V-Bat - VTOL / Fixed Wing Expeditionary Class I/II UAV

Martin UAV LLC

Principal Investigator: Wayne McAuliffe

Area of Interest: Larger UAS (Class I/II)

Capability Description: The Martin V-Bat is a ‘tail sitting’ ducted fan based VTOL UAV that, once clear of obstacles makes a level transitions to wing borne flight for mission execution. During the mission, if required, it can make repeated level transitions to a hover and stare at a particular area of interest. It makes a level transition to a hover and a vertical decent to a landing. V-Bat is capable of operating from confined spaces as small as 20’ x 20’. A truly runway independent system, it does not require or use any specialized launch or recovery equipment. The ducted fan protects personnel in the vicinity of the AV as its prepared for flight, launched and recovered. Payload support is via a commercially encrypted TCP/IP Wave Relay network. Its 5-10 lbs payload capacity is capable of carrying customer required sensors. Currently a UAV Vision CM-100 EOIR system is installed. The V-Bat is an LOS system that has flown from shore numerous times accumulating several hundred hours during its development to date. In May this year it flew from the roof or an Army LCM MK-2 in Chesapeake Bay. With a 5 lbs. payload it has an estimated endurance of 8-10 hours. As payload weight is increased endurance is reduced. Time in hover beyond takeoff and landing also impacts mission endurance. An entire mission in hover mode is estimated to last 2 – 2.5 hours. The current Ground Control Station is a basic commercially available system.
Experiment Objective/Hypothesis: The hypothesis we seek to prove;

1. A 75 lbs. maximum gross weight Class I/II UAS can operate in an austere, runway independent environment with no launch or recovery equipment providing Full Motion Video to a small footprint GCS for more than 8 hours continuously.
2. Interspersing several (8) hover and stare mission requirements of limited duration (5-10 minutes each) can provide better data concerning activities in an urban canyon environment than that provided by a continuous level flight UAV.

Experiment Plan / Data Collection Plan: Martin UAV will safely launch the V-Bat with an EOIR system from a designated confined area with personnel in close proximity to the vehicle while operating. Candidate areas included wooded clearings, between buildings in an urban environment or simply a designated 20’ x 20’ space. An eight-hour ‘on-the-wing’ mission plan will be uploaded that takes the V-Bat over varied terrain and elevation to collect FMV of roads, buildings and other areas of interest. The UAV will return to the original launch point, transition to a hover and land in the same confined area that it departed from.

A second flight will be planned along the same path as the endurance flight but now will include hover transition way points at the urban terrain test area to hover and stare at several designated areas on the roofs of designated buildings and along urban canyons. An eight-hour flight will be planned with one five (5) min hover interval per hour to collect staring FMV.

We will record launch and recovery environments; size shape of the area and height of obstacles within 100yds of the perimeter, meteorological data at launch and at 30 min intervals throughout the flight period (Temperature, wind speed and direction, pressure altitude and atmospheric pressure changes), record air vehicle VTOL performance, hover stability assent to transition and transition to wing borne flight. Track time of launch and recovery. Collect actual fuel state prior to launch (weight of the AV after fueling minus weight of the AV empty), fuel states from the GCS at 10 min intervals throughout the flight, actual fuel state upon landing. For the second flight FMV as well as fuel consumption and environmental will be collected. Emphasis will be placed on designated areas for comparison of hover and stare video to areas recorded in forward flight previously. The secondary objective will be to determine the extent of the impact of hovering during long endurance missions on total mission length.

Measures of Performance & Effectiveness:

1. Ability to operation from a confined austere launch and recovery site safely with personnel in close proximity to the air vehicle
2. Total flight endurance of greater than 8 hours for a single vertical takeoff and vertical landing ISR flight
3. Successful hover and stare video collection from designated targets of interest
4. Impact of less than 1.5 hour on endurance with the addition of eight hover and stare waypoints to the 1st endurance flight.
**What new capability does this represent?** The V-Bat provides a unique ability to safely operate from confined spaces with personnel in close proximity with no launch or recovery equipment required. Additionally it is not limited to a single hover event for takeoff and a single hover event for landing, but can hover on demand as the mission requires, at any point during the mission.

**What capability gap does this address?** Martin UAV believes our V-Bat addresses Area of Interest 10. Larger UAS Class I/II. The V-Bat is a runway independent UAV that does not use any launch or recovery equipment. It can be launched from confined urban or at sea locations. The ducted fan concept protects personnel in close proximity to the AV as it is prepared for flight, launched and recovered. Its payload support architecture is TCP/IP based and the data link provides commercially encrypted network access. It is a LOS, 8+ hour UAV.
Hydra Fusion Tools for Rapid Airfield Damage Assessment System

Lockheed Martin CDL Systems USA, Inc.

Principal Investigator: Tyler Chandler

Area of Interest: Intelligence, Surveillance, and Reconnaissance (ISR)

Capability Description: The main software product, Hydra Fusion Tools is capable of constructing a 3D model in near-real time based on incoming data from a Lockheed Martin Indago quadcopter using a Snap Dragon 12 MP camera. The Hydra Fusion Tools product can be deployed on a laptop system and will generate three dimensional reconstructions during the flight.

Experiment Objective/Hypothesis: Create real-time 3D image of a location via flight with Lockheed Martin Indago and Hydra Fusion Tools Software.

Experiment Plan / Data Collection Plan: Create real-time 3D image of a location via flight with Lockheed Martin Indago and Hydra Fusion Tools Software.

Measures of Performance & Effectiveness: Effectiveness will be measured by a successful flight and 3D reconstruction of terrain.

What new capability does this represent? We create 3D images in real time, not via post-processing a set of images after flight.
CANCELLED

Long Endurance SUAS (VTOL and Hyperspectral)

Lockheed Martin

Principal Investigator: Lee Ritholtz

Area of Interest: Intelligence, Surveillance, and Reconnaissance (ISR)

Capability Description: The ability for a fixed wing, long endurance SUAS to incorporate VTOL (Vertical Take Off and Landing) capabilities greatly reduces the logistics and operational footprint of the system. The VTOL capabilities will enable maritime/expeditionary forces to operate a long endurance SUAS independent of runways while maintaining the endurance, range and payload capacities not associated with conventional multi-rotor UAS. Hyperspectral sensors enable the detection for chemicals of interest from a stand-off distance.

Experiment Objective/Hypothesis:
1) Demonstrate 8-12 hours of endurance (non-VTOL) for persistent ISR.
2) Demonstrate VTOL and transition to forward flight/hover with a fixed wing SUAS without the need of a runway.
3) Demonstrate long endurance of a fixed wing SUAS using VTOL capabilities.
4) Demonstrate remote sensing for chemicals of interest from two perspectives (forward flight and hover).

Experiment Plan / Data Collection Plan:
1) Launch and remain airborne for 8-12 hours (non-VTOL configuration).
2) The VTOL capability is in-progress, we plan to execute multiple vertical take offs, transition to forward flight, transition to hover and vertical landings.
3) The hyperspectral payload integration is a new capability. We plan on multiple collections with chemicals of interest 1) at various ranges 2) from forward flight 3) from a hover.
Measures of Performance & Effectiveness:
1) Can we achieve an 8-12 hour single flight?
2) What is the timeline for vertical take offs, transition to forward flight, transition to hover and vertical landings?
3) What is the endurance with the VTOL configuration?
4) What are the detection ranges for chemicals of interest?
5) Is there a difference between collection and detection based upon platform movement (forward motion vs hover)?

