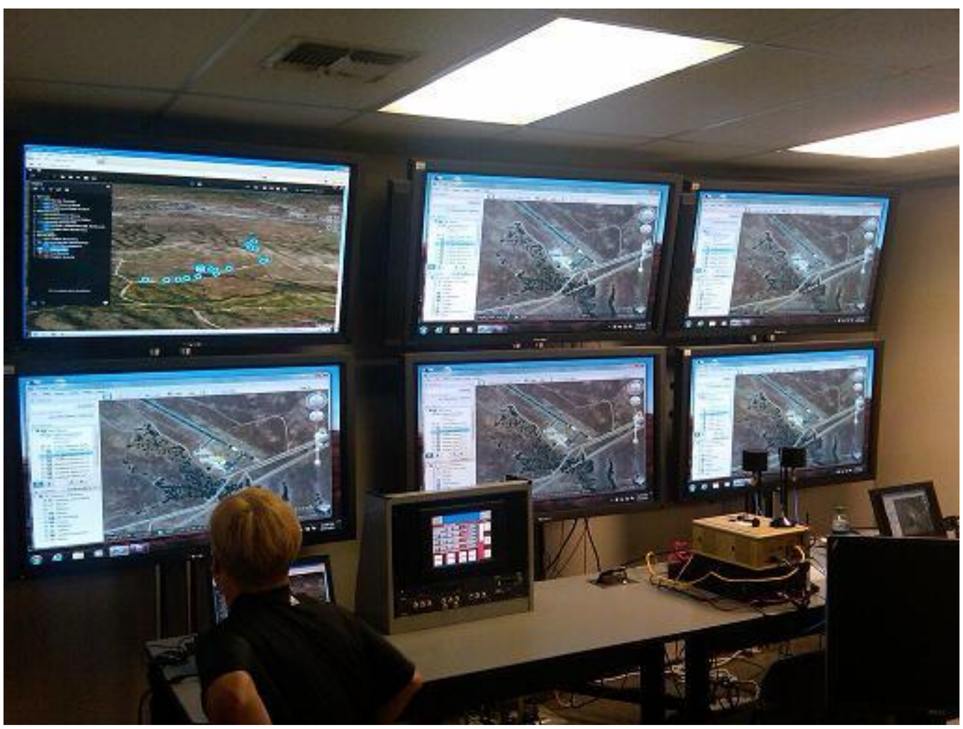
Naval Postgraduate School
National Defense University
RELIEF 12-4

Research & Experimentation for Local & International Emergency First Responders (RELIEF)

Quick Look Report



Camp Roberts, CA
13-17 August 2012

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Event Statistics

Event Highlights

- A real-time, on-site solution developed between the Department of State's consular affairs and the Joint Vulnerability Assessment Branch that resulted in a successful identification of a legitimate request for non-combatant extraction in Syria.
- First ever workflow between FEMA and the Civil Air Patrol that pioneered a formal imagery tasking process to be used in accelerating the gathering and processing of imagery in domestic post-disaster settings.
- Numerous ad hoc experimentation initiated by participants to address cross cutting humanitarian problems needs through new, innovative approaches.

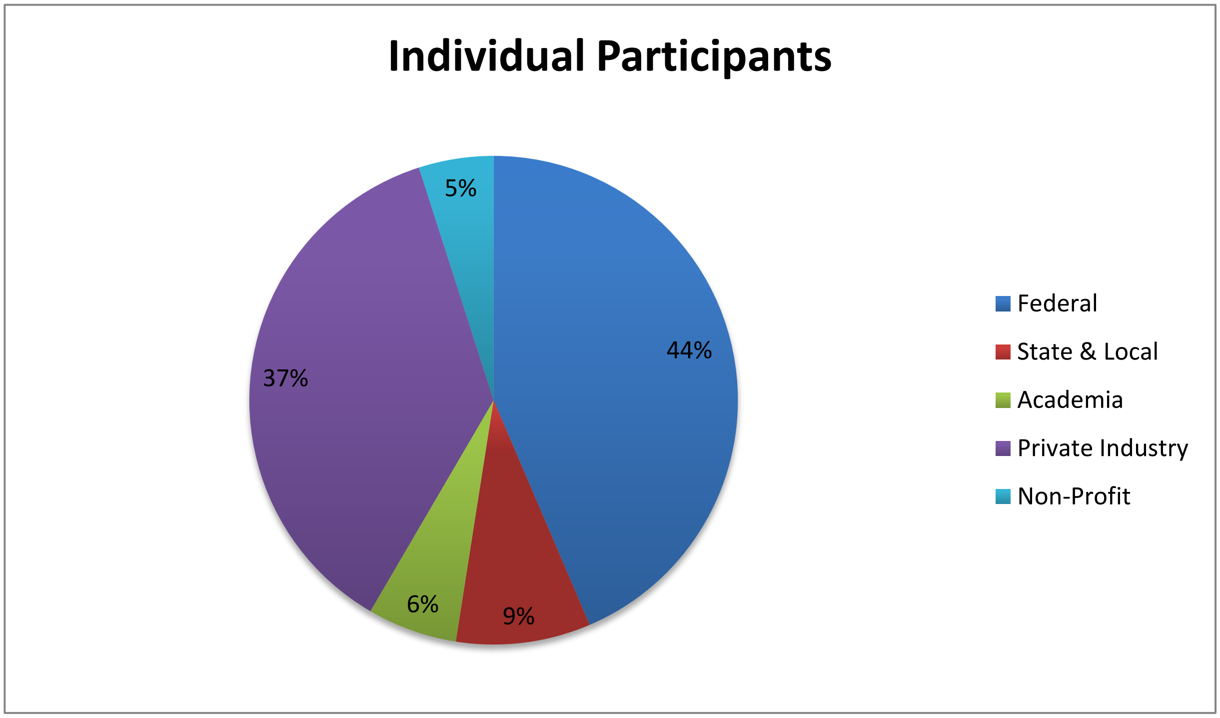
By the Numbers

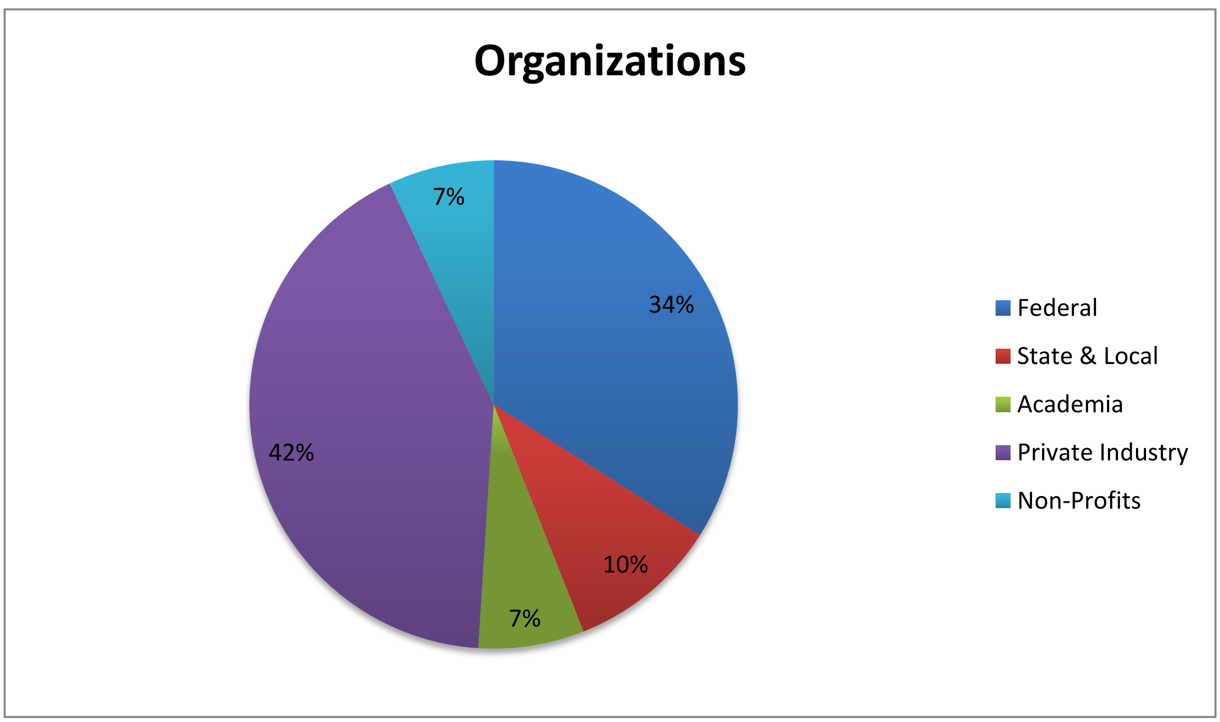
129 Organizations Represented

- 34% Federal Entities
- 10% State & Local Entities
- 7% Academic Institutions
- 42% Private Industry
- 7% Non-Profits

329 Registered Participants

- 44% Federal Employees
- 9% State & Local Employees
- 6% Academia
- 37% Private Industry
- 5% Non-Profits


Individual Participants
5%
44%
37%
6%
9%
Federal
State & Local
Academia
Private Industry
Non-Profit


Organizations
7%
34%
42%
10%
7%
Federal
State & Local
Academia
Private Industry
Non-Profits

Experiment # A-06

Small UAV Deployable Communications Relay Extending Range of Civil Authority Handheld Radios

Boeing

TCCR operations with ScanEagle UAV

Principal Investigator/Lead: Richard G Paquette, Boeing

Working Hypothesis:

By utilizing a communications relay in a UAV system, larger communications systems ranges are achievable, as well as improved level-of-service in various Emergency Operational Environments.

Approved for public release; distribution is unlimited.

Objective:

Demonstrate the capability to dramatically extend the range and area coverage of Emergency Responder handheld and other radios operating with Civil Authority Frequencies utilizing a Communications Relay capable of being mounted in small, widely deployed UAV systems.

Overview/Background:

Boeing has developed a Tactical Compact Communications Relay of extremely small size, weight and power requirements. The relay is capable of being flown in a small, tactical UAV (Unmanned Airborne Vehicle) such as the Puma and ScanEagle. The Puma UAV system with Relay is small enough to be carried in the trunk of a vehicle.

An earlier version of this relay was developed and currently supports operation with military band radios in Theater. Boeing has developed an experimental research and development model that is compatible with Civil Authority radio frequencies. The developmental system will extend the range of first responder handheld radios, and also permit connection over intervening hills, buildings, other obstructions, and near ground RF emitters.

Emergency Responder personnel can benefit from the ability to rapidly deploy a UAV with the Compact Relay which provides connectivity to personnel dispersed over a wide geographical area. Additionally, the relay is capable of providing a send home capability to get data back from deployed sensor systems to home base.
The system is capable of operating in areas of high levels of RF energy and in environmental conditions compatible with current deployed UAV operational environments.

Experiment Description:

The demonstration will consist of flying the Relay aboard two different UAV's; the hand-thrown PUMA UAV and the catapult launched ScanEagle UAV. The different UAV's will provide a wide range of experiment parameters including ability to rapidly deploy, to deploy to a wide range of altitudes, and to deploy for in support of emergency operations for extended periods.

Responder personnel attending the event with standard handheld and other radios will be able to evaluate the Relay's capability to enhance communications during emergencies with other hand-held radio users over significantly expanded areas and over intervening hills and other Line of Sight obstructions. Communications may be voice and/or data, encrypted or non-encrypted.

The experimental Relay is configured to provide coverage at particular transmit / receiver frequency pairs throughout the 136 MHz to 174 MHz band. Specific frequencies will be selected based on interest of attending Civil Authorities.

We seek to demonstrate and evaluate the Relay effectiveness to support emergency operational exercise objectives that would be of interest to the Emergency Responders' community in providing a comprehensive operational evaluation envelope.

This experiment will provide valuable insight to us in determining the value of a number of features currently in development, such as dual simultaneous channels, change of transmit and receive frequencies in flight, etc.

Test / demonstration timing would be possible in a few hours; however, the UAV could stay aloft for extended periods to support longer duration evolutions during a number of other activities if that would be of value.

Measurements/Data Collection Plan:

The demonstration will provide a communications link between deployed fixed and/or mobile radio systems. This demonstration will provide insight for ourselves of the system QOS (Quality of Service) and operational value to the user community in the area and Emergency Operations Scenarios and Exercises of interest to attending Civil Authorities.

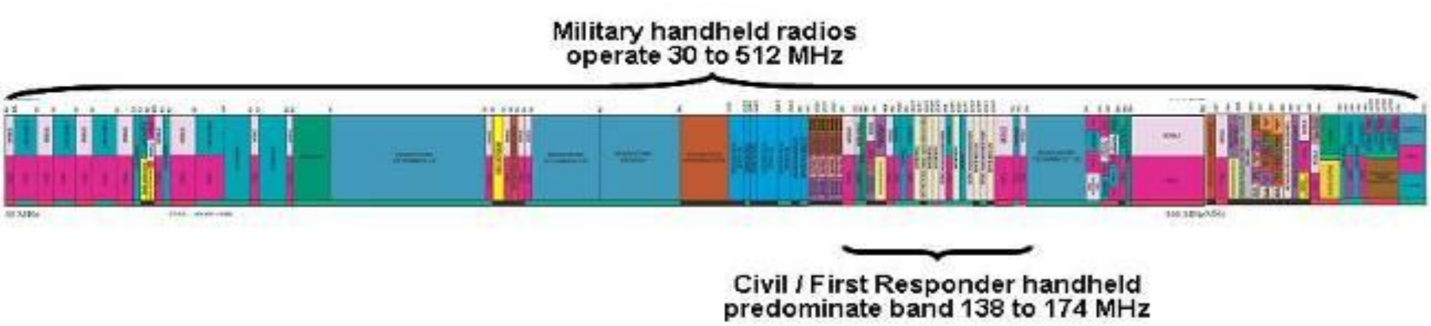
Measures of Performance/Measures of Effectiveness:

This demonstration will provide an evaluation of the benefits of communications systems range and LOS improvements in various Emergency Operational Environments, UAV operating altitudes, and UAV flight persistence.

What new capability (or improvement to existing capability) does this represent?

This experimental Relay supports First Responder and Civil Authority radios operating in the 136 MHz to 174 MHz band. Operating frequencies may be selected / changed while the UAV is in flight. The capability of the Tactical Compact Communications Relay provides for dramatic improvement in range and operational area for tactical communications systems; for both voice and data, and encrypted and non-encrypted communications.

Quantitative Results:



Summary Results

Eight flight operations were conducted in the 3 day period of exercises with two different rapidly deployable, small UAV systems; ScanEagle and Puma. The Relay was able to provide connectivity of handheld radios operating in civilian, First Responder frequencies. Demonstrations extended to handheld radios deployed locally on the based into hilly terrain, and to just over 20 miles, and well over the intervening California Central Coast range. Normal range for these radios is 6 to 7 miles; and 0.5 to 1 miles in the hilly terrain of Camp Roberts and many other locations in California areas where hills, crevices, and urban structures abound.

A number of issues developed over the demonstration period which limited flight operations. Some issues were very useful in determining actual operational environments during emergencies. A number of the planned demonstrations were affected by a “Spoofing Experiment” which was being operated at the same time as the RELIEF exercises.

Qualitative Results:

During the 8 flight operations, numerous First Responder RELIEF participants joined our demonstration team at the launch and recovery site. One of our handheld radios was always retained at the site to permit a full experience for the participants on the launch, operations, and recovery of the UAV deployed Relay.

Questions, comments, encouragement, and active participation was provided by the large number of First Responder personnel that traveled to the L&R site, as well as follow-up discussions during morning meetings and afternoon debriefings. This interaction provided our team valuable insight in determining the value of both the existing system, and a number of features currently in development, such as dual simultaneous channels, change of transmit and receive frequencies in flight, and a lighter more compact size.

Collaboration / Ad Hoc Experiments:

On the third day of operations, a number of exercise participants, under the leadership of DHS / FEMA personnel, worked with the Relay team to devise an ad hoc exercise with the numerous RELIEF participants that had brought handheld radios to Camp Roberts. A standard frequency was used in participation with the Lockheed Martin communications suite that was at RELIEF. Participants traveled around the base via cars in caravan style. Some experience was gained form this exercise. However, it was determined that during part of the exercise, the mobile "Spoofing Experiment" had been rebroadcasting older relay communications broadcasts. This caused a bit of confusion until it was discovered near the end of the day.

Observations & Comments:

As usual, the Camp Roberts environment created by the NPS leadership provided quite a bit of qualitative and quantitative experience for use. Most of what we accomplished was due to issues that developed over the exercise periods, and which could be instantly responded to by the team through reconfigurations and modification of demonstration parameters.

Experiment Details

System description

Boeing has developed a Tactical Compact Communications Relay (TCCR) of extremely small size, weight and power requirements. The Relay is capable of being flown on small UAV systems (Unmanned Airborne Vehicle) such as the Aerovironment Puma, Insitu ScanEagle, Schiebel S-100, and the SOFCoast commercial aerostat. . The Relay can be configured by Boeing to serve military (TCCR-XR-V3) or civil use frequencies (TCCR-ER-V3). The Relay has been demonstrated with both military and civilian handheld radios.

When flown at altitude, the relay expands the handheld radio's communications area coverage by 50 to over 100 times.

Through relatively minor modifications, Boeing has converted one of our IRAD TCCR Relay units to be compatible with Civil Authority radio frequencies. As with the unit operating at military frequency bands, this unit will extend the range of first responder handheld radios, and also permit connection over intervening hills, buildings, other obstructions, and near ground RF emitters.

When existing infrastructure fails, or when normal operations extend into areas where radio coverage is difficult, or not possible, Emergency Responder personnel should benefit from the ability to rapidly deploy a UAV with the TCCR which provides connectivity to personnel dispersed over a wide geographical area. Additionally, the relay is capable of providing a send home capability to get data back from deployed sensor systems to home base. The system is capable of operating in areas of high levels of RF energy and in environmental conditions compatible with current deployed UAV operational environments.

Demonstration frequencies

For this event, the Relay was programmed initially with a set of frequencies to conduct initial checks. If exercise participants requested, these frequencies could be changed during the exercises to accommodate particular scenarios. However, the Relay remained at the following receive and transmit frequencies throughout the 3 days of flight.

- Receive frequency 152.5 MHz
- Transmit frequency 168.325 MHz

During trouble shooting conducted while the "Spoofing Exercise" system was in the area, we used the military unit which was configured to receive at 346.45 MHz and retransmit at 262.2 MHz.

System Demonstration

The demonstration consisted of flying the Relay aboard two different UAV's; the hand-thrown PUMA UAV and the catapult launched ScanEagle UAV. The different UAV's provided a wide range of experiment parameters including ability to rapidly deploy, to deploy to a wide range of altitudes, and to deploy in support of emergency operations for extended periods.

The Emergency Responder personnel attending the event with standard handheld and other radios were able to evaluate the Relay's capability to enhance communications during emergencies with other hand-held radio users over significantly expanded areas and over intervening hills and other Line of Sight obstructions. Communications may be voice and/or data, encrypted or non-encrypted; for this event, all comms were unencrypted voice

This experimental Relay supports First Responder and Civil Authority radios operating in the 136 MHz to 174 MHz band. Operating frequencies may be selected / changed while the UAV is in flight. The capability of the Tactical Compact Communications Relay provides for dramatic improvement in range and operational area for tactical communications systems; for both voice and data, and encrypted and non-encrypted communications. Specific frequencies were selected based on initial discussions with FCC personnel. A number of Civil Authorities attending the RELIEF were able to tune to these frequencies in the field. Normally, the Relay would be programmed to operate at the emergency frequencies around 171 MHz.

Daily Exercise Results

Day 0 (12 August) Pre-event ground testing at Camp Roberts:

Boeing conducted pre-flight operational checks on the ground checks of the Relay, a ScanEagle UAV, handheld radios, and instrumentation being used to assure system safety.

Day 1 (13 August) Scan Eagle flight Test and Results:

TCCR launched aboard ScanEagle UAV

- ScanEagle flight #1
- The ScanEagle was flown at an altitude of 11,000' above sea level, then elevated to 13,000'. It was decided to operate the ScanEagle at high altitudes as the following 2 days the Puma operations would be able to provide operational parameters at lower altitudes.
- Radio checks commenced immediately after launch and during flight to altitude.
- Handheld radios were deployed around Camp Roberts to establish initial verify system operations. Successful link from McMillan airfield to second condemned bridge, approx 5 miles west in Camp Roberts.

- When the ScanEagle reached 11,000', a team with a handled radio left the base by car to extend the demonstration into the hills and roadways surrounding the Camp Roberts area.
- The FCC license we obtained permitted our operations to extend to 50 miles from the base. This range permitted demonstrations out to areas beyond the California coastal range in Morro Bay / Cayucos area. Successful links were obtained for these areas.

Day 2 (14 August) Puma flight Test and Results:

Puma launch with TCCR Relay

- The Relay with civil frequencies was integrated for the first time on Puma. Many flights with its exact cousin (the military version of TCCR) led the team to believe there would be no issues.

- Three flights were made on Day 2.

- During Puma Flight #1, with Puma at 5,000' above sea level. The link was demonstrated as operational. Intermittent operation limited range and the unit was recovered

- During Puma Flight #2, with Puma at 1,000' above sea level. Relay had similar performance as Flight 1. At this time, while the system was being exercised, it appeared that EMI might be an issue as the relay AGC appeared to be overtaxed, and operations became normal when the UAV was put into glide mode. We were unaware that the "Spoofing Exercise" equipment in the area was transmitting on our frequencies at up to 48 watts.

- Between flight #2 and flight #3, a jamming test coordinated with the "Spoofing Exercise" team; 48W at 9 meters to jam TCCR to verify TCCR recovers after being jammed. Verified TCCR appeared jammed then recovered.

- Puma flight#3, plan to run RF link tests with coordinated glide periods. But no comms at all. Bring plane back and measured no DC power to TCCR, and TCCR was cold, indicating a second issue was in play, an intermittent power cable from the UAV.

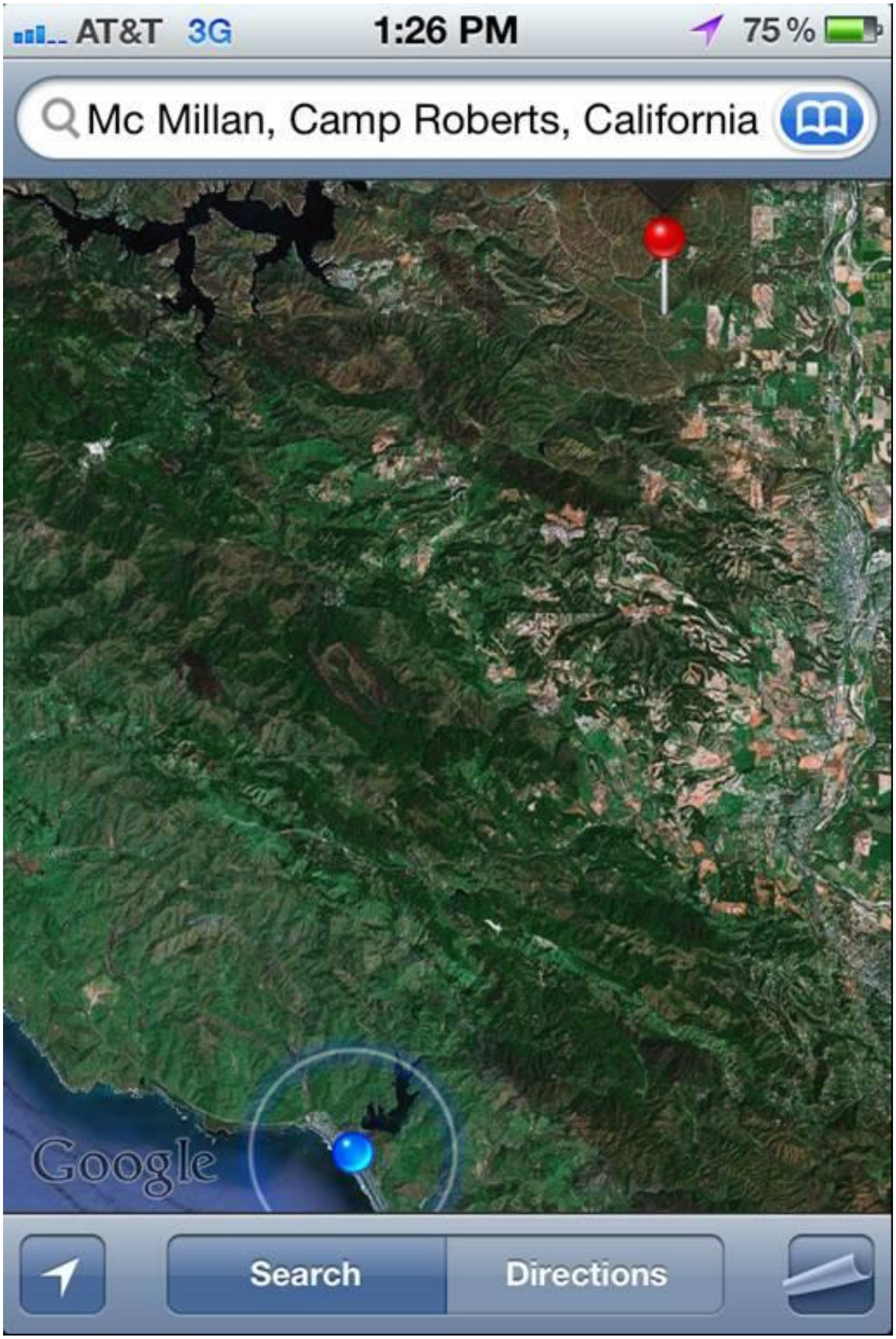
- There was concern after this test that the high jamming power might have damaged the TCCR that then caused other observed anomalies.

- After-hours repair of the power cable was accomplished

- Additional issues on Day 2 were experienced with the UAV C2 link. It was discovered that the initial frequency assignment (Channel #35 = 1780 MHz) appeared to have a very weak link. Upon being told by the Air Boss, that there were several other RF users in close RF proximity, Aerovironment (AV) requested another frequency assignment, and was given several other channels to try in sequence, which all experienced similar weak link characteristics. Eventually it was found that Channel #25 seemed to be working. Three successful flights were made on Day 2 without further incident.

- The following day, it was discovered that on Day 2, the “Spoofing Exercise” team had recorded voice communications between the Base Station and the Mobile radio teams that had gone thru the Relay, and then periodically re-broadcast these same messages on our Comm-Relay frequencies, which at times caused considerable confusion, as each party thought they were receiving a clear message from the other. This continued to be an issue during Day 2, still unknown to us until later in the day. The “Spoofing Exercise” did claim that they also had the ability to block GPS signals in the area at will.

Day 3 (15 August) Puma flight Test and Results:



TCCR Relay extension of handheld radio communications from Camp Roberts to coastal area

- During day #3; 4 flights were made.

- Demonstration activity, for the most part, was consumed by intermittent links and troubleshooting. A substantial log was kept of this.

- Puma flight #4; the power cable had been upgraded / repaired overnight. Weak link issues continued during this flight. Additionally, issues with the UAV C2 link were experienced.

- Puma flight #5; Flew with relay off,; still experienced issues with C2 link

- Puma flight #6; Flew with the TCCR, still some issues on the range.

- Puma flight #7; The TCCR payload was requested to participate in the DHS Ad-Hoc Experiment, and therefore the Civilian Band TCCR-V3 payload was replaced with an older Military band TCCR-V2 unit. To assure best opportunity for success, the previous version of the TCCR was flown that had demonstrated outstanding range and deep crevice link capability a number of times at Camp Roberts. We linked this system through the Lockheed Martin comms systems at the site to provide frequency compatibly with the first responder radio frequencies. Quite a significant number of participants were able to use the link in the “caravan” groups roaming Camp Roberts.

- The launch time was delayed by approx 1 hour due to Exercise coordination effort, but once requested, the TCCR was airborne and appeared to function flawlessly, as usual. One additional constraint of this Experiment was that the UAS could only operate at 400 ft AGL (to mimic the intended Civilian usage scenario). During the flight an additional request was made to re-position the UAS closer to the area of the exercise, somewhere towards the middle of the Base, which we did.

- However, in the post-flight de-briefing it appeared that the voice communication from Hand-Held radios used by the two separate teams was only partially successful, in that some messages appeared to get through while others apparently did not. There was no way for us to monitor this message traffic during the event, so it is not known whether or not the patch-through failed at times; or whether the range and terrain blocked the signal; or whether the Spoofing Team were trying to corrupt the communications at times. However, as the clarity, range, and general QOS level was not that which was experienced with exactly the same equipment previously at Camp Roberts, and at 5 other military base locations, it was determined that there were local issues; likely as a result of the "Spoofing Exercise" equipment operations at 48 watts at, or near, the Relay and the UAV C2 frequencies.

TCCR as integrated with Puma

TCCR as configured for Civilian Authority Bands

Experiment # A-07

Deployable Interoperable Infrastructure

Lockheed Martin Corporation

Principal Investigator/Lead: Russell Chan, Lockheed Martin

Working Hypothesis:

If disparate wireless technologies are able to effectively communicate and interoperate, then better situational awareness and information sharing may be achieved.

Objective:

Demonstrate situational awareness and information sharing with voice and video through an interoperable network with heterogeneous wireless technologies (tactical radios, Land Mobile Radios, 2G and 3G cellular).

Overview/Background:

Lockheed Martin's concept demonstrates capabilities that enable collaboration and communications to people and organizations connected to an Internet Protocol (IP) based communications network. The devices used for data/voice are GPS enabled smartphones, tablets and laptops. The architecture also includes pan, tilt, zoom camera and video encoding technologies (hardware and software) to enable video transmission across bandwidths as low as 9 kbps. The key components of the architecture are; a) pan, tilt, zoom (PTZ) camera b) IP communications network c) video encoder d) GPS enabled devices. The IP-based communications network is based upon Lockheed Martin's Universal Communications Platform (UCP). The UCP is the second generation of a currently deployed system called RIPRnet (Radio over Internet Protocol Network). RIPRnet is in use by USCENTCOM/USCENTAF/MNFI for Convoy C2 and tactical (SINCGARS) LMR networks in Iraq and Kuwait. RIPRnet is DISA approved/JITICS verified. The UCP system can provide interoperable communications between Thales, Motorola, Harris, EF Johnson, P25 LMR trunk systems, 2G GSM/3G/4G cellular, tactical and SATCOM radio systems. The system converts all communication Input/Output (I/O) to IP format. The UCP system can support NSA Type 1 secure communication with the proper encryption hardware; OTAR (Over-the-Air-Rekeying); OTA (Over-the-Air-Programming). The UCP and smartphones/laptops can support NSA Suite B certified algorithms on smartphones and laptops to provide secure communications between the devices in the field and the data servers attached to the UCP at the operations center. The architecture is a demonstration of interoperability of various wireless technologies (tactical radios, 2G GSM, 3G) to communicate, collaborate, disseminate timely and relevant information to end users (first responders, commanders, officials at city, state and federal levels).

Experiment Description:

The experiment is a series of demonstrations based upon creating an interoperable IP based network to allow voice/data connectivity between heterogeneous radio networks. The vehicle mounted camera will allow the collection of still images and video clips in addition to streaming video to mobile devices. An observer working on a laptop will create user defined video clips of streaming. Both the images and video datasets are ingested into a database. User's with GPS enabled devices (smartphone/tablet/laptop) will be able to query the database to discover images and video related to their specific geospatial position and a temporal parameter. For example, any data within 1 mile of my location and within the last 24 hours would be the query criteria. The results would be displayed on the user's device as unique icons representing images or videos. There will be two visualization modes; 1) 2D Google map; 2) augmented reality. Upon selection of the icon, the actual image or video would be displayed. Streaming video across low bandwidth communication links to smartphones and laptops will be demonstrated across the network and also point-to-point with tactical radios. A high resolution image extraction capability from the real-time video stream will be demonstrated. As part of the disaster scenario, we would propose to stress the communications network by inviting as many participants with their own radio systems to integrate with our hardware to create a seamless interoperable network. This integration would represent a real world scenario of military, first responders, federal, state, and local personnel arriving on scene and establishing an interoperable communications network with heterogeneous radio devices.

Measurements/Data Collection Plan:

Data collection will begin after the communication networks are established to allow the vehicle with the camera to be driven along various roads to collect geospatial and temporal datasets. Coverage areas for the various wireless technologies will also be noted.

Measures of Performance/Measures of Effectiveness:

1. Data discovery of previously unknown image and video content by a user based upon geospatial and temporal queries in two different user visualizations.
    a. 2D maps
    b. Augmented reality
2. Streaming video over low bandwidth communication networks
3. Extraction of high resolution image from video stream
4. Seamless communications between different wireless technologies
5. Value of video and voice coverage of an area of interest
6. Ability to integrate other radios into an interoperable communications network

What new capability (or improvement to existing capability) does this represent?

Interoperable IP based communications with various wireless technologies (LMR, 2G/3G, tactical radios), remote control of wireless technologies, low bandwidth streaming video, data discovery

Quantitative Results:

We successfully demonstrated a seamless interoperable voice/data network with PRC-148 radios, Thales Liberty Multi-band radios, commercial cellular, private cellular and SATCOM communication networks.

Qualitative Results:

We provided transparent voice/data communications to participants using their own communications devices. This is a real world situation where military, NGO, federal, state and local personnel respond to either a military or disaster area. The ability to provide seamless, transparent communications across all communications networks is vital to the success of any operation (military or disaster).

Collaboration / Ad Hoc Experiments:

Small UAV Deployable Communications Relay (A-06) – Boeing. Lockheed Martin successfully integrated the communications relay's RF into our communications network and passed voice communications to other first responder and commercial cellular networks. This allowed all participants to communicate with their own communications gear operating on different frequencies.

Lightweight Low Energy Antenna Form (A-01) – ChamTech. Lockheed Martin provided private cellular network connectivity to ChamTech to allow battery drain testing of cell phones utilizing the spray-on antenna technology from ChamTech. The testing confirmed extended battery life with the antenna technology.

Portable Terminal with Exede Ka-Band Satellite Service – ViaSat. Lockheed Martin was able to integrate and use the ViaSat small terminal as our backhaul communications to the open Internet for the duration of the JIFX/RELIEF event. This small SATCOM package provided enhanced bandwidth to our network. This is an extremely small package for the bandwidth capacity. We may look at replacing our existing SATCOM with the ViaSat product due to reduction in size and increased performance.

DHS Ad Hoc Experiment. Lockheed Martin provided the seamless interoperable communications network between PRC-148, Thales Liberty Multi-Band radios and commercial cellular. We successfully demonstrated this interoperability at McMillan airfield. We patched the Fire Chief's personal cell phone into the network. The Fire Chief was able to communicate (utilizing his personal cell phone) with the first responder's in the field. The first responders were using Thales Liberty radios. Our capability demonstrated the seamless integration of multiple radios systems operating on different frequencies and the ability to allow seamless voice communications across heterogeneous radio systems.

Observations & Comments:

This is a unique event where collaboration and experimentation is encouraged between the diverse set of participants (both large and small companies). The focus is exploration of future capabilities in a non-competitive environment. We are privileged to participate in these events and look forward to future events.

Experiment # A-08

CANCELLED

Deployable Airborne Cellular

Lockheed Martin Corporation

Principal Investigator/Lead: Russell Chan, Lockheed Martin

Working Hypothesis:

If interoperable IP based communications can leverage a small aerial platform, then greater C4 may be achieved in tactical situations through an increased range of connectivity.

Interoperable IP based communications with various wireless technologies (LMR, 2G/3G, tactical radios), remote control of wireless technologies.

Objective:

Demonstrate voice and text communications over a 2G GSM cellular network from a small unmanned aircraft system. This will create a roaming cellular coverage area.
For the instances where the roaming coverage area overlaps with an existing fixed site with interoperable communications networks, the voice and text from the airborne 2G GSM can be routed to other networks.

Overview/Background:

Lockheed Martin's concept demonstrates a capability to establish a 2G GSM cellular area of coverage from a small man portable airborne platform. The airborne platform will be the Lockheed Martin Stalker UAS with a 2G GSM cellular payload. The IP-based communications network is based upon Lockheed Martin's Universal Communications

Platform (UCP). The UCP is the second generation of a currently deployed system called RIPRnet (Radio over Internet Protocol Network). RIPRnet is in use by USCENTCOM/USCENTAF/MNFI for Convoy C2 and tactical (SINCGARS) LMR networks in Iraq and Kuwait. RIPRnet is DISA approved/JITICS verified. The UCP system can provide interoperable communications between Thales, Motorola, Harris, EF Johnson, P25 LMR trunk systems, 2G GSM/3G/4G cellular, tactical and SATCOM radio systems. The system converts all communication Input/Output (I/O) to IP format. The UCP system can support NSA Type 1 secure communication with the proper encryption hardware; OTAR (Over-the-Air-Rekeying); OTA (Over-the-Air-Programming).

Experiment Description:

The experiment is a series of demonstrations to determine range and coverage at various UAS altitudes for both voice and text messages. For other experiments with dependence upon voice reports or text messages from the field, we can provide this data via the Universal Communications Platform's interoperable IP network. For the disaster scenario, these capabilities can provide voice/text communications and situational awareness.

Measurements/Data Collection Plan:

Data collection will begin after the UAS reaches the desired altitudes. Range and coverage area will be noted.

Measures of Performance/Measures of Effectiveness:

1. Value of voice and text coverage for a disadvantaged area of interest
2. Ability to integrate the deployable airborne communications into an interoperable communications network

Experiment # A-09

Range Networks

Range Networks Inc.

Principal Investigator/Lead: Jeff Stern, Range Networks Inc.

Working Hypothesis:

If robotic systems can be controlled over private and commercial cellular networks, process and store information on-board, and run on very low power, then an increase in dependability and range of communication is achievable.

Objective:

Demonstration that shows existing military robots from QinetiQ North America can be successfully adapted to operate from a far-stand off position using commercial cellular radio technology and commercial Android based tablet computers as well as legacy laptops.

Overview/Background:

Range Networks provides a complete GSM standards based cellular network in a single box. The box includes all radio, call processing, RAN Core, authentication and call processing elements to operate as a stand alone cell system and process local calls/data sessions, or to integrate into a larger network with handoff of communications between base stations.

U.S. military units have deployed these base stations. QinetiQ North America's Dragon Runner DR-20 robot is a very robust and dependable robot, which has been successfully deployed mainly by in EOD operations by United States armed forces.

DR-20 Robots which have been deployed in the past, have computation that are typically on PCs using proprietary software. They have communications packages that make use of WiFi (802.11) and military radios.

The DR-20, which will be demonstrated has a radically new approach to computation and communications for military robots. It's on-board computation capability has been enhanced by using a 1 GHz ARM processor which is integrated with a cellular communications package that supports the Universal Mobile Telecommunications System (UMTS), a standard 3G protocol based upon the GSM standard. The cellular communications package also supports the General Packet Radio System (GPRS), which is a 2.5G data communications radio standard based also upon the GSM standard.

The DR-20 makes use of its ARM processor to run the open source Robot Operating System (ROS) running directly on the DR-20, and communicates sensor and navigational data over the cellular system using the mobile cell system in a box from Range Networks. It can also perform the same functions over available commercial cellular networks and WiFi. However with WiFi operating communications distance is very limited, as it is with onboard military radios. With public networks, operating characteristics may be affected by issues of contention for network resources. However, using a private cellular network, as can be deployed with the Range Networks system, issues of radio resource contention are eliminated and security is enhanced, as system authentication is controlled by the operating unit.

The use of processors such as the ARM processor with is used widely in the commercial cellular market to support interfaces to a wide variety of sensors on smart phones, provides the opportunity to quickly and cost effectively integrate those sensors onto the robot platforms and the robot control terminals. These sensors include cameras, accelerometers, GPS radios and magnetometers.

The use of ROS supports rapid integration of a variety of specific robot motion capabilities, semi-autonomy and additional robot specific sensors such as light detection and ranging systems (LIDAR). The use of standard cellular capable user terminals such as the Android Pad allows high speed and easy communications between the robot and the controller using either commercial cellular, private cellular of WiFi radios. Sensor and control information is exchanged between the Robot and the Android Pad using ROS Java, running on the Pad.

Experiment Description:

The experiment consists of execution of 3 missions:

Mission 1: Airfield Reconnaissance

The purpose of this experiment is to demonstrate that a robot can be used effectively to do an airfield survey and locate debris and other undesirable objects that could impede safe and successful aircraft and human operations on the airfield and on its near perimeter.

The robot will deploy to McMillan Airfield. It will be controlled from a far-stand off position of approximately 1 Km distance or a simulated far-stand off position from inside a simulated TOC. It will collect LIDAR, photo and video data, store data and transmit exceptions to its controller. Positions of exceptions or threat objects will be marked. The robot will autonomously return to the controller over traveled distance and will be refitted with a robotic arm to remove threat or exceptional objects from the airfield. The robot will redeploy from a far-stand off position and remove the threat/exceptional objects from the airfield, thus clearing it for air operations. These operations can be repeated during nighttime.

Mission 2: Building Survey

The robot will deploy to a building and be controlled from a far standoff position of about 1 Km. It will survey the contents of the building creating a position map of walls and objects in the building using a nodding LIDAR. It will photograph objects of interest in the building and communicate the photos and LIDAR imagery to operators who are in a far standoff position.

Mission 3: Mobile ISR

The robot will deploy to an area where it will not be seen easily and will be left unattended. It will take photos, video and sound recordings of any persons or vehicle that moves within its field of vision and transmit those back to controllers within a TOC. The robot will then redeploy under the control of operators at the TOC and move to a new location with handoff of control signals to second cellular base station during redeployment. At the new location the robot will repeat the audio, video and photographic capture of information. The robot will then return to a designated rendezvous point for retrieval.

Measurements/Data Collection Plan:

Mission 1: Airfield Reconnaissance

Ability to sense arbitrary objects on the airfield and transmit their exact location and nature to operators; Distance of operators from area of operation; Latency of transmission; data speed; ability to control robot, its sensors and its arm from a 1 Km distance; decay in control as distance from the base station increases; ability of base station to deny access to unauthorized users and grant access to communications resources to authorized users only (binary). Ability of operator to take control decisions on video and LIDAR data transmitted over cellular to Android Pad.

Mission 2: Building Survey

Ability to create a map of the interior of the building and transmit that map over a 1 Km through the cellular data connection. Ability to compare building map data to existing LIDAR database information and recognize known building plans. Ability to control robot in building from a distance of 1 Km (or more if using multiples cellular base stations). Ability of operator to take control decisions on video and LIDAR data transmitted over cellular to Android Pad.

Mission 3: Mobile ISR

Ability to deploy robot to a remote location while under the control of operator using Android Pad from a distance of 1 Km. Ability to automatic collection of ISR data over the private cellular network in real time or near real time from the deployed robot. Ability to use the private cellular network to redeploy the robot to a new observation location that is not within range of the first cellular base station that the Robot used for communications at the first location, and continue to conduct ISR operations. Ability of robot to exceed communications distance and return data after returning to within range of the cellular base station.

