UAS Program Strategic Plan: Draft- March 6, 2017

Vision: "Innovative and cost-effective UAS capabilities are available to meet NOAA's observing requirements."

Mission: "Identify, Evaluate, and Transition effective and affordable UAS capabilities to satisfy NOAA's observing requirements."

UAS Innovation Cycle

The UAS Program Office (UASPO) focuses on providing effective observing strategies through testing, evaluation, demonstration, and, transition of UAS for meeting NOAA's mission requirements. Using the NOAA Observing Systems Council definition, a requirement is a documented, validated user need of environmental parameters, along with its associated attributes, required to produce specific products and services to meet mission objectives (NAO 212-16). The UAS innovation cycle is composed of three phases: research, development, and transition. The process of unmanned technology innovation requires a systematic approach that begins with an analysis of alternatives for a given application, identifying the target requirements, and technology (including the platform, sensors and data managements) that is best suited to meet those goals and develop an observing strategy.

During the research phase we aim to identify possible UAS innovation, new trends and capabilities that have the potential of meeting NOAA's observing requirements. During this stage an analysis of alternatives (AOA) will be conducted to determine the best possible and cost-effective options for meeting an observing requirement. Starting with the stakeholder needs and corresponding business requirements, user observation requirements are identified along with corresponding observing system, sensor and budget requirements. Exploratory testing may be conducted in conjunction with partners in order to best assess the feasibility of the UAS application.

Once options for a UAS observing strategy are identified, the development process begins with preparation of an initial transition plan, including a concept of operations, data management, and a staffing and budget plan. During development, the UAS capability will be demonstrated in an operational, real-life environment. This process should be conducted along with the intended users of the observing strategy who would receive this capability once it reaches the transition phase. Given NOAA's specialized requirements an already tested platform may require the integration of new payloads or sensors thus reducing the overall technology readiness level of the system for a new application.

Testing, evaluation and demonstration of a UAS then involved assessing and tracking the technology readiness of the platform, payload, observing system and observing strategy. As new applications for UAS merge along with new platforms or sensors, the technology readiness needs to re-assessed and evaluated prior to developing an operationally ready system. The readiness level (RL) development process can be described as an innovation moving from early stages of research through development and finally, transition into operations.

Research Focus Areas

The UAS Program aims to test, evaluate and demonstrate UAS technology as an environmental science capability that can be transitioned as part of NOAA's routine observing system. These observations are intended to be cost-effective and to fulfill gaps or complement existing observing capabilities. The UAS program has focused on three mission areas for this technology innovation, which include high impact weather, marine science and monitoring and polar science and monitoring. These focal area projects are developed jointly with NOAA scientists across the Line Offices, interagency partners, academic partners, in particular cooperative institutes, international partners, and private industry.

Research Area 1: High Impact Weather

The UAS Program has evaluated a broad range of UAS platforms and sensors for meetings NOAA's research and forecasting needs for high impact weather events. This includes the use of high altitude UAS, such as the Global Hawk, for sampling large areas over oceanic storms including tropical cyclones with remote sensors and in situ observations, as well as the use of small UAS for improved marine boundary layer, inner eye sampling, and tornadic event prediction. The goal is to utilize UAS as a compliment to current manned assets, especially where the UAS can provide cost-effective and otherwise hard to obtain data in support of the National Weather Service.

Research Area 2: Marine Monitoring

The UAS Program has been involved in demonstrating various UAS systems, with a focus on small UAS for marine science and monitoring applications across NOAA including both rotary and fixed wing UAS. This work has supported the operational needs on NOS's Office of National Marine Sanctuaries, National Geodetic Survey, Office for Coastal Management and the National Marine Fisheries Service Office of Science and Technology and Science Centers. The focus has included protected resource monitoring and research, turtle and bird counts, oil spill response, marine debris collection and collection of photogrammetric data. Other project areas include gravimetry for coastal mapping, as well as habitat characterization, wildfire damage assessments and digital elevation mapping.

Research Area 3: Polar Monitoring

The Arctic and Antarctic environments are a priority area for collecting hard to obtain environmental observations, and pose additional challenges for UAS systems to operate in these extreme environmental conditions. The UAS program has supported technology demonstrations of small UAS, jointly with partners in the US Coast Guard and private industry to evaluate performance, communication and ability to use small UAS for wildlife, sea ice mapping, rapid response and maritime domain awareness in Polar environments during ship-based operations. Other focal areas include Greenland/Norway mapping and monitoring of sea ice loss, and atmospheric distribution of black carbon for climate-cryospheric interactions.

Within each of the research focus areas described above, the UAS Program will select 2-3 key science priority areas that will drive its UAS research investments in three year cycles. These key science priority areas will be identified by a comprehensive review and analysis of the science requirements in each focal area. This requirement review and prioritization will take place with direct participation by UAS PO stakeholders, including NOAA's Line Offices, Cooperative Institutes, interagency partners, and as appropriate, international partners. These science priorities will also be reflective of NOAA and OAR strategic and research plans.