What new capability does this represent? The capability to have a long endurance (8+ hours) SUAS launch and recover independent of a runway has both logistics and operational benefits. From a logistics perspective, there is no need for launch and recovery equipment. From an operational perspective, no footprint required for launch and recovery equipment in addition to supporting shipboard and expeditionary scenarios.

What capability gap does this address? A5. sUAS with Multispectral and Hyperspectral Sensing Capabilities  
A10. Larger UAS Class I/II, Expeditionary/Maritime, Encrypted C2 and data links, Tactical Reach
Persistence testing of a Tethered Rotorcraft

Otherlab, Inc.

Principal Investigator: Mark Phillips

Area of Interest: Persistent ISR Assets.

Capability Description: We are developing a rotorcraft tethered aerial platform (TAP) to carry payloads up to 25kg at altitudes up to 500 feet for long endurance times that can be measured in days and months. Current UAV technology is greatly limited by battery life, so aircraft must be small and light and are only able to carry small payloads for any reasonable flight times. By providing power from the ground (grid, generator or solar array), the rotorcraft can maintain altitude indefinitely. By being able to lift payloads up to 25kg (55lb) the TAP could include sizeable communications, inspection, surveillance or reconnaissance equipment. For these tests at JIFX 16-4 we are proving out our design and control system and are planning to carry dummy loads to simulate future payload mass.

Experiment Objective/Hypothesis: Our experimental objective is to prove that our design for a persistent tethered rotorcraft is robust during continuous operation. Our system is a unique combination of mechanical design (featuring a rotor head with few moving parts), autonomous controls (an aircraft on a tether must respond differently to changes in flight conditions than an untethered aircraft) and electrical power (power is up-converted to high voltage for transmission along the tether and down-converted to a working voltage onboard the rotorcraft). By the end of September, we hope to have completed several
multi-day tests (up to 120 hours continuously) to validate our design and controls methodology. This information will be used to develop the next generation of TAP that will reach higher altitude and endurance times of months.

**Experiment Plan / Data Collection Plan:** The experiment will test improvements to hardware and autonomous control systems. We would like to test the rotorcraft continuously for several days of flight to demonstrate that the system is robust to changes in weather (wind and temperature). All data from the aircraft is logged locally and sent via telemetry to the ground-station. This data allows the engineering team to debug flight control software and make improvements to the mechanical and control systems to improve stability for the system.

**Measures of Performance & Effectiveness:** Otherlab's TAP has a large number of sensors onboard to collect data during flight, including IMUs, GPS, tether angle & load, temperature of critical components, and total power required to fly. To further optimize flight parameters and efficiency, we need more time flying our aircraft. Current FAA regulations for autonomous aircraft make it difficult to perform continuous (overnight) tests of our aircraft. We would like to run overnight testing and collect data from varying weather and temperature conditions for future development of our control system and mechanical design. We also wish to test the robustness of the electrical systems, including the ground-station up-converter and aircraft-based down-converter, and determine the energy required for long flights. Payload performance (e.g. ISR or communications) might be limited by the overall stability of the aircraft (XY location, yaw, pitch roll). We also wish to collect more data from these parameters to fully understand the capability of the aircraft for carrying different payload configurations.

**What new capability does this represent?** Current UAV technology is greatly limited by battery life. Aircraft must be small and light and are only able to carry small payloads for flight times that are measured in minutes. In order to provide long dwell times, power must be provided continuously to the aircraft. Current solar panels and batteries are currently not up to the task of keeping an aircraft aloft for long flights. TAP closes this gap by providing continuous power to the aircraft from the ground via an electrical tether. The tether also provides mechanical constraint on the system, so that the aircraft cannot fly further from the ground station than the length of the tether, providing additional security and safety for operators.

**What capability gap does this address?** The capability addressed by Otherlab's Tethered Aerial Platform is relevant to A(ISR).6 (Persistent ISR Assets). We are developing the capability to autonomously fly a tethered aircraft that is able to lift sizeable communications or ISR payloads, up to 25kg in mass.
Autonomous, multi-micro-UAVs for ISR in indoor environments

Shield AI, Inc.

Principal Investigator: Andrew Reiter

Area of Interest: Autonomous swarm micro-UAVs

Capability Description: Our experiment will demonstrate how micro-UAVs (mUAVs) can provide Special Operations Forces (SOF), infantry units, and ship boarding teams life-saving ground Intelligence, Surveillance, and Reconnaissance (ISR) when enabled with our autonomy software. Our innovative software enables a small quadcopter to fully or semi-autonomously explore building interiors, dense urban environments, and GPS degraded areas and relays threats via video stream to soldiers so that they can adjust tactics and save lives. This same technology can also be used during partner force operations in order to provide US forces a clear blue and green force picture on the battlefield. Shield AI's small man-portable quadcopter carries ISR payloads to stream encrypted video that can be viewed by soldiers in the field or back at base in the Tactical Operations Center (TOC). Later, the same quadcopter platform, could be deployed from Predator-esque drones and enabled to carry signals intelligence for 3-D target localization and weapons payloads for minimal collateral damage strikes.

Experiment Objective/Hypothesis: Our experiment seeks to prove that SOF operators and soldiers are safer and can make better tactical decisions when equipped with a Shield AI micro-UAV that can fully or semi-autonomously explore indoor environments. Our
objectives for the experiment will be to demonstrate the utility of autonomous micro-UAVs in indoor environments to the defense community. Specifically, the experiment will demonstrate Shield AI’s quadcopter autonomously exploring an indoor facility that would be the target building for a SOF or infantry force. After a single flight, Shield AI will demonstrate three quadcopters working collaboratively to explore a target building. A successful experiment will demonstrate four key performance indicators (KPIs): 1) The quadcopter will be launched outside the initial entry point of a structure and autonomously find and enter the entry point 2) The quadcopter will autonomously explore the entire first floor of a structure (excluding closed doors) while providing video feedback to a simulated clearance team outside 3) The quadcopter will return to the clearance team when commanded to do so. 4) The quadcopter will complete performance metrics 1-3 during subsequent tests on different structures. 5) KPIs 1-4 will be demonstrated by three quadcopters working together.

Experiment Plan / Data Collection Plan: The experiment will be measured by how effectively and how quickly the quadcopters are able to meet the five KPIs. KPIs #1, #2, and #3 must be met in a particular structure before moving to a different building for testing (KPI #4). All data is collected in flight test logs and analyzed to better enable debugging efforts. The data from all the quadcopter’s sensors (LIDAR, sonar, camera, optic flow) is sent via wifi to Shield AI’s laptop. From this data the engineering team creates flight test reports, debugs errors from these reports, and is able to update the autonomy software which leads to a better, smarter quadcopter.

Measures of Performance & Effectiveness: KPIs #1-#5 are our measures of performance. If the quadcopter crashes during any points of a test run, the KPI being evaluated will be considered a fail point. The quadcopter must stay in flight while validating a KPI for a KPI to be considered successful. The measures of effectiveness are determined by how many rooms are in a structure being explored (room metric) and the speed at which the rooms are explored (speed metric). For example if a structure has ten rooms and the quadcopter autonomously explores eight rooms, then the quadcopter is 80% effective with respect to the room metric. The speed metric is measured by rooms explored divided by total time for a room/second measurement.

What new capability does this represent? Current approaches to indoor ISR in battlefield environments include: sending humans inside to provide ISR (incredibly dangerous), throw-able cameras (unrealistic to throw and pick up a camera in every room during a large multi-building clearance), and remote controlled ground robots (soldiers lose situational awareness when focused on remote piloting a robot). Our robot autonomy software will eventually enable, for the first time, the meaningful deployment of robots on the battlefield at the soldier level for intelligence gathering purposes. With our mUAVs, soldiers will have access to intel inside structures that was previously only available when sending soldiers into these dangerous environments. Our mUAVs will provide soldiers indoor and outdoor ground intel that removes the fog of war and enables soldiers to make better, more informed tactical decisions.