Measures of Performance/Measures of Effectiveness:

Mission 1*:* % of foreign objects of the airfield observed; accuracy in distance of where foreign objects are marked for later recovery; distance from airfield that robot can communicate to operators; data rate of communication from robot; % of unauthorized users whose service requests from base station are denied.

Mission 2: LIDAR map creation and transmission to a far distance over cellular. Transmission time, throughput (bps) latency (sec.); comparison of transmitted data to stored data in cloud.

Mission 3: Distance from which robot can be guided to remote location (m); accuracy of putting robot into target position (m); distance robot can be moved from position 1 to position 2 (m); successful cellular handoff of control between adjacent bas stations (% of success based on number of attempts).

What new capability (or improvement to existing capability) does this represent?

Ability of robot to make use of the exclusive resources of a private cellular network, while the network denies access to other radios in the area that request access and use of mobile radio resources.

Ability to control a military robot using an Android Pad over a commercial cellular network technology.

Ability to operate the robot from distances that far exceed current operational capabilities. This has the potential to reduce the threat of OPFOR to robot operators and reduce the force protection requirement for robot operators.

Ability of robot to do significantly more on-board processing and storage of information than was previously possible using very low power consumption smartphone processors, thus increasing the mission time on task for the robot battery.

Ability to make use of open source software to inherit new functions, capabilities and sensors on a military robot.

Ability to move a military robot through a wide area of operation using cellular hand off to increase area of effective operation of the robot from far stand-off.

Experiment # A-10

CANCELLED

Managing Large Scale Wifi Deployments in Disaster Zones

Haiti Connect/ Disaster Tech Labs

Principal Investigator/Lead: Evert Bopp, Haiti Connect

Working Hypothesis:

If software can manage bandwidth distribution in major disaster zones that experience a large diversity of users, then bandwidth shortages to critical applications can be enjoyed.

Objective:

The objective of our experiment is to establish how well BYOD device on-boarding management will work when used for a wifi network deployed in a (outdoor) disaster area. We want to test how seamless and user-friendly the authentication process is, how well the pre-configured users profiles, device permissions & application permissions work.

Additionally we will test two different types of centralized network management applications allowing management of both devices and users on the network.
The ultimate aim is to see which software and hardware will be best suited for future use by our rapid response team.

Overview/Background:

Currently WiFi networks deployed in disaster zones are either unsecured (open-for-all) or have a default access code (WPA-PSK type or similar). This does not allow for real user, device or application management. You either allow access to everyone without any real control or you allow access to a limited group of users but also without any further control. This means that network assets (data) is at risk, that the often limited amount of bandwidth cannot be managed etc. As bandwidth is a scarce commodity in disaster response scenarios the latter is extremely important. You want to avoid one user who might be trying to pull down large amounts of data (streaming video) to use up the majority of bandwidth while other more critical applications are left without sufficient bandwidth. The software that we will be testing allows all this to be managed in great detail and in real time from a central location. Network admin people do not need to configure every device individually (an impossible task in such circumstances) but can preset these three levels of permissions from their NOC. This will them allow the wide influx of users with an unknown variety and type of devices to connect to the network and authenticate using a user friendly web based process.

Haiti Connect was formed in response to the Haitian earthquake of 2010. Our initial goal was to use long & short range wifi links to build a communications network that could be used by NGO's & other disaster response organizations working in Haiti. This work has evolved and for the last two years we have been building wifi networks & computer networks across Haiti providing connectivity for hospitals, schools, clinics, orphanages and similar organizations. We have recently expanded our scope by forming a rapid response team which will be on call to deploy WiFi networks in disaster areas across the globe to provide a communications infra-structure in support of other disaster response organizations.

We have selected several types of hardware and software solutions to rapidly build out such a network and to enable us to manage it centrally. This architecture allows the greatest number of users to use the network while at the same time still enabling secure network & resource management.

Experiment Description:

We will deploy a number of WiFi mesh access points outdoors in order to build a network providing wifi coverage across a set area (simulating a disaster zone). This network will be managed from a central location. The network management software will be used to preset usage permissions based on type of user, device & application. The software will allow a user to connect to the network with any device and authenticate autonomously using a pre-provided user type. Once he/she does that the network management software will provide access to network resources and bandwidth based on pre-set permissions.

We intend to build the network, distribute generic user-type log-in credentials to testers (our own & other participants) and allow them to connect to the network and access network resources (server data) and bandwidth. We will measure ease-of-use (for both the user & the network admin), throughput and stability.

Our hypothesis is that this type of network access will allow a quick deployment of such a network in a disaster zone and will allow a wide range of users from an unknown number of organizations to use the network resources with prior unknown devices while still maintaining network security & stability.

Measurements/Data Collection Plan:

Once the network has been build we intend to test and measure three aspects;

1) The stability and ease of use of the actual network hardware
2) The ease of use form a user perspective; will the network accept a wide range of "unknown" devices, will it assign the correct permissions and will the user be able to perform his or her required tasks (email, video conferencing, VoIP calls, access data on remote servers etc.)
3) Will the management software perform as required. Will be assigned correctly, will devices show up as clients on the management interface, can access and permissions for devices be adjusted in real time etc.

Clients/users and Network Admin personnel will have run a number of scripted tests and will have to complete an evaluation form to report their experiences. Simultaneously we will use software tools to measure network performance (throughput, latency etc) and will digitally record the performance of the management software.

Measures of Performance/Measures of Effectiveness:

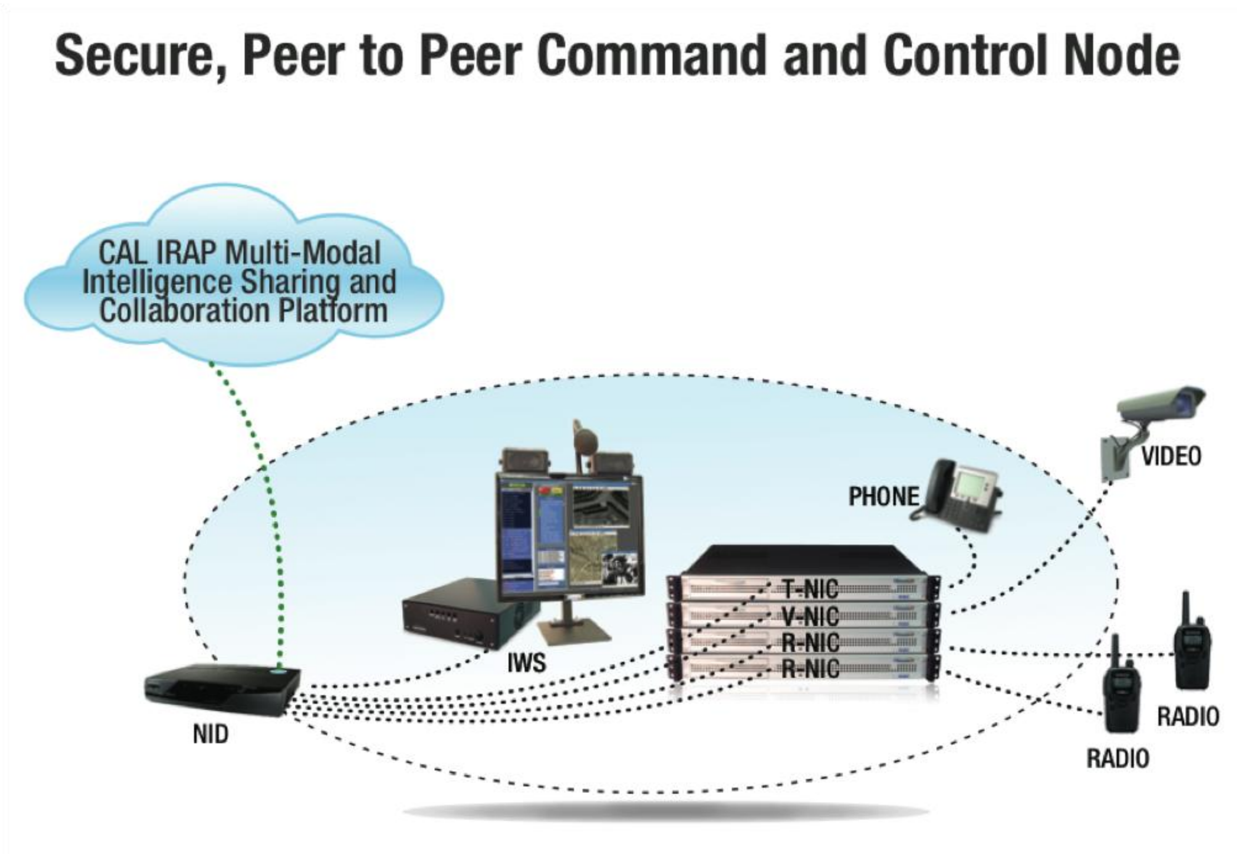
The network & software will need to meet the following standards in order to be successful:

1) Clients will need to be able to send & receive email, browse web-pages and make a Skype call.
2) Users will need to be able to roam while staying connected to the network.
3) The network management software will need to assign the preset permissions based on user type, device and application.
4) The network management software will need to allow network admin staff to manage it from a central location and to monitor and manage usage in real time.

Experiment # A-11

Mutualink

Mutualink



Principal Investigator/Lead: Steve Scott, Mutualink

Working Hypothesis:

If all forms of communications (radio, video, telephony, text, file sharing, etc.) can become collaborated within a network of multiple people and groups, then a response team can more efficiently search and rescue within disaster zones.

Objective:

Demonstrate the capability for enhanced situational awareness, forward actionable intelligence, force multiplier and collaboration across all forms of communications (radio, video, telephony, text messaging, file sharing) with a larger group of RELIEF participants that will be engaged in the Earthquake Scenario.

Explore methods for improving HADR and DOD DSCA operations with Civil Agencies and Private Sector Participants through enhanced communications capabilities and formation of a common operating perspective across and between all participating members, including Naval Post Graduate School (NPS) Camp Roberts EOC, Camp Roberts TOC, Camp Roberts FOB, Monterey County Office of Emergency Services, City of Monterey, Cal Fire, Salinas Fire Department, California State Parks, Cal EMA/Sacramento, California National Guard, FEMA DOD, SDSU Visualization Center, NOAA, Red Cross San Diego Chapter and other CAL IRAP Participants from Northern California of which NPS is a member of (Please see Network Diagram for CAL IRAP participant list). In-country public safety, hospitals, universities and Schools, property management and hotels, NGO's, and critical infrastructure suppliers “could/will” be added as needed to support the requirements of the exercise.

Explore experimentation opportunities for:

1. Meet other exercise participants to explore and experiment the ability to gather and share sensor, map and location, seismic, medical reports, hospital locations, food and shelter, available resources and building diagrams to support stakeholders involved in the earthquake exercise. Provision and implement at least two command points at Camp Roberts in at least one of three locations, the TOC, the FOB, Camp Roberts Fire Team's EMS Center. Command point with radio and video is currently deployed at NPS in Monterey, CA on-campus. Discuss larger COI as indicated in item #2.
2. Discuss plans for tying in Monterey County Office of Emergency Services, City of Monterey, Cal Fire, Salinas Fire Department, California State Parks, Cal

EMA/Sacramento, California National Guard, FEMA DOD, SDSU Visualization Center, NOAA, Red Cross San Diego Chapter via a combination of IWS Command Points, Conference Bridges and two way radio utilizing Secure VPN IPSEC Extranet.

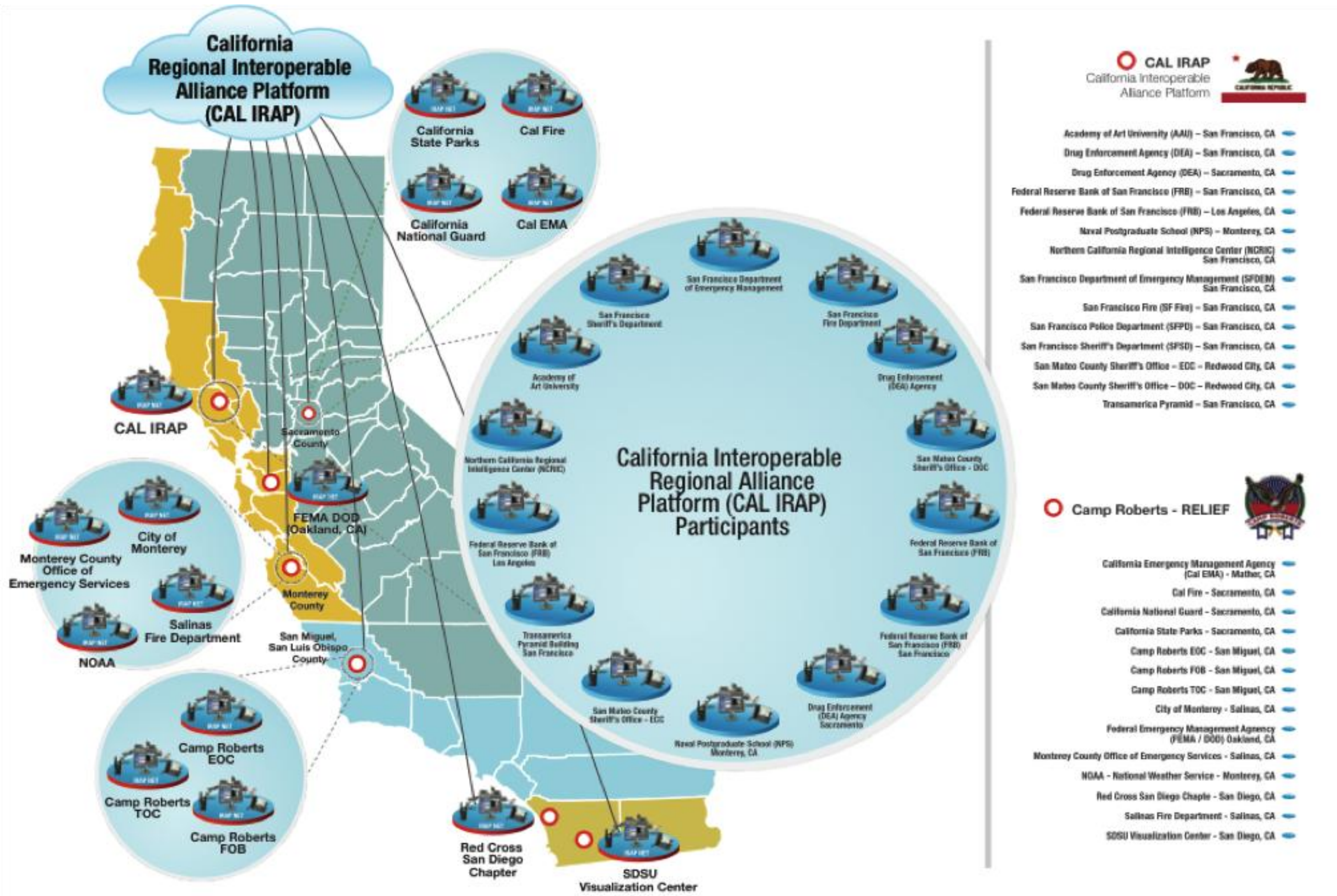
3. Tie into the CAL IRAP community of interest as needed or desired to support operations and display the possibilities for enhanced situational awareness, common operating perspective and force multiplier. Possible participants would potentially included NCRIC, SF Fire, SF OEM, San Mateo OEM, and Transamerica Pyramid. (Please see Network Diagram for CAL IRAP participant list.)
4. Explore and demonstrate the ability to "gather and share data" including but not limited to real time live and near real time imagery via satellite, light aircraft and UAV's.
5. Explore the ability to tie in imagery/ video from other Relief Participants and share across larger Community Of Interest to improve Situational Awareness for more efficient response and recovery activities.
6. Explore scope of work for extending Community of Interest to Rapidly Deployed GSM Infrastructure for multiple tiers of integration. Develop list of options and priorities.
7. Explore scope of work for plotting IWS Community of Interest in GIS framework through recently launched API.
8. Explore and discuss best methods for extracting data and other useful information from Social Media for distribution across wider audience.
9. Exercise capabilities of Multi-Mode, Multi-State, Multi-National Federated Platform.
10. Examine issues of Chain of Command/Incident Command and how to make good decisions in a tense environment.
11. Discuss areas of InterRegionalism, to include "practical yet revolutionary" Inter-operability tools and more importantly >>> Inter-Capabilities using your existing investments in people, plans and communication resources.

12. Look into and discuss how to form better, more resilient Public/Private Partnership and Enhanced Cooperation
13. Share "Lessons Learned" - Live

CAL IRAP Eligible Participants: Public Safety, Private Sector, Military, UASI's, Fusion Centers, EOCs, Homeland Security/Homeland Defense/CIKR, Public Safety, Fire and EMS, Airports, Sea Ports and Maritime Security, Schools and Universities and Sports Arenas

CAL IRAP Participating Agencies A-Z:

Academy of Art University (AAU) – San Francisco, CA
Drug Enforcement Agency (DEA) – San Francisco, CA
Drug Enforcement Agency (DEA) – Sacramento, CA
Federal Reserve Bank of San Francisco (FRB) – San Francisco, CA
Federal Reserve Bank of San Francisco (FRB) – Los Angeles, CA
Naval Postgraduate School (NPS) – Monterey, CA
Northern California Regional Intelligence Center (NCRIC) – San Francisco, CA
San Francisco Department of Emergency Management (SFDEM) – San Francisco, CA
San Francisco Fire (SF Fire) – San Francisco, CA
San Francisco Police Department (SFPD) – San Francisco, CA
San Francisco Sheriff's Department (SFSD) – San Francisco, CA
San Mateo County Sheriff's Office – ECC – Redwood City, CA
San Mateo County Sheriff's Office – DOC – Redwood City, CA
Transamerica Pyramid – San Francisco, CA



Overview/Background:

Functional Overview

The Mutualink Platform overcomes the major hurdles to implementing a pervasive interoperable communications capability, because (i) it is cost effective by utilizing existing communications assets, (ii) it utilizes standard IP based internet networking infrastructure, eliminating additional network costs, (iii) it is scalable and modular allowing parties to join as and when funding permits rather than requiring a monolithic build-out, (iv) participants retain sovereign control over their communications systems because controlling intelligence is distributed to the edge and no central server or administrative control point exists, (v) it is very easy to use, meaning a broader spectrum of participants can use it, and (vi) it is a “bridging” technology that can handle both legacy and new radio protocols allowing an effective pathway to next generation radio systems which various jurisdictions may pursue in the future. The solution consists of intelligent end-point devices that can interface with existing communications and multimedia systems, such as radio systems, telephone systems, mobile phones, video distribution systems and public announcement systems. Once connected into the Network via a broadband internet connection, these assets can then communicate, as well as share video and other data, in real time with other network participants who have been invited into the same secure incident session. Participation in the incident session is controlled solely by each participant through an interoperable work station which allows for communications with invited participants and for the participant to dynamically add or remove various communications assets to or from an incident as the circumstance dictates and the communications asset owner desires.

Other members on the network can be seen and can be requested to join an incident at any time by sending an invitation. This provides a dynamic ad hoc capability that allows the right parties to be joined as the circumstances of an operation or emergency require. Only participants who are in a secure incident session can hear or monitor communications. All other members on the network do not know an incident is occurring until they are invited to join. This same environment provides a standing capability for any number of agencies to collaborate, plan and share intelligence on the fly, and provides a pre-operational briefing and post-operational after action report forum. Finally, the platform can be used to rapidly and easily engage in various exercises and mission training scenarios in a more cost effective manner.

System Components:

The fundamental components of the Mutualink system consist of:

1. ***Interoperable Workstations (IWS)***,
2. ***Network interface Controllers (NICs), and***
3. ***Network Management Service and Key Distribution Service (NMS/KDS).***

Each IWS and/or NIC (an "end-point") is network enabled, meaning that they may communicate, control or be controlled by other end-points via the peer virtual network. The virtual peer based network is a virtual network constructed over the internet or private wide area network using secure VPNs and multicasting technology. Below is a basic diagram which shows the relationships between various end-point types. The basic principle is that an IWS controls NICs. NICs interface with existing communications resources. Through an IWS, NICs can be brought into a communications session with other NICs controlled by other IWSs.

IWS. The IWS is a dedicated workstation or laptop operating a secure Linux variant known as CentOs. The IWS is a dispatch station that controls various communications resources that are connected to the IWS endpoint via the NICs which the IWS controls. The IWS employs a computer screen and computer peripheral devices, including a mouse, speakers and microphone, through which a user can communicate with other IWSs in the interoperable network as well as endpoint communication devices such as two-way radios. The IWS enables a user to initiate an interoperable communication session and invite other participants into the session, and allows a user to accept or reject an incident session invite. Using drag and drop functionality, an IWS user can bring communication devices into the interoperable communications session enabling those device users to talk with the IWS dispatch user as well as other IWS dispatch users and other communications devices that are participating in the communications session.

NICs. Network Interface Controllers are devices that enable various communication devices, such as radios, telephones and video feeds, to be connected into the interoperable network and enable communications and data to be transmitted between the device and its parent IWS and other interoperable network IWS and devices. NICs are IP gateway devices that interface with, decode and code, communications inputs and outputs into an IP based protocol. Mutualink's NICs include the following:

- RNIC (Radio NIC) - The RNIC interfaces with diverse types of land mobile radio devices.
- VNIC (Video NIC) - The VNIC interfaces with diverse types of multimedia video formats.
- TNIC (Telephone NIC) - The TNIC interfaces with digital and analog telephone systems.
- INIC (Intercom NIC) - The INIC interfaces with public announcement and intercom systems.

NID. The Network Interface Device is a dedicated and configured router which handles IP Multicast. A NID is installed at the user's premises and interfaces with one or IWS within the same network space and/or NICs. The NID is owned by Mutualink. Network participants are linked together via private network connections. Mutualink employs AES 256 encryption for secure communications.

NMS/KDS. Network Management Services and Key Distribution Services are over overlay services which are administered via secure administration servers maintained by Mutualink (or other administrative party) and to which the IWS and NICs can communicate.

The NMS provides three primary functions. They are:

1. updating network directory information to distributed end-devices,
2. delivering software updates, and
3. network quality and monitoring services. Communications functions are not dependent upon the availability of the NMS or KDS services for any existing or previously authenticated devices.

Experiment Description:

Peer to peer router will be provisioned for operation at Camp Roberts and other interested participating agencies. Upon completion of router installation, the IWS Command Point, RNIC, VNIC and TNIC will use the router as a default gateway and be attached the CAL IRAP network and be able to collaboration with stakeholders in the Counties of San Francisco, San Mateo, Seattle and Boston. This effort should take less then one (1) hour and is start forward. The RNIC will be interfaced to a radio control station for immediate use. The TNIC requires a typical analog POTS line (Fax). As soon as the telephone line is attached to the TNIC, any permitted telephone number can be dialed and introduced into a session. The VNIC requires a composite cable to be connected between the output of the Video Distribution System (VDS) and the input of the VNIC. Upon completion, video stream can be introduced, shared and removed in real time.

What new capability (or improvement to existing capability) does this represent?

Any radio, video or telephony system can be placed on any agency, entity or country's properly provisioned IP network with that agency, entity or country retaining and maintaining control over their radio video and telephony systems. When a session is formed with other network participants, alignment between planners, operators and mobile field teams can take place in real time for any time duration. During the session, video from one entity can be shared with the other and mobile field teams can hear all traffic. Exercise will be an opportunity to evaluate ability to evaluate platform API to share a whole spectrum of live, near real time data, imagery, maps and reports across platform's inherent secure VPN IPSEC extranet.

Qualitative Results (please be as descriptive and detailed as possible):

1. Cenetix / MIO experimentation discussions initially began at February 2012's RELIEF session with Dr. Alex Bordetsky, NPS, Ph.D. Associate Professor, IS Director Director, Center for Network Innovation and Experimentation, P.I. for TNT and MIO Experiments. Those discussion evolved and continued on a

regular basis following RELIEF. In May 2012, a permanent secure enclave was implemented at NPS in the Labs of Dr. Bordetsky. The Secure Enclave included one IWS Command and Control Point, one VNIC and one RNIC and immediately connected NPS to a larger national community of interest including public and private partners from San Francisco, CA to Boston, MA and beyond (see photos below). Initial key drivers for the implementation include, the sharing of radiation data and other live streaming imagery from the San Francisco Bay Area with CAL IRAP participants in the Bay Area, participation in Joint User Interoperability Communications Exercise (JUICE), where radiation data was shared between NPS installation in Souda Bay, Greece and Monterey, CA and with the Army's CHEMBIO unit at Aberdeen Proving Ground, MD with culmination of MIO Integration efforts tying in USSOCOM partners. Deeper discussion took place with Dr. Bordetsky and Eugene Borokov during this past August 2012 RELIEF Exercises to determine next steps, scope of work and priority list for initial co-development and integration efforts. Initial priorities are slated for implementation before the end of October 2012 and will grow from there. As detailed efforts are documented, updates will be provided to NPS RELIEF Team for further discussion and incorporation in RELIEF Exercises.

2. RELIEF Earthquake Exercise: Participation was primarily observation with discussion around supporting future exercises, initiatives and efforts. Initial concept proposed is depicted in illustrations below. Suggestion was to tie in all the RELIEF Exercise Participants for real time communication across command and mobile field deployed teams across all modes of collaboration (Command Point, Radio, Video, Telephony) and form "Reach Back" with larger community of interest. Purpose was for demonstrating the capability to arrive at any location, domestic or foreign >>> "Ground Zero" and tie into available means of Internet Connectivity, form secure IP SEC VPN GRE tunnels with all participants and all available nodes to connect with HADR partners to leverage and mobilize personnel, expertise, resources and supplies for streamlined disaster mitigation and response. Due to the restricted timeline, RELIEF Earthquake Participants could not be tied in ahead of time though the concept resonated with exercise

stakeholders and conference attendees and spawned meaningful discussions that continue.

Collaboration / Ad Hoc Experiments:

Range Networks discussions started in February 2012 RELIEF and continued through August 2012 RELIEF and have culminated in discussion around a tight integration with GSM Wireless Technology to leverage extended service area for live comms, text messaging over 2 and 2.5G and MMS (Video and Files Sharing) when 3G services are implemented.
Virtual Agility discussion started shortly before August 2012 and continued during the RELIEF Exercise around the capability to extract useful artifacts from the Virtual Agility Platform for the purpose of creating and implementing industry standard CAP Alerting routines.

Observations & Comments:

RELIEF under Dr. Buettner leadership and stewardship has been an incredibly rewarding experience. He fosters a great deal of innovation in a shorten time frame in a Team Orientated Framework. The "open access environment", he has nurtured and cultivated, coupled with his approaches, his underlying philosophy and his direct facilitation of networking, personal introductions and positivity makes him one of the most gregarious technocrats I have ever met and plan on staying in touch with. Dr. Bitner and his team know how to attract really bright, capable attendees, participants, stakeholders and fellow academics from all levels of many organizations from across the Country. Good meaningful progress that would not been contemplated are a direct result of RELIEF, the efforts of Dr. Buettner and the team he assembled to support it. Tristan Allen, Vic Therou and Ramsey Meyer were particularly helpful and I appreciate our interaction and supports.

Experiment # A-12

Portable Terminal with Exede Ka-band Satellite Service

ViaSat

Principal Investigator/Lead: Justin Luczyk, ViaSat

Working Hypothesis:

If a portable and high capability terminal is able to be easily assembled by novice users, then satellite and terminal connections with high terminal speeds becomes possible in remote areas.

Objective:

The SurfBeam 2 Pro Portable terminal has been designed as a rapid deploy communications terminal. The small 75cm Ka-band antenna operating on the Exede service is capable of data rates beyond what is typically done on Ku 1.2-2.4 meter dishes. The objective is test the terminals capabilities when employed by DoD forces and recieve feedback on design and performance. For the purposes of this evaluation, ViaSat would like to evaluate novice users ability to set up and employ the terminal after only 20 minutes of training and evaluate the terminal speed (up to 12Mbps Rx / 3Mbps Tx).

Overview/Background:

ViaSat's latest high capacity satellite, ViaSat-1, brings well over 100 Gbps of aggregate capacity to North America, or more than all US Ku satellites combined. This new design facilitates higher data rates from smaller terminals at lower cost. The satellite was initially designed to provide "residential satellite internet", however with the leap in capacity ViaSat is looking at DoD and First Responder applications as well. For the purposes of this evaluation ViaSat intends to provide a SurfBeam 2 Pro Portable or

"Fly-Away" terminal however vehicular mounted and fixed site systems are also available.

ViaSat-1 Satellite Overview:
http://www.viasat.com/broadband-satellite-networks/viasat-1

SurfBeam 2 Pro Portable Data Sheet:
http://www.viasat.com/files/assets/surfbeam2_ProPortable_Datasheet_015_web.pdf

Terminal Setup Video (from Engadget):
http://www.engadget.com/2012/02/13/viasat-surfbeam-2-pro-portable/

Experiment Description:

This experiment will be primarily a demonstration of both the terminal and satellite service. However, ViaSat would like to evaluate "untrained" and "semi-trained" users ability to deploy the terminal.

Beyond the experiment description provided above, ViaSat would also like to offer the terminal for remote internet access if required for remote locations at the NPS facility. For example a terminal located at the airfield could serve as a remote link to the operations center.

Measurements/Data Collection Plan:

Data will be collected on how quickly new users are able to unpack, setup and point the terminal as well as for the terminal data rates by ViaSat personnel. Additionally, other feedback on the system design will be solicited.

Measures of Performance/Measures of Effectiveness:

It is expected a user with 20 minutes of training will be able to set up the terminal in less than 15 minutes. This is the primary performance metric. Additionally the terminal "internet" speed will also be evaluated.

What new capability (or improvement to existing capability) does this represent?

This represents a significant improvement in terms of satellite and terminal speed (faster), size (smaller), and cost (less expensive) than comparable systems. The requirement for the ability to send and receive IP data in real time has grown exponentially over the last few years and this trend is expected to continue. The new Exede service and portable terminal is able to provide users an high speed link from remote locations that can enable C4I.

Quantitative Results:

The ViaSat SurfBeam 2 Pro Portable terminal was quantitatively evaluated based on time to assemble and get satellite / internet access. This assembly and satellite acquisition was conducted 8 times in order to evaluate repeatability.

Maximum Time: 8:32

Minimum Time: 4:41

The testing was able to validate that the system could be repeatedly set up and put into operation from the transit configuration in less than 10 minutes.

SurfBeam 2 Pro Portable

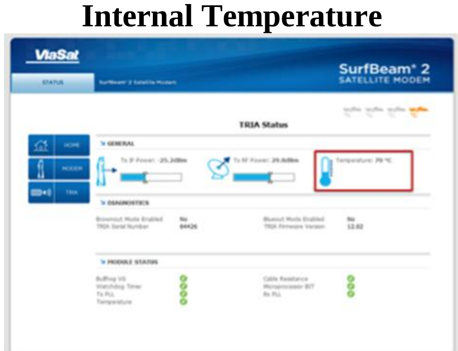
Transit Configuration

Deployed

Additionally the data rate throughput and latency of the ViaSat Exede service was measured using both FTP testing using 30MB and 50MB files, as well as the Web based tool. The expectation is that the typical terminal data rate would be 12 Mbps receive and 3 Mbps transmit, with less than 1 second of latency. The three deployed terminals were tested daily and conformed to these expectations. Throughput of almost 20Mbps receive and 5 Mbps transmit was recorded on several occasions and is depicted below.

Screen Shots of Multiple Speed Tests using the SB2PP

Internal Temperature



The final metric captured was temperature performance. With ground temperatures well over 100 degrees Fahrenheit, and active electronics out in the sun, the team wanted to see how the unit performed. The terminal GUI provided access to internal temperature readings showing that the internal temperature was 70 degrees Celsius or about 160 Fahrenheit, with no performance degradation.

Qualitative Results:

Overall the system performance was in line with expectations. The only terminal outage lasted about 10 minutes and was due to a power failure. In the future operation off of a battery backup would be able to prevent this type of occurrence. For the duration of the event the wind speed remained moderate (15MPH max), so there was no need to use additional ballast on the legs of the portable system, however in stronger wind environments (25 MPH+) additional staking / ballast would be required.

Collaboration / Ad Hoc Experiments:

Prior to execution, ViaSat had coordinated with Range Networks (A-12) and EOC in a Box (A-17) to provide satellite internet backhaul for those experiments. In both cases "integration" only consisted of plugging in the SurfBeam 2 Pro Portable Ethernet Port into the Wide Area Network port of their routing equipment.

Collaboration with Range Networks

For the Range Networks experiment, ViaSat was able to provide backhaul for their local cellular network. This meant that users connected to the Range Networks cellular infrastructure were able to reach back and make calls to any location.

EOC in a Box with SurfBeam 2

EOC in a Box used the service to provide connectivity to the operations center personnel. The system developed as part of this experiment needed the capability to support 20+ users operating on virtual machines. Feedback of network speed was very positive, and the only minor challenge was controlling remote video streams from other locations. To resolve this the satellite terminal's integrated router had to add port forwarding to allow traffic to pass through. Once the ports were set into a forwarding mode, users were able to remotely operate the video appliances originating from EOC in a Box.

Additionally, during the event collaboration took place with Deployable Interoperable Infrastructure (Lockheed Martin A-7). Initially this experiment had been using 1.5Mbps SATCOM internet, but by moving to the Exede service, they were able to increase this to 15Mbps which facilitated increased video resolution and better internet speeds for the duration of the event.

Observations & Comments:

ViaSat was pleased to be selected to participate in JIFX 12-4, and looks forward to continued involvement. In the future, ViaSat would like to be able to provide the SATCOM backhaul to additional locations and experiments in order to test the robustness of the network.

Experiment # A-13

CANCELLED

Tracker-based GEOINT to Enhance Disaster Rescue "Victim Targeting"

The Chaos Collaborative

Principal Investigator/Lead: Robert S. Katz, The Chaos Collaborative

Working Hypothesis:

If disaster response search and rescue teams incorporate real-time tracking data with victim targeting transmissions, then post disaster scenarios will dramatically be improved by the probability of teams locating and rescuing disaster survivors.

Objective:

To improve the value of GEOINT provide to disaster response search and rescue teams by incorporating near real-time tracking data into the creation of the "victim targeting" transmissions sent to the rescuers in theatre.

This enhanced C4ISR capability will be equally valuable in CONUS or OCONUS post-disaster scenarios as it will be to COCOMS undertaking conventional or "stability" operations.

Overview/Background:

Spontaneous requests by search and rescue teams en route to initiate operations in Japan spawned rapidly developed, ad hoc support efforts to provide high-value, analyst-enhanced satellite imagery to the deployed rescuers. This included specific pre-event and post-event analytical products covering large swaths.

The geographic domain that even a large seventy person search and rescue team can reasonable cover and clear in a single day can be extremely small, especially in a dense urban environment with unfavorable weather conditions. Since the survivor viability window is also extremely small, the search areas much therefore be chosen with great care so as to maximize the probability of successes.

Efforts in Japan, and in most disasters, were further compounded by the lack of stable power and reliable communications.

Without knowing exactly from one hour or day to the next where specifically the team was located, efforts to vector them to specific nearby grids for the subsequent search duty cycle were hampered. Practically, only very specific data could be sent to the field since the extreme communications, power, and workload restrictions only allowed only very small data sets to be transferred, if at all. Sometimes only a simple voice or text message could be transmitted, requiring the data to be very specific in terms of next area to be searched, with the highest probability of saves. Japan communications was sometimes augmented by the establishment of "runners" from a regional Air Force base. However, the full day's journey was not always feasible and the timeliness of the information was therefore often compromised.

The viability window in Japan became even smaller once the rescuers finally arrived in theatre. Even if the lucky survivors found void spaces within the collapsed buildings after the earthquake were also inland or high enough to avoid being drown by the subsequent tsunami-driven flooding, they were then subjected to potentially pathological hypothermia from the post-disaster snow fall.

This experiment seeks to improve the communication feedback loop between the GEOINT creation and the rescue personnel in an automated closed loop to increase the likelihood of locating viable victims, while actually reducing the logistics burden on the rescuers.

Experiment Description:

The concept and execution of this experiment are surprisingly simple.

A set of self-contained, battery-operated global satellite tracking geo-location devices will be supplied to the deployed search and rescue teams. (Only one is actually needed, the others are merely back up.)

Information from these trackers will be used to create and analyze the satellite imagery for the next potential search area(s). The location information may even be used to schedule satellite or UAV overpasses to secure new data.

Additionally, trackers with two way messaging can then be further used to provide the search vectoring to the field personnel and can also allow the rescuers to provide feedback to the GEOINT Ops Center on the utility and accuracy of the supplied vectoring.

As a collateral benefit, the specific location of the team can be provided to the Incident Commander for valuable situational awareness, which can then help to monitor the safety of the team members and help to intelligently deploy additional teams or other resources, as needed.

Measurements/Data Collection Plan:

Collect the geo-location information from the COTS trackers and add to the COTS web-based and/or standalone mapping clients/systems.

This information will then be supplied either electronically or manually to commercial and/or government geo-spatial intelligence providers, or simulated versions of these sources.

Measures of Performance/Measures of Effectiveness:

Having a control group of rescuers who will NOT be tracked and therefore will NOT be receiving tracker-enhanced data should not be necessary to achieve success metrics. Even if done, rescue conditions are almost impossible to duplicate, which a truly scientific control group would require.

The effectiveness of the new process can instead be easily compared with previous similar rescue exercises with no or with traditionally supplied "victim targeting." Full lifecycle timing can be collected to assist.

Comparisons to numerous real rescue operations, such as Japan, Haiti, and the 2004 Asian Tsunami are also possible.

What new capability (or improvement to existing capability) does this represent?

By allowing more accurate rescue data to be supplied sooner, and in much smaller data sizes, this location tracker enhanced GEOINT for disaster search and rescue "victim targeting" will dramatically improve the probability of teams locating, and therefore rescuing disaster survivors.

Experiment # A-14

INFORM: Imagery Needs to Focus on Operational Risk Management

Cal State University Long Beach

Principal Investigator/Lead: Briton Voorhees / Dr. Chris Lee / Ted Ralston

Working Hypothesis:

If we recognize that the world of HADR will always be informed by a high degree of ad hoc and unprepared or ill prepared data and imagery collection and depend more and more on informal or social-network based information, then a broad range of unspecified imagery and supporting data can occur without impacting or impeding its creation or mandating any particular data configuration.

Objective:

The overall objective of participation in RELIEF by the Remote Sensing and GIS components of the Geography Dept at CSULB is to create leadership in operational understanding and technology application to assist in establishing an agenda for the most effective use of remote sensing capability, imagery management, and imagery exploitation in decision support.

The sub-objective of participation in 12-4, August 2012, is to observe the dynamic, ad hoc, and technical level of imagery utilization and the barriers to better implementation, at any point in the lifecycle of information from the incipient RFI through the sequence of Task-Collect-Process-Exploit-Disseminate-Inform.

Participation beyond 12-4 will be based on experimental solutions, in whole or in part, to the complex task of managing the flow and analysis of ad hoc imagery, combined with other intelligence and information that complete the picture of collected and voluntarily provided geographic information.

INFORM seeks to provide a framework for ordered, effective, and risk reduction orientated utilization of imagery to solve problems and advise leadership in the HADR domain.

Overview/Background:

The higher educational system must incorporate the state of the art in relevant industry and agency operations into its experience framework in order to provide the most effective educational program. Conversely students and faculty must be given the opportunity to participate in realistic and current exercises and experiments in order to keep lines of communications open with users, suppliers, and multi-disciplinary views or novel approaches to traditional problems. Third, industry and agency must be given access to new developments created within academia and can turn to academia for evaluation, comparison, and prototype implantation of new or borrowed technologies.

Recent experience at CSULB with regard to remote-sensing generation of multiple sets of data through multiple remote-sensing technologies in a field situation, albeit with nowhere near the pace of a threatened-life HADR operation, lead us to the realization that the capability to generate multi-artifact, ad hoc data will rapidly exceed the ability of analysts or analytical systems to manage the flow in any sort of orderly, prioritized way. Confusion can mount quickly as unknown sensor types are used; as the requested imagery is subverted to a field decision to gather different imagery; as the metadata may be inaccurate such as date-time stamp; as the imagery is recorded at the wrong overlap rate or in oblique instead of nadir; as the ambient lighting condition affects the recording; as payload instability impacts image quality and sharpness; and as the imagery collection people become disconnected or intermittently so with the analysts and leadership.

Experiment Description:

INFORM team will be in an observation and discussion role at 12-4. It may be possible to use the VirtualAgility Workcenter from our partner VirtualAgility as the collector function for the INFORM LOG COP as an initial demonstration. Our findings will be reported at the end of RELIEF and periodically thereafter.

Measurements/Data Collection Plan:

August 14-17 POP; data collection and measurement will be by personal involvement and personal interview with other participants; collection of sample and typical artifacts; discussion on data content, volume, rate, quality measures, resolution, imagery orientation, blur, tie of day or effect of wind and atmospheric matter and other environmental effects; registration and distortion; latency or timeout factors; meta data tagging, interface characteristics, and where possible, testing for example with alternate data bases or interfacing data with different analytical engines.

Measures of Performance/Measures of Effectiveness:

At this point in the understanding of the imagery collection and exploitation process it is perhaps more of a measurement of the ineffectiveness that we will be seeking; this leading to a definition of the gaps that we must pursue.

What new capability (or improvement to existing capability) does this represent?

If we recognize that the world of HADR will always be informed by a high degree of ad hoc and unprepared or ill prepared data and imagery collection, and depending more and more on informal or social-network based information, the new capability that INFORM seeks or will inspire to design is one that allows this broad range of unspecified imagery and supporting data to occur without impacting or impeding its creation or mandating any particular data configuration be adopted. Rather, as anticipated at this point, what we can see is a self-organizing workflow system actively seeking the most relevant information and analytical products from the total being collected, based on prioritized needs at command and tactical levels within the command structure. Likely this will include local as well as cloud services. Role-based access and a credentialing process must be factored in as well as the need to without delay, feed collected imagery and other data into analytical engines.

Experiment # A-15

Cloud Based Solution for Situational Awareness and Analysis

Esri

Principal Investigator/Lead: Kurt Schwoppe, Esri

Working Hypothesis:

If imagery, LIDAR, and location based information is fused, than the situational awareness and effectiveness of a disaster response team is greatly improved.

Objective:

Our objective is to demonstrate that a cloud based solution to fuse imagery, LIDAR and location based information can greatly improve the situational awareness of a disaster response team. Key to our approach is the use of an Image Data Management (IDM) Appliance that is capable of ingesting raw sources of imagery, performing automatic image processing, then serving this processed imagery via open standards to a cloud solution globally accessible to all those participating in the JIFX exercise. The IDM Appliance is designed to be a mobile serving capability that can rapidly be setup within or near the Tactical Operations Center (TOC) so that as imagery, LIDAR and other location based content becomes available it can be rapidly served or published to the cloud for all operators to access. Once published, all relevant information can be fused for visualization in a common operating picture or used to solve more in depth analysis such as change detection and volumetric analysis (for debris removal). Global access to all these capabilities during the exercise will be provided to participants via web clients and/or Apps developed for iOS and Android devices.

