February 2020 provides an overview of ongoing progress on the application of AI in support of NOAA's cross-functional mission priorities.

This NOAA AI Data Call should be considered preliminary and not a complete summary of the all various efforts across the NOAA Line Offices to begin transitioning AI into operational efficiencies.

NOAA AI Data Call - Applications




NOAA AI Data Call – Data Type
80
60
40
20
0
Satellite & Meteorology
Underwater imagery
Aerial Imagery
Electronic Monitoring
Active Acoustics
Passive Acoustics
Environmental
Other
NESDIS NWS NMFS OAR NOS
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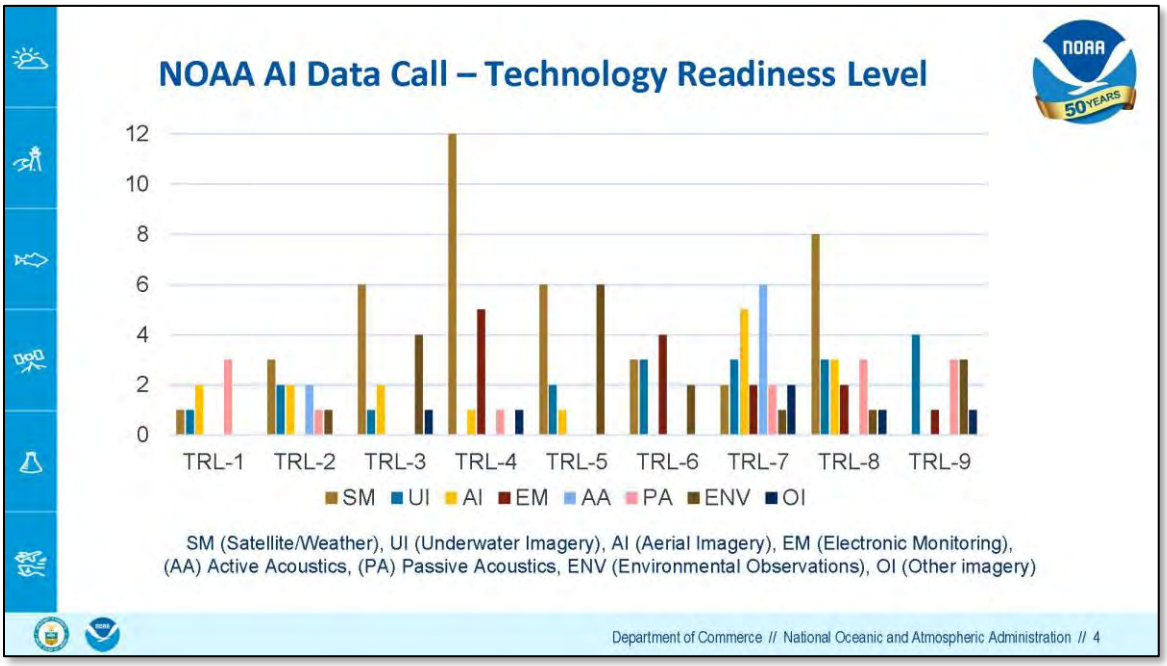
NOAA AI Data Call – Technology Readiness Level
12
10
8
6
4
2
0
TRL-1
TRL-2
TRL-3
TRL-4
TRL-5
TRL-6
TRL-7
TRL-8
TRL-9
SM UI AI EM AA PA ENV OI
SM (Satellite/Weather), UI (Underwater Imagery), AI (Aerial Imagery), EM (Electronic Monitoring),
(AA) Active Acoustics, (PA) Passive Acoustics, ENV (Environmental Observations), OI (Other imagery)
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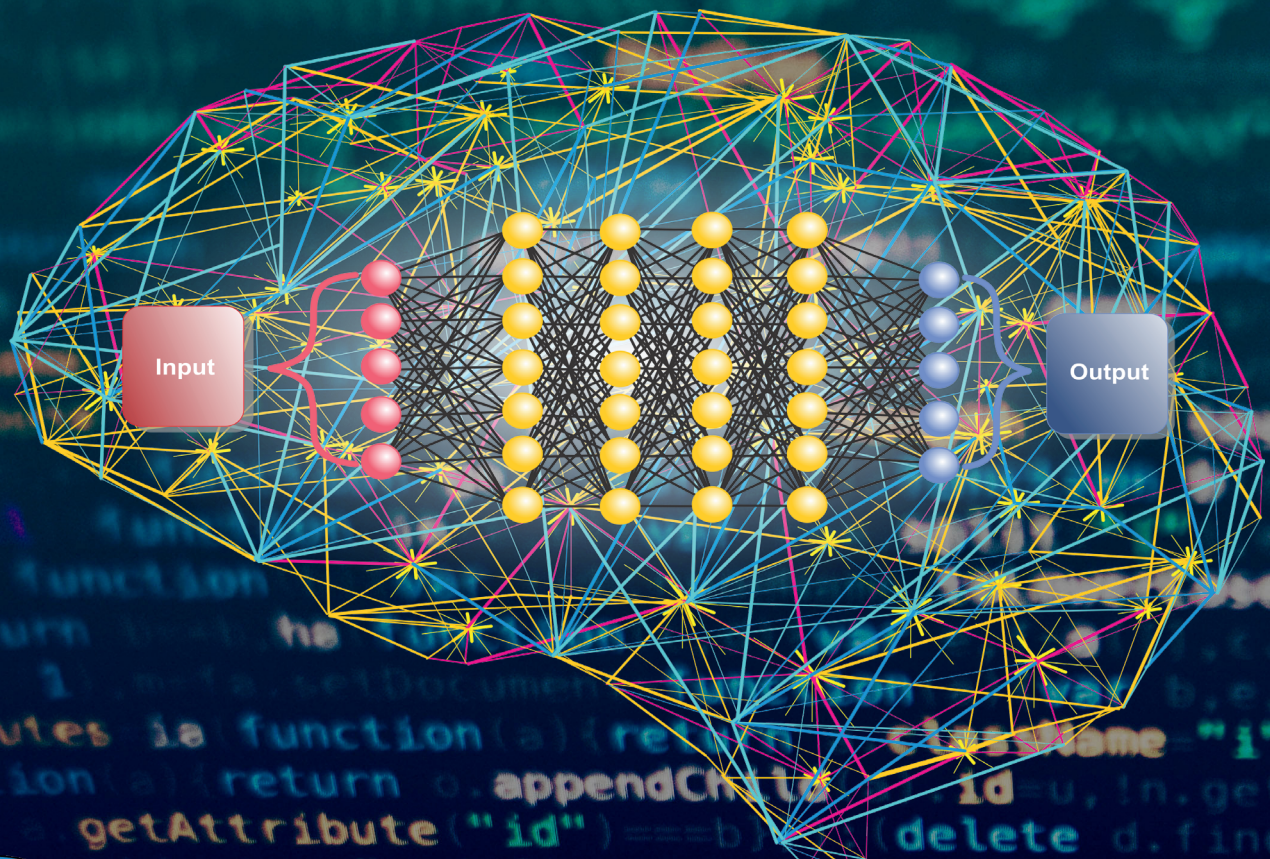

U.S. Department of Commerce
Wynn Coggins, Acting Secretary

National Oceanic and Atmospheric Administration
Benjamin Friedman, Acting NOAA Administrator

National Marine Fisheries Service
Paul Doremus, Acting Assistant Administrator for Fisheries

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Lorem ipsum