What capability gap does this address? Our experiment will demonstrate autonomous indoor mapping and object situational awareness. The experiment primarily focuses on two significant capability gaps faced by SOF and infantry units. Currently SOF and infantry units lack a platform...
capable of providing indoor ISR during clearance operations. Shield AI’s autonomous quadcopter will provide indoor ISR with minimal user interface interaction. The autonomy component of Shield AI’s PRD enables SOF operators and infantry units to maintain front sight focused and situationally aware of the hostile environments they operate in. The indoor ISR Shield AI’s PRD provides allows SOF operators and infantry units to make better, more informed tactical decisions. The second capability gap addressed by our experiment are the blue-green force picture issues that arise from partner force operations. During partner force operations, like the operations taking place in Iraq today, US forces are unable to maintain a clear green force picture of where the partner force is during urban clearance operations and also if the partner forces are in fact effectively conducting clearances. Shield AI’s quadcopter could monitor partner forces during the partner force's clearance in addition to providing partner forces with life-saving indoor ISR.
CANCELLED

“Chimney Sweep” Underground Ballon/Aerostat

Shilat Optronics Ltd. (Israel)

**Principal Investigator:** Christopher Weller

**Area of Interest:** ISR

**Capability Description:** Underground Tunnel Reconnaissance Balloon/Aerostat: A lightweight, rapidly scanning system, capable of maneuvering around obstacles in narrow and long closed cavities while transmitting real-time video to the user. General Description: The system composed of three main modules * Maneuvering module (sweep) * Operator unit * Inflation unit The maneuvering module is controlled by the operator, can move in a range of few hundreds of meters and transfer real-time live video image to the operator. The system is carried by a single backpack The system is operated by single operator after 2 days of training. Operator unit: The operator unit consists the following: * An operator tablet that displays and records the video image, and system status * An electronics module for interfacing between the tablet and the sweep * An gamepad controller for operating and controlling the sweep The operator unit is packed in dedicated bag that allows fast connection and deployment The inflation unit: * The inflation unit includes a lightweight helium cylinder and pressure accessories that allows fast inflation of the sweep balloon in field conditions The system is packed in a backpack that allows fast deployment * 5 min for operational readiness
Experiment Objective/Hypothesis: Building on Israeli SOF Operators TTPs we wish to mimic their method of use and gain feedback from U.S. SOF on how to “Americanize” the system. 1. Employment with small SOF forces 2. Method of Intelligence gathering and discernment in the field 3. Recovery 4. What needs to change in the system to make it useful for SOF Operators and ease of use.

Experiment Plan / Data Collection Plan:
1. Base-line is how it is successfully operated in Israeli by Israeli SOF Operators. Using lessons learned from system employment and interdiction in the GAZA Strip or similar areas.
2. Field modification to U.S. SOF Operators to use equally as effectively

Measures of Performance & Effectiveness: The system will come with highly training Israeli Ex-SOF Operators who currently train the Israeli Defense Forces.

What new capability does this represent? Yes, the use of a "tethered Aerostat" underground replacing robots that cannot overcome large obstacles in tunnels, buildings, ships.

What capability gap does this address? ISR for Tunnels
CANCELLED

Deployment of rapidly deployed ad hoc meshed WiFi network

TacSat Networks Corporation

Principal Investigator: Brian Steckler

Area of Interest: Interoperable Communication Solutions in Network Denied Disaster Response Environments

Capability Description: Our experiment will demonstrate and allow us to stress test a self-contained, self-meshing, self-healing ad hoc wireless network infrastructure enabled by VSAT (satellite reachback in Ka mode – much faster than traditional Ku) and/or new L Band offerings in CONUS and OUTUS markets, accompanied by 802.11 meshed WiFi and 802.11 long haul terrestrial wireless links and a variety of IP data network enabled voice communications options including a relatively new voice/chat program for iPhones and Androids (ESCHAT rebranded as TacCHAT) that uses a radio gateway to integrate with UHF/VHF radio systems, a satellite based voice phone, UHF/VHF radios, and other voice/data/video tools. A Search & Rescue mission requirement will also be supported by semi-professional drones (Phantom 3’s) delivering surveillance video to the TOC or to the dirty Internet via YouTube. Further, the entire Wide Area Network (long haul links connecting specific areas) with same IP backbone VSAT reachback system, will be powered completely off-grid using standard US mil-spec BB2590 batteries or sets of BB2590 batteries and flexible solar panels.

Experiment Objective/Hypothesis: Our hypothesis is that we can, within a few hours, set up from nothing, a high data rate, secure, ad hoc wireless Internet accessible network that
enables the integration of all possible voice, video and data communication technologies, and to continue to power the system indefinitely with solar power and a series of customized mil-spec BB2590 and slightly larger mil-spec batteries alone. Secondary hypothesis is that we can integrate effectively for surveillance a semi-professional small drone to provide 2k video back to the Tactical Operation Center (TOC).

Objectives:
1. Setup of a complete wide area network within 4 hours connecting two facilities to the Internet at speeds of at least 15 mbps down by 10 mbps up.
2. Provide network-wide voice and chat communications that is completely integrated between Androids, iPhones, push-to-talk UHF/VHF radios and that includes blue force tracking information back to the TOC.
3. Power EACH of our integrated network devices 100 percent of the time off-grid using military specification batteries (BB2590 and larger) with custom-made battery integration kits.
4. Test and demonstrate the utility of a semi-professional (affordable and small and easy to operate) quad rotor drone to conduct pre-designated search patterns, can fly way-points, and can fly/video around a specific point of interest AND send all video back to the TOC or an Internet connected device in reasonably useable resolution.

Experiment Plan / Data Collection Plan: We will be measuring a variety of things in this set of experiments:
1. Time to set up complete infrastructure (using stopwatch).
2. Time to transfer video from drone to TOC (using stopwatch once drone launched).
3. Time to send pre-designated pre-sized files across the network to measure network performance (using various network performance and analysis tools).
4. Distance and associated bandwidth for the long haul wireless 802.11 5.8 GHz links (using built in measuring tools and network performance and analysis tools for data throughput measurements).

Data Collection Plan:
Our data collection plan is simple: to have dedicated data collection personnel who will be filling out pre-built forms for each measurable parameter at key times in our various activities. Some data collection will be accomplished with our online web based tools as part of some of our systems application suite. We also plan to video much of our activities for use in future training and promotional materials as part of our corporate communications activities.

Measures of Performance & Effectiveness: Our measurements of performance:
Engineers view, network infrastructure: that each of our measurable systems (VSAT, L Band, 4G, WiFi) functions within pre-determined/verified product or service provider specifications falls within such specifications and if not, why.
Engineers view, drone operations: that each pre-programmed or standardized specification works as specified (battery life, streaming video feeds, network connectivity, etc.). What are your measurements of effectiveness?
Customer view, network infrastructure: that each of our wireless connectivity options functions seamlessly as an area-wide broadband pipe out to the Internet, and/or that the terrestrial wireless elements of the connectivity “cloud” function as expected with secure high speed links between all voice, video and data systems.
Customer view, drone operations: that video from the drone is sufficient as to resolution and picture quality for Search & Rescue and/or tactical surveillance requirements and mission types; that the drone’s battery life is as expected and that the user friendliness is optimal.