Overview/Background:

Esri has been working with FEMA and others to implement emergency response cloud solutions based on ArcGIS Online. They are designed to provide a collaborative environment where critical geospatial data and other location based information can be fused, visualized, and analyzed based on user need. One challenge recently discovered during FEMA's support of the Waldo Canyon Fire was the ingestion of near real-time imagery up into the cloud to be used for change detection and fire extent analysis. Traditional digital upload methods via FTP were prohibitively slow, and once the imagery was in the cloud, little could be done with the data from an image processing standpoint. For this approach to work in a crisis situation, a better solution to rapidly incorporate imagery and LIDAR into a cloud environment is required.

The JIFX provides a great opportunity to test improvements to this process by implementing a capability called the Image Data Management (IDM) Appliance. This specialized ArcGIS solution is designed to rapidly ingest, manage, process, and publish image services to server and cloud based solutions using OGC open standards. This approach should significantly reduce the time and effort needed to provide near real-time imagery and LIDAR sources to collaborative cloud environments. As an appliance, it's field deployable and readily implemented with a basic web connection. Rather than push all the image pixels into the cloud, it is designed to publish standard services that cloud based applications can efficiently consume as needed.

Experiment Description:

Our experiment is designed to prove the following hypotheses:

1) A cloud based geospatial fusion capability is an effective solution for disaster relief by providing situational awareness and location based analysis. Exercise participants will test this hypothesis by accessing an Esri cloud solution called the JIFX GeoPortal. The JIFX GeoPortal will be updated throughout the exercise and will be accessible via web and mobile clients. Rating tools are available for each App so users can evaluate what aspects of the JIFX GeoPortal best meet

their requirements.

2) The capacity to rapidly provide updated imagery collected of the disaster area will greatly enhance the usage of JIFX GeoPortal. This hypothesis will be tested by measuring how quickly relevant content is made available to JIFX participants and how often the service is accessed by users. Esri provided base imagery and imagery collected during the exercise will be processed and served as it becomes available.

3) Locating the IDM Appliance at the disaster area TOC will greatly improve the overall capability of the solution. This hypothesis should become self-evident during the course of the exercise. Collocation ensures priority areas are covered first, that specialized analysis tools can be developed based on situational needs, and emergent forms of information discovered during the exercise can be incorporated into the cloud.

Measurements/Data Collection Plan:

Our plan for conducting this experiment is as follows:

Step 1 - Prior to arrival, the JIFX Geoportal cloud site will be established and populated with a typical baseload of geospatial data covering the exercise area. Upon startex, participants will receive directions as to how they can access and use the site.

Step 2 - Esri will bring to the exercise an additional test dataset consisting of imagery and LIDAR. Upon startex we will begin processing and serving this data using the IDM Appliance. This test dataset is designed to simulate new imagery being collected in the event that other JIFX participants are unable to provide us a real source.

Step 3 - Throughout the exercise Esri will be standing by to receive, process and serve any other geospatial content collected by other participants during the exercise.

Step 4 - Throughout the exercise Esri will be developing various geoprocessing (GP) models, such as change detection, feature identification, volume analysis, and route analysis. These GP models will be accessible by all participants via the JIFX GeoPortal.

Step 5 - All imagery services, GP models, and Apps will be evaluated and given a usability rating directly online by JIFX participants.

Measures of Performance/Measures of Effectiveness:

The primary measure of effectiveness will be based on the time and level of effort that it takes for raw sources of imagery, LIDAR, and other location based information to be published to the cloud for global visualization and exploitation by the JIFX participants. More specifically we will measure:

- The time required and level of difficultly to prepare raw imagery and LIDAR for publishing as a service. Special emphasis will be placed on any imagery generated during the exercise. Uploaded imagery will also be evaluated for geospatial accuracy.
- The speed and efficiency of using the IDM Appliance to serve large raster datasets to the JIFX GeoPortal. Specifically we will measure what capacity network is required to support cloud based disaster relief.
- The time required to create and upload tile cached services created by the IDM into the JIFX GeoPortal. These tiled cached services in the cloud will be evaluated to determine if they truly provide improved performance.
- The usability of all data being served by the IDM Appliance via the cloud will be evaluated. Functionality tested will include visualization speed, fusion with other information sources, and the ability to use the served data for analytical processing.
- The usability of the JIFX GeoPortal as a collaborative situational awareness and analysis capability. Users will directly rate these online.

- The usability of various imagery & LIDAR analysis apps that best support exercise objectives. Users will directly rate these online.

What new capability (or improvement to existing capability) does this represent?

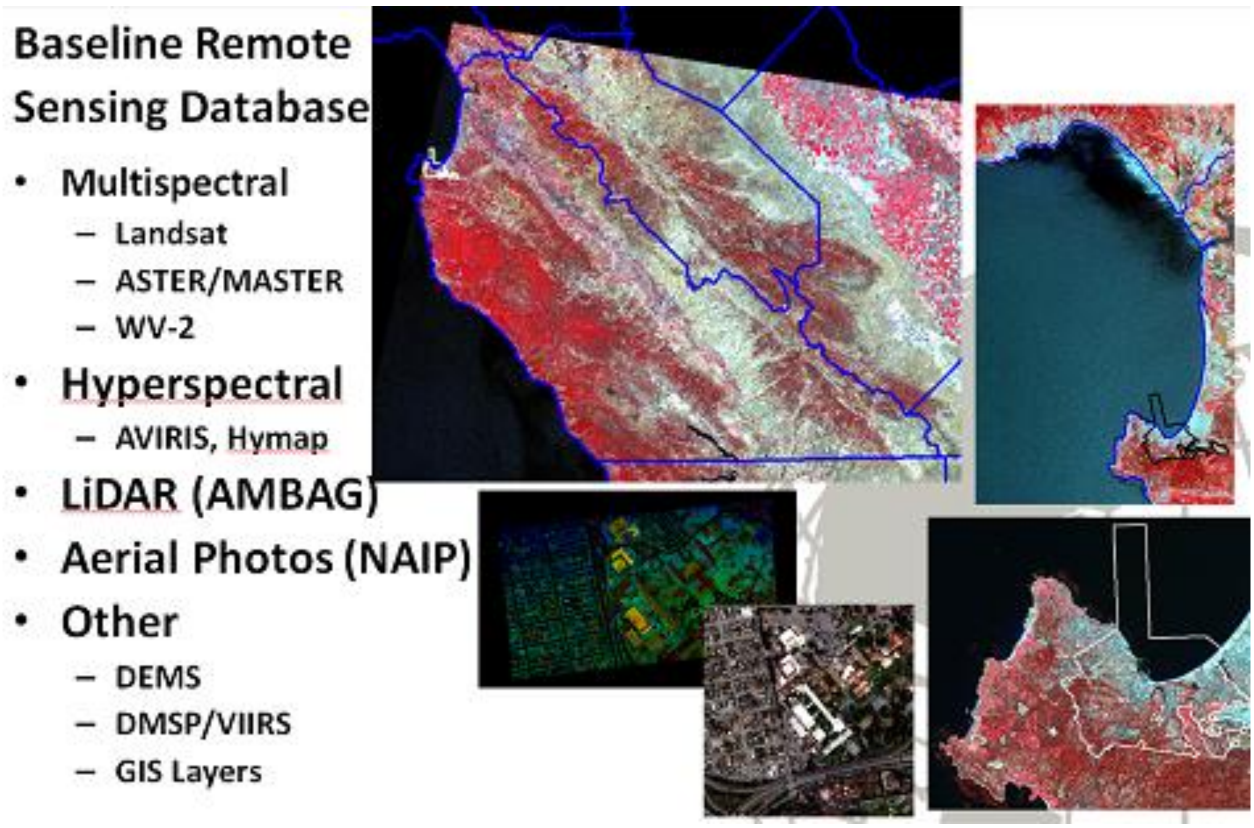
Our experiment intends to provide the following new or improved capabilities:

- Provide a collaborative situational awareness capability within a cloud based solution that is globally accessible via web clients and various standard commercial mobile devices such as the iPhone, iPad and Android devices.
- Provide near real-time updates of imagery into a cloud collaboration environment using OGC standard services and other standards.
- Provide for the fusion of imagery, LIDAR, and other location based information within the cloud that is globally accessible.
- Allow for crowd sourced content to be able to verify, update and/or improve the information being shared in the collaborative cloud.
- Provide various analysis functions within the cloud for in-depth analysis such as change detection, feature identification, routing decisions, and volumetric analysis.

Experiment # A-16

NPS Earthquake Emergency Response Exercise

Naval Postgraduate School Remote Sensing Center



Principal Investigator/Lead: PI: Dr. Fred Kruse / Lead: Mr. Chris Clasen

Working Hypothesis:

Through mock exercises of disasters, real life scenarios are able to test integration, capabilities, and effectiveness of different aspect of HADR.

Objective:

This event is meant to provide hands on training and demonstrations for the attendees on the capabilities of an integrated system of DHS initiatives developed by NPS to support earthquake response. The focus will be remote sensing applications and products. Specific injects and training sessions will provide real world experience for participants in austere environments on use of the tools available to improve capabilities of emergency response organizations to respond to disaster situations. A complete exercise plan (EXPLAN) will be provided to participants and observers.

Overview/Background:

The response scenario simulates an earthquake of similar magnitude and location to the 22 December 2003 6.5 magnitude San Simeon earthquake which resulted in several deaths in Paso Robles and that created widespread damage along the Central Coast of California. With an epicenter ~30 kilometers (19 miles) west of Camp Roberts, this real-life example is well-suited for establishing the simulation parameters. The earthquake's simulated effects included extensive building damage in the Camp Roberts cantonment area, as well as loss of power and communications. NPS has been called upon to assist emergency response efforts via proper channels and within the guidelines of the National Response Framework.

Experiment Description:

The NPS Remote Sensing Center has organized and integrated a number of NPS activities directed at disaster response for the Camp Roberts exercise. A mobile emergency operations center will be used to host and demonstrate RSC remote sensing imagery and derived geospatial products. Both on-site and remote communications and infrastructure support will also be demonstrated to illustrate operations in an austere environment.

Technologies to be highlighted based on the various scenario injects will be provided separately. This exercise plan (EXPLAN) will describe the scenario, injects, network architecture, and training that will take place around the simulated earthquake response. Highlights of the activities that will be generated from the injects include:

Remote Sensing and imagery demonstrations:

- Baseline satellite and airborne data
- Mobile application deployment and field data collection
- Near-real-time imagery collections using light aircraft and potentially with UAVs.
- Change of detection and information extraction demonstrations

Geospatial data analysis and derived products:

- Critical infrastructure
- Social media and crowd-sourced data feeds

Communications infrastructure creation in austere environments using a set of integrated communications technologies including:

- VSAT/BGAN (satellite communications and high bandwidth Internet reachback)
- WiMAX (point to multipoint broadband bridging)
- Wave Relay Meshed WiFi (to create wireless "clouds" or areas of coverage that overlap to create a mesh of coverage)
- Voice Over IP / Remote video camera integration (and for video teleconferencing)

Mobile Emergency Operations Center "Emergency Operations Center (EOC) In A Box" with mobile virtualized infrastructure

- Power outages and affected population products
- Common Operating Picture (COP) demonstrations
- Alternate hybrid power generation (hydrogen fuel cell, solar, wind)

Measurements/Data Collection Plan:

Data will be collected in the field at the Incident Command Post near the cantonment area of Camp Roberts, CA and sent back over Wi-MAX links to the deployed EOC located at the McMillan Airfield TOC. The data will be processed, analyzed, and published at the EOC and disseminated to a remotely hosted server; the Sensor Island.

Measures of Performance/Measures of Effectiveness:

The NPS Earthquake Exercise will integrate several initiatives for emergency management and disaster response. The goal is to successfully integrate all the parts of the system and provide training for the early responders that will use them. As with any exercise, the performance will be based on the level of participant satisfaction. We would like to capture feedback from a variety of stakeholders to determine how to best continue the technology transfer after the exercise.

What new capability (or improvement to existing capability) does this represent?

This exercise will demonstrate the integration of communications, virtual operations hardware/software, mobile applications, alternate power, and data collection/analysis/dissemination. The combined systems will provide the early responder with a complete system of tools to use after a major disaster.

Quantitative Results:

The NPS Earthquake Response Exercise at JIFX/RELIEF 12-4 represented a unique opportunity to test the integration of a full range of earthquake response activities in support of first responders and emergency managers. The event brought together elements of several separately funded Department of Homeland Security (DHS) initiatives underway at NPS (See Figure 1). The overall exercise was integrated and managed by the NPS RSC. The common theme was the use of remote sensing imagery, GIS data, and products for improved earthquake response in a field environment, with stand-alone communications and power. Participating NPS organizations/projects included:

1. NPS Remote Sensing Center (RSC): Improved Earthquake Response Using Remote Sensing
2. NPS Cloud Computing and Virtualization Lab: Integration of RSC data with EOC-in-a-Box (EOCIB) hardware and virtualization technology

3. NPS Hastily Formed Networks Center (HFN): Internet connectivity, broad-band WiFi cloud, alternate power sources (solar,/wind/hydrogen fuel cell) in support of EOCIB and RSC Emergency Operations Center
4. NPS Center for Asymmetric Warfare (CAW) and Peak Spatial: Sensor Island Common Operating Picture for NPS/RSC
5. NPS Common Operational Research Environment (CORE) Lab application "Lighthouse", utilized by RSC on mobile devices to gather field damage assessment data and send to the Common Operating Picture

Additional direct support to the exercise was provided by:

- San Diego State University (SDSU), NEOS Ltd., and Terrapan Labs, LLC: Near-real-time aerial imagery and change detection products
- Science Applications International Corporation (SAIC) and U.S. Department of Homeland Security, Science and Technology Directorate: Unified Incident Command and Decision Support (UICDS); Regional incident board for the NPS earthquake exercise established to act as middleware to pass events and data between Sensor Island and San Diego County EMS WebEOC incident management software
- University of South Carolina, Department of Geography, and U.S. Department of Homeland Security, Science and Technology Directorate: Apple iPad mobile-device-based mobile imaging application for damage assessment
- San Diego County EMS: Provided their instance of WebEOC and support for integration with the NPS earthquake exercise
- NOAA National Geophysical Data Center: Demonstrated night-lights satellite-based power outages and fire detection using Defense Meteorological Satellite Program (DMSP) and Visible Infrared Imager Radiometer Suite (VIIRS) satellite data

Ad-hoc Experiments were also performed in conjunction with the NPS exercise by:

- AVWATCH (commercial contractor): Operated fixed wing manned aircraft, WiFi mesh extension, and provided ISR capabilities (real-time airborne streaming video)
- National Geospatial-Intelligence Agency (NGA): Demonstrated "GLIMPS" mobile application for point to point streaming video from webcams and mobile devices for search and rescue
- ViaSat, a commercial satellite company, supplied a satellite dish at the Tactical Operations Center (TOC) that provided internet backhaul to allow completely autonomous networking (no links to any other outside communications source)
- NEOS Ltd. (commercial contractor and SDSU research partner): Acquired pre-event baseline true-color imagery for City of Monterey, CA, critical infrastructure. Flew near-real-time imagery for SDSU change detection effort

A partial list of attendees/participants from the first responder/emergency management community and other interested organizations includes the following. Others are listed in the Collaborating Groups section near the end of this report:

- San Diego County
- San Jose County
- San Luis Obispo County
- Sacramento County
- Monterey County
- Monterey City
- CAL-FIRE
- Community Emergency Response Team (CERT) representatives
- FEMA
- NGA
- DHS

The above organizations participated in a scenario-based field exercise based at JIFX/RELIEF that included demonstrations and training for the benefit of first responders. The presented scenario was an emergency response to damaged and collapsed buildings at the cantonment area of Camp Roberts as a result of an earthquake of similar magnitude and location to the 22 December 2003 6.5 Mw San Simeon earthquake. As a condition of this exercise, the cantonment area was considered within an austere electrical and communications environment. The concept of operations for the exercise called for a Tactical Operations Center (TOC) established in a field tent at McMillan Airfield and a Forward Incident Command Post (ICP) at the cantonment area with a variety of self-contained communications equipment. Remote sensing baseline data, imagery and GIS analysis software, multiple virtual workstations, and training sessions, ran on the "EOC in a Box" (EOCIB) in the TOC. The common operating picture for the event (Sensor Island) was hosted at offsite NPS facilities at Point Mugu, California. Participants operated either on a local area (onsite) wireless network or remote wide-area network depending on location and communications requirements (See Figure 2).

Quantitative results from the above activities included:

NPS RSC Training/Demonstrations (Fred A. Kruse, NPS, fakruse@nps.edu, 303-499-9471): Six separate demonstrations/presentations were conducted in the TOC utilizing the EOCIB resources, HFN/*IPC3* connections, and NPS RSC remote sensing data resources and software. Topics presented and/or demonstrated included:

- Baseline Imagery and Map Templates: Examples were shown for baseline imagery of Monterey County, City of Monterey, and Camp Roberts, including Worldview-2 multispectral satellite data, multi-year aerial photography; and advanced data types such as hyperspectral, LiDAR, and Radar (Figure 3). Participants were informed about sources of these data and how to get them pre- and post-earthquake event, image preparation and preprocessing requirements, and basic image analysis approaches and methods. The U.S. National Map Grid was discussed along with its use in establishing incident templates in ArcMAP (GIS) and production of GeoPDF and paper map products. Impromptu demonstrations were given to selected emergency managers based on interest of capabilities utilizing the EOCIB, baseline imagery, and analysis results.
- Lighthouse Mobile Application (Damage Assessment): Lighthouse is an application developed by the NPS Common Operational Research Environment Lab (CORE) lab using Google's Open Data Kit for data collection

using forms. It was adapted for earthquake response and this exercise by NPS RSC by designing custom forms for the earthquake scenario based on input from San Diego and Los Angeles Counties, City of Monterey, CAL Fire, and FEMA. The Lighthouse app was presented to a group of about 20 first responders and other observers in a training environment. A prototype Playbook handout with instructions on how to create your own instance of all the Open Data Kit elements titled “How to create, collect, and interpret your organization’s forms using Open Data Kit” was provided to the participants. Before the presentation we loaded the app onto 7 android tablets and phones with damage assessment forms from Monterey CERT, CalFire, San Diego Office of Emergency Services, Los Angeles County Office of Emergency Management, and FEMA. After the presentation we gave the participants the opportunity to go into the cantonment area and collect data using the forms that had been loaded into Lighthouse on the tablets and phones. The participants filled in approximately 5 of the Monterey CERT Damage Assessment forms in order to become familiar with the app’s operation and the general layout of the forms. Results were posted to the Sensor Island application (See Figure 4).

- Social Media for Earthquake Response: NPS RSC use of social media for earthquake response was demonstrated using the Ushahidi software platform. The concept of crowd-sourced information was introduced using an image-map based example from the Monterey Peninsula, CA. Damage assessment examples were imported and posted in Ushahidi and ArcMap integration was demonstrated.
- Integration of Mapping Products with EOCIB: NPS RSC Mapping Products were preloaded on the EOCIB. These were used to demonstrate Incident mapping; Vector and raster organization; Critical Infrastructure data; and Slope, Contour, and Flood/Tsunami mapping. Electronic and paper maps using GeoPDF’s were demonstrated.
- NPS Common Operating Picture: NPS RSC remote sensing data and analyses were loaded to Sensor Island, UICDS, and WebEOC for situational awareness and to present a common operating picture. Uploading of incident data from the ICP

(damage assessment mobile app) was demonstrated. Integrated webcam and aerial video from the NGA Ad Hoc experiment were loaded through the EOCIB and projected in the TOC. The UICDS bridge to WebEOC was demonstrated to illustrate pushing remote sensing data and information to WebEOC incidents

- Post Event Imagery Analysis: Post Event Imagery and Lidar Analysis training was conducted utilizing examples from Monterey and Camp Roberts (Figures 5 and 6). An overview of the use of Lidar for 3D modeling and damage assessment was presented. An example of using LiDAR data in conjunction with Worldview-2 multispectral data was shown for roof top extraction and composition.

Emergency Operations Center in a Box (EOCIB) (Buddy Baretto, NPS, abarreto@nps.edu, 831- 402-1463, see also complete summary for JIFX/RELIEF Experiment A-17); The EOCIB hardware (See Figures 7 and 8) and architecture (See Figure 9) supported 14 Windows-7 machines, 3 Linux servers, and almost 6 Gigabytes of imagery data being analyzed. The EOCIB was setup in the TOC tent, providing support for the full framework of the exercise (Figure 1), the training, and the scenario inject demonstrations (Figure 10). Typical server CPU Utilization was well under 50% with a few short spikes near 85%. Some issues were noted with disk utilization in the form of high latency on writes and some degradation of the Remote Sensing virtual machines (VM). These are being studied further. Training was presented describing the EOCIB Virtualized Computer Operations for Emergency and Disaster Geospatial Analysis. Advantages of virtual machines were described; How to scale operation, Machine setup and drive configuration, Data available on the EOCIB E:\ drive, Overview of installed software, and the Internal website configured for Monterey County.

Independently Powered Command/Control/Communications System (IPC3) (Brian Steckler, NPS; steckler@nps.edu, 831.402.1584, see also complete Ad-Hoc AAR prepared by Brian Steckler and submitted in conjunction with this AAR on behalf of HFN): The Hastily Formed Network Center provided a broadband WiFi cloud around the Cantonment Incident site and the NPS Earthquake Response Tactical Operations Center within 3 hours of establishment of these operations. A total of 8 WiMAX bridges (Redline AN-80i) and 6 Meshed WiFi Access Points were established; a 3-hop link was used to establish communications between the TAC and the Incident Site (See Figure 11). An independently powered (solar/wind) energy source was used to run some of the equipment at the incident site (cantonment area). The network infrastructure was run for approximately one hour after setup on Tuesday afternoon (14 AUG) for testing purposes and then 0900 to 1800 the next two days (15–16 AUG) with great success sans a short one-hour outage. The wireless networking technologies *in toto* included MESHED WIFI/WIMAX/VSAT and BGAN for IP backbone access, an aircraft to relay communications and to provide surveillance, and solar/wind/fuel cell for primary or backup power. HFN received feedback from all parties that the network performed very satisfactorily in all instances. A VSAT terminal from Inmarsat was integrated into the exercise (they came and set up and operated a 3/1 mbps VSAT terminal next to the Nemesis NetWarVan). On the other side of the network (at the TOC), a 12 mbps ViaSat VSAT terminal provided the network with a high speed Internet connection. A redundant Meshed WiFi network was overlaid on top of the WiMAX infrastructure using Persistent Systems Wave Relay (tm) meshed Access Points. These units were set up in "mesh" mode versus "bridge" mode for the redundancy. The network was provided with IP backbone access from both sides - the cantonment area and the tactical operations center's (TOC) tent. It worked fine to use either of the two VSATs (ViaSat's 12 mbps or Inmarsat's 3/1 mbps)......in either/both directions. Alternate power systems (Yeti - solar only) and a SolarStik alternate power system (solar, wind, hydrogen fuel cell) were successfully used to run various network components. These systems performed perfectly and the included battery packs were keeping up with energy demands from all devices attached to them. An emergency communications and alternative power demonstration was conducted at the Cantonment area.

CAW/Sensor Island (Alan Jaeger, NPS, ajaeger@nps.edu, 805-989-1786; see also complete summary for JIFX/RELIEF Experiment A-18): Sensor Island provided integration and dissemination of NPS RSC remote sensing products in support of the earthquake response scenario. These included GeoRSS, GeoPDF, and imagery files (kmz/kml, img, tif, sid). Exercise and Manager Common Operational Pictures were generated for viewing products and real-time updates, and edits made in the Manager COP such as event locations, sensor/camera locations, and communications nodes. Data were linked to COP grids over Monterey and Camp Roberts, hyperlinking geographic compositions and other imagery products within those grid zones. Four webservices were created for products and geographic data – Dynamic, Event, Static (queriable), and Static (non-queriable). The web services provided access to a number of external COPs such as ArcGIS and Google Earth. Sensor Island was used to collect and display data from the Lighthouse mobile application. 19 text reports from exercise participants deployed to the cantonment area on 15 Aug and 8 additional reports from Monterey area were loaded via JavaScript Object Notation (JSON). This information was shared with DHS's UICDS and San Diego County WebEOC. All reports were received and displayed on the Exercise COP and ultimately in the WebEOC application. Sensor Island was also used to interactively control a live high-resolution webcam situated at the ICP from the TOC. Training was presented on Sensor Island heritage, Common Operating Picture and Incident Data Integration, Sensor Island and the JIFX/RELIEF 12-4 exercise implementation. Configuration, Data Products/Formats, Sensors, and Output/Consumable Mapping Services were discussed.

Rapid, High Spatial Resolution Image Assessment of Post-Earthquake Damage (Professor Douglas A. Stow, Dept. of Geography, San Diego State University; stow@mail.sdsu.edu, 619.594.5498; with support from TerraPan Labs, LLC and NEOS Ltd.; see also complete summary for JIFX/RELIEF Experiment B-11): SDSU's experiment in support of the NPS RSC earthquake response effort demonstrated rapid and automated change detection with airborne imagery as part of a post-earthquake disaster response scenario. True color airborne imagery were captured by a digital color camera mounted on a NEOS Ltd. light sport aircraft. A swath covered by three overlapping images was imaged multiple times on both August 15th and 16th. Each day, the aircraft flew a single flight line six times collecting 3 inch spatial resolution imagery, and three times collecting 6 inch spatial resolution digital color imagery. Three images were collected on each imaging pass, with 100 m spacing between them along the flight line. After the completion of each imaging pass by the aircraft, participants on the ground at the cantonments site moved several targets to simulate changes, including boxes, tarps, canopies, and strips of strapping and duct tape. When imaging was complete each morning, the aircraft landed at Paso Robles airport and the digital images and supporting metadata files were delivered to the McMillan Airfield by ground vehicle. Upon arrival at the RELIEF event, the images and associated information about aircraft position and heading at the time of image acquisition were input into an automated work flow, which included automated image co-registration and automated change detection developed by SDSU/TerraPan participants. Analysis focused on a pair of images for each day that were co-registered within 2 pixel accuracy, selected by quick visual inspection in the web-based viewer. On the first day, a total of eight aggregate features changed. Two of these features were not detected. A pile of white boxes, which was stacked in the first frame and knocked down in the second time frame, was not detected likely due to similarity with the bright soil background. Likewise, a person with a low profile was not detected. Some small features such as boxes and peoples shadows were only partially detected, while large changes such as the movement of a car, rotation of a canopy, and slight movement of a blue tarp were reliably detected. Three false detections occurred where shadows moved substantially were highlighted with the default parameters for the change analysis algorithm. For the Thursday August 16th mission, 10 changes were staged between each pass, for the selected pair of images. All but two of the changes were detected. One was a person that appeared in the frame, and the second was a small teal tarp that was moved. With default parameters on the change analysis algorithm (the parameters are interactively adjustable as part of the demonstration), no false detections occurred and white boxes that were challenging to detect based on Day 1 (Wed.) imagery were easily detected (Figure 12). A closing car trunk door was detected, and the tarps that changed position were well quantified in terms of their shape and area in the image change product. Overall, the SDSU change detection effort was very successful. This approach, algorithms, and baseline data demonstrated that imagery collected using a light aircraft are well suited to rapid change detection in a post-earthquake environment.

UICDS/WebEOC (James W. Morentz, SAIC, james.w.morentz@saic.com, 703-589-3706)/Robert Barreras, San Diego, Office of Emergency Services, Robert.Barreras@sdcounty.ca.gov, 858-715-2341): SAIC set up an UICDS Incident Board for San Diego County's instance of WebEOC running on the EOCIB and provided instructions for operation and remote support. UICDS acted as a bridge between Sensor Island and WebEOC connecting to all of the exercise data and analysis results (Figure 4). The regional incident board was viewed in WebEOC to put all exercise events into the framework commonly used by many California emergency management organizations to manage disaster events.

MIAT (Image-based Damage Assessment Mobile Application) (Michael E. Hodgson, Department of Geography, University of South Carolina, hodgsonm@sc.edu, 803-777-8976; and Bruce Davis, Bruce.a.davis@dhs.gov, (202) 254-5893, U.S. Department of Homeland Security, Science and Technology Directorate): An iPad-based mobile application utilizing NPS RSC baseline imagery and real-time GPS locations for Camp Roberts was demonstrated to several emergency managers at the NPS/RSC TOC. Data were interactively collected on the iPad then uploaded to a server at the University of South Carolina through the EOCIB and HFN wireless connections. The data were stored in an ESRI Geodatabase and were available for redistribution as an ArcGIS Server web service illustrating image-based mobile damage assessment.

NOAA (Chris Elvidge, National Geophysical Data Center, chris.elvidge@noaa.gov, 303-497-6121): Fire incidents detected by the VIIRS sensor for August 16 2012 for the entire United States, the State of California, and specifically northern California were posted to Google Earth, with markers keyed to magnitude (Figure 13).

NEOS, Ltd. (Richard McCreigh, neos500@gmail.com, 928-776-1950): High-resolution (6 inch) color imagery covering 29 sq kilometers were acquired from a NEOS light aircraft system surveying critical infrastructure in Monterey, CA on 12 - 13 August 2012. Several hundred geo-referenced, at-nadir images were acquired over the city and outlying areas in a period of five hours. The digital imagery were processed by NEOS on a notebook computer as ortho-rectified mosaic tiles in GeoTiff and KML format in about 1.5 hrs and provided to NPS RSC for use in the JIFX/RELIEF exercise and as baseline imagery for delivery to the City of Monterey, CA. A low-resolution quick-look output screen shot is displayed in Figure 14.

AVWATCH (Chris Kluckhuhn, clk@avwatch.us, 508.360.4398; Bob Griffin, reg@avwatch.us, 508.274.6910; In conjunction with US Air Force – Pentagon Office of ISR Innovation, Coast Guard 1st District Office Of Law Enforcement, L3 Communications; Also see complete Ad-Hoc AAR submitted with this AAR): Avwatch coordinated multiple airborne live video flights over the cantonment area that represented the impact zone of the earthquake simulation and hosted a remote TOC. From here utilizing the US Air Force sponsored ROVER system from L3 Communications and the Coast Guard's TRIDENT Network, video was downlinked via a secure S-Band Digital, C-Band Digital and L-Band Analog frequencies. Once on deck, using the TRIDENT Network the video was shared at different camps in the immediate cantonment area and then further pushed through the Coast Guard TRIDENT VPN MANET Network through SATCOM and/or an aircard to a secure video server hosted by Avwatch. From this source, live FMV was distributed to shareholders at the EOC situated at McMillian Field and a Flag Officer at Navy Region Southwest. Video was available via direct Internet linked computers or through on smart phones with 3G service.

National Geospatial-Intelligence Agency (Benjamin Tuttle, NGA-Denver, Benjamin.T.Tuttle@nga.mil, 303-677-4457); loaned 6 Android tablets and phones for our exercise so as to demonstrate the Lighthouse Application. He also demonstrated the NGA GLIMPS application for real-time point-to-point video streaming over mobile devices.

Qualitative Results:

Initial responses from first responders and emergency managers regarding the NPS Earthquake Emergency Response Exercise at JIFX/RELIEF were very positive. Several participants provided feedback and noted that the event was successful in providing training and real-world experience. Aside from a few minor glitches, the exercise nicely showed the feasibility of an integrated hardware/software/data solution for improved earthquake response using remote sensing imagery and mapping technology. Overall, the exercise was a resounding success.

For this simulation, a Tactical Emergency Operations Center (TOC) was established at McMillan Airfield while an Incident Command Post (ICP) was established at the cantonment area. At the TOC, a virtualized operations center operated on the network infrastructure provided by a large-capacity, deployable server (see experiment A-17: "EOC in a Box"). This server allowed concurrently-running virtual workstations to operate, thus providing first responders access to crisis data (critical infrastructure, archived satellite and aerial imagery, ArcGIS layers, LiDAR, etc.) for analysis. Communications were provided under the assumption of an austere (limited) infrastructure situation by the NPS Hastily Formed Networks Center, in the form of meshed WIFI/WIMAX/VSAT and BGAN for IP backbone access. This exercise acted as a test platform for prototype products for improved earthquake response. Selected products will be delivered to Monterey County on the EOC in a Box platform based on results from this experiment. The results of this exercise are also expected to be influential in designing 'Playbooks', a set of instructions on how to use geospatial software to analyze imagery and derive products from that imagery for use by first-responders.

The exercise also provided an opportunity for focused training sessions where first responders, using demonstrations, with some hands-on interaction and experimentation, worked with and provided feedback on a variety of geospatial, communications, and network technologies. Geospatial data and analysis software available on the EOC in a Box were used in these exercises. NPS baseline imagery data were shown, processed, and manipulated along with GIS overlays to allow pre-event situational awareness and to demonstrate potential products for post-event response and recovery. Map templates were used to build and demonstrate standardized map products from the remote sensing data.

WiMAX connectivity links from the TOC to the ICP as well as the Wi-Fi mesh at the ICP were successfully created. The WiMAX and WiFi connectivity was consistent, allowing for near-continuous network and server access near the cantonment area. In this austere electrical environment, critical components at the ICP were powered by fuel generators in addition to alternative power sources such as wind, solar panels, and a methane-powered fuel cell (see Independently Powered Command/Control/Communications System IPC3 Ad Hoc AAR). Power generation at the ICP was never an issue as both the fuel generators and the alternative power sources provided sufficient energy to maintain the ICP communications systems. As the ICP near the cantonment area was in an austere communications environment, internet connectivity was provided by WiMAX links from the EOC server at McMillan Airfield (IPC3). A locally generated Wi-Fi mesh at the ICP allowed mobile devices to connect directly to the WiMAX link, providing access back to the EOC server and to the external internet (see Mobile Application results). This connectivity gave users the ability to transmit locally generated damage assessment reports, done using an Android-based mobile application (Lighthouse/NPS), back to the EOC server for data collection.

Data collection via the Lighthouse mobile application worked as designed. Damage assessment forms were completed outside of the WiFi mesh near the barracks at the cantonment area. Data was stored on the tablets and mobile phones until these devices could establish network connectivity back at the ICP. Once connectivity was established, the tablets and mobile phones containing the damage assessment forms pushed the data back to the EOC in a Box for storage and analysis. Results were posted through Sensor Island to UICDS and WebEOC.

SDSU imaging and change detection went as planned (see experiment B-11 AAR for specifics). The imaging and change detection demonstration was successful, and results contributed to the larger NPS coordinated earthquake response exercise. Specialized image collection and processing techniques yielded pixel-level spatial co-registration between ultra-high spatial resolution (3-inch) imagery, and the automated change detection routine detected many of the introduced change targets with little false change detection. The automated processes were made possible by server side processing that combined and optimized all automated components. Change detection products were presented in a web-based visualization tool that allowed visual interpretation of the images and change detection results, interactive adjustment of change detection parameters, and submission of change detection results (graphics and text) to the NPS RSC Sensor Island common operating picture via GeoRSS feed. The image-based change detection results that fed into the common operating picture as a GeoRSS feed contributed to the overall situational awareness of the simulated earthquake response event.

The Sensor Island (see experiment A-18 AAR for specifics) data integration and visualization capability also performed well. The EOC in a Box could easily communicate and push geospatial data to Sensor Island's remotely located server (Point Mugu, CA), which was then displayed on the visual COP via projector in the EOC. The interoperability of Sensor Island was also proven as data collected during our exercise was received and displayed on the COP as well as on the WebEOC (an emergency management software application) through the DHS Unified Incident Command and Decision Support (UICDS) middleware environment.

Collaboration / Ad Hoc Experiments:

1. Various emergency management personnel participated in the exercise, including San Jose and Monterey Counties, Monterey City, Sacramento County, San Diego County, CAL-FIRE, Community Emergency Response (CERT), and FEMA. They attended briefings and training, and participated in data and product review, and field data collection demonstrations.
2. Air Force A2Q Intelligence Innovation office in OSD at the Pentagon (sponsor of the AVWATCH fixed wing manned aircraft that was in our infrastructure providing surveillance some IP cloud relay capabilities)
3. US Coast Guard, Boston HQ - for the USCG Trident network demonstration and provided Wave Relay support to the rest of the team.

4. CAL Nat'l Guard IC4U comms van and trailer. Provided redundant VSAT and local WiFi.
5. Salinas Fire Department - operating the very large new state of the art COMMAND VEHICLE.
6. Monterey County COMMS TASK FORCE - set up and operated the push-to-talk VHF radio network for our teams to have voice comms while in the field throughout the base at Camp Roberts. Supported setup and dismantling of the NPS HFN Center provided VSAT/BGAN/MESHED WIFI/WIMAX/ALT PWR comms package.
7. Monterey Police Department sent their Deputy Chief to observe.
8. CAL Fire sent several Chiefs to observe.
9. DHS sent several senior executives to observe.
10. The contractor AVWATCH flew and provided the fixed wing manned aircraft and WiFi mesh extension and ISR capabilities. See attached Ad Hoc After Action Report
11. ViaSat: provided additional communications capabilities. See experiment A-17: EOC in Box
12. NEOS, Ltd.: High-resolution (6 inch) color imagery were acquired from a NEOS light aircraft system surveying critical infrastructure in Monterey, CA on 12 - 13 August 2012. Additional data were acquired in support of the SDSU RELIEF demonstration effort on 15 – 15 August 2012. The digital images for RELIEF provided toSDSU for automated processing and change detection with further posting to the exercise Sensor Island COP
13. National Geospatial-Intelligence Agency (NGA): Dr. Benjamin Tuttle from NGA-Denver loaned 6 Android tablets and phones for our exercise so as to demonstrate the Lighthouse Application. He also demonstrated an NGA application for real-time point-to-point video streaming over mobile devices.

Observations & Comments:

Overall this was an effective training, education, and operational experience enjoyed by all. The entire 20-25 person team performed together extraordinarily, particularly in view of how many diverse agencies were involved. For the most part all systems and project components worked flawlessly on 15-16 AUG. The exercise successfully demonstrated the fully integrated earthquake response effort of NPS, all of its components, and its associated partners.

Selected participants completed an on-line survey regarding their experience at the exercise. Initial feedback on our demonstrations and training sessions were very positive. Although a small sample size, the consensus from the attendees providing feedback was that the products were relevant and that these attendees would most likely want to use these products in the future. In addition, the fact that these attendees, 2 of which are geospatial experts, could not suggest any additional products or tools that should have been included is an excellent result. While the feedback is initially positive, we will continue to work with first responders and crisis managers to gather more feedback and further refine our work.