UAS Key Science Objectives for 2017-2020

High Impact Weather

Test, develop and operationalize unmanned aircraft systems to provide observations needed for improving warning, forecasts and decisions for high-impact weather events, in particular continental and oceanic storms.

Apply objective, simulation based approaches and data evaluations, such as observing system observing (OSE) experiments and observing system simulation experiments (OSSE) to determine the best observing systems for meeting NOAA's mission needs.

Marine Monitoring

Evaluate and demonstrate how unmanned systems can improve ecosystem- based management by providing more precise and accurate observations of marine and coastal ecosystems, including key populations and the impact of habitat loss, change or degradation.

Polar Monitoring

Provide improved observations for Arctic ice mapping, oil spill mapping and remediation, and collection of Planetary Boundary Layer (PBL) data to better assess changes the Arctic.

UAS Research to Operations

The overall framework of the UAS PO project management and funding cycle will revolve around research, development, and transition of UAS systems and applications into routine operations or research. Each project will be tracked based on its readiness level (RL), with the focus of the program targeting mid to high level RL concepts (RL 4-8 range). Funded or supported projects may be selected at any point of the technology development cycle, however, they each project will need to prepare a transition plan that shows how the application will move from research or development into routine operations.

Incubator concept

The UAS program aims to advance unmanned technology for meeting NOAA's observing requirements. The capability of each application- platform, sensor and observing system is tacked using the Readiness Level (RL) scale, focusing on successful transition from research into operations. In order to enable research advancement at various transition levels, from early research to demonstration testing. The UAS Program will manage and fund projects at their early, exploratory phase though a "technology incubator program". The aim of this incubator effort will be to provide a set amount of annual funding to NOAA scientists looking to explore a new UAS technology application that has not been supported to date. These projects will be selected through a Request for Proposals open to all the NOAA Line Offices. Selected projects would ideally move from the RL 1-3 level, allowing room for new, untested effort to either successfully advance to the next development stage or to provide lessons learned from these exploratory concepts. It is anticipated these projects allow room for exploratory research and development, and may not always transition to the next phase, depending on the outcome of the project. Projects which successfully demonstrate their initial concept, and move to the RL 3 level, can be incorporated as part of the UAS Test Bed that prepares them for advancing towards a transition into operations.

Testbed Concepts

The UAS Program aims to have a test bed for advanced projects. These will include applications in high impact weather, marine and polar monitoring. The testbed will focus on projects at the 4-8 RL level, allowing for systematic support and assessment as the capability advances between research and operations. This would include coordinated efforts with recipients of this technology in NMFS, NOS, NWS, NESDIS, and OAR. Projects included as part of the testbed will have signed and agreed to transition plans, allowing for a gradual transfer of this technology into routine operations or routine research.

Under the high impact weather activities, the testbed will facilitate collaboration between researchers working on UAS applications and operators in the NWS and NESDIS allowing for early on coordination in transition planning and assessing how new data and methodology will be incorporated into routine operations.

The focus of the testbed under high impact weather would be weather, water and air quality observing strategies for sampling the lower atmosphere that could be used routinely to guide or provide operational input to prediction model and decision support tool development, which is critical for NOAA's priorities to provide information that makes communities more resilient and to evolve the National Weather Service. This would provide for a holistic approach that systematically evaluates data for operational use and assesses the quality and impact of this data. The activities under high impact weather supported in the testbed would build upon the successful efforts of the Quantitative Observing System Assessment Program, Hurricane Forecast Improvement Project, NOAA National Weather Radar Testbed, NOAA Hazardous Weather Testbed, and Sensing Hazards with Operational Unmanned Technology project to quantitatively assess various aspects of data impact, technology readiness, cost effectiveness, and operational feasibility, while focusing efforts on unmanned systems. As part of these efforts, research teams will work with operational partners to more consistently evaluate observing strategies across common themes, primarily centered on improved understanding and observations of the lower atmosphere over land and sea in key regions including the Gulf of Mexico, Alaska/Arctic, Pacific/Hawaii and the Upper Mid-West.