**What new capability does this represent?**  
The ViaSat broadband IP connectivity system (VSAT) in the L Band has not been used in this sort of scenario based field experiment/demonstration before as it is a brand new service from ViaSat? We will use this L Band network (Inmarsat BGAN-like) with Thrane/Thrane L Band modem/antenna systems.

The YouTube streaming while flying via waypoints or a point-of-interest tracking settings from a semi-professional drone in a field experiment/demonstration has not been done before to our knowledge.

Integrating the ESChat (www.eschat.com) push-to-talk smartphone app (branded as TacCHAT) with typical UHF radio integration via a gateway device and over an IP based WiFi enabled network as well as integrating all other methods to obtain voice communications (VoIP, mobile phones, satellite phones, etc.) to have a secure and seamless voice command and control infrastructure.

To our knowledge there are no commercially available complete scalable wireless infrastructure systems that can use standard military grade (mil-spec) BB2590 batteries used to power all devices, and with solar power to maintain the networks for extended periods of time.

**What capability gap does this address?**  
Areas of interest include:

a.6. persistent ISR assets;
a.4. maritime C4ISR capabilities;
b.4. secure communications and data;
b.5. scalable, mobile and OTH digital communications networks;
b.7. network security for hastily formed networks and mobile ad hoc networks;
b.8. location tracking and communications technologies;
b.22. interoperable communications in network denied disaster response environments;
Locating lost personnel and coordinate teams in comms denied environments using secure low-cost, low-weight, ad-hoc radios

goTenna

Principal Investigator: Jorge Perdomo

Area of Interest: Secure Communication and Data.

Capability Description: goTenna seeks to run an experiment demonstrating the effectiveness of goTenna burst-data non-voice technology to fill gaps in survival radios as well as other needs for agile network architectures in comms denied environments. With goTenna technology regular smartphones can communicate over high-power radio links in a secured fashion without any training and at very low cost, size, and weight. The devices can be used for ground-to-ground communications as well as air-to-ground. The devices require no training to operate and are immediately usable with any breadth of missions which require agile mobile networks in comms denied environments.

Experiment Objective/Hypothesis: We seek to prove that a low-cost burst data only radio system can fulfill the requirements of many government comms-denied environments challenges without the need for voice. Environments include HADR, wartime rescue, clandestine operations, air/ground comms, etc.

Experiment Plan / Data Collection Plan: We will work with JIFX organizers and partner companies to create a variety of experimental conditions which will simulate a variety of environments of interest to the government such as:
SAR ground operation – A test subject will be “lost” on the grounds and will have to be found by ground searchers

SAR drone operation – same as above but using a drone with a partner from JIFX

Comms between different groups – Different groups of people will be stood up on goTenna in a completely comms-denied environment and we will demonstrate how quickly and easily it can be done, followed by the effectiveness of the communications between the groups.

Data will be collected via self-report questionnaires and practical effectiveness.

**Measures of Performance & Effectiveness:**

- Ease of use for test participants
- Effectiveness to coordinate searches, resources, etc.
- Ability and speed to setup systems in comms-denied environments
- General usability/user feedback
- Tester feedback on the comparative value of non-voice comms

**What new capability does this represent?** We are offering high-end ad-hoc data communications for a fraction of the price, weight, and complexity of other competitive systems. We are also consciously choosing to forgo legacy requirements for voice communications in favor of critical burst data only.

**What capability gap does this address?** Secure communication and data***

Combat Survival Radio Systems***

Location tracking and communications technologies*

Tech that provides communication in any environmental condition***

Agile network architectures***

Information exchange and comms between disparate organizations***

Non-combatant evacuation operations

Interoperable comms solutions in network denied disaster response***

Air to ground comms hardware

Mobile data collection in disasters
Enhanced In Transit Visibility (EITV) Phase III EITIC and IoT Ad Hoc Mesh Network Cross domain Integration

Strategic Mobility 1 Inc with collaborating strategic partners

Principal Investigator: Dr Lawrence G Mallon

Area of Interest: Near Real-time In-Transite Visibility (ITV)

Capability Description: Enhanced In Transit Visibility (EITV) is the near term logistics operational capability (on a technology development fusion pathway applicable to the entire IOT spectrum) to track geolocation, status, and condition of contents at the item level:

1. While associated with and inside an air or sea container while being transported by one or more modes of transportation (air, sea, surface) across an end to end global supply network and one conveyance to another (aircraft, vessel, truck, rail)

2. (a) using an advanced ad hoc self organizing mesh network comprised of small Next Gen Radio Frequency tags as platforms embedded in smart pallets capable of transmitting and receiving “seeing” through steel or concrete walls using radio multiple frequency modulation, (b) employing multiple on board related content condition based and independent data collection enabled sensors (temperature, pressure, movement, other emitting sources e.g. counter radiological miniaturized mass spectrometer) and (c) communicating with other tags directly as daisy chain or through base unit, and reporting via internet, cellular, radio or satellite uplink link with a global network operations center (NOC) with common command and control (C2) in a C5ISR cyber secure environment.

The individual tags incorporate low power consumption, long mission duration, long life (up to 10 years), reusable, with large on board data storage capacity and capable of in situ data analysis both at the edge and server level as a Big Data repository, and either daisy chain or using a base station to operate at long distance beyond line of sight (BLOS) in an operational environment.
**Experiment Objective/Hypothesis:** The progressive USJFCOM type joint experimentation campaign will extend the unique smart chip way beyond initial logistics capabilities analogous to the NVIDIA smart autonomic vehicle on board master processing chip (encompassing radar and lidar collision avoidance systems) with a technological origin and application in Smart Cities-Smart Ports-Smart Trade Corridors persistent self healing network into a self organizing ad hoc mesh network capability across the Internet of Things (IOT) (with an estimated 50 billion global independent autonomous connections by the year 2020) entire spectrum from single function industrial controls to unmanned autonomous systems (UXS) platforms and their onboard sensor suites and real time and asynchronous data analysis capability operating under common C2 across an Area of Responsibility (AOR) to enable real time total cross domain awareness in a C5ISR eventual EAL 7 cyber secure operating environment.

This follow on progressive series of joint experiments will: 1) test multiple tags embedded in smart pallets in conjunction with a base station with on board platform sensors (temperature, vibration, etc) in a variety of operating areas (terrestrial, marine,) situation awareness orientation (stationary and moving), geographic terrain features, climatic/weather, and conveyances (truck, vessel/USV, train, warehouse, open forward logistics depot to test operational limits of the prototype chips/smart pallets across networks common to logistics mode of operations of deployment and sustainment.

The objectives are to demonstrate the performance of individual smart chip embedded pallets, embedded prototype chips in other devices as available, in a variety of operating conditions and environments, and a self organizing mesh network of similar devices and base stations to include in future other squawking active and passive devices to acquire onboard data for near real time analysis at the edge, and at a remote server, as well as storage of data for reuse, predictive analytics, and Big Data applications.

The ad hoc network concept will be employed inter alia in the context of Humanitarian Assistance and Disaster Response (HADR) in applying the NSA approved protocol for Secure Web Integration Framework (SWIF) to share key data elements among first responders across multiple security classification levels.