Figure 1. NPS Coordinated Applications for Disaster Response

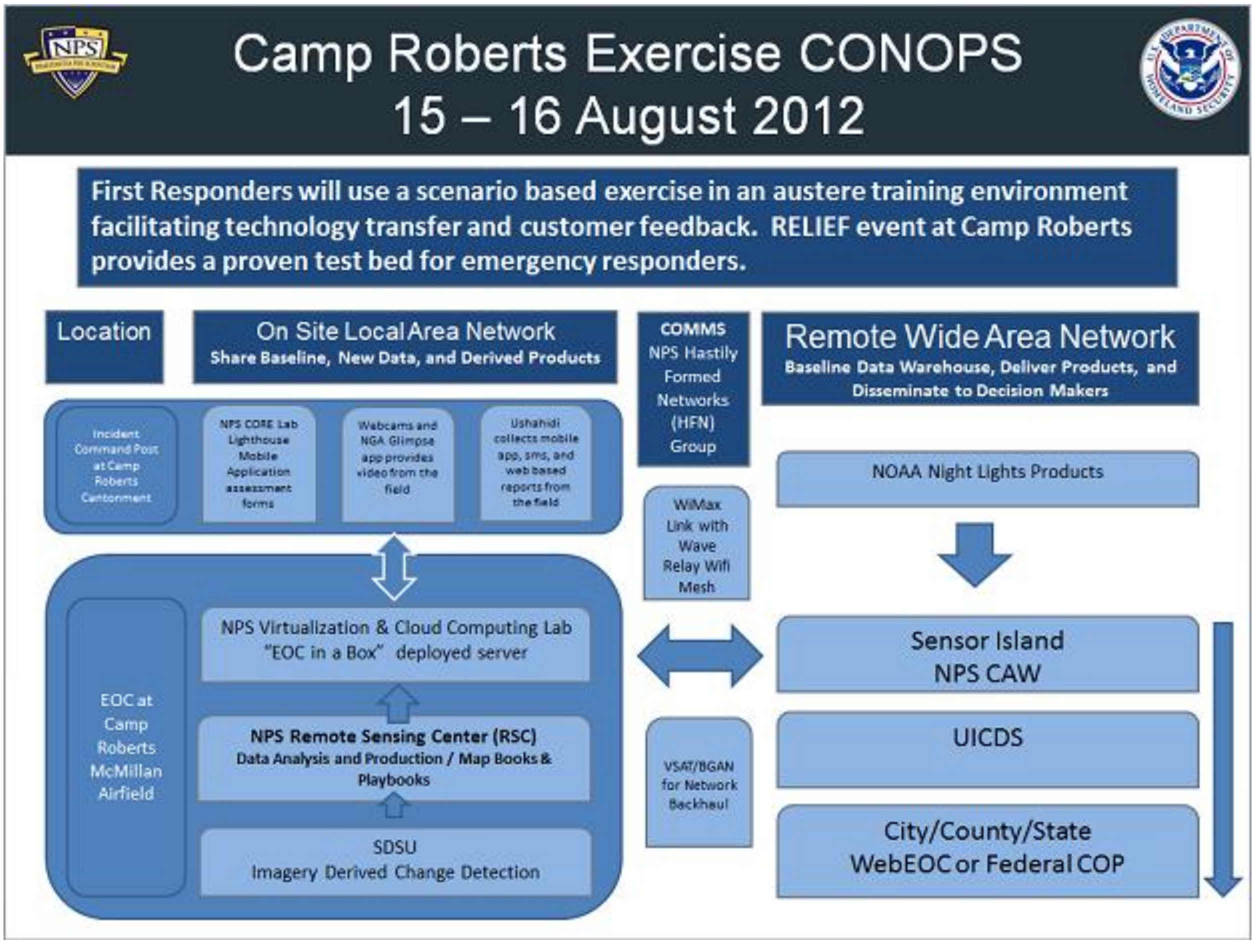
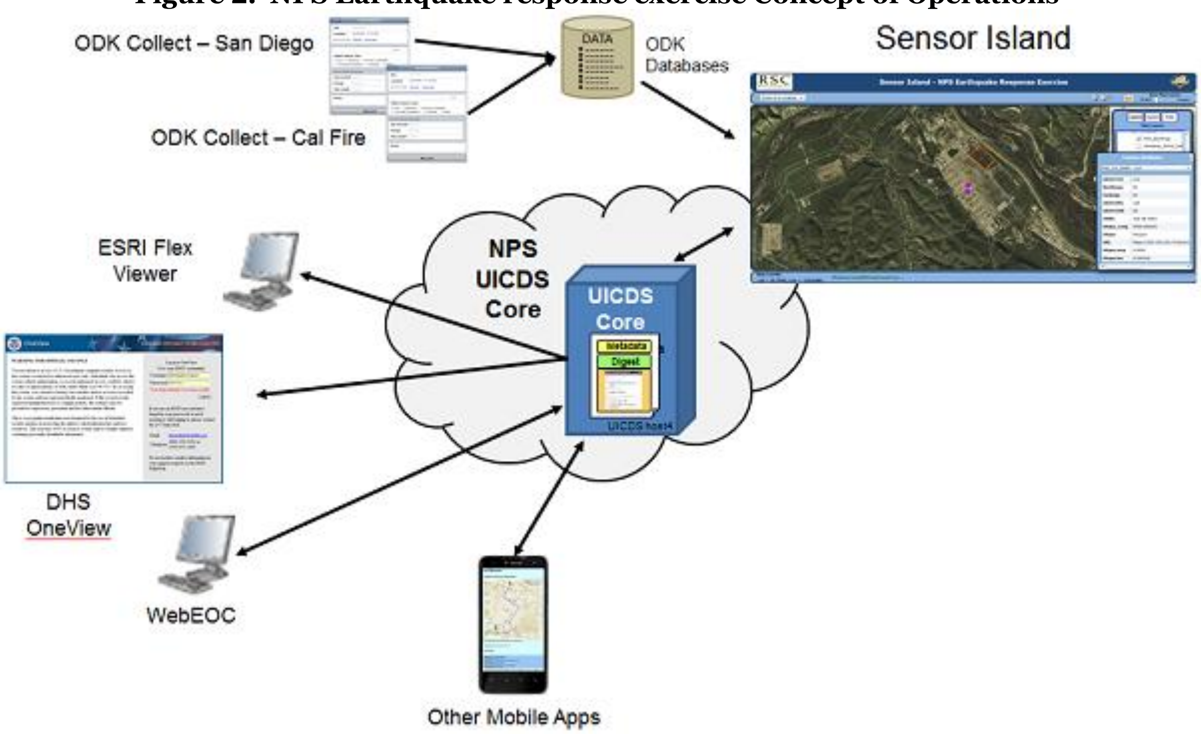


Figure 2. NPS Earthquake response exercise Concept of Operations



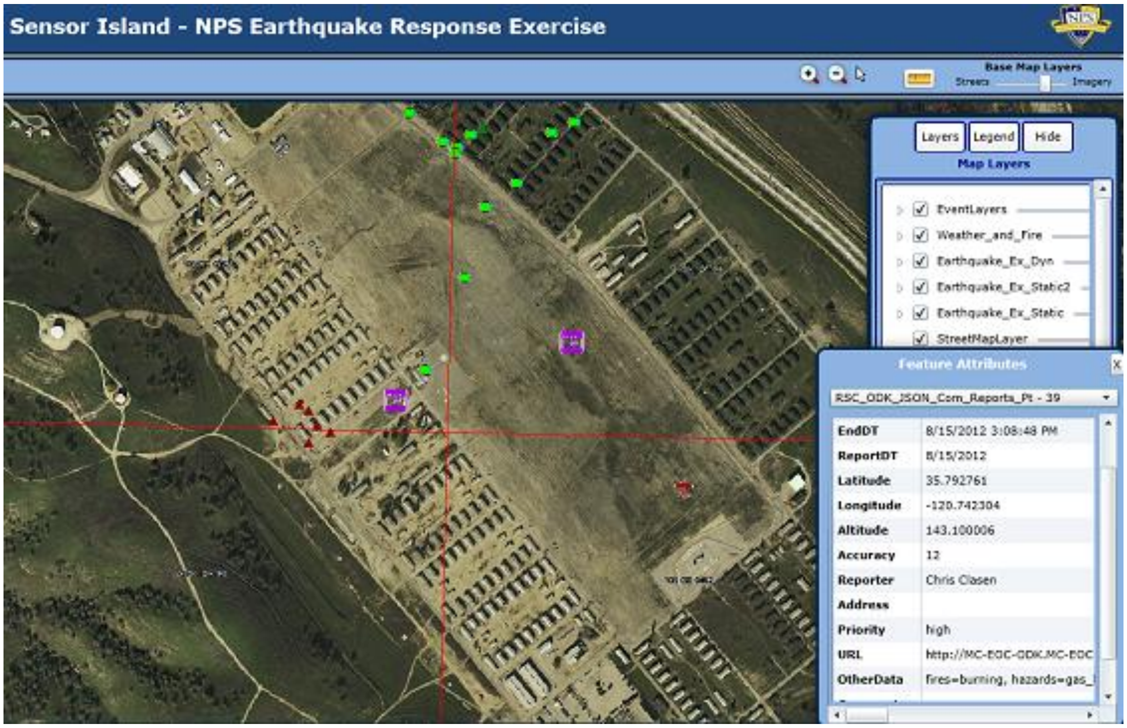


Figure 4: Sensor Island data integration and common visualization environment as implemented for NPS/RSC with UICDS and WebEOC. Bottom image shows locations and information for damage assessment reports submitted through the Lighthouse mobile application.

Figure 5. Post Earthquake Image Analysis Example (LiDAR Damage Assessment)

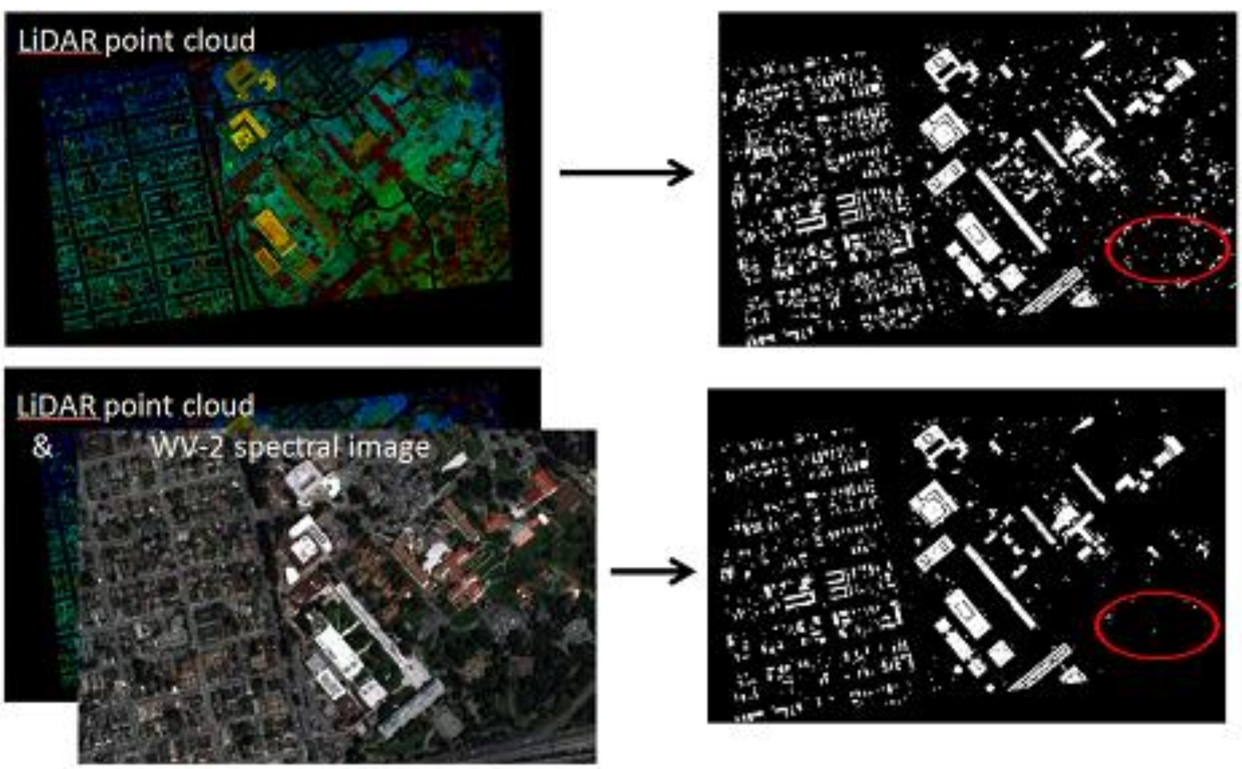


Figure 6. Post Earthquake Image Analysis (LiDAR/WorldView-2 Rooftop Mapping, NPS)

Figure 7. EOC in a box showing from top to bottom: Raritan PDU, TrippLite KVM, CORAID SAN, V3 Server, and CyberPower UPS.

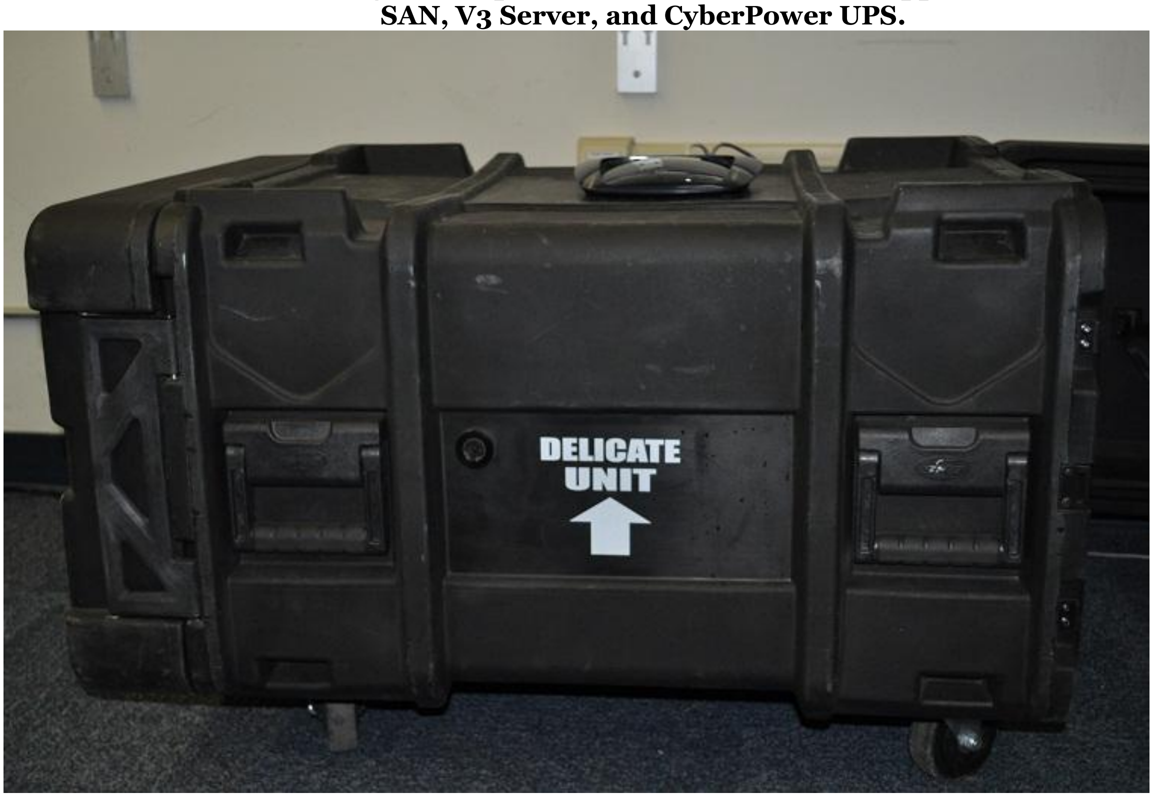


Figure 8. EOC in a box SKB shock case with removable front and rear doors and Cisco WAP.

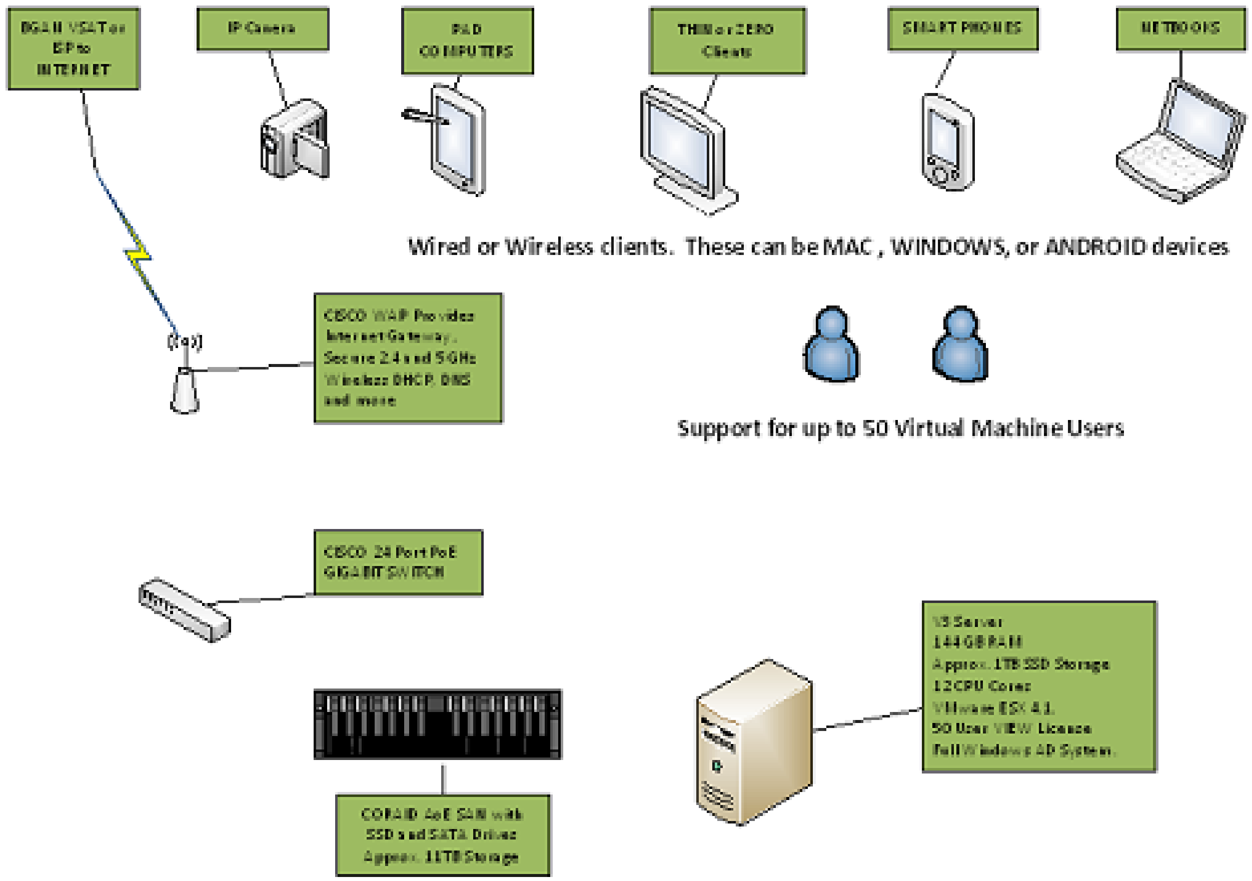


Figure 9. EOC in a box Architecture

Figure 10. NPS JIFX RELIEF Tactical Operations Center (TOC)

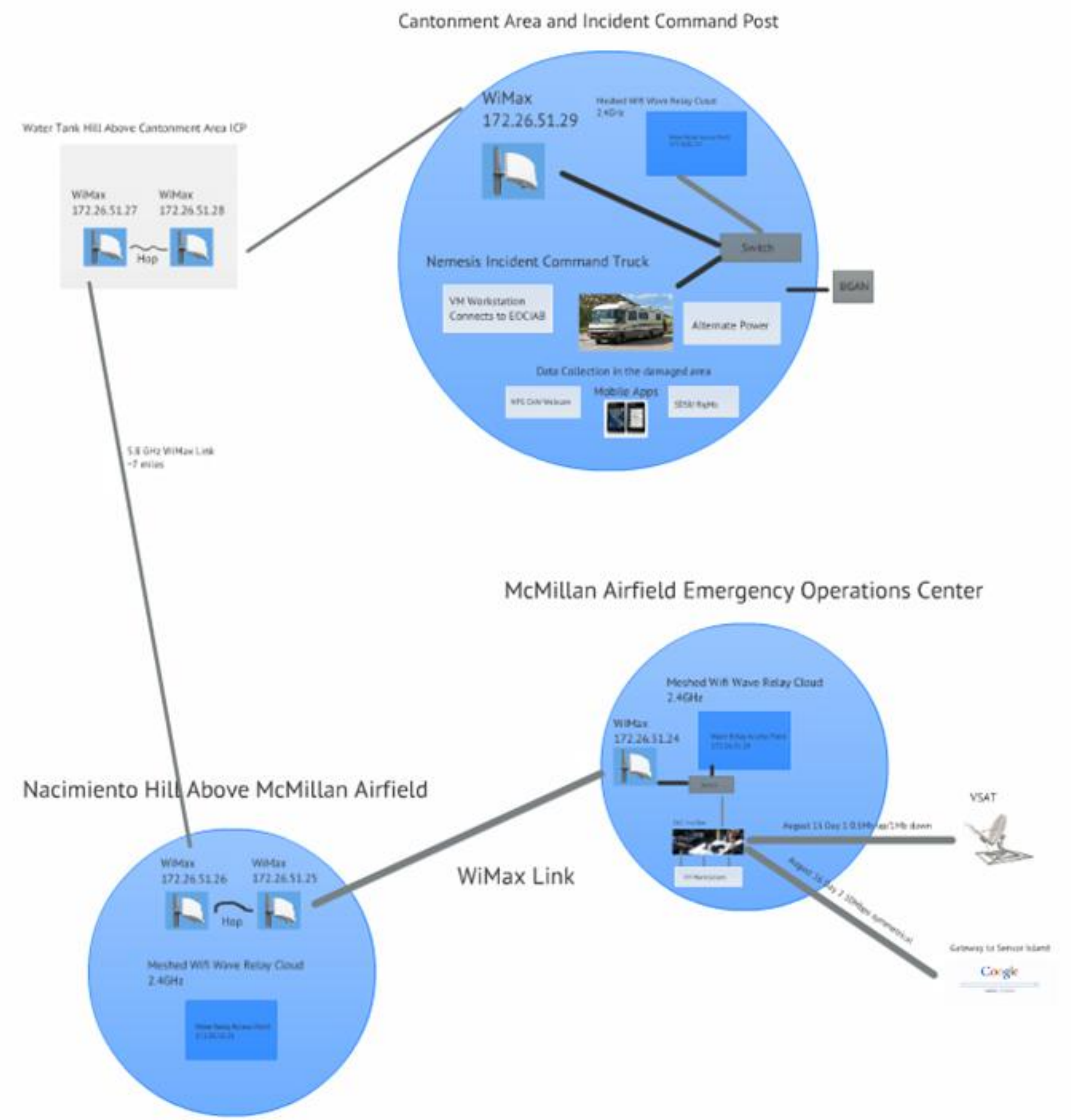


Figure 11. NPS Earthquake response communications and power overview

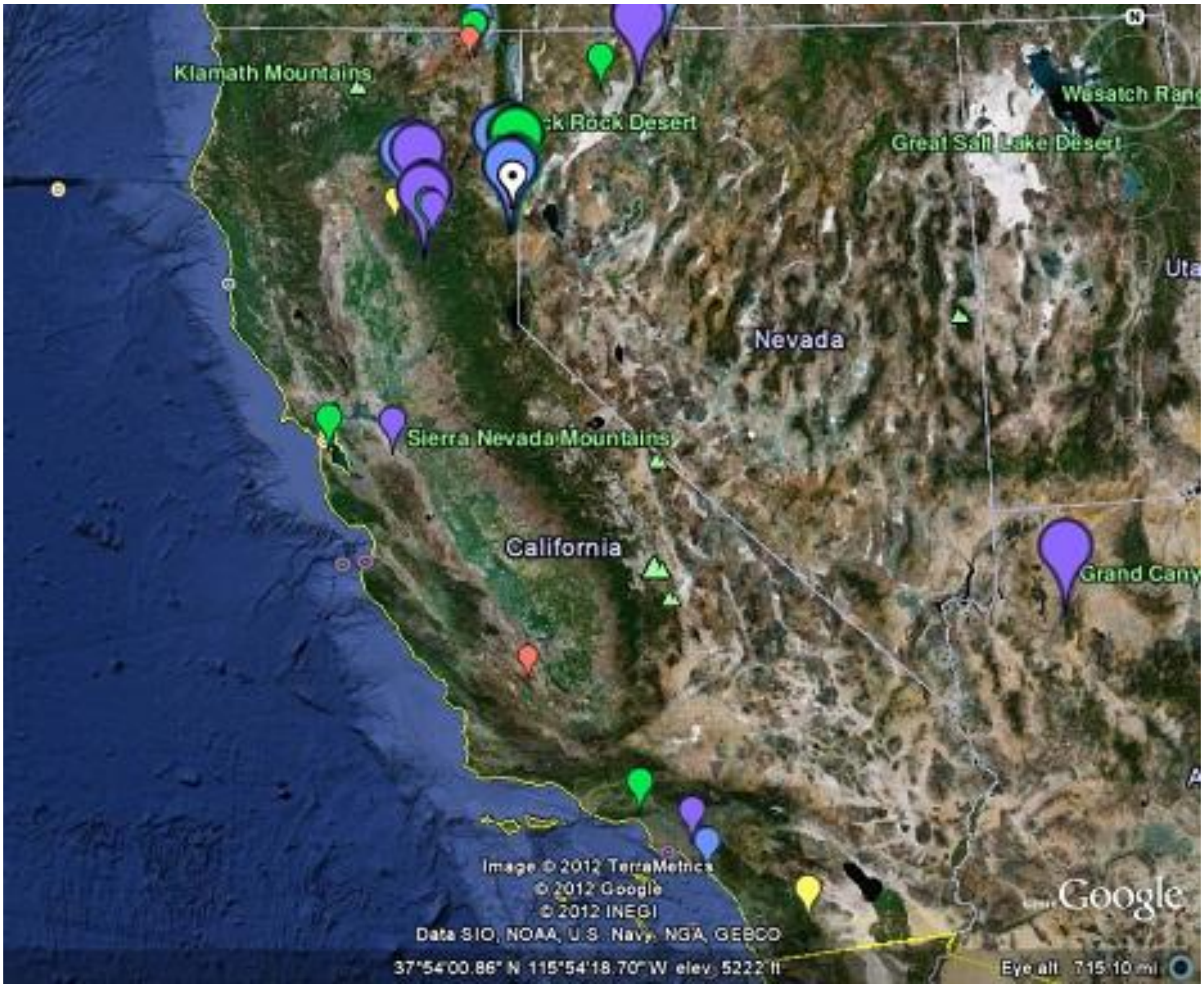


Figure 13. VIIRS Near-Real Time Fire Detections for the state of Calfornia, 16 August 2012.

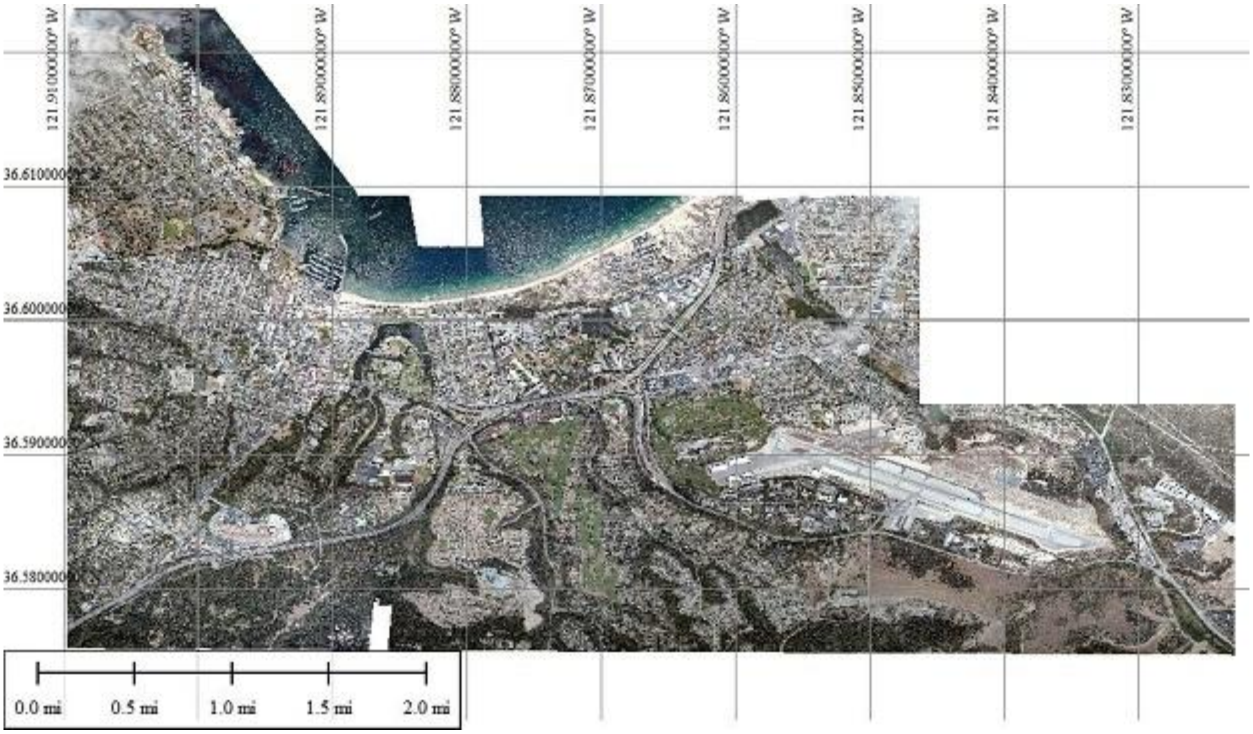


Figure 14: Screen shot of city-wide mosaic of high-spatial resolution imagery collected of City of Monterey, CA critical infrastructure by NEOS Ltd. on 12 August 2012 in conjunction with JIFX/RELIEF

Experiment # A-17

EOC in a box

Naval Postgraduate School

Principal Investigator/Lead: Albert Barreto III, NPS

Working Hypothesis:

By combining the capabilities of first responders and autonomous systems, as well as the ability to create a sustainable mobile network, efficient disaster relief is more attainable.

Objective:

The objective of this experiment is to demonstrate capabilities of the EOC in a box. The EOC in a box is an autonomous system developed for the first responder community and is designed to provide C2 capabilities in an austere environment by providing a virtual machine infrastructure, local SAN storage, and the ability to provide LAN/WAN access via the most common mobile devices such as laptop computers, iPads, and thin and/or zero clients. The EOC in a box runs VMware ESX and VIEW and supports up to 50 virtual machines and hosts several web based and desktop applications such as ENVI, ArcMap, Ushahidi, and WebEOC.

Overview/Background:

This experiment is designed to merge and showcase several technologies developed under DHS funding. These include an independently powered command and control system of systems which includes alternative solar, wind, and hydrogen fuel cell technologies, and 802.16 and 802.11s network with BGAN and VSAT connectivity, and a mobile C2 system which serves up virtual machines, web based, and remotely sensed imagery applications as well as traditional back office applications. This exercise will attempt to integrate all of these systems with the other systems funded by the DHS at NPS with the goal of having stand-alone system of systems which can be self-powered and provide Internet access via BGAN or VSAT, and to collect and distribute data and analysis products via WI-MAX and Wi-Fi mesh technologies to the incident participants while providing the complete infrastructure.

Experiment Description:

Two experiments are proposed. The first will demonstrate the EOC in a box system of systems. This will include integration with the alternative power system as well as the Wi-MAX, Wi-Fi Mesh and BGAN/VSAT COMMS links. This experiment will take place on day 1 of the larger NPS earthquake response exercise, August 15th.

The second experiment will integrate the EOC in a box with data analysis and production in the ICS framework. This will involve the NPS Remote Sensing Center collecting data from the Incident Command Post at the Cantonment area of Camp Roberts, pushing it back to the EOCIAB, and disseminating the products to a wider audience via a remote server called Sensor Island. This is designed to have the EOC in a box serve as a remote Emergency Operations Center over a local area network (LAN). Early responders participating in the earthquake exercise will be trained to collect, analyze, and distribute imagery/geospatial data and results to and from each of these systems. This will be performed on the VSAT back haul connection to a wide area network (WAN) on the first day, August 15th. On day 2 of the exercise, August 16th, the existing network infrastructure at Camp Roberts for connectivity and reach-back as well as local power will be utilized. This will represent the connection improvements over the course of a response.

The EOC in a box has a fairly large SAN capable for hosting several TB of data, and sufficient memory and CPU capabilities to perform analysis on data collected from the various sources. This will be the first time we attempt to have remote access to the system, rather than local reach-back to the Internet provided by our own VSAT.

Measurements/Data Collection Plan:

Data will be collected in the field at the ICP from various mobile applications being tested. In addition, internal monitoring from the on-board Raritan PDU for power usage analysis will be performed. Utilization values from the ESX server console will provide total system as well as individual VM measures on Power, CPU, RAM, network, and disk performance. We will also be able to analyze log files from the SAN to look at IOPS, latency, and throughput.

We will also be looking at performance with a minimum of 10 users to stress the system, and to establish a baseline for performance expectations. We will be looking at LAN throughput and latency per VM as well as CPU, memory, disk, and power of individual VMs and the system as a whole. Capturing of data outside the LAN is beyond the scope of our tools.

Measures of Performance/Measures of Effectiveness:

Our MOP and MOE will be based on number of users we can support, usability of virtual machines, and various devices for accessing the system and ease of use. We have known constraints in certain graphics areas in the virtual environment, and we expect to determine if these limitations limit the effectiveness of the system for certain imaging and processor intensive applications, or if the observed performance is acceptable in an austere environment scenario.

We also expect to determine if bandwidth limitations prevent us from successfully moving image data between nodes and physical locations. Understanding what to expect when moving between LAN connected nodes and WAN connected nodes will help us determine the final configuration for the EOC in a box and what applications can reliably and effectively be deployed on this system.

What new capability (or improvement to existing capability) does this represent?

The EOC in a box is providing an autonomous, self-contained C2 capability. By integrating current virtualization capabilities with existing alternative power and Wi-Fi, Wi-MAX, and satellite communications systems, we have developed a mobile command and control system which can be setup and deployed in under two hours and provide power, communications, and access to applications and data without using any infrastructure. Additionally, as the infrastructure is restored, we can shift our system to integrate with those capabilities.

The use of any device such as zero and thin clients, MACs, Windows, and Linux systems as clients makes this system ideal for deployment into an area where there is no existing infrastructure and little control of who and what will be on hand to act as clients.

Quantitative Results:

Several performance measures were captured which relate to the effectiveness of the EOC in a box as a deployable replacement to a traditional EOC in a box.

Power consumption: As configured, average power consumption is approximately 560 watts

CPU Utilization: With 14 Windows 7 machines, 3 Linux servers, and almost 6 Gigabytes of imagery data being analyzed, the server CPU Utilization was well under 50% with a few short spikes near 85%.

Disk Utilization: In the SAN, we did notice rather high latency on writes, spiking into the 100s of milliseconds. This appears to be due to using a RAID 5 configuration rather than RAID 6, and having all the Remote Sensing virtual machines on a single LUN, rather than distributed across multiple LUNs. A better understanding of what type of data is used will allow for a better LUN and RAID architecture for future experiments.

We did notice some degradation of the Remote Sensing vms, and this appears to be issues with the storage unit configuration. I plan to work with the vendor on analyzing these results as better SAN performance was anticipated

An example of disk utilization and performance on one of the Remote Sensing vms is: Read Rate 384 kbps, Write Rate 81.722kbps, Read Latency 5.739ms, and Write Latency 23.028ms

Disk utilization and performance from vms running on the internal storage of the server, on SSD drives hit rates of: Read Rate 2530kbps, Write Rate 1587, Read Latency 1ms, and Write Latency 1ms

SAN Throughput on the initiators varied by demand and application with reads as high as 36523kbps and writes as high as 24529kbps.

Also, there were only two one Gigabit hardware initiators in the server chassis, and typically there will be four our more to allow for Round Robin Multi-Pathing. Initiators are also available in a 10 Gigabit format which would improve throughput, but not necessarily reduce latency on writes

Qualitative Results:

Using job shadowing, multiple users were able to work with Zero, Thin, laptop, and IPad clients running Windows 7 virtual machines and access EOC in a box hosted applications. Instruction on who, what, why, and how was provided via presentations followed by hands-on exercises. Most users I observed where able to follow along with minimal assistance if they had an understanding off the applications they were using or what events they were watching.

Collaboration / Ad Hoc Experiments:

NPS CAW/Sensor Island. Capturing and working with data, moving data between locations. We operated a remote camera via TCP/IP link and a remote workstation locally and via remote location over a VSAT link. We also worked with imagery data that was processed at Sensor Island and pushed to and from the EOC in a box.

NPS HFN, Alternative Power, BGAN, VSAT, Wireless Mesh. Used the HFN autonomous infrastructure to access camera feeds

ViaSat, Provided a .75m VSAT Ka band Surf Beam Pro satellite for the experiment. They provided the system and access to a 20Mbps x 6 Mbps throughput link for 2 days AVwatch provided an airborne Wave Relay node which integrated with the HFN mesh and provided live video feed to their remote servers which were then viewed on multiple terminals served by the EOC in a box and delivered via the ViaSat link.

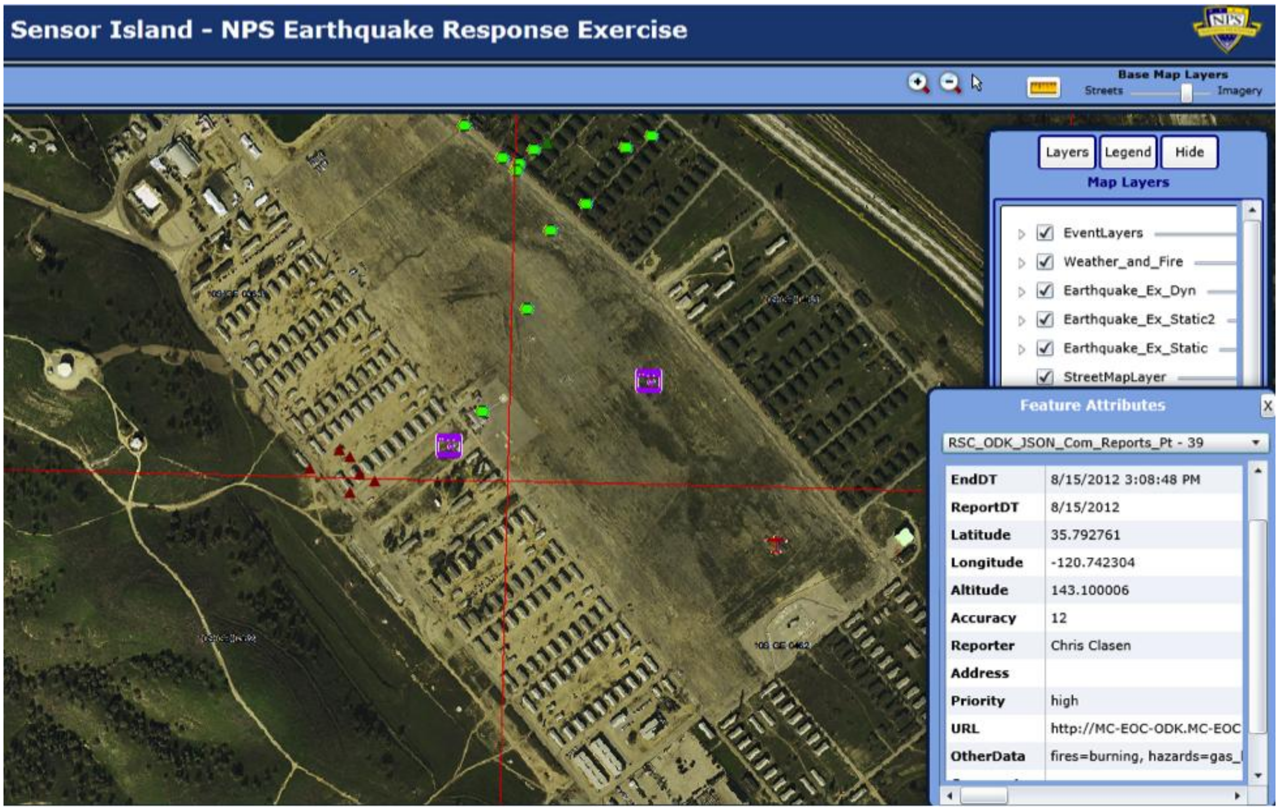
Observations & Comments:

This was my first exposure to eh JFIX and RELIEF experiments, as well as my first trip to Camp Roberts. The support provided was excellent, the facility provided ample resources and the structure of the events was very well executed.

Experiment # A-18

Sensor Island

Naval Postgraduate School - Center for Asymmetric Warfare (CAW)



Principal Investigator/Lead: Alan Jaeger, NPS

Working Hypothesis:

If collection, sharing, dissemination and enhancement of situational awareness across the dynamic response and team are associated with and necessary to disaster response, then the sensor island framework can adapt and translate sensor inputs into consumable outputs to responders.

Objective:

Test the Sensor Island framework, operating out of the Center for Asymmetric Warfare, by connecting the framework to dynamic elements of the JIFX exercise and disseminate information from those elements to participants and their individual common operational picture components. The test will include a deliberate examination and assessment of sensor and device performance (latency, content, visualization, bandwidth impact etc) via the island, common operational picture compatibility, and scaling of the sensor island to accommodate a range of consumers and consumer parameters. The dynamic elements could include select sensors, platforms (unmanned and manned vehicles/aircraft), data entry devices (smart phones i.e. Lighthouse type apps), and geolocation beacons. In addition to providing a common sharing portal, the Sensor Island will also be used to cue devices and actions based on the dynamic element responses.

Overview/Background:

The Sensor Island concept was established at the Center for Asymmetric Warfare and contractor facilities to support exercise activities including Operation Golden Phoenix, the AUVSI Firefighting Exercise, and Coastal Trident 2012. Sensor Island components include database, software and geographic information system software configured to operate on the CAW gigabit network with sensor and protocol adaptors who's end purpose is the common ingest of sensor and platform/device data from various consumers, adapting and translating those inputs into commonly consumable geographic outputs, and providing dynamic updates of that information to a variety of common operational picture/situational awareness capabilities used across the responder community. The Sensor Island has been used to integrate a wide variety of sensors, data feeds, mobile objects/unmanned and manned vehicles and this specific experiment concept elevates the assessment of the island to answer questions about scaling, extensibility, and operational performance across a number of potential common operational pictures and user environments.

Experiment Description:

The Sensor Island has been demonstrated in other exercises but has not been stressed/tested as a core element of those exercises. This experiment proposes to elevate this critical data collection and dissemination capability to discover it's capacity, potential sensor/device and client loading, and constraints of operations. The system, operating at the Center for Asymmetric Warfare will be tested for individual sensor and device performance as well as combined sensor operations. The experiment will be accomplished as part of the JIFX activity and will adapt to the sensors and devices of the experiment but will also be specifically stressed to identify performance of the island infrastructure itself. Exercise participants will be connected to the Sensor Island as contributors, consumers, or both and their infrastructure/connectivity tested against the tested performance parameters of the system. The participants will evaluate the utility of the shared information and the impact on and compatibility with their inherent situational awareness tools.

Measurements/Data Collection Plan:

Collect information on sensors, platforms and client common operational picture frameworks

Integrated select sensors and platform data feeds into the sensor island architecture and calculate data throughput and storage requirements

Collect remote sensing products from field analysts and translate and disseminate those products via the sensor island to client COPs - test on desktop/laptop and mobile versions of COPs

Test different open geospatial consortium (OGC) formatted products for delivery performance (speed/bandwidth consumption) as well as content and attribute information - e.g. Web Mapping/Feature/Processing Services - WMS, WFS, WPS

Test dynamic updates across COP platforms and Sensor Island's ability to push updates at different time intervals

Measures of Performance/Measures of Effectiveness:

Common Operational Picture compatibility across all tested platforms.
- Desktop/laptop
- Mobile apps on Android tablets and phones and potentially iOS equivalents

Test browser types for compatibility with COP and Sensor Island displays
- IE9+, Google Chrome, Firefox,

Test browser refresh speeds/performance

Test latency of sensor information across the networks and out to COPs - define the "near real time" performance constraints

Measure server performance against multiple consumer scenarios using various update settings

What new capability (or improvement to existing capability) does this represent?

The new capability provides for the collection, sharing, dissemination and enhancement of situational awareness across the dynamic response and teaming associated with and necessary to, response to disasters.

The common "sensor island" framework adapts and translates various sensors and platform inputs into commonly consumable and tailorable outputs to responders and their information/common operational picture architectures.

The specific new extension of what's been done with Sensor Island in the past is that the island itself becomes the evaluated and assessed component. The utility of the island concept has been established in previous exercises. This new activity provides NPS and future users of the capability a better understanding of the strengths, limitations, the potential for expansion of the capability, and will likely identify new uses for future activities.

Quantitative Results:

Established and demonstrated dissemination paths for NPS/Remote Sensing Center products including: GeoRSS, GeoPDF, and imagery files (kmz/kml, img, tif, sid)

Created Exercise and Manager Common Operational Pictures for viewing products and real-time updates and edits made in the Manager COP such as event locations, sensor/camera locations, and communications nodes.

Created ftp folder system linked to COP grids over Monterey and Camp Roberts hyperlinking geographic compositions and other imagery products within those grid zones

Created four webservices for products and geographic data – Dynamic, Event, Static (queriable), Static (non-queriable). The web services provided access to a number of external COPs such as ArcGIS and Google Earth.

Created automated dropbox function to translate kmz/kml and JSON files to displayable geographic data within the COPs. No real time/near real time data or products were created during the exercise so this automated capability was not taxed.

Established video camera link at the exercise site/cantonment area. Video camera functioned well when WIMAX comm was active. WIMAX comm was not always operational throughout the exercise.

Collected 19 text reports from exercise participants deployed to the cantonment area on 15 Aug and from 8 additional reports from Monterey area via JavaScript Object Notation (JSON) and shared that information with DHS's UICDS and WebEOC. All reports were received and displayed on the Exercise COP and ultimately in the WebEOC application.