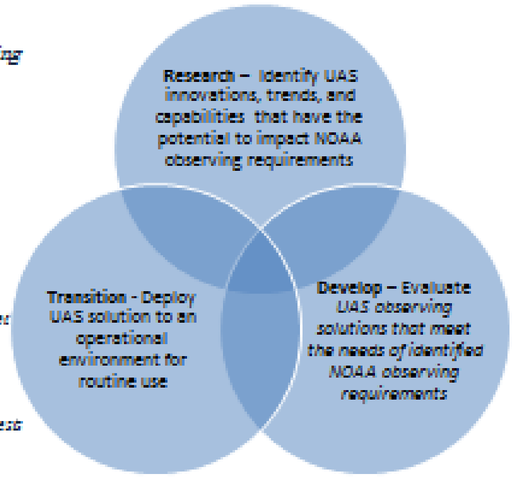
This testbed will also support activities in the marine monitoring and polar monitoring focal areas. In order to provide a coordinated and systematic way to test, evaluate, demonstrate and transition UAS technology into supporting these efforts, the UAS Program will manage more advanced projects in marine and polar monitoring as part of the testbed. NOAA's mission mandates in managing marine resources, as well as regional and coastal ocean planning require observing systems that can better inform existing models and assessment efforts to understand how changes on the regional and global scale (ocean acidification, sea-level rise, extreme events) impact the abundance, distribution and resilience of marine life and habitats. These ecosystem impacts also reflect the knowledge needed by the agency to support resilience and preparedness efforts of coastal communities and economies. Unmanned technology has been increasingly used to collect the type of environmental data required by NOAA to meet these mandates and has tested application in protected species research, coastal mapping, habitat characterization, and marine monitoring.

Incubator and test bed projects will be funded and supported on a three-year cycles, with the possibility of extension depending on the successful technology advancement of each application and suitability of moving onto the testbed for further advancement.

UAS Innovation Cycle

Research. *Identify UAS innovations, trends, and capabilities that have the potential to impact NOAA observing requirements. Determine the barriers, challenges, and capabilities of potential UAS solutions to determine applicability or "user case" in real world operational environments.*

Outputs: Market Scans, Gap Analysis, Requirement Documents, Technical Priority Listing, Analysis of Alternatives, Reference Databases,



Develop. *In collaboration with industry, academia, and federal partners, evaluate UAS observing solutions that meet the needs of identified NOAA observing requirements and demonstrate UAS applicability in a real-life environment.*

Outputs: Technical Analysis for Payload and Platform selection; Initial Transition Plans; Data Management requirements; Request for Proposal (RFP); Performance Reports, Whitepapers, Workshops, Concept of Routine Operations documents,

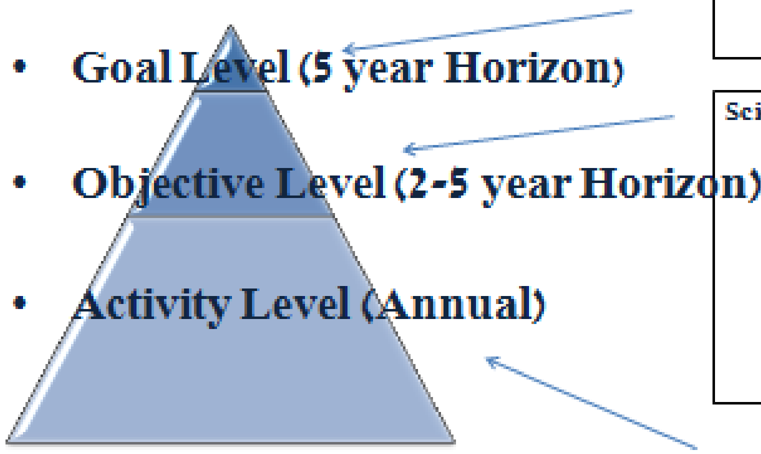
Transition. *Deploy UAS solution to an operational environment for routine use. Understand the impact of the UAS Innovation Cycle on the NOAA Observing Capabilities and how well transitioned solutions meet User Requirements*

Outputs: Technical Positions Statements, User Recommendations, Briefings; Metrics, Reference Databases, Measurement & Reporting,

An Observing Requirement is met through effective Observing Strategy

- An Observing Strategy is the culmination of a series of planning steps and resource allocation decisions necessary to deploy and routinely utilize a UAS for operational observing duties.
- An Observing Strategy is designed for each Observing Requirement and it is presumed that the "owner" of the requirement will be an active participant in the design of the strategy
- A Transition Plan is primarily focused on the technological development of a UAS solution, while an Observing Strategy is focused on improving the observing capabilities of a specific user.
- Multiple Observing Strategies can exist for a single Observing Requirement. The selection of one over another is based upon the Business Case of each – a balance of operational effectiveness and cost efficiency.

UAS Strategic Framework



Science Focus Areas:
- Polar Monitoring
- High Impact Weather
- Marine Monitoring

Science Objectives:
- Planetary Boundary Layer Data Collection
- Artic Ice and Oil Spill Mapping
- Key Population Data Collection
- Marine & Costal Ecosystem management
- Simulation based approaches and Data Evaluation
- Improved Warnings & Forecasts of Oceanic and Continental Storms

Science Questions:
- Science questions in each focus area will be identified through mission requirements workshops conducted jointly with UASPO stakeholders.