**Experiment Plan / Data Collection Plan:** (1) In the initial joint experimentation phase, one or more smart pallets will be transported across a representative expeditionary warfare deployment, sustainment, and reset-retrograde cycle of operations across an area of operations including: (a) simulated pre-deployment marshaling and staging at a simulated installation transport office/rail ramp power project platform in an open environment to obtain single sign on version of ground truth of unit equipment and containers; (2) physical transport by road or rail to a surrogate Strategic Seaport of Embarkation (SPOE i.e. Oakland, LA LB); (3) loading on board Pure car Carrier (PCC) as a surrogate for a Low Medium Speed Roll On Roll Off vessel (LMSR); (4) ocean transport to Seaport of Debarkation (e.g. HI as surrogate for Guam or Korea); (5) discharge at Seaport of Debarkation (SPOD); and (6) transport by road or rail to theater deployable depot (e.g. DLA NOMADD) or (7) transport to an autonomous surface vehicle (USV) or manned vessel.
simulating a pallet capable TAKE or Maritime Platform Vessel (MPP) for Joint Logistics Over the shore (JLOTS) as in current Cascadia joint NORTHCOM/DHS, USTC HADR field exercise in Pacific Northwest.

(2) Real time data will be collected both autonomously and manually over the mesh network by polling at selected intervals during and at exchange points between conveyances in comparison to today’s limited RFID choke point reader

(3) The next experiment will track and trace a rail car shipment by container or unit to and from the SPOE POLA POLB and an inland depot (CA Steel and/or DLA Sharpe (Stockton) CA and demonstrate real time geolocation, status and condition monitoring and data analysis on the fly.

(4) The next experiment sequence will segue into Big Data and predictive analytics in partnership with the Foundation for Sustainable Communities as follows: (a) Supplemental RFI Big Data SM21 Interagency Field Exploration The SM21 Mobility Network is linked with the Analytics Center of Excellence – a platform for IBM Analytics providing: network (fluid data layer) for autonomous data, data analytics, and advanced cognitive learning designs. (b) Fluid Data Layer: In order for data to become of great value, it must be made available and accessible so it can be combined with other sources for more detailed insights and analysis. The fluid data layer represents a distributed infrastructure that runs, scales, and secures the data to provides autonomous data access and responsiveness for analytic power. (c) Data Analytics: Through an array of IBM analytics tools – Cognos, SPSS – ACE provides a platform to process data from multiple sources and offers the ability to add context to insights for new understanding and better decision making. This expertise will further add value to the data in critical areas, including: logistics, cybersecurity, homeland defense, transportation, and healthcare. (d) Cognitive Computing (Watson): Cognitive systems are taught, not programmed, using the same types of unstructured information that analytics uses. As with analysts, the system can learn as it goes, able to recognize terms and make connections between them, so it can understand questions and use reason to provide answers. The IBM Watson team will teach Watson (AI) the language, including cybersecurity, by annotating and feeding thousands of documents into the system to build knowledge. the system will be able to recognize and automate connections between millions of pieces of data at an unparalleled scale and speed.

(5) Using the smart chips as data collection platforms additional on board and independent IOT sensors (i.e. radiological portable mass spectrometer) will be used to demonstrate capability of ad hoc mesh network to identify other emitting IoT entities, capture and analyze data on the on the fly in real time.

**Measures of Performance & Effectiveness:** Key Performance Parameters (KPP)

**MOP**

Data collection across factors (1) location E.g. ground (moving/ stationary, conveyance (vessel, truck rail)), (2) distance; (3) reliability; (4) accuracy; (5) robustness; (6) network interoperability reliability.

Self organizing - autonomous data collection

Cyber security from intrusion, compromise, jamming, damage etc

**MOE**
Resiliency measured in reliability - in the face of obstacles, passage of time, battery life, weather impact, network intrusion, self-healing,
Enhanced end to end in transit visibility at the item level as to geolocation, status and condition

**What new capability does this represent?**  EITV and cross domain It represents a game changer over traditional RFID tags: (1) vulnerability to damage or intrusion as deployed only at container not content level. (2) operational end to end visibility constraints by (a) container or conveyance steel walls; (3) high power consumption; (4) short useful life; (5) no data storage or analytical capability; (6) no network redundancy and common C2 capability;
The potential is there to extend the persistent smart network derived smart chip capability from a closed loop self-organizing ad hoc mesh network across multiple physical domains (air, sea, terrestrial, space, cyber) into the organizing principle and physical and cyber capability for an infinitely extensible distributed network of IoT entities on a global scale

**What capability gap does this address?** b. Command, Control, Communication, Computers / Situation Awareness (C4/SA). Especially capabilities that include unmanned, robotic or autonomous systems or that will leverage these systems.
1. Near Real-time In-transit Visibility (ITV). Near real time asset visibility assessable through a suite of devices that harness the capabilities of existing and future communications technology (e.g. open mesh, 3G/4G LTE, etc.). Information would be accessible throughout the distribution pipeline and on the battlefield. Global supply chain management solution utilizing open source architecture, standards based methodology, with the ability to support visibility data being sent to DoD enterprise ITV and applicable business IT systems. Desired characteristics include:
   • Ability to report identification information, global positioning system (GPS) location (X, Y, & Z planes), and environmental conditions (temperature, humidity, barometric pressure) of intermodal freight containers.
   • ITV system with ability to support other ad-hoc sensor data (i.e. light, motion...etc).
   • Devices which interconnect or network that have secure, self-forming, self-healing and power conservation capabilities.
   • ITV system that allows for integration between future and existing backhaul communications capabilities available throughout the Department of Defense Distribution Enterprise.
   • Ability to access and share time sensitive, sensor-based logistics alerts detected on combat and
support vehicles that affect mission capability, as well as the off-load of health and usage data postmission for logistics analysis at tactical and national echelons. This data needs to be shared over secure, and in many cases, classified networks.
Low-cost, Rapidly-Biodegradable Air Delivery Vehicle

Otherlab, Inc.

Principal Investigator: Richard Turner

Area of Interest: Global Access Technologies

Capability Description: We are developing a low-cost, biodegradable air delivery vehicle designed to deliver cargo to deployed forces in a timely, safe, and undetectable manner. We have designed and built cellulose-based vehicles that can be produced using cheap materials and rapid prototyping techniques, incorporating minimal non-degradable avionics. We have tested them for flight-worthiness and stability from low altitudes, and now wish to test their capability for higher altitude launches and longer range flights. The aim of our project is to produce a vehicle capable of carrying a 1.5 kg payload over a distance of 150 km and landing in a target area with a 10 m radius. The vehicle uses a small central electronics unit for flight control and to activate a few steering surfaces, and has no active propulsion. Use cases include delivering water, medical equipment, or ammunition to battlefields. The vehicle shall be low cost to produce, and the bulk of the vehicle shall be constructed from cellulose-based materials seeded with fungal spores designed to rapidly degrade the vehicle. The degradation process will remove traces of the delivery and prevent re-use of the vehicle by enemy forces.

Experiment Objective/Hypothesis: We hope to use JIFX as a testing ground for demonstrating satisfactory aerodynamic and controls performance of our aircraft. So far we have shown that our vehicle can fly stably and accurately over small distances from low
altitude catapult launches. JIFX provides an opportunity to prove that our vehicle can perform accurate, long-range flights when launched from higher altitudes.

**Experiment Plan / Data Collection Plan:** We want to use high altitude launch capabilities provided by JIFX to attempt long range flights to a pre-determined target location. Ideally we would like to drop the vehicle from a low velocity carrier such as a helicopter or weather balloon, from an altitude at or above 5000 ft AGL. We will monitor the flight from a ground control station and record the trajectory of the vehicle using the onboard inertial measurement unit and GPS. Data will be collected and saved onboard and recovered with the vehicle. The vehicle will carry a satellite based tracking system to ensure recovery. We will also have an onboard shock sensor to measure and record mechanical shocks during launch and landing.

**Measures of Performance & Effectiveness:** Our key performance measures are:
- Accuracy: Does the vehicle land within the desired 10 m radius of the target?
- Range: What is the total length of the trajectory? Do we reach our desired glide ratio of 12:1?
- Communications Uptime: Do we maintain telemetry and GPS uplinks throughout the flight?
- Vehicle Shock: Does the payload experience shocks in excess of our 100 g target?