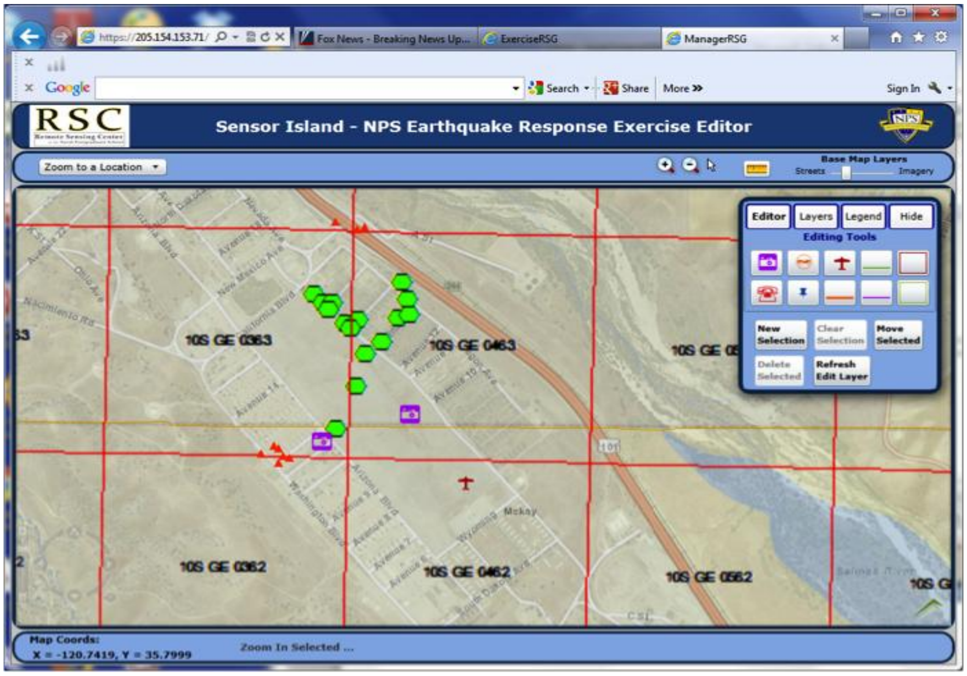


Figure 1 - Grid Zones (red squares) for Camp Roberts Products

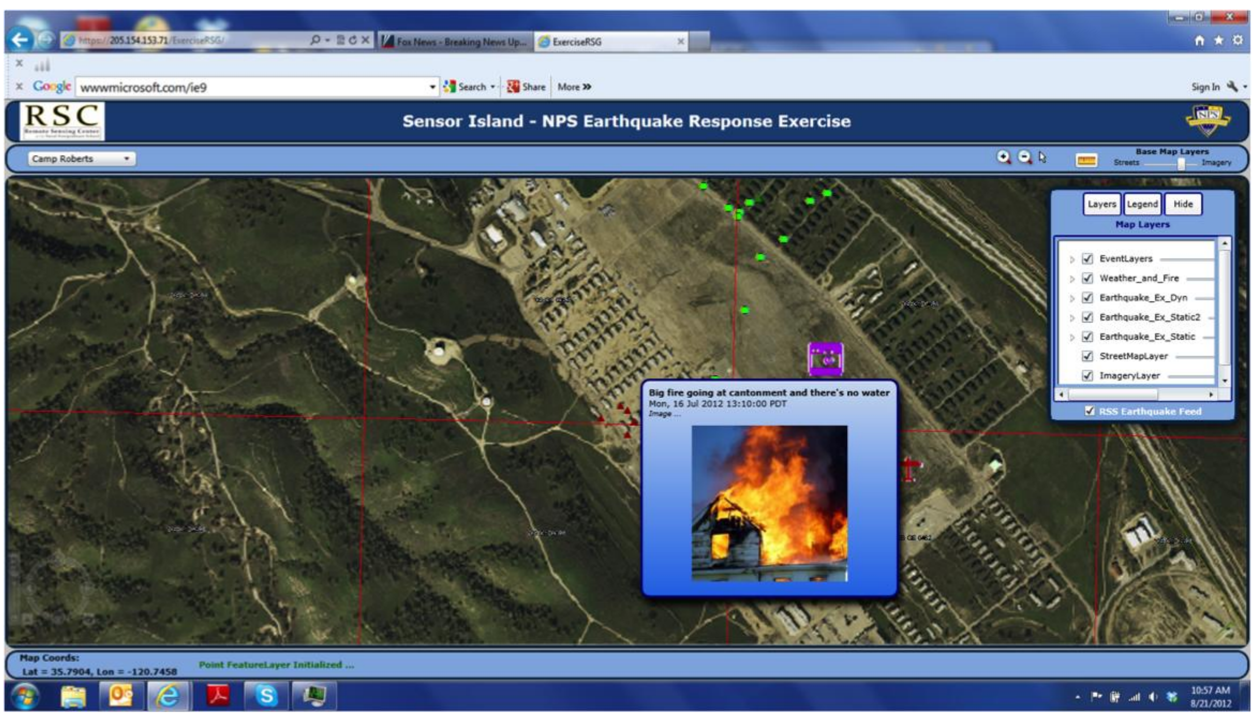


Figure 2 - Exercise COP showing GeoRSS feed, JSON reports (green), and video cam location

Qualitative Results:

Sensor Island operated continuously throughout the exercise time period and the exercise and manager common operational pictures were accessible at all times.

Exercise participants entered data from the cantonment area on Weds afternoon and data was transmitted to Sensor Island and disseminated among consumers including the exercise COP, UICDS, and from UICDS to WebEOC.

TerraPan Labs produced change detection products in the field and posted them to their GeoRSS URL which published the product and text to the COP infrastructure. The products showed changes in the geography and location of items as small as boxes and vehicles within the scene. For future implementations, larger imagery pics and more descriptive text capabilities would be useful as well as date/time stamps on the products to provide temporal context.

The movement of social media type text updates via the Lighthouse application, the Sensor Island drop box feature and the UICDS to WebEOC connection proved to be a reasonable and relatively straightforward implementation with little human interaction required. The specifics of the messaging content and the applicability to emergency responders and command centers should be examined or more directly connected to the needs of the end user.

GeoPDFs were created prior to the exercise and were placed in the grid boxes/ftp accessible folders on Sensor Island. The products themselves were good but no new products were built during the exercise so no assessment was made of the utility, speed, or effectiveness of the products themselves or the impact on Sensor Island in terms of throughput. These products are relatively large (10-50Mb files) and may not be sustainable in constrained communications environments.

Collaboration / Ad Hoc Experiments:

- NPS/Remote Sensing Group – imagery product creation and dissemination, Primary activity
- NPS/Center for Asymmetric Warfare – Sensor Island, communications infrastructure, video camera integration, Primary activity

- NPS/Hastily Formed Networks – WIMAX and SATCOM communications infrastructure
- DHS UICDS – web service sharing and data dissemination through UICDS to WebEOC and other EOC applications
- Monterey County EOC/GIS – web service sharing and WebEOC support
- San Diego State University, Department of Geography – change detection imagery production
- TerraPan Labs LLC – change detection imagery production and publication via GeoRSS

Observations & Comments:

All systems for producing and disseminating remote sensing products for JIFX, including Sensor Island, worked very well though the systems weren't stressed with significant, dynamic data flow that might be expected in the event of an actual emergency response situation. The communications network set up to support initial day's operations worked sporadically throughout the period and the video camera implementation at the cantonment area operated well when WIMAX was operating.

Recommendations - Future work should focus on stressing the flow of these products from collection through processing and to various methods of dissemination to determine where the weaknesses are in the end-to-end process. The utility of the products for individual consumers should also be assessed to determine data collection and production priorities in response to events.

End user consumption of the products, via web services of various types and through GeoRSS and ODK types of feeds should be established by product and provided as a transitioned capability.

Experiment # A-19

Frontier (FFT)

ITT Exelis

Principal Investigator/Lead: Bryan Charboneau, ITT Exelis

Working Hypothesis:

If friendly force tracking devices have advanced tracking/data exfil capabilities, remote command/control functions, and low-visibility vision, then communication, personal, and friendly force tracking is all achievable in disaster zones.

Objective:

Deploy multiple Frontier FFT devices in field exercise in order to collect performance metrics and user feedback related to flexible application of the device.

Performance metrics of interest include: position accuracy, reporting consistency vs. challenged environment parameters, battery life, monitor/control post flexibility/functionality, form factor user feedback, etc…

Possible applications include asset/vehicle tracking/logistics, personnel tracking in tactical environments, high value personnel tracking (e.g. first responders), low baud rate sensor data exfil, remote command/control function, and low-visibility friendly force tracking (LVFFT) SOF applications.

Overview/Background:

Frontier is a friendly force tracking (FFT) device providing global multi-mode communications/tracking capability for asset/vehicle tracking/logistics, personnel tracking in tactical environments, high value personnel tracking, and low-visibility friendly force tracking (LVFFT) SOF applications.

Positional and sensor data is autonomously transmitted in encrypted form from the remote tracking device to a monitor-control post (MCP) per pre-configured mission requirements. Device behavior/reporting can be configured to alter based on location, temperature, motion, programmable button(s), tamper and/or external sensors. Frontier devices allow for remote reconfiguring and data retrieving. The base configuration of the remote device has two communication modes for redundancy and improved coverage – SMS over a GSM cellular network and SBD over the Iridium satellite network. Additional line of sight LPI/LPD communication, geolocation, and DF capability can be included. Frontier also has the capability to exfil internal and external sensor data.

Frontier is small (4"x2.4"x0.95"), light weight (140g), low-power (12 hr life per charge with 1 report per minute), accurate (3-6m position accuracy) and highly configurable in function and form factor.

Experiment Description:

For friendly force tracking applications, we will deploy Frontier on vehicles, dismounted personnel or other assets if available. These hosts may follow scripted and unscripted paths. The various tracking devices and their internal sensors will be monitored via a Frontier specific MCP or other available situational awareness tools such as RAPTORX, ATAK, or LIGHTHOUSE (availability dependent). The MCP will also provide the ability to command/control reporting/configuration parameters remotely for each device.

Possible ad-hoc experiments (if time allows) could include experimenting with an alternate line-of-sight communication link with Frontier, performing direction finding of a Frontier, and ATAK integration testing.

Measurements/Data Collection Plan:

The MCP will be used to collect data from Frontier devices. Each message received will be saved on the MCP and can be retrieved at any time. Data collected in the MCP for each message includes time, location, temperature of device, remaining battery life, motion status, and the distress signal (blue force applications). This data can be compared to the known status of the vehicle or object being tracked.

Measures of Performance/Measures of Effectiveness:

Quantitative:

- Number of devices tracking objects during the course of a scenario
- Time to switch between GSM and Iridium networks
- Minimization of the number and duration of track losses
- Location accuracy compared to ground truth (estimated to be 3-10 m)
- Battery life prediction and consistency

Qualitative:

- Form factor function with various host (weight, size, etc..)
- Device function in challenged environments (antenna performance in real life scenario)
- Monitor and control post function and flexibility

What new capability (or improvement to existing capability) does this represent?

The Frontier solution is a leap forward in tracking/data exfil capability implemented with state-of-the-art components and integration techniques. It satisfies multiple missions by enabling rapid, configurable, and accurate tracking/data exfil in a small, lightweight and power efficient form factor.

Experiment # B-10

DART 20

CACI-SystemWare

Principal Investigator/Lead: Pete Moret, SystemWare

Working Hypothesis:

If a portable radio frequency collection and analysis platform is able to perform RF spectral mapping, RF surveys, and give indication and warning missions to forces, then HADR and frequency detection becomes more rapid and accessible within security operations.

Objective:

Demonstrate the DART System's ability to support First Responder activities by performing RF Spectral Mapping, RF Survey, and Indications and Warnings missions for deployed forces in support of Humanitarian Assistance/Security Operations.

Overview/Background:

DART is a portable, fully functional Radio Frequency (RF) collection and analysis platform that can operate independently or be networked as a multi-sensor system. Each DART is built with an on-board tuning module and processing module, embedded PC and internal GPS. This design enables the system to sweep extremely fast and provide a wide array of analysis tools that can be used in a real time or post collection mode.

The DART can also be remotely monitored via any broadband connection utilizing CACI-SystemWare unique monitoring software. The DART's small form factor and powerful analysis capabilities make it an ideal platform for multiple collection mission profiles. Whether in a single DART mode or be networked together in a mutually supporting role, this system is ideal for static or mobile collection missions.

Experiment Description:

Scenario - Humanitarian Assistance - Frequency Management/Deconfliction.
System Operators will demonstrate the DART's basic system functions of identifying and classifying known intercepted signals. Then the scenario based portion can begin by having the DART system search for unknown emitters and report their signal parameters. This portion of the test can be performed from a static position as well as mobile. This scenario can highlight the system's ability to assist in identifying active emitters to either assist in locating them or for spectral mapping and management.

Measurements/Data Collection Plan:

The data collection plan will consist of comparing the list of know emitters to the list of intercepted frequencies.

Measures of Performance/Measures of Effectiveness:

Measure of performance and effectiveness will be the comparison of known transmitters to the number of actual intercepted transmitters.

What new capability (or improvement to existing capability) does this represent?

The DART system is an extremely sensitive receiver with advanced analytical software that can provide enhancements in the following areas:

- Identify low power transmitters both friendly (during HA support or after loss of major infrastructure) or enemy (indication and warning of enemy transmissions or identify remote sensors utilizing spread spectrum signals)
- RF spectral mapping/survey utilizing Google earth application
- RF spectral management
- Force Protection - Indications and Warning

Experiment # B-11

Rapid, High Spatial Resolution Image Assessment of Post-Earthquake Damage

San Diego State University Center for Earth System Analysis Research / NEOS Ltd. / Terrapan labs

Principal Investigator/Lead: Dr. Douglas Stow, SDSU

Working Hypothesis:

If image assessment of post-earthquake damage can be analyzed with rapid change detection and characterization from airborne platforms, then cloud-based image processing and distribution will allow for rapid communication, detection, and action on the ground within post-disaster damage.

Objective:

To demonstrate the utility of airborne imaging for post-earthquake assessment of damage to critical infrastructure features using light aircraft image collection, semi-automated spatial co-registration of collected multi temporal image sets, and automated detection and identification of image change features associated with changes to critical infrastructure. During RELEIF we further seek to demonstrate the utility of a novel frame-to-frame image processing methodology and a newly developed image processing and change interpretation software/platform for expedited detection of changes over wide-areas.

Overview/Background:

San Diego State University's Center for Earth Systems Analysis Research, in collaboration with TerraPan Labs LLC and NEOS LTD (supported by the Naval Post-Graduate School's Remote Sensing Center) has developed an integrated remote sensing system for the rapid mapping of damage following earthquake events. The prototype system demonstrates the feasibility of using flexible and cost effective light sport aircraft, server side image processing and distribution, and a novel image collection and processing approach, to rapidly and automatically generate and distribute information on the nature and location of landscape changes caused by large scale hazard events such as earthquakes.

Experiment Description:

The utility of the prototype system will be demonstrated and detected change results will be incorporated into the larger NPS-RSC post-earthquake response demonstration. A baseline data set will be collected and then a series of fabricated change features will be introduced to the scene. A second imaging flight will be completed and the aircraft will land in Paso Robles to off load image data, the data will be taken to Camp Roberts by ground vehicle, and rapid damage/change analysis will be carried out. Data will be automatically processed to an enhanced change product and detected change features will be contributed to the NPS Earthquake Scenario common operating picture (COP) in the form of a KML. Multiple users will be allowed to interpret and annotate detected changes via the browser accessed interface and to submit those results to the COP.

Measurements/Data Collection Plan:

We will complete two imaging flights at a minimum: 1.) a baseline and 2.) a flight to detect changes since the baseline. Tarps, canopies, and other man made features will be introduced to simulate change features. We had originally intended to take-off and land the aircraft from the Camp Roberts airfield, but based on recent communications it seems that this will not be possible, so we will use the airport at Paso Robles. Additional imaging flights may be conducted if requested by the exercise director.

Measures of Performance/Measures of Effectiveness:

The number of targets introduced as change features will be compared to the number of detected targets. Users/interpreters will be asked to provide subjective reports of their experience and how the interface might better enable efficient characterization and reporting of change associated with damage.

What new capability (or improvement to existing capability) does this represent?

The experiment will demonstrate several novel technologies for rapid change detection and characterization from airborne platforms. Repeat photo-station acquisition, a novel image collection paradigm, is leveraged to enable automated, near real-time, and precise image co-registration and multi temporal image analysis. A novel server/cloud based image processing and distribution architecture permits distributed access to and analysis of automatically generated enhanced change products through a standard web browser to provide rapid access to change detections and descriptions from any networked system.

Quantitative Results:

Our experiment integrated with several other NPS RSC earthquake response exercises and demonstrated rapid and automated change detection with airborne imagery as part of a post-earthquake disaster response scenario. Airborne imagery captured by a digital color camera mounted on a NEOS Ltd. light sport aircraft platform and resultant change detection products were transferred in electronic form and integrated into the RSC earthquake response system. A single flight line was delineated across the axis of the cantonments area of Camp Roberts and a swath covered by three overlapping images was imaged multiple times on both August 15th and 16th (Figure 1). Each day, the aircraft flew a single flight line six times collecting 3 inch spatial resolution imagery, and three times collecting 6 inch spatial resolution digital color imagery. Three images were collected on each imaging pass, with 100 m spacing between them along the flight line. After the completion of each imaging pass by the aircraft, participants on the ground at the cantonments site moved several targets to simulate changes, including boxes, tarps, canopies, and strips of strapping and duct tape.

When imaging was complete each morning, the aircraft landed at Paso Robles airport and the digital images and supporting metadata files were delivered to the McMillan Airfield by ground vehicle. Upon arrival at the RELIEF event, the images and associated information about aircraft position and heading at the time of image acquisition were input into an automated work flow which included automated image co-registration (using an algorithm developed and coded from scratch by SDSU/TerraPan participants) and automated change detection (also developed by SDSU/TerraPan participants).

Figure 1. Flight line used for repeat-pass imaging of the cantonments area and detection of moving change targets.

Of the images collected on Wednesday August 15th, 10 pairs of images were found by the automated processing routine to be within a strict 1 m Euclidean distance between imaging stations, and these images were automatically co-registered as the next step in the processing pipeline. Of these 10 pairs, three were not co-registered with sufficient accuracy to perform detailed changed detection as determined by visual inspection in the web-based visualization and analysis tool. This likely resulted from inaccuracy in the results of a student generated automated point matching routine. On the second day, 16 images were found to match within a 1 m threshold. Four of these images were co-registered poorly by the automated co-registration routine, but the remainder were visually accurate, with many seemingly within 2-3 pixel registration accuracy.

Since the same area of ground was imaged by all six passes, we focused on a pair of images for each day that were co-registered within 2 pixel accuracy, selected by quick visual inspection in the web-based viewer (Figures 2-5). On the first day, a total of eight aggregate features changed. Two of these features were not detected. A pile of white boxes, which was stacked in the first frame and knocked down in the second time frame, was not detected likely due to similarity with the bright soil background. Likewise, a person with a low profile was not detected. Some small features such as boxes and peoples shadows were only partially detected, while large changes such as the movement of a car, rotation of a canopy, and slight movement of a blue tarp were reliably detected. Three false detections occurred where shadows moved substantially were highlighted with the default parameters for the change analysis algorithm.

For the Thursday August 16th mission, 10 changes were staged between each pass, for the selected pair of images. All but two of the changes were detected. One was a person that appeared in the frame, and the second was a small teal tarp that was moved. With default parameters on the change analysis algorithm (the parameters are interactively adjustable as part of the demonstration), no false detections occurred and white boxes that were challenging to detect based on Day 1 (Wed.) imagery were well detected. A closing car trunk door was detected, and the tarps that changed position were well quantified in terms of their shape and area in the image change product.

Figure 2. Review of multitemporal images in web-based change detection and visualization tool. The white box to the right shows the location of the change on a map when connected to high speed internet, but was turned off at RELIEF.

Figure 3. Review of change detection result in web-based change detection and visualization tool. The white box to the right shows the location of the change on a map when connected to high speed internet, but was turned off at RELIEF.

Figure 4. Change detection (top to bottom: first pass, second pass, change) example from repeat pass images collected Wednesday August 15, 2012.

Figure 5. Change detection (top to bottom: first pass, second pass, change) example from repeat pass images collected Thursday August 16, 2012.

Qualitative Results:

The imaging and change detection demonstration was successful, and results contributed to the larger NPS coordinated earthquake response exercise. Specialized image collection and processing techniques yielded pixel-level spatial co-registration between ultra-high spatial resolution (3-inch) imagery, and the automated change detection routine detected many of the introduced change targets with little false change detection. The automated processes were made possible by server side processing that combined and optimized all automated components. Change detection products were presented in a web-based visualization tool that allowed visual interpretation of the images and change detection results, interactive adjustment of change detection parameters, and submission of change detection results (graphics and text) to the common operating picture of the NPS exercise via GeoRSS feed.

The image-based change detection results that fed into the common operating picture as a GeoRSS feed contributed to the overall situational awareness of the simulated earthquake response event. The efforts of all of the NPS exercise team members made SDSU's process from image collection to results in a common operating picture seamless.

Mr. Dave Potter with the City of Monterey Emergency Services met individually with Pete Coulter to discuss the technology. Mr. Potter was interested in the capability for rapid image-based change detection, and was very happy that current, 6-inch spatial resolution imagery serving as a baseline for future change detection would be made available to him and his colleagues. During the NPS team presentations Thursday afternoon, Mr. Potter was particularly interested in how well *ad hoc* imaging attempts could perform relative to the repeat pass imaging and facilitate rapid change analysis.

Collaboration / Ad Hoc Experiments:

SDSU's image-based change products were submitted to the NPS common operating picture managed by Peak Spatial Enterprises using their sensor island platform (Figure

6). The change analysis and visualization tool developed by TerraPan Labs, as part of the SDSU team, was used to highlight significant change detections. Then, the tool was used to publish entries to a GeoRSS feed on a TerraPan Labs web server. This GeoRSS feed was monitored by the sensor island software and new entries were displayed on the map in the common operating picture. GeoRSS entries contained descriptive text, change detection image chips, and were referenced to point locations on the map. As an alternative publishing source, the XML file for the GeoRSS feed was also uploaded to a virtual machine hosted on the EOC in a box that NPS managed. This allowed publishing of the GeoRSS over the satellite internet connections hosted by the EOC in a box in the case that the feed could not be updated through standard internet sources.

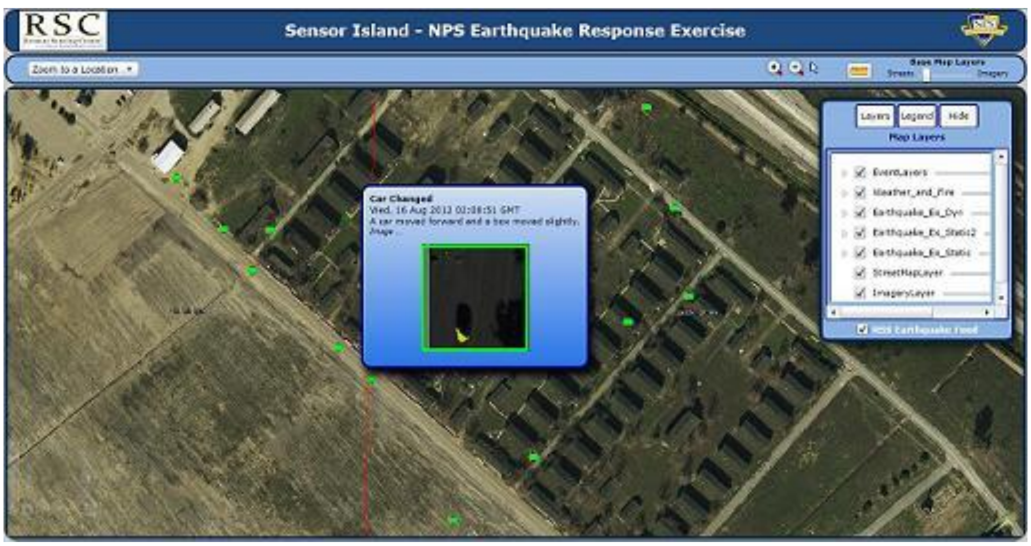


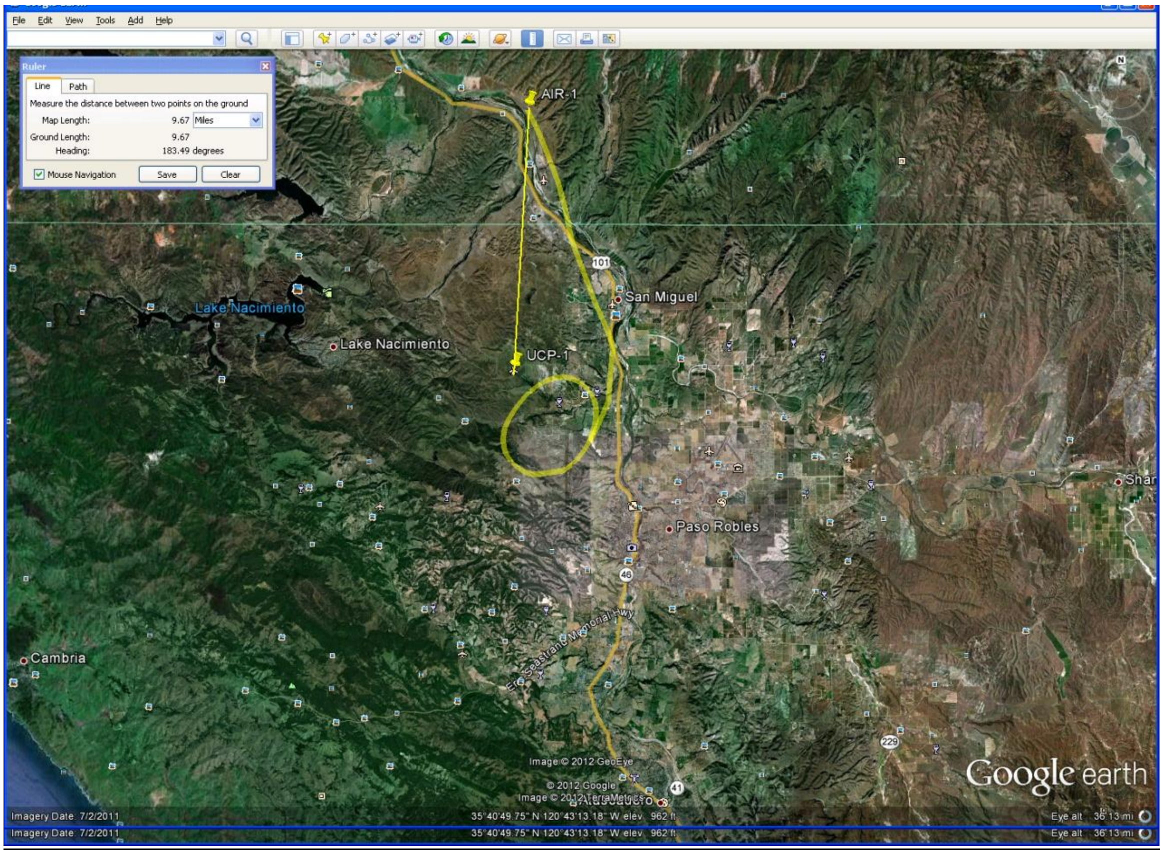
Figure 6. Example of SDSU's image-based change detection product in the common operating picture.

Figure 7. SDSU and other participants gathered for the NPS Post Event Imagery and Lidar Analysis training session (Training 6).

Experiment # B-12

Direct Imagery Tasking and Dissemination

Lockheed Martin Corporation



Principal Investigator/Lead: Russell Chan, Lockheed Martin

Working Hypothesis:

Direct dissemination of videos from a sensor platform and a deployable network infrastructure is vital to the communication between pilots/sensors and ground personnel to share information (streaming video, voice, text, etc.) for HADR.

Objective:

Demonstrate the capabilities to share information (streaming video, voice, text) between pilots/sensors and ground personnel. Demonstrate the creation of an airborne 2G GSM cellular coverage area.

Overview/Background:

Lockheed Martin's concept demonstrates a capability to establish a 2G GSM cellular area of coverage and stream video from a manned airborne platform. The airborne platform will have a 2G GSM cellular payload, laptop and video encoder. Voice communications will utilize smartphones. Video encoding technologies enable the video transmission across low bandwidth communication links like 2G GSM. The low frame rate video will be delivered to smartphones directly from the sensor/platform. If desired, we can show secure data-in-motion communications to the smartphone with our implementation of National Security Agency (NSA) Suite B certified algorithms. The smartphone and NSA Suite B certified algorithms have not been certified or accredited as an integrated system.

Experiment Description:

Our experiment would like to request the use of the Naval Postgraduate School Pelican manned aircraft. The video encoder and low power (<1 watt) 2G GSM cellular payload have flown on the Pelican at a previous RELIEF event in November'2011. For this experiment, we would propose a 20 watt 2G GSM payload for enhanced coverage, video encoder and the addition of a laptop. The experiment is a series of demonstrations to determine range and coverage at various aircraft altitudes for both voice, text messages and streaming video. Determine the value of direct communications from ground personnel observing the live stream video back to the pilot for subsequent direct tasking will be captured during the disaster scenario. Determine the value of voice communications in a disaster area where the current communications infrastructure is disabled or destroyed. For other experiments with dependence upon voice reports or text messages from the field, we can provide this data via the Universal

Communications Platform's interoperable IP network. If desired, we can add a second video encoder to disseminate the streaming video via a commercial cellular carrier (AT&T, Verizon). For the disaster scenario, these capabilities can provide voice communications and situational awareness.

Measurements/Data Collection Plan:

Data collection will begin after the aircraft reaches the desired altitudes. Range and coverage area will be noted.

Measures of Performance/Measures of Effectiveness:

1. Value of voice, text and streaming video coverage for a disadvantaged area of interest
2. Value of direct pilot engagement for imagery tasking
3. Ability to integrate the deployable airborne communications into an interoperable communications network

What new capability (or improvement to existing capability) does this represent?

1. Direct dissemination of video from the sensor platform.
2. Deployable cellular infrastructure for information sharing (voice, text, video).

Quantitative Results:

We successfully demonstrated both voice calls and streaming video via our private 2G GSM cellular network flying aboard the Naval Postgraduate School Pelican aircraft. The demonstrated voice and streaming video range was approximately 300 square miles with the Pelican at an altitude of 7500 feet AGL. The streaming video source was the Predator EO/IR turret imaging system flying on the Pelican aircraft. Utilizing our video compression algorithms, we successfully streamed low frame rate full motion video to smartphone and laptops connected with our private 2G GSM cellular network also flying aboard the Pelican aircraft. The performance is driven by the smartphone hardware limitation with lower transmit power and lower antenna performance. Our direct communications with the Pelican aircraft was through the Pelican ground control station. We could re-direct the turret camera pointing in near real-time since we had streaming video to our 2G GSM smartphones.

Qualitative Results:

The capability to provide real-time streaming video to the ground and communications paths back to the airborne platform will enable timely decision making for both commanders, military and first responders in any situation.

Observations & Comments:

This is a unique event where collaboration and experimentation is encouraged between the diverse set of participants (both large and small companies). The focus is exploration of future capabilities in a non-competitive environment. We are privileged to participate in these events and look forward to future events.

Experiment # B-13

Accelerating Imagery Collection with Manned Aircraft

National Defense University Center for Technology & National Security Policy | TIDES

Principal Investigator/Lead: Dr. Linton Wells II, NDU / John Crowley, NDU

Working Hypothesis:

If the time to collect imagery from an aircraft is reduced, then the federal ability to scope disaster zones and mobilize/push federal resources for the aid of state and local responders is reduced, increasing situational awareness in response operations.

Objective:

To accelerate the collection, processing, and analysis of the first imagery taken after a disaster: photographs from manned aircraft. The objective is to accelerate the derivation of damage/flood polygons to define the area of operations for arriving responders.

Overview/Background:

After a disaster, the first imagery is usually collected by manned aircraft. However, because flight crews are often given only basic collection plans, and because camera systems tend to lack technology that makes it easy to automate the subsequent photogrammetry on the raw imagery, the first imagery after a disaster is poorly integrated into the situational awareness of either the local EOC or national GIS desks.

Experiment Description:

This meta experiment will explore several interlocked methods to accelerate the collection, processing, and analysis of imagery from manned aircraft.

1. Dynamic Tasking Plan: using map algebra, the team will explore the fusion of USGS shake maps, US critical infrastructure maps, social media data, and demographic data. By identifying grid squares where there is a high correlation between critical infrastructure pathways, high shake intensity and/or high population, and either high social media reports of damage or silence from social media in high population areas, the team will build a collection plan for manned aircraft to image.

2. Camera Systems: Most manned aircraft use handheld digital SLR cameras. The team will explore TTPs to make these camera systems more amenable to automated or crowd-based photogrammetry to build mosaics of the affected area.

3. Comparison of Photogrammetry systems: Automated photogrammetry and crowd sourced mosaicking each offer the ability to turn handheld photos into composite imagery that can be used as base maps. The team will explore options for accelerating the process of mosaicking imagery from handheld camera systems as well as other mounted camera systems.

4. Derivation of Damage/Flood Polygons. The team will explore the use of crowd sourcing to derive damage/flood polygons from processing imagery from manned aircraft.

Measurements/Data Collection Plan:

Imagery will be collected using several aerial platforms for comparison of TTPs: CAP Nikon D90 DSLR with geotagging attachment; AVWatch camera system; ROVER camera system; and the Predator A optical package on the CIRPAS Pelican aircraft. Other data will derive from previous incidents in the USGS database and comparison with public infrastructure data. Imagery will be shared with GISCorps via web services for photogrammetry and derivation of flood polygons.

Measures of Performance/Measures of Effectiveness:

a) Speed of collection of critical infrastructure points.
b) Speed of mosaicking collected imagery
c) Speed of derivation of damage polygons.

What new capability (or improvement to existing capability) does this represent?

Damage polygons often take days to release. This capability would reduce the time to hours and would enhance federal ability to scope disaster zones and mobilize/push federal resources for the aid of state and local responders. It would also prove capability of using local pilots in other countries for rapid imagery collection after a disaster.

Quantitative Results:
The purpose of the experiment was to deliver imagery of greater utility to FEMA at higher velocity (earlier in the response). Utility was to be qualitatively measured using a qualitative scale of 1-4 assessed by imagery analysts at JIFX, and speed was to be determined by the tempo of collection through processing.
The results of the experiment are still being calculated. Preliminary metrics are as follows:

1. **Field of View**: CAP had traditionally acquired imagery at 12 megapixels from 1000-1500 AGL with a 30-45 degree oblique angle to show building damage, giving a field of view of approximately 300m x 200m (or smaller) plus the area covered in the trapezoid of the oblique. Experiments showed optimum balance of resolution and field of view could be obtained with a focal length of 30mm from ~3050m AGL (~10,000 ft), giving a field of view of approximately 3km x 2km and bringing the imagery far closer to the ideal of nadir. Resulting imagery was approximately 1m in resolution, akin to early commercial satellite imagery from disasters, which turned out to be the resolution that FEMA needs. Analysts subsequently built a calculator to allow camera operators to calculate analogous

field of views for low altitudes (temporary hosting at http://iconocla.st/m/focal.html).

2. **Speed as a function of field of view**. Because CAP can now fly at higher altitudes and take photographs that are approximately 100 times larger, speed needs to be measured in future experiment in two ways:

    a. **Collection**: CAP collection times should decrease between one to two orders of magnitude, depending on the weather, air speed, and air space restrictions that require special flight routing. This hypothesis needs to be tested at a future JIFX.

    b. **Processing**: Analysts will need to process about 100 times fewer photographs. Whether performed using automated geo-registration (as detailed below) or manual tie-point matching, the time to process should drop by more than an order of magnitude. This hypothesis also needs to be tested at the next JIFX.

Qualitative Results:

Abstract

The JIFX field explorations at Camp Roberts enabled FEMA, NGA, and Civil Air Patrol (CAP) to rethink their concept of operations for collecting imagery in the first two-days of a disaster response operation. Traditionally, CAP has collected thousands of high-resolution photographs from low altitude, with each photograph covering a few hundred feet on each side. This method made it impractical for FEMA to stitch the photographs into a comprehensive map in the early hours of an emergency, and often relegated CAP's imagery to use for specific (later) spot analysis. By convening the stakeholders to CAP imagery at Camp Roberts/JIFX, the team developed a new CONOP for CAP:

1. **Collection**: Sorties will fly at higher altitudes (10K ft AGL at 30mm focal length or at lower altitudes with a focal length to create the equivalent field of view of 10K ft with 30mm focal length), collecting survey imagery that covers

approximately 6 National Grid squares per photograph. The goal is to enable rapid collection and processing of large areas, enabling FEMA to determine where CAP should collect high-resolution imagery of specific locations in subsequent sorties.

2. **Mapping**: CAP will integrate with FEMA's National Grid standard for its operations, gradually pulling it in line with the rest of the federal ICS structure.

3. **Crowdsourcing**: imagery processing will be farmed out to a bounded (trained) crowd to identify National Grid squares with no damage, light damage, and heavy damage. This first filter will enable federal analysts to focus on locations which need the most help and accelerate allocation of federal resources to these areas. It should also enable federal agencies to more accurately scope their operations, saving tax payer dollars. An opportunity exists to define the crowd as a subset of CAP's 60K volunteers, as they are all technically members of the USAF Auxiliary and highly committed to supporting their peers; competitions between wings are also possible incentive structures for motivating aid during smaller disaster response operations.

Background

When disasters strike, responders need to discover where aid is needed and mobilize assets to those sites as fast as possible. While overhead imagery is usually the fastest method to identify areas that have been damaged, high-resolution imagery from satellites and aircraft is often not available until day 2 or 3; cloud cover and weather can delay imagery until even later in the response. As a result, responders revert to trusted (and reliable) two-way radios and paper forms, leaving the manual task of aggregating all individual verbal/radio and written reports into a comprehensive map to staff an emergency operations center. As a result, despite investments in geospatial tools, damage assessment is still a very paper-based process. The team discovered a way to improve this situation with a change to practice, rather than new technologies.

The Civil Air Patrol (CAP) is often the first organization to collect aerial imagery after a disaster. With over 550 aircraft spread across the country and 60,000 volunteers, it can mobilize crews to fly over affected areas within hours of a catastrophic event. CAP collects high-resolution photographs of damaged buildings and critical infrastructure from relatively low altitudes (1000-1500 ft above ground level (AGL)). During Hurricane Ike, CAP collected over 40,000 photographs of damage. However, this imagery has rarely been exploited in ways that provide federal and state responders with a broad overview of the disaster. Imagery arrived in format that did not allow for rapid processing: images were large files (often more than 6MB each), were not aligned with National Grid, had little metadata, and were consequently difficult to rectify on FEMA's maps.

Current Concept of Operations (CONOPS)

CAP can operate in two modes: operating under its Title 36 authorities and agreements with state and local agencies; and under Title 10 part of the Air Force Auxiliary. Because Title 10 status provides additional liability insurance and worker's compensation insurance to its volunteers, CAP prefers to fly under authorization from the USAF. (NB: More research is needed to understand how the time to obtain Title 10 authority might delay imagery collection during the first 24 hours of an emergency.)

Under authorization from the AFNORTH (601st AF), CAP collects imagery in a disaster zone at low altitude (usually 1000-1500 ft AGL) using a COTS Nikon D90 digital single-lens reflex (DSLR) camera with basic geotagging capability. Imagery collected is generally shot at the full-resolution of the camera (about 12 megapixels), with each sortie collecting around 4000 images over a relatively small area. Photos tend to be shot at a 30-45 degree angle off nadir (aka, "obliques"), enabling the viewer to see conditions of buildings from above and the side.

Problems with Current CONOPS

While the high-resolution "oblique" photographs are useful as spot photographs, other federal aerial imagery collection assets have far superior cameras with nadir mounts that can fly around day 2 or 3 after a disaster. As a result, FEMA considers the value proposition of CAP imagery to be very perishable: CAP is most useful for an initial glimpse of the disaster, providing a quick view of the scale and severity of the incident during the first 24-48 hours.

That said, the current CONOP makes it difficult to exploit CAP's efforts: in the initial operation, federal officials need to see an *overall* view of the disaster to scope the federal response; only then do agencies zero into investigating the status of specific locations. The time necessary to stitch tens of thousands of photographs into a comprehensive map is impractical: the imagery's utility will have perished before that process could ever be completed, even using existing automated methods or harnessing new capabilities of crowdsourcing.

It should also be noted that FEMA has a responsibility to provide data and operating procedures to CAP. To the knowledge of the participants, FEMA and CAP have never before met to discuss requirements for imagery collection. It will be necessary for FEMA and CAP to develop both a CONOP and SOPs.

Field Exploration

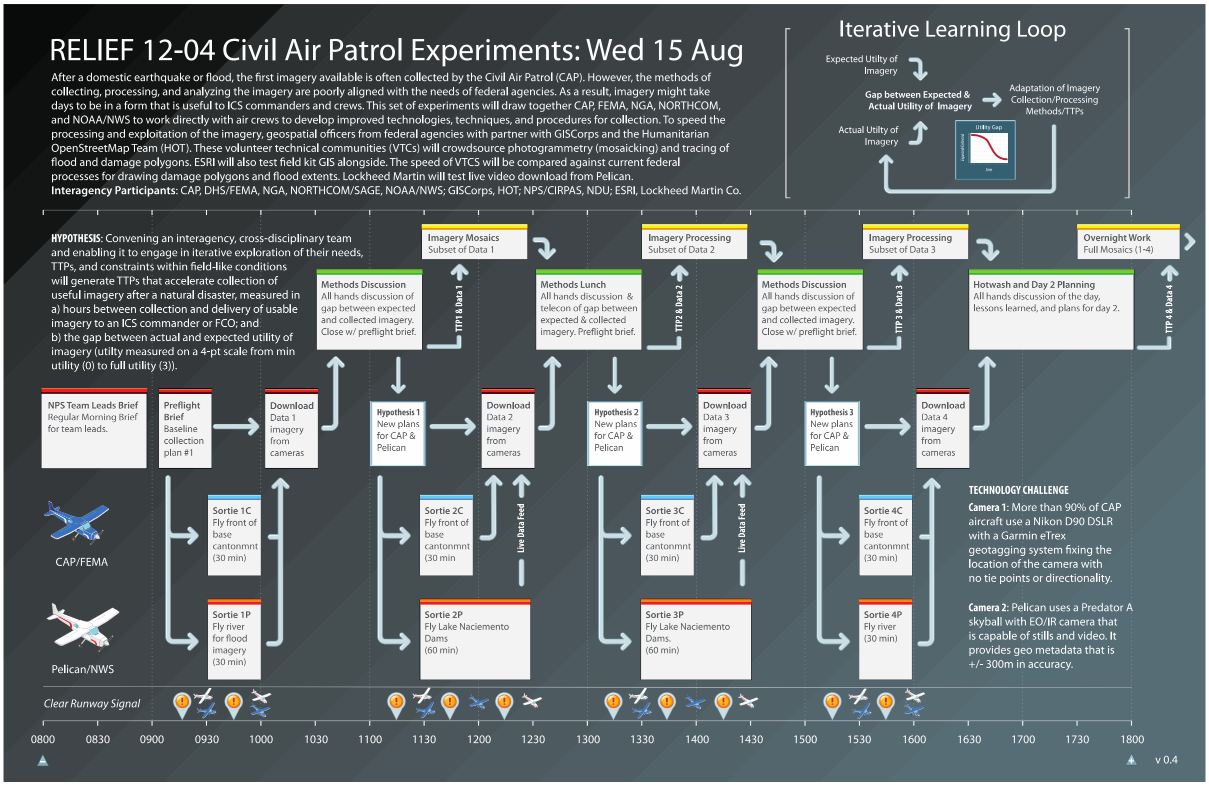
Because the field exploration at JIFX 12-04 was the first time that CAP, FEMA, and NGA had convened and discussed interagency requirements in memory, some of the field explorations were quite literally discovery. The conversations between the teams to establish parameters for sorties and data collection have become a proto-framework for a new CONOPs.