**What new capability does this represent?** We are building a vehicle using non-traditional materials (cellulose-based, including corrugated fiberboard, kraft paper, and papier-mache) and rapid prototyping methods (such as laser-cutting). This promises to provide low-cost, disposable delivery vehicles that can be deployed en masse or targeted with great accuracy. We also propose a unique biological method for disposing of the vehicle after completion of the mission, which is valuable in scenarios where traces of the mission must be minimized.

**What capability gap does this address?** Our proposal falls under area B19: Global Access Technologies. Our vehicle is a rapidly deployable, unmanned system for delivering vital cargo to remote locations. The low weight and high accuracy ensure safety in the delivery zone, and the rapid biodegradation reduces the change of detection or re-use by enemy forces, helping to ensure the long term safety of our warfighters.
CANCELLED

Deployment Testing of Novel Slow-Descent Communications Platforms

Otherlab, Inc.

Principal Investigator: Alexander Naiman

Area of Interest: Technologies Supporting Swarm and Counter-Swarm Unmanned Autonomous Systems (UAS)

Capability Description: This experiment will explore the deployment of novel unpowered, slow-descent, extremely compact aerial platforms that have been designed under a DARPA project to improve rapidly deployable ad-hoc communications relays. We have built several vehicles of different configurations sized to be deployed from a standard chaff/flare dispenser. These vehicles can carry a communications payload and are designed to provide up to one hour of loitering flight time without a propulsion system when deployed from 15 km above ground level. Low level flight testing has demonstrated performance that meets these requirements, but higher level flight is desirable to test resistance to environmental factors such as wind gusts.

Two vehicle configurations are to be tested during this experiment: a rotor-chute and a fabric hang-glider. For both configurations several variations will be tested to determine the performance characteristics of each. The hang-glider configuration has active control surfaces and its controller will attempt to fly it within a pre-designated loitering target area. The rotor-chute configuration has no ability to actively control its trajectory, so it will be carried by prevailing winds.

The test vehicles will not carry any specific communications payload, but have been designed as flexible platforms to allow various payloads of interest to be used. It is
envisioned that both omni-directional as well as high-gain systems could be installed as required, with a greater degree of pointing control required for high-gain systems.

**Experiment Objective/Hypothesis:** Our experiment seeks to prove that the vehicles we have designed meet all performance requirements for high altitude deployment and flight. In particular, we seek to demonstrate the following objectives:

1. Vehicle control systems provide guidance and control in response to wind gusts.
2. Loiter flight time performance meets requirements.

**Experiment Plan / Data Collection Plan:** For each vehicle to be tested, the experiment will be the same. The vehicle will be deployed from the drop vehicle at 5000 feet of altitude and its flight will be monitored from a ground control station. Flight parameters will be logged on board the vehicle for later analysis. Vehicles will be equipped with telemetry radios and backup GPS trackers for in situ tracking and analysis and to aid recovery efforts. Once vehicles have landed, they will be recovered and their performance will be analyzed according to the experiment objectives.

**Measures of Performance & Effectiveness:** Each of the experiment objectives has a corresponding measure of performance/effectiveness:

1. Were the vehicle control systems able to provide guidance and control in response to wind gusts? This can be assessed by examining actuator inputs and the resulting vehicle dynamic response, both of which are logged by the vehicle controller.
2. Did the vehicle meet loiter flight time requirements? We will measure overall vehicle sink rate and assess whether the vehicle stayed within its designated loitering target area.

**What new capability does this represent?** Our novel vehicles are intended to replace existing chaff/flare dispenser-deployed systems based on standard parachutes. Each configuration offers its own advantages over currently existing systems. The rotor-chute provides improved loiter time (lower sink rate) with the potential for actively controlled antenna pointing for communications payloads. The hang-glider provides a much improved loiter time with the ability to actively control vehicle trajectory. Both of the new configurations achieve these improvements while also fitting in a smaller deployment package and using materials with a longer shelf life as compared to existing systems. Our vehicles leverage recent improvements in miniaturized electronic devices, using tiny commercial off-the-shelf autopilots for guidance and control.

**What capability gap does this address?** The proposed experiment addresses several areas under the current event’s RFI relevant to Area of Interest B, Command, Control, Communication, and Computers / Situational Awareness (C4/SA). In that the current experiment focuses on the development of a suitable loiter vehicle, area B.28, Technologies
Supporting Swarm and Counter-Swarm Unmanned and Autonomous Systems (UAS), is relevant. Each of the vehicle configurations we have designed is small enough to enable two to four vehicles to fit inside a single chaff/flare dispenser tube. A swarm of such vehicles could therefore easily be deployed during flight to provide a multiply redundant communications relay system over an area of operations.

As a generally relevant technology, the deployment of long loiter time communications relay nodes enables a number of other areas of interest under C4/SA by extending the range of line-of-sight systems. These areas potentially include B.5 (Scalable, Mobile and OTH Digital Communication Networks), B.8 (Location, Tracking and Communication Technologies), B.15 (Agile network Architectures), and B.27 (Air to Ground Communication Hardware).
NPS Video Cloud System

Naval Postgraduate School

**Principal Investigator:** John H. Gibson

**Area of Interest:** Interoperable Communication Solutions in Network Denied Disaster Response Environments

**Capability Description:** The NPS Video Cloud System project aims to provide the capability to stream live 4K video via satellite from remote locations in support of military public affairs organizations. Emerging high speed satellite capabilities allow for gigabit per second transmission speeds, while more efficient video codecs and computer hardware allow for the compression of ultra high definition video.

**Experiment Objective/Hypothesis:** The experiment utilizes a previously researched video transcoding and management system and a previously tested medium Earth orbit (MEO) satellite constellation. This experiment integrates the two capabilities and tests the suitability of the integrated solution for the purpose of streaming live 4K video over satellite.

**Experiment Plan / Data Collection Plan:** Various network performance tools that are provided in the CentOS package repositories will be used to measure data throughput and jitter: iperf3 will be used to test the limits of the satellite network connection, including max speed and jitter; nload will be used to monitor current, average, and total bandwidth...
usage from the server; top will be used to monitor CPU and memory usage on the remote server.

**Measures of Performance & Effectiveness:** The experiment will measure network performance over the O3b MEO satellite constellation, including network throughput and jitter. The experiment will also measure the transcoding performance of the remote server, specifically, its ability to maintain a “live” transmission rate.

**What new capability does this represent?** The NPS Video Cloud System utilizes cloud computing principles to deliver an integrated, multi-node system that will capture and transcode high quality video from a remote location and deliver it via satellite for service to users. The delivered product can be distributed from the fixed server that currently resides in the NPS data center.

The unique solution offered through using two nodes with viaPlatz 3.0 installed allows the system to capture, transcode, stream, and serve high resolution video from a remote location. The viaPlatz software also offers the ability to scale, for example, to have multiple remote servers providing video to a central fixed server.

**What capability gap does this address?** Commander Naval Air Forces Atlantic (CNAL) identified a need to deploy a small public affairs team with the capability to transmit HD video from remote locations. These locations have limited to no high speed Internet access and limited electrical capability in the field. The capability further requires airline transportability with containers that are “two man lift” or less.
Free Space Optical Communications to Support Tactical Maneuvers

NPS Military Wireless Communications Research Group

Principal Investigator: John H. Gibson

Area of Interest: Scalable, Mobile and OTH Digital Communication Networks

Capability Description: This experiment seeks to explore the performance characteristics of current medium-length free space optical (FSO) communications capability. The purpose of the research is to determine the near-term potential for laser-based communications to support beyond-line-of-site expeditionary-force insertions in remote locations. The desired end-state of the research is identification of the viability of very small form-factor devices capable of relaying high data-rate communications.