Design

Experiment was designed to allow iterative exploration of capabilities and constraints at all levels of the imagery workflow: sortie planning, collection flights, transmission of data to FEMA, analysis, and evaluation, and the activation of CAP for subsequent collections. It tested the following hypothesis:

Convening an interagency, cross-disciplinary team and enabling it to engage in iterative exploration of their needs, TTPs, and constraints within field-like conditions will generate TTPs that accelerate collection of useful imagery after a natural disaster, measured in a) hours between collection and delivery of usable imagery to an ICS commander or FCO; and b) the gap between actual and expected utility of imagery (utilty measured on a 4-pt scale from min utility (0) to full utility (3)).

The following graphic illustrates the intended workflow of the JIFX experiment (figure 1).



Experimentation as Performed

The team was able to fly three of four intended sorties with CAP, and had to fly the Pelican collections on a previous day, but was able to complete all work and data collection.

CAP Imagery

The team collected three sets of imagery:

Sortie 1: Base cantonment area from 1000 ft AGL and multiple camera resolutions. This imagery was very high resolution (able to discern telephone wires and roof tiles). While FEMA and NGA initially found high utility in the imagery for focused damage assessment, the overall goal of scoping the federal response revealed that the imagery was too “close in” for wide-area assessment and too oblique to use to make wide-area maps. The determination was made to explore other fields of view from various altitudes: 2K, 4K, 6K, 8K, and 10K AGL at an angle closer to nadir at full resolution of the camera.

Sortie 2: Base Cantonment area from 2K, 4K, 6K, 8K, and 10K. The CAP air crew took imagery using a fixed focal length (30mm) at five altitudes (camera was fixed to 30mm with painter's tape). On analysis, FEMA and NGA determined that the imagery from 10K AGL at 30mm had the highest utility for wide-area surveys and just barely had the resolution needed to determine initial damage assessments. The altitude also had the effect of bringing the camera closer to nadir. The team scoped a third mission to test the hypothesis that this field of view and altitude would yield required results for FEMA and NGA.

Sortie 3: Paso Robles from 10K ft AGL at 30mm Focal Length: The CAP air crew shot imagery from 10K ft AGL at 30mm focal length at 12 megapixels. The resulting imagery was deemed to be of high utility by FEMA and NGA, but a new issue emerged around oblique shots from higher altitudes. The TTP will need to include instructions on controlling camera angle and CAP may need to investigate fixed camera mounts for use inside its aircraft.

Pelican Imagery

The data from Pelican are still being processed (they were not able to be autoregistered in the field using existing methods). The team is currently looking into automated methods for turning these videos (stored on Super 8 tapes) into maps. There are a number of promising avenues (including Lockheed Martin's tools and Radiant Blue's OSSIM plugin for the Predator A) but no results to report yet to the JIFX council.

Implications

Faster Collections

CAP collection times should decrease, depending on the weather, air speed, and air space restrictions that require special flight routing. It there is a theoretical potential to see a decrease of in collection times of 10x or more. The actual realized potential will need to be tested.

Faster Transmission Times

Because CAP is now taking 100x few photographs per unit area, the time to transmit imagery should go down by a large factor. That said, the pipe that CAP is using—cellular modem and/or BGAN terminal—have an upper data limit that will still mean imagery takes many hours to upload to FEMA. This transmission problem should b considered as a new S&T capability gap, perhaps for the next JIFX RFI.

Faster Processing

With a fewer number of images, processing the individual photos into a composite mosaic should be greatly accelerated. The goal is to build a map for the arriving FCO within hours of the onset of an event. That goal is now technically possible. Actual practice will need to be the subject of future JIFC experiments and Simulation-Exercise work.

Potential Reduction of Federal Expenditures per Disaster

If CAP imagery can help FEMA more accurately scope the federal push to an incident, the method has potential to save federal expenditures and time on responses, particularly when the scope or scale of a given response seems large but the actual damage is light.

Discovered Issues

Airspace Coordination

CAP's ability to collect imagery in an disaster area is mediated by its ability to obtain authority to enter restricted airspoce (s). This new CONOP at higher altitudes will need to be integrated with NORTHCOM and AFNORTH (601st).

Data Downlinks from CAP Aircraft

Getting imagery in real time from the aircraft would greatly accelerate the analysis of the damage. This work could be faciltated by satellite communications (high altitudes may may it difficult to use cellular data connections). Use of significant compressi algorithms could also speed transmission times, which may also assist in transmission from ground stations.

Fixed Camera Mounts

CAP discovered that even experienced camera operators can fall off nadir. As a result, the team recommended that CAP explore the pursuit of an open hardware design for CAP camera mounts, which might be pursued under the America Competes Act as a competition for the best, low-cost camera mount that works in all of CAP's aircraft. Geeks without Bounds is exploring next steps.

Dynamic Collection Plans

Determining where CAP should collect imagery first requires knowledge of the intersection of a number of situational awareness streams: first responder reports, social media reports, locations of critical infrastructure, maps of population density, weather reports, fire lines, shake maps, and the like. At JIFX 12-04, ESRI/GeoIQ explored the use of dynamic real-time maps that cross-correlated these various factors. The development of this dynamic map and its inclusion on a tablet for the CAR spotter and incident commander might well focus CAP on the hot spots at the earliest possible time, rather than 24+ hours after their discovery. NGA and ESRI are exploring.

Automated Imagery Processing

Auto-georegistering imagery and computing diffs between pre and post imagery could greatly speed the creation of maps and focus federal analysts on areas with high damage (determined from a high differential between pre and post conditions). Lockheed Martin developed a prototype tool at JIFX to perform this task, and is exploring further work with FEMA, CAP, and NGA.

Crowdsourced Analysis

Kate Chapman and Schuyler Erle of Humanitarian OpenStreetMap Team (HOT) developed a crowdsourcing application to perform a Hot or Not for damage assessments. This tool could be used to

Future Camera Systems

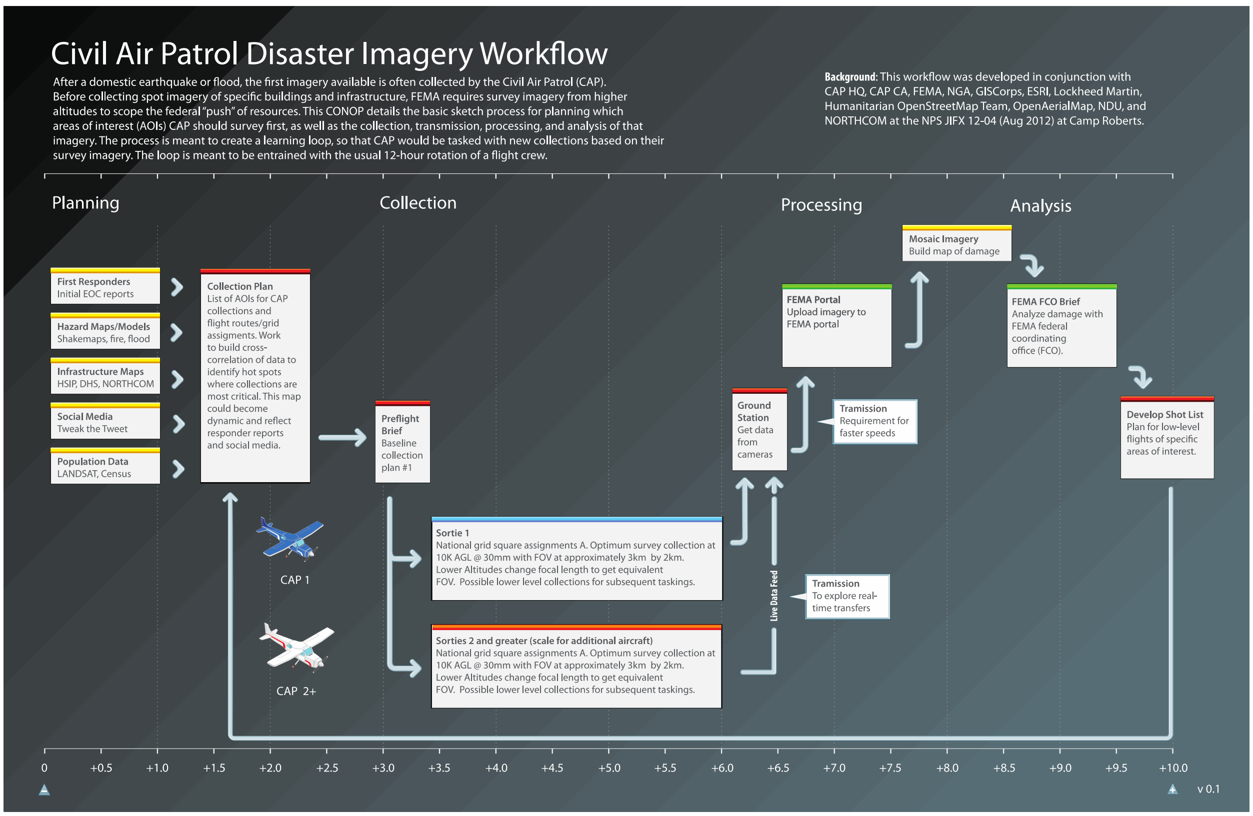
CAP may explore the replacement of its current GP-1 GPS device and assess the use of a 3D compass to give tie points of photographs, which could enable autostitching software to be more effective in this context.

NWS Rapid Probabilistic Damage Models

FEMA would like to explore the integration of weather models into the CAP CONOP, so that a map could highlight areas of high probabilities for damage. This would be particularly important when tornados have multiple (or hundreds) of touchdown points.

Emerging CONOPS 2.0

Based on the experimental results, the partners to the research are exploring a new concept of operations, summarized in figure 2:



The model would place existing differentiation of spot photography and remote mapping into an integrated workflow:

1. **Damage Survey Sorties**: A wide area collection performed with a field of view of approximate 3km x 2km, as close to nadir as is possible (and usually performed at higher altitudes).
2. **Damage Assessment Sorties**: A small-area collection performed with a small

field of view (approx 300m x 200m) to investigate the status of specific infrastructure, buildings, and other points/areas of interest. These damage assessment sorties would be assigned based on analysis of wide-area damage survey imagery.

Survey Sorties

With the goal of collecting wide-area damage assessments, FEMA and NGA would need to partner with CAP to develop a CONOP for higher altitude collections, including the contingency of having to collect at lower altitudes during bad weather or thick haze.

Collection Plan

When a disaster occurs, FEMA, NGA, and CAP would develop an initial collection plan for multiple CAP aircraft to collect wide-area imagery surveys. These collection plans would be generated using several cross-correlated data sets: LANDSAT population maps, Homeland Security Infrastructure Project (HSIP) critical infrastructure maps, hazard maps (e.g., shakemaps, weather patterns,), and analysis of social media reports. This collection plan would be briefed to the pilot as a track to follow at a specified altitude, and to the camera person as a calculated field of view for the altitude and shutter frequency for the estimated air speed. The calculation will be based on capturing approximately 6 square kilometers per photo (3x2).

Sorties

CAP will divide the disaster area into multiple AOIs, so that multiple aircraft can collect imagery.

Using existing calculations from JIX 1204, the goal is to collect at approximately one photo of 6 grid every 45 seconds during a 240-minute sortie. Assuming 120 minutes of actual collection time (i.e., excluding transit from home airfield to target of 60 minutes), that would enable each aircraft to potentially collect 960 sq km of imagery per sortie (about 1/4 of Rhode Island or a bit more than 5 times the District of Columbia). At that rate, it would take approximately 34 sorties to image the entire state of Maryland (32K sq km); given 20 aircraft with two crews each, that could mean that Maryland could be mapped in the first day of a disaster, assuming perfect conditions. CAP will develop an

SOP so that the appropriate number of aircraft can collect imagery in the highest priority areas.

Transmission

Once aircraft land, they will transmit imagery from the SD card in the camera to an FTP site run by FEMA. This transmission will occur over BGAN, cellular modem, and (when available), high-speed commercial Internet connections. Because each sortie will generate approximately 160 photographs @ 5MB per photo, transmission speeds of 800 MB may be a significant bottleneck. At 256 kbps (a typical BGAN or cellular upload speed), it would take 7 hours to transfer 800MB to FEMA from the aircraft to FEMA; it might be faster to fly the imagery to a commercial Internet connection, and CAP may wish to investigate a pony express sortie for this purpose.

Processing

CAP will explore two methods of imagery processing:

1. **Crowdsourcing**: the use of GISCorps to train CAP volunteers to hand-stitch photographs together into mosaics. Given 160 images per flight, it is likely that this process could take a few hours to complete. It may possible to have GIS Corps perform the work, or to engage a commercial crowdsourcing firm to recruit thousands of volunteers to perform the work.

2. **Automated Methods**: auto-georegistration may be able to stitch the photos together in ways that at least allow for FCOs to get a general sense of the disaster. While the results will not be perfect, it may be fast and good enough.

Analysis

FEMA GIO and FCO review imagery and determine areas which require high-resolution imagery from low-altitude. Delegate these targeted sorties to CAP, allowing other federal assets free to pursue additional collections that will become the official imagery for recovery efforts. 7869

Targeted Sorties

NGA, FCOs and FEMA will review the initial imagery and determine locations which require additional, close-up imagery. These targets will be built into a CAP collection plan for Days 2+, and the imagery will be collected in a similar manner to the

Collection Plan

Based on initial survey imagery, paper-based assessments, EOC reports, social media, and critical infrastructure maps, as well as other damage maps released by USG agencies.

Sorties

TBD, but similar to sorties for surveys.

Transmission

TBD, but similar to transmission for surveys.

Processing

The detail of the photographs from spot photograph or small mosaics will make it more difficult to integrate into the mosaics from wide-area surveys. This imagery will need to have a new CONOP associated with it, and might be the subject of future experimentation at JIFX.

Analysis

The development of the Hot or Not model noted above may be crucial to the timely triaging of photos from CAP. This method would likely be used with a commercial crowdsourcing firm or by harnessing CAP's 60K volunteers

Collaboration / Ad Hoc Experiments:

Lockheed Martin: autoregistration of CAP still photography and development of an automated method to identify areas with heavy changes between pre- and post- disaster conditions.

ESRI: Both a photogrammetry team and a team from GeoIQ participated in the field explorations with the ESRI Grab and Go Box and the GeoIQ social media tool, Twitch.

HOT: The Humanitarian OpenStreetMap team developed a "hot or not" application to rapidly categorize damage in individual photographs from CAP.

GWOB: Geeks without Bounds explored potential crowdsourcing methods, including the application of open hardware development for CAP fixed camera mounts.
Rob Munro: One of the world's experts in crowdsourcing assisted with thinking through potential commercial crowdsourcing options for imagery processing, which could greatly accelerate the tempo of categorizing damage and building an overall map of the disaster.

Experiment # D-01

Open Source HA/DR Software Security Evaluation

Rogue Genius

Principal Investigator/Lead: George Chamales, Rogue Genius

Working Hypothesis:

Open-source software is a valuable HA/DR tool that provides map information, message processing, and information dissemination during disaster times, but live security tests are needed to test the risk of malicious attackers.

Objective:

Test the security of various open source projects that are commonly used in HA/DR operations.

Overview/Background:

Open source software has been used in a number of HA/DR operations to provide map information, message processing, and information dissemination. While these products are being relied on more and more by organizations around the world, many have not undergone basic security evaluations to ensure that they are not susceptible to attack from malicious attackers.

Experiment Description:

The experiment will utilize a virtual machine containing several open source projects that have been used in HA/DR response operations. The projects will be installed and configured for use in a manner similar to that which is used in production. The target virtual machine will then be made available to teams of security professionals for evaluation of the various software systems' security. Issues found during the testing will be reported back to the providers of the software so the vulnerabilities can be fixed.

Measurements/Data Collection Plan:

The results of the testing will be collected and consolidated into a report containing findings and suggestions to software providers. The reporting process will take place during the testing as well as in de-briefs following the testing cycle.

Measures of Performance/Measures of Effectiveness:

Evaluation of security via pen-testing operations is challenging based on the wide range of attack surfaces provided by the various programs. Exercise success will be measured based on issues found as well as lessons learned and suggestions generated during the testing process!

The virtual machine itself will also be made available to outside members of the security community for their own use in testing. The goal of the release is to generate additional findings as well as establish the virtual machine approach as a model for future testing of open source HA/DR software.

What new capability (or improvement to existing capability) does this represent?

This will be one of the earliest live security tests of open source HA/DR software. The process of creating and leveraging a self-contained virtual machine that can be utilized by testers is seen as an opportunity to set the standard for future events and testing activities.

Quantitative Results (please be as descriptive and detailed as possible):

This experiment had three primary goals:

- Test a new process to simplify HA/DR software security evaluation
- Integrate members of the professional computer security community into the RELIEF process
- Identify the level of cyber security-awareness of the RELIEF experiments

New Testing Process:

As part of this experiment, a self-contained virtual machine (VM) running a set of three open-source HA/DR tools was created and released for testing. The VM applications included: Ushahidi, OpenStreetMap, and Sahana Eden. Each of the software applications were configured and ready for testing as soon as the virtual machine was booted. In addition, a set of documentation was created for the VM which contained information on the system's configuration, installation details, application background, and recommendations for testing. The testing image was publicized through numerous security and HA/DR online communities as well as provided to the JIOWCS security team present at Camp Roberts.

Security Professional Integration:

Prior to RELIEF, invitations were sent to numerous security and HA/DR-centric community soliciting interest from security professionals to participate in the event. The invitation generated interest from several different professionals ranging from those working in major corporations, independently, and in activism-centric organizations. As the final program for RELIEF began to come together, the experimenter leads for several projects were contacted to identify their interest in meeting to discuss the security of their projects. Several experiment leads responded and arrangements were made to meet and discuss their work and the security implications. During the event, members of the security community met and discussed the security implications of their work with 10 different groups (listed below).

Cyber-Security Awareness:

The security professionals met with 10 different experiments, qualitative details of those discussions are described below.

Qualitative Results:

New Testing Process:

The creation and release of the self-contained virtual machine represents a significant advance in the process of testing HA/DR software. Before this, those with security backgrounds who may have been interested in contributing to security reviews of humanitarian-centric software were required to identify which applications were available for testing, learn the application-specific installation process, understand how the application works and what should be tested, then perform their testing. With the creation of the VM, professionals can simply download the disk image, boot it in their testing environment, and begin testing. This approach can be used in future events and experiments to significantly improve the efficiency of testing HA/DR software.

Security Professional Integration:

Integration of the security community with the RELIEF experiments marks a first of its kind partnering process, where security experts are on hand to provide their expertise to those developing systems and applications that may be deployed against adversaries with active cyber-attack capabilities. The members of the security community present at the event appreciated the opportunity to meet with those working in an area that utilized technology that was significantly different from their day-to-day activities in Silicon Valley. The members of the RELIEF community were consistently open and inviting with the group and willing to discuss their experiments and the potential security issues. The results of the discussions are described below.

Cyber-Security Awareness:

Prior to the event it was unclear to what level the experiments and their members were taking into account the need for cyber-security in their development process. The security professionals were pleasantly surprised by the pervasive awareness of the need for cyber-defense and the sophisticated cyber-security aspects of several of the experiments. It was obvious from the discussions that the experiment participants were both aware of the threats and had thought through the ways in which those threats could seek to attack and exploit the systems under development. Several of the experiments had already proceeded through certification for use on government networks – processes which require prior evaluation of the threats and mitigation steps be implemented to prevent successful attacks.

Collaboration / Ad Hoc Experiments:

1. Virtual Agility: Review of their content management platform, defensive features of the system.
2. JIOWC Red Team: Provided the team with the virtual machine for testing .
3. Cervello/IBM: Discussion of their content integration tools & defensive features of the system.
4. Geeks Without Bound: Shared discussions on security with various groups.

5. MITRE: Discussion of security evaluation frameworks and approaches.
6. Strategic Mobility 21: Explanation of security testing methodologies and organizations.
7. Navy Technology Transfer: Crowdsourcing security issues and path forward.
8. Infinitum Humanitarian Systems: Discussion of security concepts.
9. Synergy Strike Force: Discussion of security challenges of data fusion processes.
10. DeLorme inReach: Discussion of the security aspects of their satellite-based tracking system.

Observations & Comments:

The process for gathering security professionals and bringing them to Camp Roberts can be challenging based on these professionals' daily work schedules which may require them to take vacation time to visit the event. Providing a better sense of what the participants can expect to achieve from the process may enable them to make the case to their management that the process is a worthwhile use of company time. The work done in this experiment certainly lays the foundation for making that case and information on the types of experiments taking place may further support that effort.

During the lead-up to the event, better outreach with experiment participants on the part of the leader of the security group can help to socialize the plan for the professionals and potential utilization of the security group, however based on the general open-ness of RELIEF it was quite easy to approach experimenters without having made prior arrangements.

Identifying specific experiments to meet with may help entice security professionals to join the group and participate at the event. This can be challenging based on the timing of the finalization of experiment plans, which leaves a small window for security professionals to choose to attend, however it should be possible to leverage the types of experiments interacted with in the previous year to provide an adequate amount of information and interest for potential participants.

Experiment # E-01

Humanitarian Emergency Response Operations (HERO) Virtual Logistics Tactical Operations Center (LOGTOC)

Strategic Mobility 21 Inc

Principal Investigator/Lead: Dr. Lawrence G Mallon, Strategic Mobility 21

Working Hypothesis:

To provide a platform for stakeholders to share real-time common operational pictures, an evolving system is necessary to enable a dynamic aggregation of data from multiple sources.

Objective:

The overall SM 21 program transition objective through the Office of Naval Research and California State University is to position Strategic Mobility 21 Inc non-profit social enterprise as a key logistics and information technology enabler and physical intermediary in the physical, information, social, and geopolitical domains in the exercise of NGO and USSOCOM HADR-DRRR and stability operations joint mission planning and execution through: (a) military and commercial transportation and distribution logistics virtual integration, synchronization and mutual support; and (b) facilitating mission critical information exchange and collaboration among military, civil/first responders, commercial carriers, and NGO public and private stakeholders. The net overall outcome or effect will dramatically improve situation awareness and understanding among the distibuted joint task force to include first responders, interagency, coalition, commercial, military and NGO stakeholders.

As the first phase of this ultimate objective, the Combined JIFX 12-4 (Infrastructure as a System) and Operation Relief experiment objective is twofold. One is to demonstrate a Humanitarian Emergency Response Operations (HERO) virtual Logistics Tactical

Operations Center (TOC) baseline network centric capability. The objective is to facilitate the rapid self-organization and collaboration for effective joint decision making among a diverse broad based joint HADR task force in a no notice operational environment and the establishment of a Hastily Formed supporting mission critical information sharing network, and synchronized military and commercial logistics support within a regional and global agile supply network.

This involves the rapid localization and deployment of a pre-populated collaborative emergency management data fusion platform configured as a Municipal Response system for Rio De Janeiro and based upon a FEMA National Incident Management System (NIMS) organizational model through a multi-user, configured on the fly virtual LOGTOC logistics capability to rapidly capture key business processes, priorities, capabilities, resources, and requirements among joint task representatives to facilitate information sharing, interoperability and joint decision support of the incident commander. I would also identify areas of potential operational conflict and mitigate and de-conflict those events as part of an event management capability.

The discovery element of this demonstration will be the degree of success achieved and lessons learned in rapidly capturing from various stakeholders on the fly their unique organizational business processes, key requirements, data sources, resources, knowledge, skills, experience and capabilities and data feeds into a taxonomy or hierarchy based upon the FEMA National Incident Management System for later archival reuse and training and rehearsal continuous improvement process improvement purposes.

The concurrent discovery experiment will involve rapidly integrating other stakeholder identified on the fly feeds, e.g., CrisisMapping Twitter and GIS data, while conducting discovery interviews and field observation of first responders, NGOs and DoD personnel and onboarding business processes to set up after action analysis and construction of HADR knowledge management system and repository.

The network centric platform capability at the heart of this initial experiment is the Java based VirtualAgility platform that offers interoperability across multiforce, multiagency and multinational coalitions for Emergency Management, and Business Continuity. The VirtualAgility Logistics TOC (HERO LOGTOC) enables diverse organizations to collaborate, coordinate and manage information & operations from a common operating picture. The HERO LOGTOC platform provides single point access to assets, application, data and people from internal and external sources, and situational awareness to the variety of stakeholders.

This combination demonstration-discovery experiment will set the stage for a follow on deployment of supporting joint logistics capabilities as real time network information and hastily formed network feeds, alternative course of action analyses, feasibility assessments, optimization, and delay-disruption work-arounds and collaborative decision support.

This would include the Regional Agile Supply Network model distributed network capability through the HERO VLoGTOC portal to rapidly deploy a discrete event node arc network simulation model and collaborative decision support framework to integrate and display data (including geo-location data) from multiple sources to support rapid deployment, marshaling and staging of equipment and personnel in the right quantities from the right sources, at the right time and to the right place in the right sequence in response to a Humanitarian Assistance Disaster Response (HADR) or Homeland Defense scenario involving first responders and NGO personnel, assets, supplies, equipment. Each of these applications are designed to operate as standalone capabilities or integrated as parts of an end to end Global Distribution Management System under development.

Other initial network and eventual mobile web applications and tools under development would match demand requirements through a network portal (e.g. for food, water, power, medical supplies etc) with military and commercial transportation lift capacity in an open internet, NIPRNet FOUO, and SIPRnet environment, and to rapidly integrate multiple legacy military and commercial supply and transportation systems to match supplies down to the necessary pick unit of consumption and transportation conveyances (road, rail and air) would be added over time as a form of evolutionary acquisition strategy.

Overview/Background:

One of the two overarching findings from a recently completed logistics education and training study prepared under the auspices of the Strategic Mobility 21 (SM 21) program through the US Joint Forces Command (USJFCOM) for the Department of Defense (DOD) stated that DOD‘s lack of an Advanced Knowledge Management System is a major shortcoming in the Joint deployment and distribution process.

The other key finding is the time required to rapidly integrate diverse stakeholders from disparate backgrounds, cultures, priorities, views, perspectives, experience, knowledge, skills and expertise into a functioning effective joint task force in support of a common mission in particular a no notice HADR mission.

The study suggested that an Advanced Knowledge Management System (AKMS) or shared common logistics operational platform would help to provide rapid sharing of joint logistics information and lessons learned, to encourage collaboration, to show available tools and training, to highlight vital information, to support the decision making cycle and to provide the forward-deployed joint logistician with the required information.

A review of the literature, coupled with an analysis of the Haiti earthquake response efforts, and a review of the lessons learned when responding to other recent complex humanitarian disasters, indicates that the lack of a knowledge management system also impacts the international humanitarian community‘s initial response efforts to a complex humanitarian disaster

The SM 21 HADR AKMS when validated in joint exercises and built out in modules through evolutionary acquisition will comprise a virtual Joint Deployment and Distribution Sustainment Support Platform (JDDSP) in a box that can be deployed for DoD Joint Task Force Port Opening (JTFPO), or in support of an incident response commander in support of HADR or Homeland Defense. The suite of capabilities is comprised of : (1) a Regional on the fly node arc simulation and decision support model; (2) a DoD architectural framework (DODAF) service oriented architecture cloud based Global Distribution Management System (GDMS); and (3) demand based web services/mobile applications such as Transportation Internet Portal (like travelocity) matching CRAF aircraft and VISA shipping and DoD lift capacity with HADR mission requirements and synchronizing logistics operations in support of the HADR, stability operations missions involving DoD, coalition, interagency (e.g. State,AID, first responders), commercial carriers and NGO organizations.

The SM 21 program has previously demonstrated transportation cost and efficiency, reduced inventory and time savings in DoD joint deployment (Third Infantry Division) in multiple deployments to CENTCOM AOR and commercial logistics (Dole Foods CA) and in the process of transforming former DoD Base Realignment and Closing (BRAC) into muli-modal transfer and HADR response hubs (e.g. former George AFB SOCAL, former NAS Cecil Field FL, former Third Army Logistics HQ Fort Gillem GA).

The SM 21 program also supports Code 33 USMC at ONR in joint seabase logistics involving use of TAKE shuttle vessels operating between the seabase and the advanced base and CONUS supply depots It has also supported USTRANSCOM, SDDC and TEA in identifying critical surface transportation infrastructure and devising mitigation strategies for HADR, homeland security and homeland defense.

Experiment Description:

Evolving from an observer status at the last JIFX, and given the broad range of participants expected at an HADR scenario focused event, the logical progression is to conduct an initial discovery experiment on several levels. The actual experiment will begin in advance to identify key data feeds (e.g. USGS initial and after shock events, NOAA weather, CALTRANS traffic etc), and logistics network nodes (e.g. armories, hospitals, shelters, schools, power grid plants, microwave, police, fire, sheriff, and facilities e.g. Diablo Canyon nuclear plant, candidate secure marshaling and staging areas etc) and attributes (or meta data, e.g. GIS coordinates, size, footprint, beds, blood supply, ER and OR rooms, etc), and network arcs and attributes (Interstate and State highways and back/fire roads, airstrips with towers and VFR, ports e.g. San Luis, rail lines, etc

This data collection will be augmented with a pre-event site survey to verify Google Earth and other open data sources and to ascertain GPS coordinates using Canvass ASP for mobile devices.

The HERO LOGTOC will be pre-populated with the feeds and information exchange requirements determined. The logistics network data will be used to develop a notional ad hoc logistics network.

The combined data will be displayed through the remote HERO LOGTOC platform in the TOC and in the back end development area at the exercise site. Discovery interviews will be conducted with various stakeholders on a continuous basis during the exercise period. Additional data feeds identified by the stakeholders will be integrated in the back end venue.

Time permitting the Central California Agile Supply Network (C2ASN) simulation and operational analysis and decision support model will be developed and deployed substantially in an ad hoc on the fly in an experimental mode to match real time validated requirements from first responders with identified sources of equipment, supplies and personnel, and to determine gaps and seams benchmarked to measures of performance and effectiveness as a node arc network planning, execution, monitoring, and dynamic re-planning of focused logistics support of first responders, DoD, commercial and NGO's requirements in responding to a seismic event in central California.

Mapping the principal nodes and arcs may include: (1) the attributes and suitability of Camp Roberts as a potential regional Joint Deployment Distribution Sustainment Support Platform (JDDSP) in terms of connectivity, marshaling, staging, and throughput support requirements (e.g. power, runways, security, water supply etc) for initial marshaling and staging, and sustainment hub; (2) various air and surface arcs and connectors to other critical infrastructure; (3) sources (and alternate sources) of critical supplies and equipment. '

The simulation model will be validated in the (1) identification, acquisition and onboarding of key data elements; (2) conduct of feasibility analysis, prioritization, optimal sourcing and routing of critical items, (3) maintenance repair and overhaul required support, etc; (4) impact and resiliency of network nodes and arcs in response to delays, disruption, mitigation and recovery operations

Measurements/Data Collection Plan:

Pre event survey data collection:

1) Identify and onboard data feeds from multiple sources from California Emergency Management area, San Luis Obispo County, California Integrated Seismic Network (CISN), etc, agency and Public Safety communications, ACS (Note FCC Amateur Radio service frequencies is limited to training and emergency communications). networks, microwave, radio, satellite, video-conference, Amateur Radio - as the RACES (Radio Amateur Civil Emergency Services), Civil Air Patrol communicators, California Emergency Services Nets (Cal EMA), CALTRANS ITS etc
2) Integrate with Municipal Link

3) Use Google earth and survey nodes and arc within area of operation (SL County, coastal and central California and onboard geospatial data using Canvass mobile app

Event data collection:

1) Onboard additional feeds identified by stakeholders
2) Interview individual stakeholders to capture business processes, generate and validate logistics requirements, and LOGTOC displays for decision support, and group interaction situation awareness and understanding
3) Display limited regional agile supply network model to determine utility for HADR LOGTOC decision support

Measures of Performance/Measures of Effectiveness:

Measure of performance:

1) Number of identified pre-event feeds successfully integrated into HERO LOGTOC
2) Number of identified stakeholder event feeds successfully integrated into HERO LOGTOC
3) Number of identified pre-event nodes and arcs successfully integrated into HERO LOGTOC
4) Number of additional stakeholder identified nodes, arcs and attributes successfully integrated into HERO LOGTOC
5) Number of HADR stakeholder interviews completed during joint exercise
6) Number of post event surveys completed by stakeholders
7) Resilience measured in network up time during period of joint exercise
8) Number of network hits during joint exercise

Measures of Effectiveness:

1) Composite system performance ratings of stakeholder surveys of utility of HERO LOGTOC

2) Number of operational events captured during exercise
3) Number of displayed operational events for decision support
4) Number of logistics events tracked during joint experiment
5) Number of interventions (event management) during joint exercise
6) Number and variety of dynamic reports available to stakeholders for decision
7) Support during joint exercise.

What new capability (or improvement to existing capability) does this represent?

The HERO LOGTOC platform will provide an unprecedented ability for preconfiguring a baseline, best practices, collaborative HADR response plan that is continuously updated and can be easily modified by non-technical operators to reflect the key details of an ongoing event. This platform enables all stakeholders from top to bottom to continuously share a real-time common operational picture throughout the rapidly evolving scenario as operators onboard new and changed information. Dynamically updated reports are available on demand, configured by users according to their varying requirements. This HERO LOGTOC system enables dynamic aggregation of data from multiple internal and external sources into organization-defined forms and reports for user-defined needs. The HERO LOGTOC system preserves original plans, all updates and modifications during and at the conclusion of each event, and provides complete information and decision strings needed for comprehensive after action report AAR effectiveness analysis and archival desk top or field re-play of events.

The hastily formed Regional Agile Supply network logistics modeling, simulation and operational planning and execution capability builds an ad hoc and persistent node arc geospatial logistics support network. The smart network using virtual integration is comprised of rapidly defined nodes (transportation e.g. airports, seaports, rail and truck facilities, medical, public safety, military, logistics warehouse and distribution centers), transload facilities) and their logistics attributes (footprint, functionality, throughput, requirements power, water, etc,) integrating them as smart nodes in the network and arcs (Strategic rail and highway corridors, secondary roads, intermodal connectors, and monitored air and surface smart corridors .

The network fuses both transportation and supply system commercial message traffic and military and commercial sensor data to enable near real time location for enhanced in transit visibility down to the item level (if necessary) to mitigate diversion, delay, disruption events and enable dynamic re-planning from alternate sourcing, re-routing, re-prioritization and recovery of resilient global supply chains.

The regional agile supply network simulation and operational analytical and decision support model is the only platform of its type that has been previously validated in both DoD joint force deployment and commercial import logistics modes.

The joint experiment will identify and validate HADR first responder (FOUO) and NGO (open internet) data requirements, information exchange requirements, data display and decision support functionality requirements in a no notice simulated event response scenario,

The capability will add an entirely new dimension to the preparation for future HADR events and response capability decision support in the form of logistics command and control (LOgC2) toolkit to the incident response commander, make the network operations center a truly smart logistics nod, and make each node in turn a smart node virtually integrated and synchronized with the entire network.

Quantitative Results:

Measures of Performance

1) Resilience measured in network up time during period of joint exercise.
    a. Demonstrated repeated persistent and robust ad hoc capability (with little or no network disruption requiring local backup capability) over four days to interoperate with San Francisco Bay Area Emergency Services Network nodes though Municipal Link using public service frequencies and

protocols and transmitting, receiving, and capturing text, voice and visual data from multiple sources concerning emergency operations.

   b. Number of displayed operational events for decision support

2) Demonstrated persistent and ad hoc capability to onboard geospatial data from ESRI (FEMA) GIS and other geo-referenced data sources supporting integration/fusion with resident nodal information (hospitals, fire stations, emergency shelters etc) into an ad hoc user defined/configured common operating picture interface based upon two emergency response scenarios:
   a. 2003 San Simeon CA earthquake.
   b. 2012 Waldo Canyon Fire Colorado Springs CO and collaborative planning across Incident Command System or Joint Task Force using Virtual Agility portal/collaboration platform.

Figure 1 ESRI FEMA geospatial data integration

3) Number of identified stakeholder event feeds successfully integrated into HERO LOGTOC
4) Number of additional stakeholder identified nodes, arcs and attributes successfully integrated into HERO LOGTOC
   a. Demonstrated ad hoc capability to rapidly on board/provision wireless network applications (ASP) medical triage patient centric data in collaboration with MEDWEB through Virtual Agility platform.

b. Demonstrated ad hoc capability to rapidly on board/provision real time Civil Air Patrol radio transmission of aerial photography preliminary survey of battle/disaster event damage in support of Incident Commander and Joint Task Force Commander.

c. Successfully integrated supplied relevant HADR social media filtered data from Twitter (hashtag) into Virtual Agility planning/collaboration platform into common operating picture.

Measurements of Effectiveness:

1) Number of operational events captured during exercise. Successfully executed one live integrated demonstration of multiband (FMS-cellular WAN- to KA/KU satellite) network connectivity for data transmission during scheduled weekly event with representatives of DHS-FEMA, USTRANSCOM and multiple geographic CoCOMs in attendance through MutuaLink San Francisco Bay emergency response network

2) Number of displayed operational events for decision support. Executed integrated persistent communications network (MutuaLink) and collaborative planning/portal (Virtual Agility) combined capability scheduled demonstration for USTRANSCOM, DHS FEMA and other geographic combatant command science and technology representatives as dynamic front end common operating picture and communications network be integrated with back end global supply chain SM 21:

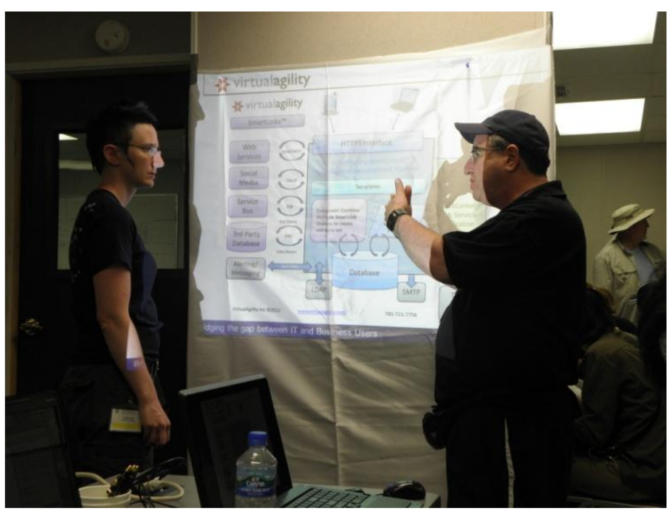


Figure 3 Combined Mutualink communications network and Virtual Agility collaborative incident planning portal demonstration

a. Regional Agile Supply Network adaptive planning/execution and event monitoring model,
b. Global Distribution Management System (GDMS); and
c. other classified and unclassified DoD supported web tools matching DoD and commercial lift capacity with HADR event demand driven solution set/suite of capabilities.

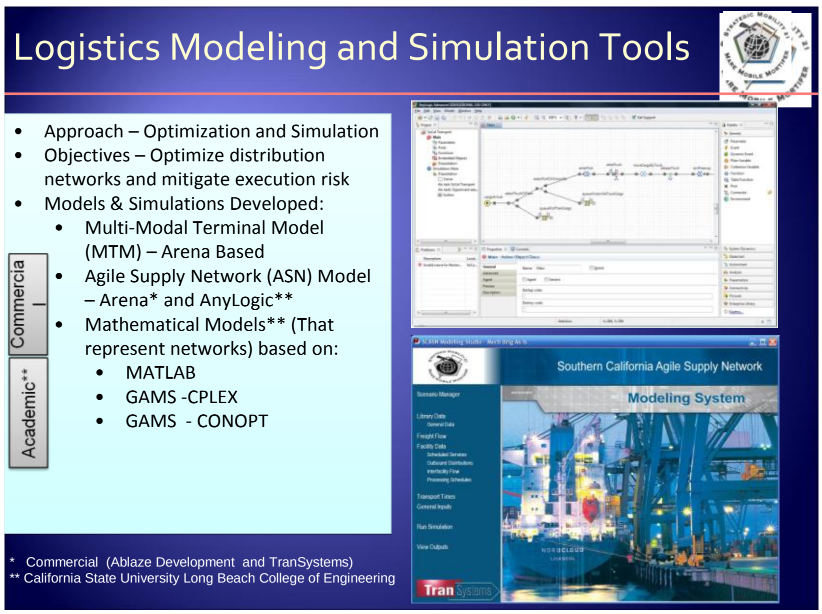


Figure 4 Strategic Mobility 21 Regional Agile Supply Network Model

Qualitative Results:

1) Conducted peer to peer prototype demonstration of potential integration of Virtual Agility collaboration platform integrated with SM 21 Regional Agile Supply Network adaptive planning/execution and event monitoring model into a prototype Marine Air Ground Task Force Operations Planning and Execution System (MAGTOPES) for HADR Incident Management and Joint Task Force CoCOM deployment.

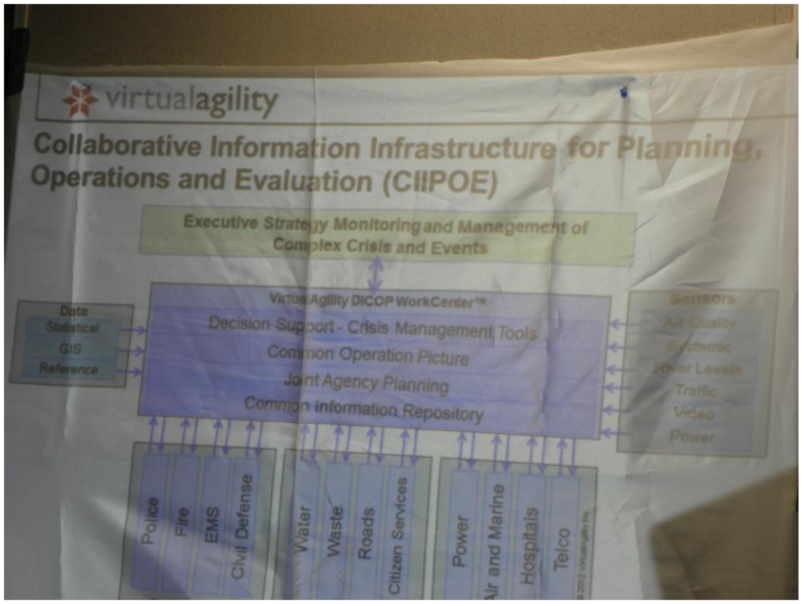


Figure 5 Virtual Agility Incident Operations Planning and Execution System Portal

2) Validated integrated end to end HADR Incident and JTF Commander logistics support capability mashup of SM 21 as NGO though integration of GIS data into Event/Mission LOGCOP, ad hoc robust communications network and persistent regional collaboration transportation and distribution portal (incident Course of Action COA support and supply network reconstitution).