Experiment Objective/Hypothesis: Commercial-off-the-shelf free-space optical communications are able to reliably close tactical links up to 12 Km.

Experiment Plan / Data Collection Plan: Two FSO links will be established at Camp Roberts. The first will connect the McMillan complex to the top of Nacimiento Hill. The second, upon successful closure of the McMillan-Nacimiento link, will connect Nacimiento Hill with the northeast corner of Camp Roberts, a link of approximately 12 Km. Link stability will be measured using throughput and delay measurements with jperf/iperf applications, as well as other open-source tools.
**Measures of Performance & Effectiveness:** FSO link performance will be evaluated according to sustainable throughput, link drop-outs, and difficulty of link establishment (time-to-establish connectivity).

**What new capability does this represent?** Previous field experimentation explored the current ability to close a 1 Km link at Camp Roberts. This effort met with marginal success, primarily due to over-heating problems with the FSO system employed. This experiment seeks to determine whether the SA Photonics technology is able to operate under similar conditions over greater ranges. While a 12 Km link is less than 10% of the operational objective, the ability to close the link and maintain connectivity over this distance will provide confidence that further exploration is warranted.

**What capability gap does this address?** The objective of this research is to identify methods for providing high bandwidth communications to Marine expeditionary forces tasked with long range insertions under conditions of limited or non-existent satellite communications or excessive RF interference.
Rapidly Deployable 3D Printed sUAS for Damage Assessment

MAMM 3D Inc

Expendable Drones

Principal Investigator: Kevin Reynolds

Area of Interest: Situational Awareness During Disaster Response

Capability Description: The experiment will demonstrate flight capabilities of a small UAS designed to be 3D printed and deployed in 24 hours for achieving situational awareness during disaster response.

Experiment Objective/Hypothesis: The experiment will prove that the rapid deployment of a sUAS with printed structural components and circuitry can provide useful advantages in certain disaster response scenarios.

Experiment Plan / Data Collection Plan: Video will be collected from a standalone camera system on the aircraft that can be remotely controlled from the ground using either first person view or a joystick.

Measures of Performance & Effectiveness: We hope to achieve a safe and sustained flight duration of 10 minutes minimum using commercial off-the-shelf components integrated into the 3D printed airframe.
What new capability does this represent? The aircraft design used for achieving situational awareness can be designed, printed, and flown in 24 hours. The design will also incorporate the use of 3D printed circuitry.

What capability gap does this address? The capability gap being focused on is the ability to achieve and sustain flight using 3d printed materials to significantly reduce lead time and manufacturing costs for small UAS.
GO ISP

Compusult Systems Incorporated

Principal Investigator: Tony A. Smith

Area of Interest: Mobile Data Collection during Disaster Response Operations

Capability Description: GO ISP is a mobile application for Android phones, Android-based tablets and Microsoft Windows Tablets/PCs that provides users with the ability to easily collect and access information and content in the field in either connected or disconnected environments. Based upon Compusult’s GO Mobile technology, GO ISP has been implemented for the SOCOM Integrated Survey Program (ISP) to more efficiently and effectively conduct surveys by:

- Enabling the download to mobile devices of SOCOM survey Geospatial Databases (GDBs) using the new Open Geospatial Consortium (OGC) standard, GeoPackage;
- Enabling the collection of survey data using intuitive data capture forms and mobile device cameras;
- Allowing use of the geospatial databases and data capture in disconnected or limited bandwidth environments;
- Providing the ability to synchronize the new/updated data with GDBs within the ISP application servers.

Experiment Objective/Hypothesis: Mobile and hand-held devices can be used as an effective tool for accessing, sharing and collecting information and content in the field in either connected or disconnected environments. The project will focus on two main objectives: 1. Deployment of a Service-Oriented Architecture (SOA) Web application, based on the
Compusult Web Enterprise Suite (WES) toolkit, which provides the server components, service interfaces for data content providers, metadata catalog, integrated support for mobile devices, including upload/download capability for files, imagery, audio/video data, etc., and tailored to support Mobile Data Collection during Disaster Response Operations. 2. Development of knowledge management technologies and inclusion/integration of advanced geospatial information and content. The intent is to enhance the Compusult GO ISP platform to enable these technologies for use by small dismounted teams operating in isolated and complex environments using mobile device platforms.

**Experiment Plan / Data Collection Plan:** The project provides an accelerated natural disaster response development/deployment capability by leveraging technologies (Compusult Web Enterprise Suite/GO ISP) already in use by DoD, and others, in delivering similar capabilities. The proposed system is built upon a mature development framework using an open systems approach, which allows system and content tailoring dependent on the specific application and organizational requirements. This approach also provides significant cost savings since it is not necessary to re-develop the entire system. Web Enterprise Suite (WES) is an integrated suite of standards-based applications that enable the expedient and efficient construction of spatial Web-based portals, which provide data cataloguing, discovery, access, retrieval, delivery, Web mapping, e-commerce and metadata management services. GO ISP is a mobile application for Android phones, Android-based tablets and Microsoft Windows Tablets/PCs that provides easy access to geospatial content and other data and services through secure wireless communications to the cloud. This project will provide an enhanced disaster response capability by extending SOA capabilities out to mobile devices using standard, industry-proven technologies in a geospatially-enabled, secure Web-based environment. This access to data in a mobile, dismounted environment is further enhanced through the use of advanced visualization technologies. We plan to measure the effectiveness of geospatially enabled mobile technology in the field. This will be accomplished by identifying and selecting geospatial information and content on-the-fly for mission-critical events and missions and allowing it to be installed on devices for dismounted operations. We plan to collect information (positions, observations, media, etc.) in the field by using the GO ISP interfaces on mobile devices and then effectively update GO ISP application servers for enhanced situational awareness to support the decision making process.

**Measures of Performance & Effectiveness:** Data on the end-user devices can be accessed by navigating the hierarchical portfolio capability for portfolios that have been selected or via a local search facility that can find things using location, temporal or keyword attributes. In the case of keywords, all words within documents such as MS Office files loaded on the device are indexed to provide a powerful search capability where users can select one or more words that may or have to appear in documents. End-user devices support a powerful capability to perform quick data capture where users indicate object of interest locations and are then prompted to enter appropriate metadata to describe the object efficiently by just making a few clicks. There is a comprehensive data capture facility where data management personnel define the metadata attributes and value lists (including interdependency between attributes) that the end-user navigates after picking an object type. Data captured by the device can be uploaded to WES for sharing to other devices in
near-real time if the device is connected to a network or later if the device is disconnected. End-user devices: € Laptops - standard windows or android-based devices loaded with the latest version of GO ISP. GO ISP interoperates with the tools and capabilities of the device to provide a powerful platform for the dismounted user. Updates made by disconnected users are synchronized when devices are re-connected to the network. Android Mobile Devices - commercial or ruggedized phones/tablets running commercial versions of Android. These devices use GO ISP to interact with the documents and data. GO ISP takes advantage of the GPS, compass, camera and gyro capabilities of these devices to provide location data and to support facilities such as augmented reality where geospatial data is displayed on top of a video view from the device’s camera. The end-user devices interact with WES and push/pull data and synchronize changes made while disconnected. They will also support the capability to plug in devices such as USB sticks and SD cards that contain data created by WES for environments where network connectivity for the end-user devices isn’t possible. We will measure how effective the devices were for conducting augmented data capture. We will measure how the devices/app performed using fairly large geospatial datasets and measure how the data can be integrated into existing C2 systems.