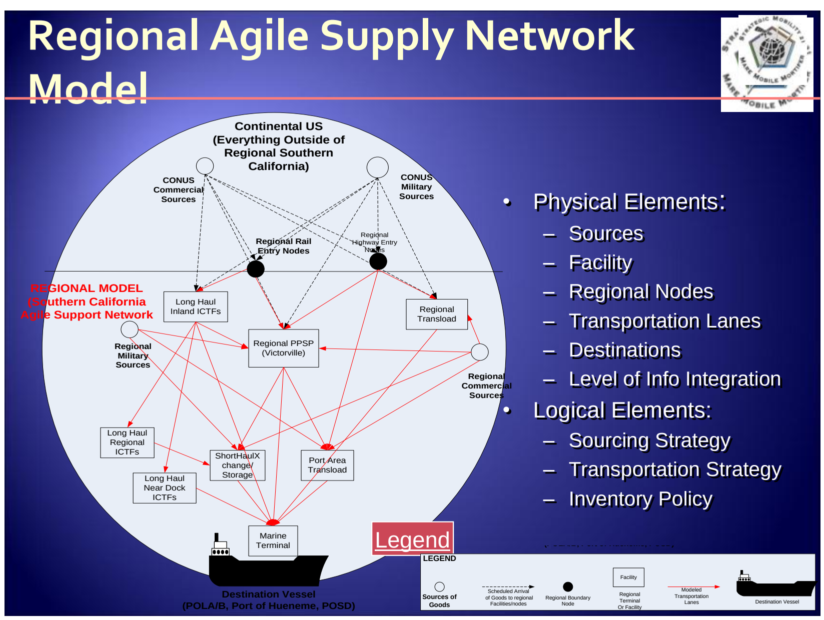


Figure 6 Regional Agile Supply Network Model

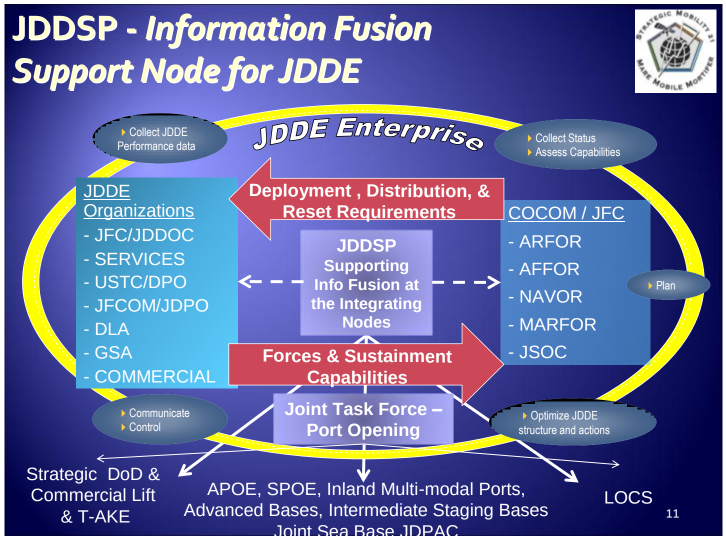


Figure 7 SM 21 Joint Deployment Distribution Enterprise Support Platform (JDDSP) Smart Node for Information Fusion

3) Validated concept of joint-interagency-coalition logistics capabilities as key enabler of HADR Civil military support
4) Validated concept of coalition rapid mobility enabled by advanced logistics capabilities as pathway to Building partnership capacity.

Collaboration / Ad Hoc Experiments:

1) Dr Chris Lee Dept of Geography CSULB re integration of geospatial data into SM 21 LogCop and CSULB future HADR Tactical Operations Center for civil emergencies

2) Steve Scott Mutualink re-integration of regional emergency services persistent and ad hoc communications network into end to end HADR regional logistics support and recovery network.

3) Stu Rudolph and Chris Harz of Virtual Agility re integration of front end collaboration joint planning and execution portal with SM 21 back end decision logistics execution and event monitoring and decision support course of action analysis of alternatives and dynamic re-planning capability

4) ESRI FEMA group on geospatial data Log COP integration and future strategic partnerships with SM 21 and CSULB in TOC COP
5) MEDWEB on medical triage web application (Pete, Arian and Jen Gold)
6) Stanford group on multi-source data fusion into Mobile adaptive mesh network
7) NPS EOS in a box capability (Chris Clausen)
8) NPS Lighthouse project (Lt Derwood) and counter-IED demonstration
9) Monterey County OES Sherrie Collins re follow on experiment with MEDWEB, CDA Dept of Health and State OES and DHS TOC in a box for November OP Relief 13-1
10) IBM DeLorme re communications operational security firmware
11) JIOWC Red Team David Rohret re DISA/FISMA certification of SM 21 capabilities and operational security/information assurance
12) Lin Wells re SM 21 integration with NDU Center for Joint and Strategic Logistics Lt Gen Chris Christianson and George Topic and Center for Technology and National Security Policy
13) In Reach re Total Asset/in transit visibility via RFID satellite transponder real time interrogation
14) 1 MEF S & T Col Steve Heywood USMC Ret re MAGTF Operations Planning and Operations System (MAGTOPES)

Observations & Comments:

The NPS Operation Relief series of field exercises is an extremely valuable joint experimentation and technology transfer mechanism to match Combatant Commanders with Science and Technology unfunded requirements with academic, industry and non-governmental organization partners in a militarily relevant environment of Camp Roberts.

In the case of the Strategic Mobility 21 program we were able to cost effectively test interoperability with several industry and academic partners that would have required months of discussion, planning, preparation prior to joint execution in order to accomplish comparable results suitable for evaluation of complementary functionality and potential for collaboration in rapidly fielding military-civil-commercial capabilities to the warfighter and the on scene emergency response incident commander.

We plan to become a major stakeholder in carrying this unique joint experimentation platform forward as part of our Office of Naval Research (ONR) supported transition plan in advanced logistics technology support of civil first responders and joint force commanders as a joint force for good in humanitarian assistance and disaster response (HADR).

Experiment # F-01

Small Team Power in Support of Single Fuel Forward Initiative

QinetiQ North America

Principal Investigator/Lead: Ian Arroyo, QinetiQ

Working Hypothesis:

If generators become lighter, and more mobile, as well as comply with the “single fuel initiative,” then power will be utilized in hard-to-reach, remote areas and serve as a valuable tool in HADR operations.

Objective:

Utilize two Q-Gen, 1kW, JP8 generators to power equipment, charge batteries, and supply small team power during the event. This will allow operators/first responders to use a JP8, man-portable power source which provides a low noise and emissions signature, in support of the DoD initiative "Single Fuel Forward", JP8.

Overview/Background:

Existing generators are heavy, large and nearly impossible for individual warfighters to carry. According to the Defense Science Board Task Force on Energy Strategy, standard generators are the single largest users of fuel on the battlefield. Regular generators are also designed to provide more power than is typically needed by individual warfighters and small combat teams, making them inefficient for mobile team mission requirements.

Weighing in at 32 pounds, Q-Gen™ is a lightweight power solution that can be transported by a single warfighter. It can be operated for up to five hours, depending on the equipment being charged. Q-Gen™ has a low noise signature, and it can use JP8 from multiple sources on the battlefield such as fuel stores, vehicles and equipment.

Equipped with two electrical sockets, one Q-Gen™ generator delivers up to 1kW of power, and multiple Q-Gens™ can be linked together to generate additional power for scalable energy solutions. In addition to supporting individual warfighter electronics, Q-Gen™ can power a variety of other equipment including universal battery chargers and base electronics. It can also help reduce the power demand on other systems by providing auxiliary support to power sources such as vehicle batteries for vehicle-mounted electronics.

- Weight: 32 lbs dry, 38 lbs wet
- Size: 18" l x 9.5" w x 15" h
- Operating temperature range: 0°F to 125°F
- Capacity: up to five hours of power based on load
- Fuel consumption: 0.12 gallons/hour at maximum load
- Noise: <62 dBA at seven meters
- Fuel: JP8 (additional fuels under development)

Experiment Description:

Train COCOMs/First Responders to start and run the Q-Gen generator. Utilize the generator to power other experimenters kit or scenarios that are being run. The generators will be available to run all day, every day of the event.

Measurements/Data Collection Plan:

Train operators/first responders to start and run the Q-Gen generators. Observe the length of time that the generators run and provide power without failure. Gather operator/first responder response from on its ease of use and reliability.

Measures of Performance/Measures of Effectiveness:

Each generator will start and run with little to no failing throughout the event, and will provide clean power while running.

What new capability (or improvement to existing capability) does this represent?

The Q-Gen generator is the only single-man portable, 1kW, JP8 generator that starts and runs on JP8. The Q-Gen provides small team power while running off of JP8 in support of the DoD's "Single Fuel Forward" initiative.

Quantitative Results:

Two Q-Gen 1kW, heavy fuel optimized generators were run for the duration of the event providing power to folks at Range Networks' experiment, ViaSat's experiment, as well as our own tent. Both generators ran cleanly on JP8/Diesel throughout the week, powering items such as satellite communications receivers, computers, small refrigerator, halogen lamps, fans, etc. On the last day one of the generators had a failure of the fan mechanism, which is a stock Honda item. It gave us the opportunity to discuss the issue with Honda and evaluate the outer ranges of their stock capability. Each generator ran for approximately 11 hours daily, and a few hours of a day at ground temperatures of 140, 135, 120, and 120 respectively. Those temperature ranges were a great test of how well the generators would run in specific DoD AORs.

Additionally, we were able to run and power on Kerosene, Gasoline, Denatured Alcohol, and 151 proof everclear.

The generators provided clean power for the duration of the event and we received no negative feedback IRT the generators surging or dropping loads.

Qualitative Results:

All-in-all this was a good event. The event gave us a great environment to test the generators against similar conditions to the CENTCOM AOR. This was a very helpful and constructive environment for learning more about the extreme end capabilities of our system.

Collaboration / Ad Hoc Experiments:

We provided power to ViaSat and Range Networks at various times throughout the week.

Experiment #F-02

One Man Portable Flex Fuel Generator (1MPG)

INI Power

Figure 3: INI Flex Fuel Generator Agnostic Fuel Architecture and Battery Charging in Full Sun Conditions

Principal Investigator/Lead: Matt Mendez, INI Power

Working Hypothesis:

If flex fuel engine technology is universal among engine fuels used in HADR operations, then the lightweight generator allows for seamless integration to bridge the power and energy capabilities gap.

Objective:

The experiments primary objectives are 1.) to demonstrate the universality of INI Power System's flex fuel engine technology on various fuels, including light and heavy distillate fuels, and 2.) to demonstrate the utility of this engine technology as integrated into INI's IntelliGEN1000 Flex Fuel Generator (INI-TS-IG1000-IC-MF) product. The Flex Gen was designed as a light weight (32 lbs.) One Man Portable Generator (1MPG) capable of seamless integration with a wide array of DOD, DHS, and HA/DR gear requiring less than 1kW of power.

Bridging power and energy capability gaps utilizing agnostic fuel sources, while also providing maximum flexibility for DOD, DHS, and HA/DR mission sets, INI's Flex Fuel Generator dramatically reduces the logistical burdens and resupply requirements necessary to conduct operations vital to the interests of the United States.

Overview/Background:

Whether conducting combat operations in various theater AORs, surveillance for counter-terrorism operations, or rendering assistance for natural disasters, power and energy is a critical and uniform requirement necessary to successfully accomplish mission objectives across the respective CONOPS for each area.

Dependence on bulk fuel creates tactical logistics support requirements that can slow operations. Several initiatives (i.e. NetZero, Operational Energy, Future Energy, etc.) have been implemented to reduce the costs and risks associated with excessive and burdensome resupply convoys.

Weight reduction and improved fuel consumption on power systems continue to be a major capability area of interest. Developing engines that run on light to heavy fuels or military common use fuels (JP-5, JP-8), weigh less, and have a decided advantage on reliability, availability, and maintainability (RAM) over current engine technologies of the same size and performance is the next evolutionary path towards success.

INI's Flex Fuel Generator provides the solution and successfully bridges this exact capability gap today.

Experiment Description:

INI's flex fuel engine technology converts commercial-off-the-shelf (COTS) spark based gasoline engines to flex fuel engines through the implementation of proprietary cold start, fuel management, and thermal management hardware and control protocols. This proprietary conversion enables lightweight aluminum engines to easily utilize any flammable fuel or any mixture of flammable fuels encountered on the battlefield including but not limited to:

1) JP-8
2) JP-5
3) F-76
4) Diesel #1
5) Diesel #2
6) Kerosene
7) Gasoline
8) Propane
9) Butane
10) JetBoil (propane/isobutane)
11) Rubbing alcohol
12) Ethanol
13) Methanol
14) E-85
15) Acetlylene
16) Syn Gas
17) Bio-gas (sour)
18) LNG
19) AV Gas
20) MOGAS
21) Bacardi 151
22) Everclear
23) Any homogenous liquid blend
24) Any homogenous gaseous blend

Measurements/Data Collection Plan:

The Measurements and Data Collection Plan will be gathered during planned and ad hoc experiments throughout the week. Inbriefs and hotwashes will be conducted daily to identify objectives for operators to accomplish utilizing the Flex Fuel Generator. INI personnel will be on site to support if necessary. Ease of use and reliability will allow for dismounted and improvised operations.

All data gathered will be captured on experimentation forms, and a summary After Action Report will be provided upon completion of the exercise.

Measures of Performance/Measures of Effectiveness:

The following criteria will be utilized to determine the Measures of Performance and Effectiveness:

1. Reliability: Power will be provided for the entire scenario duration or fuel is no longer available. Personnel will be able to successfully accomplish their mission objectives and power requirements utilizing the Flex Fuel Generator.

2. Ease of Use: Training will successfully be conducted in less than 5 minutes. Personnel whom have never seen or operated an INI Flex Fuel Generator will be able to generate up to 1kW of power with any available fuel on the battlefield.

3. Liquid Fuels: Personnel will successfully be able to generate power utilizing liquid fuels. Personnel will be given the option to operate the Flex Fuel Generator utilizing JP-8 and multiple other sources of liquid fuel.

4. Compressed Gas Fuels: Personnel will successfully be able to generate power utilizing compressed gas fuels. Personnel will be given the option to operate the Flex Fuel Generator utilizing propane and multiple other sources of compressed gas fuel.

5. Combination of Fuels: Personnel will successfully be able to generate power utilizing any combination of liquid and compressed gas fuels. Personnel will be given the option to operate the Flex Fuel Generator utilizing a combination of any liquid or compressed gas fuel available.

What new capability (or improvement to existing capability) does this represent?

Providing increased capabilities for personnel in any AOR, the Flex Fuel Generator expands the single fuel forward concept to any fuel forward. Virtually any fuel available on the battlefield can be utilized, in any combination (liquid or gas), thereby removing the handcuffs and sole reliance upon log trains in theater.

Additionally, given the potential noise emissions and exhaust emissions of generators in general, the ability to drive power over a long distance can be advantageous across the full spectrum of DOD, DHS, and HA/DR CONOPS, and therefore requires high voltage to avoid an extremely heavy power cable. Our calculations reveal that if the IG1000-IC was directly producing 28V DC, that at 50 feet, the cable needed to drive the power over that distance would exceed the weight of the Generator to avoid massive resistive losses. An AC generator producing 120V AC can be driven a much larger distance with COTS extension cords without incurring a major power loss.

The Flex Fuel Generator also bridges the mobility and vehicle challenge area, and provides an improved capability for vehicles with the absence of an onboard or detachable APU that provides continuous power while the vehicle is stationary. In lieu of this capability, personnel typically idle the main engine (often diesel) to maintain charge on the internal batteries. This is not only an inefficient fuel process, but it also creates a large amount of noise and exhaust for the personnel inside the vehicle. Main engine idling creates "wet-stacked" engine degradation that results in increased maintenance issues, and cost prohibitive and labor intensive maintenance cycles. The Flex Fuel Generator provides a more optimal solution to personnel.

Quantitative Results:

1. *Reliability: Power was provided for the entire exercise duration.* Personnel were able to successfully accomplish their mission objectives and power requirements utilizing the Flex Fuel Generator. Successfully ran from Inbrief to Hotwash (8-10 hours/day) on multiple blends of fuel, including "dirty JP-8."

2. *Ease of Use: Training was successfully conducted in less than 5 minutes.* Personnel whom had never seen or operated an INI Flex Fuel Generator were able to generate up to 1kW of power with any available fuel in a Humanitarian Assistance / Disaster Relief (HA/DR) environment.

Qualitative Results:

1. *Liquid Fuels: Personnel were successfully able to generate power utilizing liquid fuels.* Personnel were given the option to operate the Flex Fuel Generator utilizing JP-8 and multiple other sources of liquid fuel.

2. *Compressed Gas Fuels: Personnel were successfully able to generate power utilizing compressed gas fuels.* Personnel were given the option to operate the Flex Fuel Generator utilizing propane and multiple other sources of compressed gas fuel.

3. *Combination of Fuels: Personnel were successfully able to generate power utilizing any combination of liquid and compressed gas fuels.* Personnel were given the option to operate the Flex Fuel Generator utilizing a combination of any liquid or compressed gas fuel available.

Collaboration / Ad Hoc Experiments:

ANY FUEL. ANY AOR. ANY COMBINATION. INDOOR/OUTDOOR USE.
INI's Primary Objective was to successfully bridge the power capability gaps for HA/DR, RELIEF, and Stressed Populations (SP) Mission Sets. Also supporting STAR-TIDES efforts, INI Power Solutions provides sustainable support in post-war, post-disaster, and impoverished AORs, whether foreign or domestic, for short or long term operations. The One Man Portable Flex Fuel Generator (1MPG) was subjected to continuous operation in the harsh, austere environment of Camp Roberts. Ambient temperatures were 107+ °F, with average ground temperatures of at least 135+ °F.

Operating on any liquid or compressed fuel, INI's agnostic capability to integrate seamlessly with technologies from any battery charger manufacturer was vigorously tested throughout the week. The Flex Fuel Generator provided immediate power to the Bren-Tronics Soldier Portable Charger, and successfully charged up to QTY (4) BB-2590 Li-Ion batteries, and up to QTY (4) BB-2847 Li-Ion batteries throughout the day. This battery charging solution was tested successfully, and passed safely, every day, in full sun conditions, from Inbrief to Hotwash, for the entire JIFX evolution.

"DIRTY JP-8" VALIDATION TESTING:

In addition to successfully operating on the fuels listed below, INI conducted numerous successful field tests of "dirty JP-8," which is comparable to the contaminated and diluted mixtures personnel encounter in current HA/DR and RELIEF AORs.

1) JP-8
2) JP-5
3) F-76
4) Diesel #1
5) Diesel #2
6) Kerosene
7) Gasoline
8) Propane
9) Butane
10) JetBoil (propane/isobutane)
11) Rubbing alcohol
12) Ethanol
13) Methanol
14) E-85
15) Acetlylene
16) Syn Gas
17) Bio-gas (sour)
18) LNG
19) AV Gas
20) MOGAS
21) Nail Polish Remover
22) Paint Thinner
23) GOOF-OFF
24) Everclear (Grain Alcohol)
25) Bacardi 151
26) Local "hooch" in the AOR
27) Any homogenous liquid blend
28) Any homogenous gaseous blend

Left to right: Figure 4: Dirt added to container, Figure 3: Container then filled with JP-8, Figure 4: Successful operation on "Dirty JP-8" Pour

AD HOC EXPERIMENTATION: #A-01 Lightweight Low Energy Antenna Form – ChamTech

In real time HA/DR and RELIEF CONOPS in unimproved AORs, garrison Tier 3 power is often unreliable or unavailable. During JIFX 12-4, an ad hoc opportunity presented itself when basing power failed at the remote end of the field, resulting in critical Antenna operation being lost for ChamTech Experiment #A1.

INI was approached by ChamTech's Principal Investigator to see if the Flex Fuel Generator could assist in their power challenges. INI immediately topped off the One Man Portable Generator with the closest combination of fuels available (Grain Alcohol and Rubbing Alcohol), and hand carried the system to ChamTech's experiment site.

Power was delivered immediately, and ChamTech was able to restore operation to the Antenna. ChamTech utilized and operated solely with the Flex Fuel Generator for the

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remainder of JIFX. The constant, flexible, reliable, and portable power solution INI provided relieved ChamTech from the constraints of inconsistent and unpredictable power availability, especially when anchored to generators capable of operation on only a single fuel.

Figure 5: Successful Ad Hoc Integration with ChamTech Lightweight Low Energy Antenna Form (#A1)

***AD HOC EXPERIMENTATION: #A-05 VestLyte Land to Air Signaling – Lumenyte International Corp*.**

In a scenario similar to the one described above, an ad hoc opportunity presented itself to integrate with Lumenyte and the VestLyte System. After a few seconds of collaborative discussion, INI was able to immediately provide the requisite power for successful operation of Experiment #A5. By incorporating the Flex Fuel Generator, the VestLyte Land to Air Signaling System was able to be utilized anywhere throughout the JIFX AOR. The ability to undo the restraints to garrison power is a vital key to success for HA/DR and RELIEF CONOPS.

Figure 6: Successful Ad Hoc Integration with Lumenyte VestLyte Land to Air Signaling System (#A5)

AD HOC EXPERIMENTATION: #F-03 Squad Power Manager

In another successful ad hoc scenario, the SPM was connected to the Flex Fuel Generator to test the system for immediate power and battery charging. Power was provided instantaneously to charge batteries at a much faster rate than small flexible solar blankets. INI's Flex Fuel Generator is a perfect complement to Net-Zero, Operational, and Future Energy objectives.

Figure 7: Successful Ad Hoc Integration with Squad Power Manager (#F3)

Observations & Comments:

Originally designed to solve the challenges of excessive and burdensome resupply convoys in combat AORs, INI's Flex Fuel Generator capabilities are also the perfect solution for HA/DR and RELIEF CONOPS. Whether in a post-war or post-disaster environment, the ability to utilize ANY FUEL in ANY AOR is critical in rendering the necessary assistance to Stressed Populations. Having the luxury to leverage the maximum flexibility of an Agnostic Fuel Architecture, combined with the option to generate power from fuel off the local economy, will ensure that HA/DR and RELIEF objectives are accomplished more efficiently and more effectively.

Experiment #F-04

Disaster Response Applications for Rayovacs Energy-Dense High-Power Li/CFx Batteries

Rayovac Battery

Principal Investigator/Lead: William Bushong, Rayovac

Working Hypothesis:

Ultra-lightweight and energy-dense Lithium carbon monofluoride batteries can provide soldiers with longer-lasting and lighter solutions for various electronics.

Objective:

The purpose of this work is to demonstrate the applicability of lithium carbon monofluoride (Li/CFx) batteries relating to disaster response. We will use live demonstrations to visually show how these ultra-lightweight energy-dense Li/CFx batteries outperform other chemistries.

Overview/Background:

Among battery chemistries, the lithium carbon monofluoride (Li/CFx) chemistry is considered to have the highest energy density. Rayovac has been developing Li/CFx cylindrical cell since 1995. Much of this work was done under government contracts. Rayovac's government contract work has led to the development of advanced high energy, high rate primary Li/CFx wound cell designs which provide lightweight battery systems for soldiers.

Advantages of Li/CFx batteries over alkaline batteries include:

- >2.5x volumetric energy density (Wh/L)
- >3.5x gravimetric energy density (Wh/kg)
- Wider temperature window of operation and storage (-40 to 90 °C versus -20 to 55°C)
- 2x shelf life
- High rate capable (2A constant current discharge)
- Flat discharge curve

Experiment Description:

We will conduct 3 tests to assess the effectiveness of Rayovacs energy-dense batteries compared to other chemistries:

- D-cells in a high-power man-portable search and rescue flashlight (>1000 lumens)
- D-cells in a personal emergency strobe locator
- AA-cells in a ground fixed micro RC helicopter simulating a UAV

We will present the following data:

- D-cells discharged at extreme temperatures (-30°F and 120°F)

- Model of a UUV showing high volumetric energy density

Measurements/Data Collection Plan:

A relative luminance test will be done using a “Peak LED Solutions” SR2000A search and rescue flashlight. White silhouette targets will be placed 100 meters apart and illuminated by the flashlight until the battery wears out. This is a night test. A video feed will record the progress. Data will be collected every 5 minutes and plotted against Li/CFx, alkaline D-cells, NiMH D-cells, and lithium ion cells.

An ACR MS-2000M personal emergency strobe locator will be tested in two different fashions: strobe mode and incandescent mode. The locator is rated to last 8 hours in strobe mode or two hours in incandescent mode with 2 alkaline cells. The incandescent test will be done in the same manner as the SR2000A. The strobe mode test will simply assess how long the unit operates and does not need to be done at night.

Micro RC helicopters have been modified to accept AA batteries. To prevent them from flying off, they have been tethered to a platform. A head to head competition of each battery type (Li/CFx, alkaline, NiMH, Li-ion, etc) will be demonstrated.

Measures of Performance/Measures of Effectiveness:

The SR2000A search and rescue flashlight uses a high power LED requiring 10A of current to drive it to its peak output. The different battery chemistries will be compared both on how long they power the flashlight, but also at what output. The output performance will be assessed by imaging targets placed 100 meters apart. As the different batteries wear out, the targets at a distance will become more difficult to visualize. A video feed will record the progress.

The ACR MS-2000M personal emergency strobe locator in incandescent mode will test the cells rate ability and total capacity. The strobe mode is less rigorous and it’s lifetime will depend more on the total capacity of the cells. The unit is rated for 8 hours on 2 alkaline batteries and in an emergency situation it may be desirable for the device to function longer because replacement batteries are unlikely to be available.

The Micro RC helicopter presents a unique challenge: the battery must both be energy dense so that it can be lifted, but also have the rate-capability to sustain the high discharge rates required to lift the unit off the ground. Each battery chemistry, in AA size format, will be tested to see how long it can sustain "flight".

What new capability (or improvement to existing capability) does this represent?

- Higher volumetric energy density allows for longer uninterrupted operation
- Higher gravimetric energy density reduces costs associated with airdropping batteries and permits for more batteries per airdrop. Additionally, in the world of small UAV's, a lightweight energy-dense rate-capable power source allows for longer missions before refueling.
- Wider temperature window means the flashlight that's been stored in the dead of winter works when you turn it on
- Longer shelf life lowers total cost of acquisition
- Higher rate capability allows for a brighter flashlight in a smaller package
- A flat discharge curve means the flashlight or emergency strobe doesn't go dimmer and dimmer as the battery wears out

Quantitative Results:

Strobe Test (AA size cells)

An ACR MS-2000(M) personal locator strobe was used to test the operational lifetime using Energizer Max alkaline batteries (U91), Energizer Ultimate Lithium batteries (L91), and Rayovac's Li/CFx AA's (BR-6). The strobe unit has a typical power draw of 480 mW, measured using an Instek PS-1830D laboratory DC power supply. The strobe test† was done on a table, outside, exposed to the elements. The measured surface temperature of the unit during daytime operation exceeded 60 °C. This was a continuous test.

Name	Cell Open Circuit Voltage (V)	Battery Configuration	Nominal Battery Capacity to 2V Cutoff (mAh)	Battery Weight (g)	Nominal Battery Energy Density (mAh/g)	Expected Operational Life	Tested Operational Life (†Test in lab) (‡Test in field)
Energizer Max Alkaline AA	1.63 V	2s1p	2000	47.2	42.4	12.5 hours	9 hours†
Energizer Ultimate Lithium AA (L91)	1.82V	2s1p	3000	29.6	101.4	18.8 hours	18 hours‡
Rayovac Li/CFx BR-6	3.41 V	1s2p	5000	28.2	177.3	31.3 hours	>25 hours‡*

Strobe was still going, however we had to prematurely stop testing to make our flights

Table 1: AA Cells in a Personal Locator Strobe

Flashlight Test (D size cells)

An SR-2000 search and rescue light made by Peek LED Solutions was to be used to test Rayovac's Li/CFx D-cells against alkaline D-cells and Li-Po 38120 cells. This light was designed around the 38120 Li-Po rechargeable cells but was also sold with a plastic insert to allow D-cells to be used. The test involved using LUX sensors placed at 500, 100, and -3 feet to measure the flashlight's output as it discharged throughout the night. The flashlight rheostat was adjusted using the Instek PS-1830D laboratory DC power supply so that each battery type discharged at 2 amps. Previous lab tests and conversations with the manufacturer suggested that this flashlight was more than capable of handing the higher voltage found with Li/CFx batteries. Unfortunately, possibly due to the daytime temperature exceeding 43 °C and the flashlight's black surface exceeding 50 °C, the LUX sensors used to collect the data overnight failed after only 2.5 minutes and the flashlight also failed sometime overnight. After this event the flashlight would not turn on with either the Li-Po or alkaline batteries. We still don't know the exact cause for the flashlight's failure because its electronics are epoxy potted.

Name	Cell Open Circuit Voltage (V)	Battery Configuration and Nominal Voltage	Nominal Battery Capacity at 2A (mAh)	Battery Weight (g)	Nominal Energy Density (mAh/g)	Expected Operational Life (Based on a 2A set point)	Tested Operational Life (†Test in lab) (‡Test in field)
AA Portable Power Corp 38120 Li-Po Rechargeable Battery	3.72	2s1p, 7.4V	10,000	754	13.3	5 hours	N/A
Energizer Max Alkaline D Cells	1.62V	4s1p, 6.5V	6,000	571	10.5	3 hours	N/A
Rayovac Li/CFx BR-20 Primary Lithium D Cells	3.34 V	4s1p, 13.4V	18,000	318	56.6	9 hours	Flashlight Failed

Table 2: D-cells in a 2000 Lumen Search and Rescue Flashlight

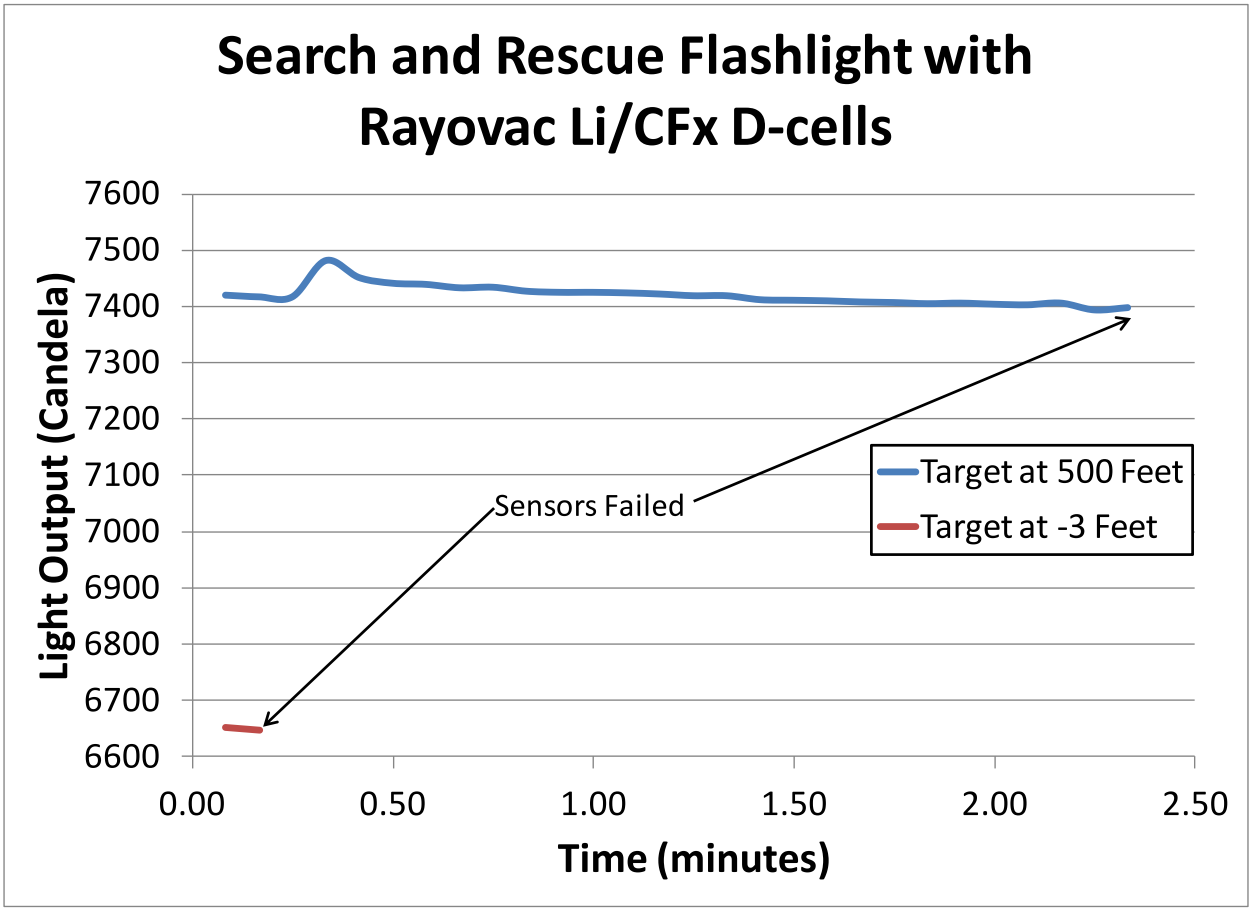


Figure 5: Limited Data Collected from the Search and Rescue Flashlight Test

Collaboration / Ad Hoc Experiments:

We had positive interactions discussing power requirements and the potential for future collaborations with:

- DeLorme
- Lumenyte
- QinetiQ
- STARA Technologies
- MedWeb
- Lockheed Martin

Observations & Comments:

Overall we found this to be a very successful event. While there were some setbacks with our D-cell testing, we found the contacts and suggestions made by the COCOMM representatives, the interagency representatives, and the commercial participants more than made up for it. We would like to thank the NPS both for hosting this event and for generously loaning us the canopy tent (it saved our skin).

Experiment # F-05

CANCELLED

AWS Mobile Renewable Water Source

Atmospheric Water Systems

Principal Investigator/Lead: Randal Moos, AWS

Working Hypothesis:

If off grid water production capabilities become portable, deployable, renewable, and standalone, then security in both water quality and water delivery operations increases.

Objective:

To convert our atmospheric water producing machine into a portable, deployable and renewable standalone potable water station.

We would utilize all off the shelf technology and components to build a deployable trailer that would house our water making machine coupled with a vertical axis wind turbine, solar cells, batteries and an inverter to power the system day and night.

Overview/Background:

Atmospheric Water Systems, Inc. ("AWS" or the "Company") is a strategically advanced participant in the potable water industry which has developed a family of proprietary products designed to optimize the world's largest untapped natural resource – water – in the form of moisture in the air.

The basic technology of extracting water from ambient air has been in existence for several years, but our expertise and patent pending innovations have created unique technologies that we have incorporated into new and highly-efficient product designs. Our existing technology, including refinements we may make thereto, will be included in our existing or future patent claims, or protected as trade secrets.

Experiment Description:

To convert our atmospheric water producing machine into a portable, deployable and renewable standalone potable water station.

We would utilize all off the shelf technology and components to build a deployable trailer that would house our water making machine coupled with a vertical axis wind turbine, solar cells, batteries and an inverter to power the system day and night.

Timeline:
This build out demonstration unit 4 Days
Test unit to verify that the goal has been achieved 1 Days
Document all results and findings 2 Days

Measurements/Data Collection Plan:

1) AWS will calculate the required energy needed to run at optimum efficiency our atmospheric water solution.
2) Design a 100% renewable energy solution to support off grid water making.
3) Source all components from local sources.
4) Build test unit per design parameter.
5) Test all sub components.
6) Inspect the completed unit to adherence to all design specifications.
7) Start the testing phase.
8) Cycle test energy output at various times of the day and night.

9) Cycle test water output at various times of the day and night.

Testing equipment needed:

- Volt meter
- Anemometer
- Barometer
- Measuring beakers

Measures of Performance/Measures of Effectiveness:

Cost of water verses cost of fuel for delivery to forward and remote bases.

Cost and security avoidance to commercial business over current acceptable delivery methods.

What new capability (or improvement to existing capability) does this represent?

The capability of off grid water production that will provide security in both water quality and water delivery with free energy once the capital cost has been absorbed. This technology simply does not exist today efficiently.

Experiment # G-02

Social Media Dashboard

EUCOM, ONR/ASU

Principal Investigator/Lead: LT Jennifer Franco, EUCOM / Dr. Rebecca Goolsby, ONR

Working Hypothesis:

By using social media dashboards to collect information and support, improved decision making and collaborations occur between the public and interagency partners.

Objective:

Develop an interactive and customizable social media dashboard to aid EUCOM decision makers and interagency partners to collaborate on mutual operations of interest.

The effort to develop a crisis response dashboard that will collect, analyze and monitor information flows regarding crisis, disaster and humanitarian emergencies, beginning with crisis zones in the Pacific and European Command's Areas of Responsibility will enable the COCOMs and supporting tactical and operational staff to more effectively support HADR operations. Actionable Goals:

- Improved support for COCOM use of social media to monitor popular perception and reactions to conventional, public affairs and information operations both within the Area of Operations (AOR) and internationally
- Improved HADR Intelligence Preparation of the Battlespace to establish and maintain baseline culture and behavior profiles based on pre-crisis media usage

- Improved HADR Cultural Awareness and Perception Management through realtime monitoring of local perceptions, actions, and reactions
- Improved HADR Logistics planning through realtime monitoring of demand signals for disaster relief supplies

Overview/Background:

Recent crises such as Arab Spring, the 2010 earthquake in Haiti and the 2011 Tohoku earthquake and tsunami in Japan gave way to opportunities to embrace social media to provide public information, utilize crowdsourcing and to leverage available resources. To this end, U.S. European Command entered into partnerships with the volunteer technical community, academia and industry to harness the power of social media to assist in humanitarian aid/disaster relief and non-combatant evacuation efforts.

- Combining efforts of traditional media with new media was hoped to help decision makers have access to social media tools that highlighted where instances of community engagements were aiding humanitarian efforts or promoting disruptions to regional security.
- During February 2012, a joint Department of State/EUCOM seminar was held to further discuss issues of collaboration, capabilities and policy that would be needed in order to operationalize the use of social media.
- Looking at social media as tool that could be actionized, operationalized and planned lead to an effort to create a social media dashboard.

Experiment Description:

- In partnership our EUCOM partners, ASU and ONR, we identified requirements for the use of a social media dashboard and agreed upon lines of operation should a Unclassified Information Sharing Cell be called upon to assist with a mission.
- And within EUCOM, we loosely determined lines of operation for the UIS cell, which included a requirement for a social media dashboard.

- While there are new products to beta test every month, EUCOM partnered with ONR/ASU to develop a dashboard on a platform accessible anywhere and that was able to provide some "discovery analysis" by plotting community engagement nodes and graphing trending information.

Measurements/Data Collection Plan:

The data used in this demonstration consists purely of tweets collected from Twitter using Twitter's streaming API. This data has been collected in accordance with the rules set forth by Twitter.

Two datasets will be used to demonstrate our system. One consists of tweets collected concerning the Syrian crisis from 2011-02-02 to 2012-04-03. This dataset consists of tweets matching a set of keywords concerning the Syrian revolution, and geotagged tweets coming from Syria. The other dataset concerns general conversation coming from Turkey, with tweets containing general tweets concerning Turkey, and geotagged tweets from the region.

Measures of Performance/Measures of Effectiveness:

Baseline Assessment

- The development of baseline assessment capabilities for significant crisis zones
- The capability to provide visualizations and analysis of crisis events together with the background data to provide contexts in the form of background reports, social network analyses, automatically generated and customizable

Multi-Lingual Processing and Data Sifting: The development of computational linguistics approaches to process and analyze online information flows

Crisis Mapping with Field Reporting: Suitably documented and robust, scalable crisis maps capable of tracking third party crisis maps (such as Ushahidi)

What new capability (or improvement to existing capability) does this represent?

The EUCOM's Social Media Dashboard concept includes TweetXplorer, a state of the art ONR project to gather social media information specifically for crisis (capable of handling flows of 100,000 messages per hour); improved crisis map capability (robust even under Internet Explorer 7.0), automated message sorting with language filters, trending on any word, and community detection algorithms.

BLUF:

EUCOM, in coordination with the Office of Naval Research (ONR) and Arizona State University (ASU), demonstrated and presented the Unclassified Information Sharing initiative and the social media dashboard to participants at the Joint Interagency Field Exploration (JIFX) at Camp Roberts from 13-17 AUG 2012. There were more than 200 JIFX attendees representing multiple Combatant Commands, civilian government agencies, and NGOs. The social media dashboard was positively received, with interest from multiple organizations as well as recommendations for additional features and refinements.

Outcome:

LT Adam Clampitt from ECPA and Fred Morstatter from ASU demonstrated the dashboard at the JIFX throughout the week, which culminated with a group presentation on Thursday 16 AUG. More than 25 people attended the group presentation representing the following organizations:

- CENTCOM
- NORTHCOM
- Naval Post Graduate School
- Department of State, Bureau of Consular Affairs
- Department of Homeland Security

- Director of National Intelligence
- JVAB (cyber security contractor)
- GeoIQ
- MedWebs
- Intellisense

Sentiment towards UIS and dashboard was overwhelmingly positive, and solidified EUCOM's reputation for innovation and leading the way when it comes to social media. Organizations were also impressed with EUCOM's ability to secure development of the dashboard with little or no impact on the EUCOM budget. Multiple government agencies expressed interest in securing the product for their own use and are going to work directly with ONR to determine next steps.

Challenges:

As a result of the demonstration, we were able to identify features for the dashboard that are not yet integrated, and recorded suggested improvements from participants to provide a more complete operational picture. Requests for future improvement to the product included:

- Inclusion of all Twitter feeds, and geo-tagged feeds as opposed to the standard Twitter Streaming API, which only captures 1% of all Tweets (geo-tagged Tweets in the dashboard currently only make up 1% of 1%). Twitter charges $10,000 per month for access to the API of all Tweets.
- The ability to monitor other social media networks in addition to Twitter, since network usage varies by country.
- The ability to monitor key words and usernames in addition to hashtags
- Integration of Google Translate to simultaneously translate foreign language feeds (currently, feeds must be cut and pasted into Google Translate which can be labor intensive).
- Integration of sentiment analysis
- The ability to generate an easy to read report on a particular topic

Conclusion:

For the "alpha" version of the social media dashboard, the product was very well received and gives EUCOM an open source product that provides a more in-depth analysis that has previously existed. However, there is much room for the dashboard to continually improve and refine which will give EUCOM a more complete situational awareness during an HADR event. Overall, the JIFX successfully validated the use-case for the product.