**What new capability does this represent?** Traditionally, it has not been possible to generate geospatial packages of information and content (road networks, satellite imagery, features, mission parameters and associated documentation) easily for users in the field that have to operate in disconnected environments. Essentially, the information you need in a simple effective container. This approach will also provide field personnel with the ability to correct information (i.e., bridge is no longer accessible) and update this information in master databases using a synchronization process. It will also provide the ability for field personnel to provide real-time and near real-time updates (what is happening on-the-ground) to command and control for situational awareness and decision making.

**What capability gap does this address?** - Mobile Data Collection during Disaster Response Operations
Personal Reverse Osmosis Backpack System

Made In Space, Inc.

Principal Investigator: Eric Joyce

Area of Interest: Water Generation and Purification Systems

Capability Description: In deployed locations, U.S. troops have experienced difficulty obtaining clean drinking water, having to rely on bottled water for hydration. This experiment proposes the field testing of a miniaturized reverse osmosis system to filter out the contaminants, particles and/or any biohazards in local water sources to make it potable for drinking purposes. The system uses a manual pump to take in the water from a water source and have it filter through the reverse osmosis, the carbon and bio filters before dispensing the sifted water into a canteen. The backpack system will also have a solar powered de-humidifier system that will extract the humidity from the air and filter the water into the canteen as well.

Experiment Objective/Hypothesis: The current policy for treating water obtained from a resource in Afghanistan is to have the water go through reverse osmosis, but that the filtered water only be used for hygiene and washing, as this type of water is not safe for drinking purposes. This experiment is an attempt to prove that drinking water can be obtained through a three-step filtration process without relying solely on bottled water. Several objectives we want to test with this experiment pack is that it is capable of being robust out in the field, as well as extract and filter water through our system collected from various ‘water resources’. During these tests, we will also be testing the de-humidifier.
system and that it can extract water from the air as well as its capability on the field. The objective of this experiment is to offer a personal water filtration system that meets the standards of the U.S. Environmental Protection Agency (EPA), and which can be used for U.S. troops as well as for developing third world countries who do not have direct access means to drinking water.

**Experiment Plan / Data Collection Plan:** We will measure our experiment by observing how much water the reverse osmosis system will take in through the manual pump and the amount of filtered water that will go into the canteen attached to the backpack. Once water has been filtered through the PRO system, we will test the filtered water using a drinking water testing kit that meets all of the U.S. EPA standards. For the solar powered dehumidifier system, we will observe how much water is extracted from the air and filtered into the canteen at its highest efficiency.

**Measures of Performance & Effectiveness:** Our experiment’s expected performance is to have our filtration system take in water from a water source that is at the same or similar level of contamination that the waters in Afghanistan are, and have it filter out the contaminants and biohazards in the water, leaving only filtered, drinking water left in the provided canteen. The effectiveness of this experiment will depend on the water left behind after the filtration process and that the filtered water tested meets all the standards set by the U.S. EPA.

**What new capability does this represent?** Our experiment utilizes a three step approach to tackling on the process of filtering water through our filtration system. The backpack system also has a redundant backup water supply by use of the solar powered dehumidifier system, through which if one system should fail the other can continue providing drinking water.

**What capability gap does this address?** Our experiment will primarily address the Water Generation & Purification Systems for the Deployable Infrastructure, Power & Water, as this experiment is only for reliable water filtration and extraction methods.
Skylift as a Small Unit Support Vehicle/Vessel

Skylift Global, Inc.

Principal Investigator: Jesse Moore

Area of Interest: Small Unit Support Vehicles/Vessels

Capability Description: Our sUAS prototype, currently in its second iteration, has a target takeoff weight under 55 lbs. and should be capable of lifting external loads over 200 lbs. We believe that it can enhance frontline resupply operations for high-priority payloads like ammunition in service areas which require a terrain-agnostic platform.

Experiment Objective/Hypothesis: We are looking to prove or disprove the hypothesis that our vehicle can act as a logistics support vehicle for multi-mission/multi-use operations.

Experiment Plan / Data Collection Plan: The JIFX 16-4 facilities will be used to test the key operational aspects of our hypothesis. Data will be collected in real-time from the vehicle’s flight controller.

Measures of Performance & Effectiveness: For this experiment, we intend to use the facilities at the JIFX 16-4 Event to demonstrate the following key objectives:
- Autonomous operation from digital flight plan
- Manual control override
- Autonomous self-landing with autorotation
- Ability to transport loads over 200 lbs.
- Stability in adverse weather conditions
- Top speed testing with radar
- Flight endurance testing
- B-VLOS navigation
- Verify takeoff weight.

Effectiveness of each metric will be compared to the performance requirements of small unit logistics operations.

**What new capability does this represent?** Our vehicle uses a proprietary configuration to achieve greater aerial vehicle safety, reliability and payload capacity. Our heavy-lifting vehicle requires no infrastructure and can operate at a lower cost per mile than current logistics transportation options.

**What capability gap does this address?** The primary objective of this Experiment Proposal is to address the capability gap for a Small Unit Support Vehicle/Vessel (B.2-i1). As secondary objectives, our vehicle could also address:
• B.2-a9 Small Personal Reconnaissance Devices (PRDs) o Small VTOL (one man portable and launch) with potential to carry and deliver payloads (3-5lb payload) o Small quadcoptors capable of indoor mapping and flight using smart sensors and object situational awareness
• B.2-a10 Larger UAS Class I/II Expeditionary/Maritime
• Independent launch/recovery methods that minimize Runway operational and logistics footprint
• B.2-a11 Rapid Airfield Damage Assessment System (RADAS) o Platforms, sensors and communication infrastructure that support data collection platforms, include or may include fixed installations (towers), mobile ground units, and/or Unmanned Aerial Systems (UAS).
• B.2-b19 Global Access Technologies o Air/Land/Sea technologies that provide timely capability to deliver cargo to dangerous (i.e. anti-access/austere) locations across a complex, distributed battlefield without jeopardizing warfighter safety.
Integration of Universal Autonomous Capabilities with Various Robotic Platforms

RoboTC

**Principal Investigator:** Ronald Wilson Pulling

**Area of Interest:** Autonomous robotics

**Capability Description:** The ability to apply standardized autonomy-enabling solutions across robots with a wide range of form-factors and objectives.

**Experiment Objective/Hypothesis:** Hypothesis: The RoboTC platform can be integrated with the robots currently in use by NPS. Objectives: Demonstrate successful integration with one or more robotic platforms with simplistic proof-of-concept autonomous algorithms.

**Experiment Plan / Data Collection Plan:** Depending on the robots that can be provided, and the available documentation of the control systems for those robots, we will have a binary integration success metric based on whether or not the target robot was able to execute a prescribed autonomous action using our platform (e.g. "follow a line").

**Measures of Performance & Effectiveness:** We will have a binary integration success metric based on whether or not the target robot was able to execute a prescribed autonomous action using our platform (e.g. "follow a line").

**What new capability does this represent?** The experiment tests our modular system for autonomous robotic intelligence. This novel approach drastically simplifies the process of testing autonomous capabilities, allowing for the rapid evaluation of and comparison between competing algorithmic solutions.
What capability gap does this address? - Versatile standards for autonomy design
- Powerful new capabilities for testing and evaluating autonomy
- Planning and reasoning for dynamic, uncertain operations and physical environments
- Natural, intuitive communications between humans and intelligent agents/systems
- Means for assessing the safety and performance of systems that learn and alter behavior over time