Next Steps:

- Recommend integration of full Twitter API into the dashboard to ensure a complete picture. Only seeing 1% of all geo-tagged Tweets severely limits visibility during an HADR event.
- Discuss with ONR/ASU the ability to integrate recommendations listed above and determine a timeline for a "beta" release.
- Demonstration to EUCOM key decision makers to gather further feedback.

Experiment # G-03

Crowdsourcing Flood and Damage Polygons

Humanitarian OpenStreetMap Team and GISCorps

Principal Investigator/Lead: John Crowley, National Defense University

Working Hypothesis:

During a major disaster, when a catastrophic event has occurred over a wide area, federal GIS resources are overwhelmed. Volunteered Geographic Information (VGI) can provide a surge capacity to these federal officials, enabling them to focus less on grunt work and more on the problems of communicating and coordinating the extent of the emergency to ICS commanders.

Objective:

As imagery of disasters becomes available earlier in the disaster cycle, volunteer organizations like the Humanitarian OpenStreetMap Team and GISCorps can create a surge capacity for government GIS officials. This experiment will test the methods and speed by which volunteer organizations trace polygons of floods and earthquakes using the high-resolutions imagery collected by the Civil Air Patrol (see experiment B-13).

Overview/Background:

VGI has become a core part of international crisis response operations. Haiti operations ran on OpenStreetMap data, including some of the data released by NGA. Contrary to the usual moniker of "crowdsourcing," mapping data tend to be generated by volunteers who have geographic expertise, sometimes in excess of 10 years of professional GIS work. That said, methods by which volunteers perform their work has not been harmonized with the expectations of US government officials who need to use the resulting data.

This experiment will bring together key volunteers from the Humanitarian OpenStreetMap Team (HOT and GISCorps with GIS officials from FEMA, NOAA/NWS, NORTHCOM, and NGA to align methods and test the speed by which volunteers can provide surge capacity around the tracing of flood and damage polygons. The goal is to develop TTPS that can be used over large areas, especially with damage patterns like the tornados in 2011, which had hundreds of touchdowns, each of which had to be traced and passed along to ICS commanders.

Experiment Description:

Discovery. This experiment is designed in four iterations. It assumes that each collection of Civil Air Patrol imagery will generate a mosaic of an affected area. HOT and GISCorps will explore TTPs for drawing damage polygons of the area based on these mosaics. It will make use of artificial features that will be left in the cantonment area of the base as part of the IAP Earthquake experiment. It will also seek to place visible ground control points near the Lake Nacimento dam or the river bed, depending on conditions.

Measurements/Data Collection Plan:

Data collection will occur through the CAP experiment. Damage polygons will be created on top of the imagery in both OpenStreetMap and ESRI tools, and data will be presented on screen to NGA, FEMA, and NOAA/NWS analysts for evaluation.

Measures of Performance/Measures of Effectiveness:

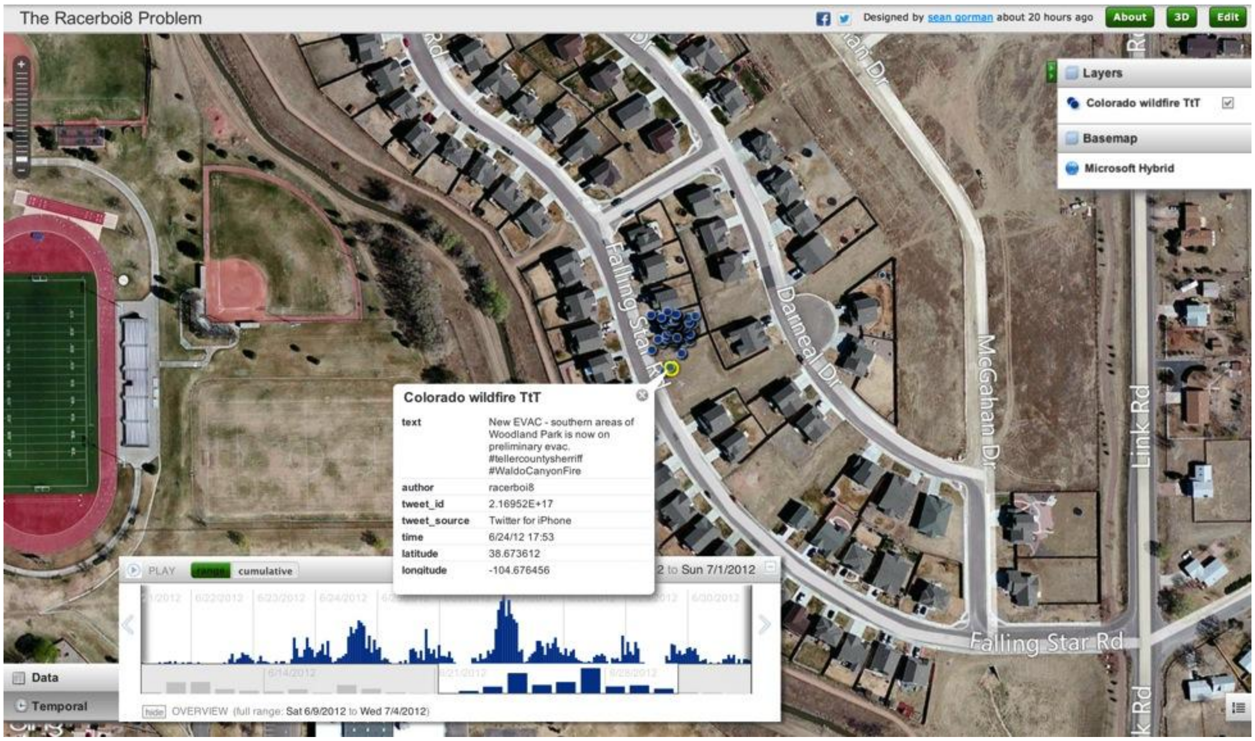
Speed of drawing polygon after processing of imagery.

Accuracy of polygons as assessed by federal analysts.

Experiment # G-04

Real time streams for criticality analysis

ESRI



Principal Investigator/Lead: Andrew Turner, Sean Gorman

Working Hypothesis:

If real time data is streamed, then areas of criticality during a disaster are identifiable as well as data portability through GIS systems.

Objective:

Experiment using real time data streams to help determine areas of criticality during a disaster, and provide interoperability and data portability with desktop GIS systems and other technologies for additional analysis/collaboration.

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Overview/Background:

With the surge in mobile devices that are GPS enabled there is a growing human sensor net which can be an invaluable resource during a disaster. One of the challenges of topping into the mobile sensor net in the high volume and speed of the data created. Also the data is dynamic and unbounded, so the answers to any analysis results can change over time. In this new paradigm innovative analysis approaches and data management techniques are needed. Also these new sources of data and analysis need to portable to enable interoperability with traditional tools and techniques.

Experiment Description:

For the experiment we'll use a dynamic data stream from Twitter, mobile events or annotations as an example source for a disaster. A stream collection application will be set up to manage the data generated. Once the stream is established an updating analysis will be established to calculate the number of events aggregated by a 1km grid over time. The grid analysis can then be exported in a variety of formats for use in other tools.

Specifically for this experiment we'll push the data to a desktop GIS system so that it can be combined with other data sources like imagery change detection, critical infrastructure and Landscan population data. All of these data sets can be normalized to the same 1km grid used for the data stream allowing a variety of map algebra operations. These techniques will allow intersections between the data sets to be calculated as well as the aggregate criticality of grid cells based on the concurrence of mobile activity, population, infrastructure and risk. These algorithms can then be leveraged to determine which 1km grid cells are the highest priority for response.

Measurements/Data Collection Plan:

The platform put in place will provide metrics on all the mobile data collected and provide a variety of options for visualization and analysis of the data. We are evaluating using mobile annotations from previous Camp Roberts exercises or using data from the recent Colorado wildfires to have a more realistic event data stream.

Measures of Performance/Measures of Effectiveness:

We will have a variety of metric to monitor the performance and loads of the software and streams. We will use the collaboration opportunities and hot washes to get qualitative feedback if the technique is useful for responders and analysts.

What new capability (or improvement to existing capability) does this represent?

This will be the first time testing real-time analytics of mobile/social streams for helping resource allocation during disaster. If successful the approach could provide a new dynamic pulse of human activity and patterns during a disaster. This could provide invaluable insight for first responders.

Quantitative Results:

The team was provided 250,000 Tweets from Catherine Starbird of Tweak-the-Tweet that covered the Colorado Wildfires of summer 2012. The experiment endeavored to discover how viable the social media data from Twitter was as a viable source of disaster information. The quantitative analysis of the data uncovered several challenges and also many potential benefits of leveraging social media and Twitter specifically.

Challenges:

1. The volume of data with precise geographic coordinates tends to be quite low. Of the 250k tweets roughly 2,400 had GPS coordinates of the Tweets location.
    a. This allows for the tactical extraction of specific Tweets, but makes for bad sample or indicator of the over all population.
2. In addition to the demographic bias of Twitter users there is also a bias in the volume of Tweets coming from individual users.

   a. Current analysis techniques treat all Tweets equally whether it is a single Tweet from a user about the disaster or a user who Tweets 120 times in a day.
   b. Aggregate analysis and correlation can be unduly influenced by deviations in the volume of Tweets from individual users.
   c. Specifically we called this the Racerboi8 problem who was a user in the wildfire data who Tweeted 10x more than the next closest user and was far removed from the threat area of the wildfires.
   d. Without normalizing the Tweet volume per users this can create false positives in the data.
3. The need to have a specific keyword to identify disaster related Tweets means social media can't be used until the disaster is well underway and the community has established keywords or hashtags.
   a. Tweak-the-Tweet does a good job of curating data with the community but requires a taxonomy emerging from the community before it can start generating data
   b. This causes the loss of the capacity to tap Twitter as an early warning and indicator of a disaster emerging

Benefits:

1. Twitter provides a unique real time information stream of how the public is interacting and reacting to a disaster
   a. Provides a distributed and resilient network of first person observers for a disaster
   b. Twitter was used by citizens and responders to provide information about the disaster and status
   c. Provides multimedia support and the ability to add geographic coordinates to information posted
2. Data from Twitter can be easily integrated with other spatial data to distill the most critical and relevant information in the social media stream
   a. Tweets can be filtered by those geographically proximate to the disaster and/or critical infrastructure

b. Easy facilities by which to parse the signal from the noise in social media stream
c. There is the potential for these filters to be dynamically updated as new data comes in.
d. Alerts from filter updates could let responders know about activity in the disaster or in close proximity to critical assets.

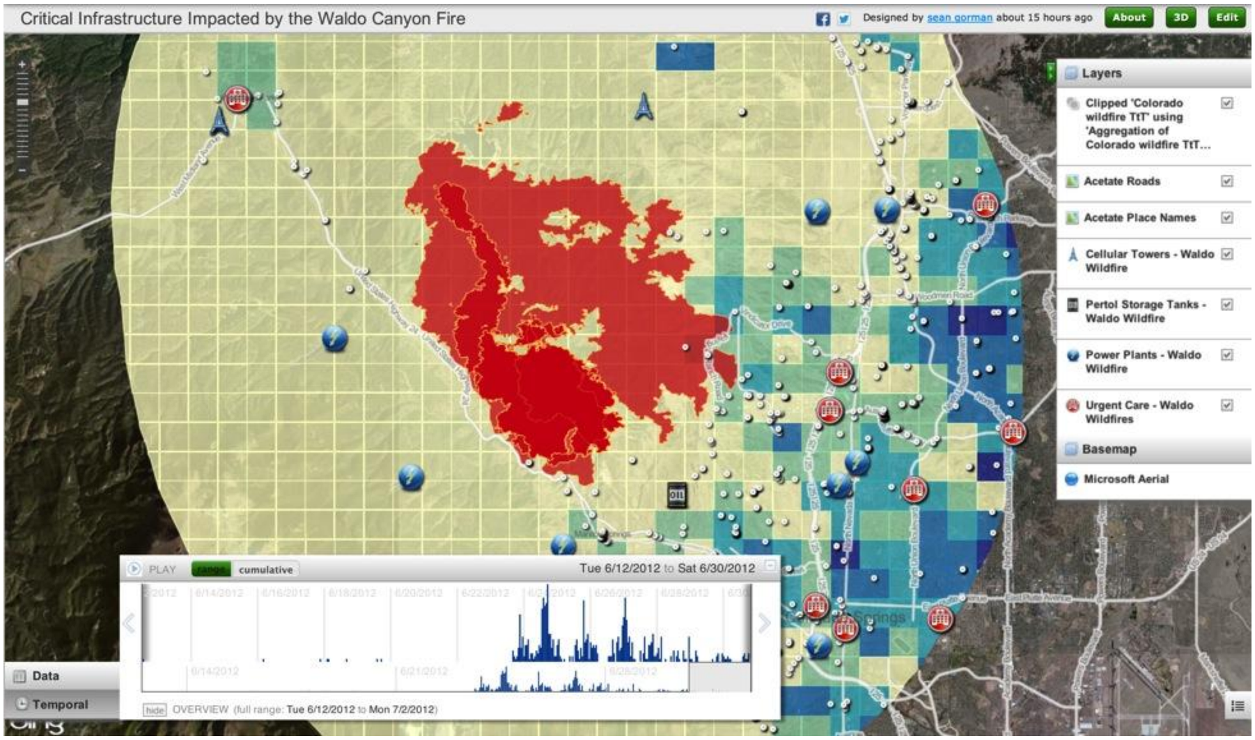
Qualitative Results:

Best practices discovered by the experiment:

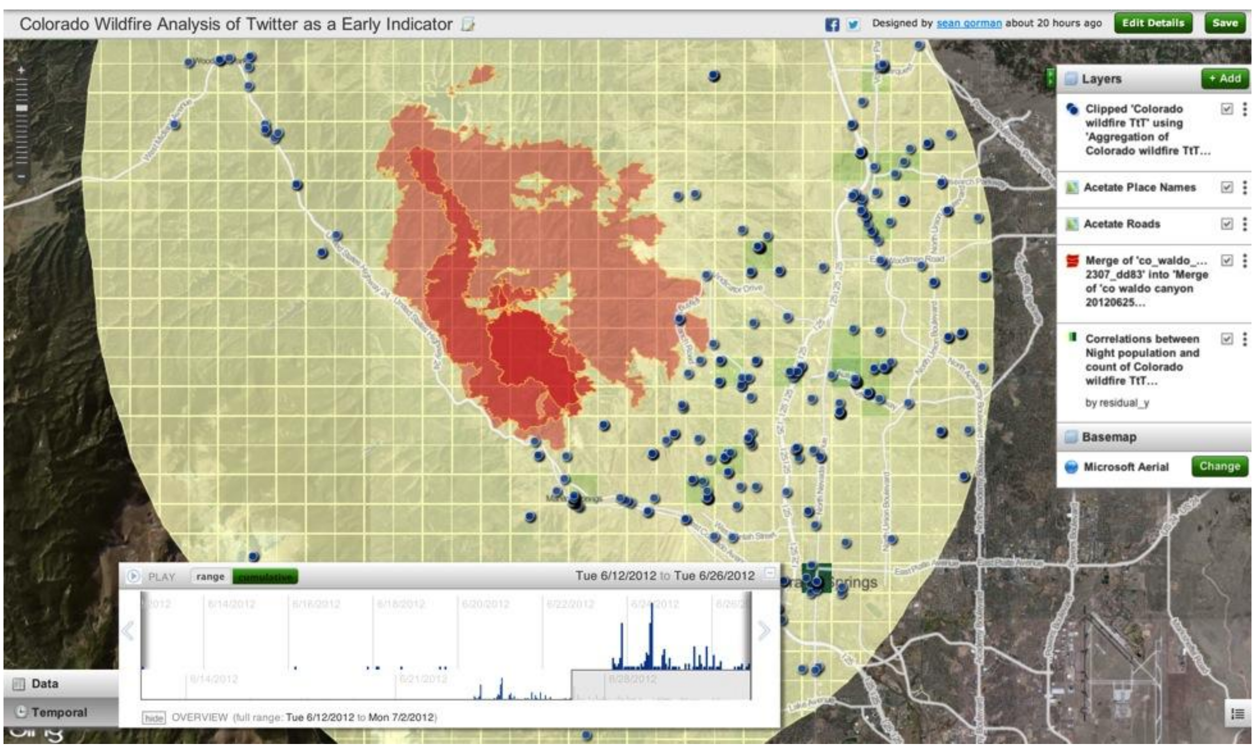
1. Filter Tweets by proximity to the disaster through intersection or buffer to remove Tweets that are reacting to news or outside observers, but not actually involved in the disaster.
2. For aggregate statistics and analysis normalize Tweets by the volume of activity by users to remove sample bias.
3. When doing macroscopic analysis like detection of patterns use the entire Twitter dataset for calculations then infer geography after the analysis has been run to do mapping and geoprocessing.
4. Use pattern detection techniques to identify emergent hashtags and keywords that can be used to kick of targeted searches for tactical use.
5. Use spatial/temporal regressions to identify social media voids by identifying geographies with more or less activity than the population would predict. Entropy could be another good indicator if users wanted to make this a dynamically updating analysis.

Collaboration / Ad Hoc Experiments:

We worked closely with Nat Wolpert and Katie Bausom of NGA as well as Chris Vaughn and Michael Gresalfi of FEMA. We also participated in discussion with John Crowley's Civil Air Patrol project on how this analysis could be used to prioritize areas for imagery capture.

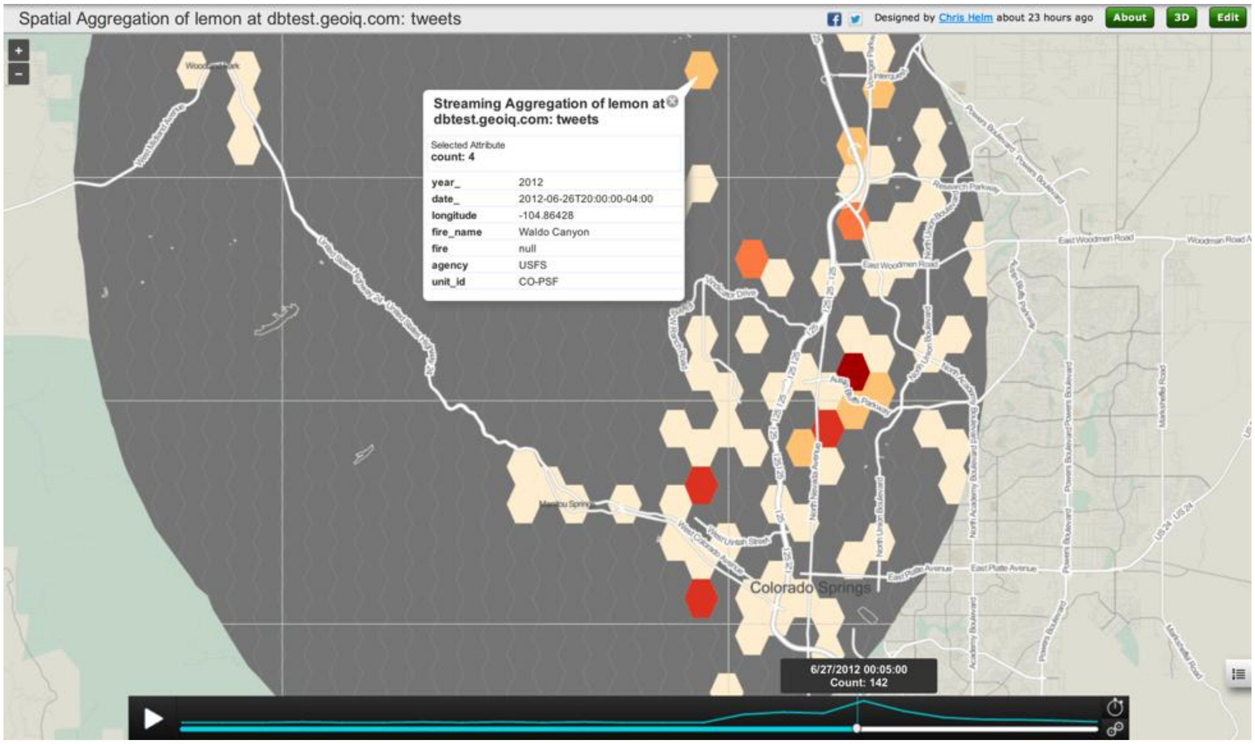


In the analysis we filtered Tweet by proximity to wildfires in Colorado Springs and their proximity to critical infrastructure. The gridded thematic is showing nighttime population courtesy of the [Landscan] project at ORNL.



To detect hot spots and voids we ran a simple linear correlation between the population in each grid cell (independent) and the number of Tweets (dependent). The resulting map highlights areas with more Twitter activity than the population would predict. The dark green square in the lower left hand corner ended up being the location of the local TV

station that was pushing out a deluge of Tweets. This and the Raceboi8 example drove home the need to normalize the data by Tweet volume for statistical analysis.



We hooked the data up to Twitch and did some streaming analysis to see what patterns we saw emerging in the data aggregated over time. Generally Twitch is better for real time events but was still useful for some post event pattern analysis.

Experiment # H-01

Lightweight Compact Evacuation Litter

QinetiQ North America

Principal Investigator/Lead: Ian Arroyo, QinetiQ

Working Hypothesis:

If litters become lighter and more compact, they will be easier to transport and manage during disaster relief efforts.

Objective:

Test and evaluate the Q-LiFT Combat Foldable Litter in a field like environment and receive feedback from the COCOMS and first responders on the ease of use, packaging, etc.

Overview/Background:

The current combat foldable litter used by DoD weighs approximately 12 lbs and is quite large and bulky. QinetiQ North America has developed a newly patented technology that allows the Q-LiFT to weigh only 8 lbs, carry a 900lb payload, and fold up to less than half of the volume of other litters in use today by DoD.

Experiment Description:

Train COCOMs/First Responders to fold/unfold the Q-LiFT and utilize it to carry "injured" personnel in S&R or medical evacuation scenarios. Receive feedback on the size, shape, weight, and ease of use of the Q-LiFT.

Measurements/Data Collection Plan:

Take down all feedback given by COCOM operators/first responders and utilize that data to make additional improvements.

Measures of Performance/Measures of Effectiveness:

Is all subjective and based on feedback from personnel who actually train on the Q-LiFT.

What new capability (or improvement to existing capability) does this represent?

The Q-LiFT reduces the weight/volume operators/first responders have to carry in S&R/medical evacuation scenarios.

Quantitative Results:

We brought one (1) lightweight, compact evacuation litter to the event for demonstration. The litter folds up to 1/3rd of the current compact foldable litter which is use by DoD today while providing a weight reduction greater than 50%. The litter is able to be carried or placed in locations where the current litters cannot. DHS, DOS, and various COCOMs came by to test and evaluate the litter. Great feedback and lots of excitement surrounding the new litter.
The QinetiQ Litter weighs less than eight (8) lbs, 34% of the folded volume of the Talon II: QNA Litter – 18.6"L x 8.7"W x 3.5"D (566.37 cu in.); Talon - 20.5"L x 8.5"W x 9.5"D (1655.37 cu in.), carries 900 lbs.
This is a significant improvement to the current litters being utilized by DoD, DHS, DOS, etc.

Qualitative Results:

All-in-all this was a good event. The event gave us the opportunity to receive feedback on the new litter from folks with very different backgrounds and mission sets. It was a fantastic forum for us to take ideas for improvement of the existing litter and provide an overall solution that fits within the need sets of DoD, DHS, DOS, etc.

Observations & Comments:

Would have liked a more scenario driven test of the litter whereby folks could actually imagine how and where it might be used, while also showing the ease of use capabilities found within the new design.

Experiment # H-02

Medical Sensor Technology

Intelesense Technologies

Principal Investigator/Lead: Dr. Kevin Montgomery

Working Hypothesis:

If medical trackers and vital sign monitors have secure wireless transmission to relay information obtained in the field, then personnel in HADR have increased awareness of medical conditions and problems.

Objective:

Field-based evaluation of medical sensor devices with first responders and AFMS medics/PJs. Evaluation of functionality, usability, field ruggedness and other metrics.

Overview/Background:

This is part of the USAF AFMS MedLink project, in collaboration with DHS S&T for the development and evaluation of personnel-based sensors for personnel monitoring, expeditionary medicine, en-route care, and force health protection.

Consists of two devices HealthWatch (provides location and physiological status/activity) and LifeGuard (field deployable vital signs monitor) that can transmit wirelessly through a distributed wireless mesh network. Has been field tested at TNT exercises, Emerald Warrior, and others, but this is the first joint exercise and the last exercise before final refinement of the device and beginning the FDA approval process, so is important to get good field evaluation.

Note- both of these devices communicate using the CoT protocol, so should be compatible with several backend systems, including the ATAK handheld software and DPIMS portals.

Please feel free to contact Dr. Montgomery for more information and background, as well as links to USAF AFMSA and DHS S&T contacts.

Experiment Description:

We are anticipating testing over a 5-day period as part of JIFX, with both AFMS and DHS personnel involved. Testing of HealthWatch will involve users (first responders and medics/PJs) wearing the watch-type device during the exercise, with wireless data transmission (900 MHz FHSS, 100mW) and viewing of personnel location and physiological status at the TOC.

Similarly, when an individual is deemed injured, the LifeGuard device would be placed by the medic/PJ and that vital signs data would be transmitted through the same distributed wireless mesh network and viewed at the TOC.

We anticipate several CONOPs that we would like to evaluate spanning expeditionary medicine, en-route care, and force health protection scenarios. Level of rigor is demonstration and test/evaluation (potentially in collaboration with AFMESA).

These systems would allow for the better coordination of medical care and resources in the field.

Measurements/Data Collection Plan:

Data will be collected wirelessly from the HealthWatch and LifeGuard devices during the exercise across several CONOPs. It is anticipated that this experiment will integrate very nicely with other exercises/projects already planned for JIFX.

Physiological data will be collected (anonymized) and viewed both in the field using the ATAK software, and also remotely using the DPIMS (GINA) portals.

Measures of Performance/Measures of Effectiveness:

Evaluation of functionality, usability, field ruggedness and other metrics:

- Functionality: veridical data transmission, transmission connect time, effective bandwidth
- Anomaly: Connection dropouts, device failure
- Performance: scalability of devices within squad-size teams
- Usability: in field, TOC visibility

What new capability (or improvement to existing capability) does this represent?

Both of these devices represent significant advanced capabilities:

HealthWatch is a small (wristwatch-sized) blue-force tracker (GPS), which also has integrated physiological monitoring (pulse rate, blood oxygenation, activity, messaging) with secure wireless transmission capability. It shows 'where are my guys and how are they doing' and is usable for DHS CBP, DEA/LE, and other personnel in the field.

LifeGuard is a small vital signed monitor designed with the field medic/PJ in mind and provides vital signs, GPS location, activity, and other capabilities that represent a force multiplier for the medic/PJ in the field.

Experiment # H-03

First Responder m-Health and Digital Exam Kit Field Testing

Medweb

Principal Investigator/Lead: Jenn Gold, m-Health Program Manager

Working Hypothesis:

If mobile health applications consist of intuitive patient identification, medical device tracking, linkage to mobile clinics, and data storage capabilities, then an end-to-end causality tracking system is achievable.

Objective:

To conduct operational testing of a mobile-based patient registration system and field deployable digital exam kit that equips emergency first responders with medical devices and associated patient image/data transmission capability to facilitate more rapid and effective triage of casualties;

To explore potential software solutions for organization, visualization and real-time tracking of individual patient identification, status, and location information (using data collected from exam kits and associated applications) in relation to existing and incoming medical and humanitarian relief assets; and

To make iterative progress toward creation of an integrated hardware and software platform providing a cross-domain Common Medical Operating Picture (CMOP) for civilian and military decision makers in the tactical, operational and strategic levels of deployed medical care.

Overview/Background:

Effective patient identification, triage and tracking - from point-of-casualty through initial treatment to evacuation out of theater - remains a major challenge in humanitarian assistance and disaster relief (HADR) operations. Ambulatory patients often arrive first and in large numbers at proximate medical facilities, overwhelming staff and resources even as more urgent critical casualties continue to stream in via ambulance or helicopter.

In complex joint civilian-military response operations taking place in foreign countries (ie Haiti), challenges are further compounded by the need to classify, separate, triage and coordinate treatment of patients that range from US military personnel, to US civilians, to expatriate third party nationals, to host country nationals, each of which is monitored through a separate reporting silo and chain of command.

This experiment seeks to identify solutions to these challenges by demonstrating a mobile-enabled all-source integrated patient identification, triage and tracking system.

Experiment Description:

Demonstration would focus on deploying first responders to casualty site/ground zero. Personnel would be equipped with single-screen smartphone applications that collect basic patient identification information along with chief complaint and expected level of triage. Contingent upon successful software and device integration in advance of event, responders may also be equipped with portable digital exam kits that allow for collection of vital signs and other frontline medical data and images. The information would be transmitted over the network to the Medweb Telemedicine Infrastructure Clinic for Treatment of Ambulatory Casualties (TICTAC), a mobile clinic that would collect and organize the data, process and triage ambulatory patients, and route them for further care.

Discovery phase would include real-time monitoring and analysis of incoming data and/or images by personnel at remote sites (ie the TOC and tertiary care facility) to identify successes, challenges, and further optimizations.

Working hypotheses would be developed based on results of above activities and applied to future iterative experiments.

Measurements/Data Collection Plan:

We plan to track several key indicators of speed and volume of patient registration and triage, for example:

- frequency by which patients can be identified and registered at point of casualty;
- frequency by which patients can be triaged and sent on from TICTAC clinic;
- time lapse for each patient at each stage of care; and/or
- other indicators as identified during planning and experimentation.

Measures of Performance/Measures of Effectiveness:

- Successful collection and transmission of individual patient data and images on devices and software application and transmitted over network back to TICTAC and server interface at TOC.

- Time taken at each stage of care, for example number of seconds/minutes/hours to: examine and register patient at point-of casualty; intake and triage patient at TICTAC; and stabilization/transfer of patient to tertiary care hospital facility.

- An interesting and useful potential 'meta-metric' would be quantification of the iterative progress made toward cross-domain hardware-software integration supporting HADR operations in a compressed and intensive one-week joint experimentation process, vis a vie the traditional processes for development and acquisition of these solutions. We would be willing to explore this cost/time performance measure in collaboration with other experiment participants and RELIEF coordinators in a post-event document as per below.

What new capability (or improvement to existing capability) does this represent?

There are a plethora of mobile (m) - health applications in various stages of development and use by civilian and military actors in HADR operations. However, our solution is differentiated and unique in that it offers integration of an intuitive patient identification and tracking m-health application with a portable suite of digital-enabled medical devices, which are in turn linked back to a mobile clinic with a telemedicine webserver platform, already in wide use by both US military and civilian actors, that can route and store patient medical records along with diagnosis and treatment data.

This integration provides the foundation for an end-to-end casualty tracking system, which can in turn be integrated with a desired medical assets tracking program on a data visualization platform of choice to facilitate a Common Medical Operating Picture for use at both the tactical and strategic levels of joint civilian-military medical command and control.

Quantitative Results:

Solar Base Station:
Medweb deployed the same base station that we used during last years experiment. Our base station was a part of the Range Network's open base station project; it accommodates 1000 users on a GSM and/or CDMA network, data rates = 3G and 4G LTE later this year, d-multiplexor to allow for transmit and receiving on one ubiquitous antenna, mesh network with no single point of failure, built in Linux server with asterisk software installed and running our patient registration and health interactive voice response systems, 300W solar panel and lithium rechargeable battery.
Details; Sustains/Improves:
The older version of the solar base station was erected and routing calls within two days of the start date. Problems occurring involved:

- Outdated IVR software; we had to update from 8.0 to 10.0 in the field. Next time we will try to load the asterisk software onto the central call switch so all calls will be routed through the central call switch to the IVR system, rather than routed through our station.
- New mini-solar base station needs reconfiguration: a smaller solar battery; a D-multiplexor; and a more secure mount within the smaller container.

m-Health Triage Application:
Medweb created a Triage application for use in the field to quickly triage and track casualties form point of casualty, throughout their points of care, ultimately to their point of release from the hospital.
Details; Sustains/Improves:

- Triage application successfully sent GPRS coordinates over 3G and WiFi networks.
- Extended API provided by Medweb developers allowed 3rd party software to query our server for triage reports sent in using Triage application.
- Triage application did not store reports on the phone database for storage on the phone when 3G or WiFi networks are not available; must reconfigure this.

m-Health Digital Exam Kit

N/A – did not experiment. Next year!

Qualitative Results:

Solar Base Station:

- We had our base station call routing between 2 additional base stations set up by Range Networks; the following day our technical specialist had to leave and we broke down the base station.

m-Health Triage Application:

- 3rd party agencies including Virtual Agility and Department of Homeland Security used our API to query the Medweb server and extract incoming information collected by our Triage application.
- Experiments used the application in a field situation, information regarding casualty's location and condition were sent in over the local 3G network and appeared within seconds of the casualties discovery within the TOC.

Collaboration / Ad Hoc Experiments:

Virtual Agility – used Medweb API for Triage application information Strategic Mobility – used Medweb API for Triage application information Department of Homeland Security – held field experiment to test different medical tracking technologies Border Patrol – used Triage application during DHS experiment Range Networks – base station network InteleSense – used Medweb API to query Triage application information

Observations & Comments:

The experiment allowed us to put our technologies to real use; we walked away with solid information we can use for really making a better product for future experiments. Seeing our tools being used within larger systems also confirmed our ease of use/access by other people; and we were able to identify information gaps that need to be filled before implementing our solutions in a real world situation.

Experiment # I-01

Explosive Remnants of War-Collection Points (ERW-CP)

Naval Postgraduate School

Principal Investigator/Lead: LT Deward L. Cummings III

Working Hypothesis:

If a cheap and effective kit may be distributed to populations suffering from Explosive Remnants of War, then low-cost, safe storage facilities may be created to store and dispose of dangerous ERW.

Objective:

To build a structure for storing ERW that, in the event of a single unintended detonation, will stop the lethal effects of ordnance-produced fragmentation without creating any secondary lethal fragmentation from the structure itself or the surrounding area. The structure will also redirect the thermal effects and blast overpressure wave away from the population and mitigate its effects as close as possible to a K-Factor of 24.

A K-Factor of 24 or K-24 (24 feet) is the minimum distance allowed between an individual and a one lb. explosive detonation without receiving life threatening or disabling injuries.

Additionally, the structure needs to provide secure storage for ERW items preventing the ERW from entering into the IED network or, stored abandon IEDs from reentering the IED cycle. Inherently, the structure will protect the item from the elements, preventing further deterioration. This is critical, as explosive items are exposed to harsh climate variations; they are increasingly sensitized, making them extremely susceptible to unintended detonation.

Overview/Background:

A system or structure is required that provides safe, secure, temporary storage of ERW at the village level. The system or structure must be scalable, readily available, and once constructed, easily accessible to the local ERW effected population. The system or structure must provide an acceptable level of security preventing theft of the stored ERW. The system or structure must be easily constructed by effected populations using primarily, locally sourced building materials at little to no cost to the local population.

Experiment Description:

- A series of experimental structures will be built in place or on transportable test platforms.
- Once in place on the range, a series of concentric circles will be placed on the ground at 24ft, 50ft, and 100ft. to determine the distance any fragmentation travels from the detonation site.
- A one lb. explosive charge, simulating ERW, will be placed inside the structures and detonated.
- A post blast investigation will be conducted and "real world" fragmentation patterns and distances will be determined.
- Based on observations, it will be determined if the current ERW-CP design meets design requirements.

Measurements/Data Collection Plan:

Extensive explosive testing has already been conducted under controlled conditions at Lawrence Livermore National Laboratories with positive results.
This series of experiments will be conducted to determine the performance of the ERW-CP under field conditions.
A very simple technique will be used to determine fragmentation distances and if this particular design requirement is being met.

A series of concentric circles will be placed on the ground at 24ft, 50ft, and 100ft. to determine the distance any fragmentation travels from the detonation site.

Measures of Performance/Measures of Effectiveness:

All secondary fragmentation must remain within the 100ft circle.

Ideally, most of the secondary fragmentation will remain within the 24ft circle with some smaller pieces of fragmentation reaching the 50ft circle.

What new capability (or improvement to existing capability) does this represent?

Currently there are no locally sourced ERW management solutions that meet all the of the design requirements. Initial testing has shown considerable promise for the ERW-CP design. This series of experiments should demonstrate the increased capabilities of minor design modifications in a field environment.

Quantitative Results:

The explosive field-testing confirmed all EWR-CP design requirements were met even when 1.25 lbs. of C-4 were.

In the event of a single unintended Explosive Remnant of War (ERW) detonation, the structure needed to stop all the lethal affects of ordnance-produced fragmentation without creating any secondary lethal fragmentation from the structure itself or the surrounding area. The structure successfully captured all fragmentation without producing any secondary fragmentation. Any large fragments that were produced by the detonation fell within 24 ft of the structure. Any smaller fragments fell well within 50 ft. The structure successfully redirected the thermal effects and blast overpressure wave away from the population and mitigated its effects to a K-Factor of 24.

Secondary fragmentation is fragmentation with an impact force of 58 foot-pounds per square inch. A K-Factor of 24 or K-24 (24 feet) is the minimum distance allowed between an individual and a one lb. explosive detonation without receiving life threatening or disabling injuries.

Qualitative Results:

Additional, but equally important, design requirements were met. The ERW-CP proved to be exceptionally secure. The structures provided secure storage for ERW items preventing the ERW from possibly entering into the IED network or, abandon IEDs from reentering the IED cycle.

The structure also protected the ERW item from the elements, preventing further deterioration. This was critical. Explosive items that are exposed to harsh climate variations and moisture are increasingly sensitized, making them extremely susceptible to unintended detonation. The thermal mass of the thick structure walls and bright paint maintained a strikingly lower, constant temperature within the structure even in the extreme 50+-degree temperature swings and 110 degree heat of Camp Roberts.

Please document, if applicable, other groups you interacted/collaborated with and what you worked on (please be as descriptive and detailed as possible):

Lawrence Livermore National Laboratories (LLNL), High Explosive Application Facility (HEAF)

Observations & Comments:

As expected, several design tweaks were made as a result of the explosive testing. The most significant, was to the outer ”shell” of fiber reinforced building material (FRBM). Usually 2-4 inches thick, the shell will be reduced to a stucco like finish, covering the outermost reinforcements of the various ERW-CPs designs. This design change was made to further reduce the possibility of secondary fragmentation. The 2-4 inches of FRBM mass will be repositioned toward the core, inside the outer reinforcement, producing the same performance properties.

Experiment # I-02

Infrastructure as a System

Synergy Strike Force / Harvard Humanitarian Initiative

Principal Investigator/Lead: Galit Sorokin, SSF

Working Hypothesis:

If an information-sharing and coordination platform for all humanitarian actors, civilian and military, were created and fully utilized, it could improve the efficiency of relief and recovery efforts by reducing duplication and enabling crisis responders to prioritize better.

Objective:

Over the course of a multi-day experiment we will explore some of the methodological, technological and coordination challenges that would arise in the course of creating a common public-facing platform to publicize information on the status of critical infrastructure in post disaster environments.

We will investigate how a combined platform could be used as a common reference point for interagency communications, cross sector cooperation, as well as providing a tool for more efficient resource management and allocating response tasks while minimizing duplicated operational efforts.

Additionally we aim to explore how such a platform might give rise to the voice of affected populations in emergency and infrastructural rehabilitation operations, contributing to situational awareness, assessment of damage and identification of needs.

Overview/Background:

For civilian relief, development organizations, governmental agencies and military actors, resistance to cooperation is primarily rooted in mutual distrust due to poor understanding of each other's missions, sometimes conflicting agendas and differing modes of operation. While the tenor of relations among them varies from crisis to crisis (most starkly between natural disasters and complex emergencies), formal interaction between sectors is generally fraught with miscommunication, an unwillingness to coordinate efforts and above all resistance to information-sharing of data that ultimately can provide an objective point of reference for advancing shared interests.

Creating a common public-facing platform will provide an objective point of reference for communications to all actors involved in work relating to critical infrastructure systems. Currently few entities understand the need for such a platform. The current availability of data maps and information visualization is broad with innumerable platforms and methods in place available to users, yet it can be difficult tracking down and aggregating sets of data in layers that illustrate the status of infrastructure in meaningful ways.

Finding avenues to combine methodologies and improve cross-sector points of communication can empower users to a much greater degree, and therefore can empower all actors involved in HADR efforts, from all sectors, including community members of affected populations.

Experiment Description:

Various data collection methods, mapping platforms and collaboration opportunities will be experimented with to be used for the purpose of combining methodologies where possible and opening new channels of communication between relief actors from all sectors, as well as with communities on the ground. For the purpose of our Camp Roberts/RELIEF experiment, we will narrow our focus to infrastructure systems essential to preventing the deterioration of humanitarian conditions and enabling recovery.

We will be investigating current infrastructural mapping applications, strategies, and platforms by demonstrating and testing their capabilities in a comparative manner, while seeking points of connection and identifying gaps in application and use.

The first phase of the experiment will be an exploration of methodological challenges, the second will deal with technological challenges, and the third phase will focus on coordination challenges.

Measurements/Data Collection Plan:

During the simulation, participants will gather information, take notes and record findings that will later be used to write up an analysis paper to be shared with the rest of the Camp Roberts/RELIEF community.

The final collection of papers will in turn be used by project leads to further investigate the challenges faced for facilitating a common platform.

Measures of Performance/Measures of Effectiveness:

(This initial stage of experimentation in this direction will tie into other aspects - and the broader scope of 'Infrastructure as a System' as an umbrella project - further down the line.)

What new capability (or improvement to existing capability) does this represent?

If an information-sharing and coordination platform for all humanitarian actors, civilian and military, were created and fully utilized, it could improve the efficiency of relief and recovery efforts by reducing duplication and enabling crisis responders to prioritize better.

There are few tools to help incident commanders and relief personnel see what is broken on a systems level. These combined maps will for the first time provide a view of the status of infrastructures as well as the impact on the system, allowing for a better understanding of where and how to intervene.

Annex A

Social Networking/Engineering: Briefings and Real-World Scenario

On 13 August 2012 the Joint Vulnerability Assessment Branch (JVAB) provided analytical support to a US State Department Bureau of Consular Affairs representative at Camp Roberts, CA, by investigating and verifying suspected US citizens in a politically unstable and dangerous situation overseas that resulted in real world actions to extract those citizens to a safe location.

JVAB provided a capabilities brief to a number of participating vendors and support staff at the Joint Interagency Field Exploration (JIFX 12-4) with emphasis on social media and the art of deception of a determined adversary within those cyber realms to disguise their identities for the purpose of counter intelligence and hostile actions against blue forces and US citizens. Official US State Department personnel asked for a more detailed brief as a follow up to provide a better understanding of what they might face in overseas arenas and what tools they might use to vet persons attempting to mislead State Department personnel from carrying out their mission. JVAB provided a white paper written several years prior to help provide a starting point in training US State Department personnel in the field of the potential threats they would likely encounter in the expanding cyber arena; and their responsibilities to assist US citizens using this medium for communications. Shortly after the follow-on brief concluded, JVAB was approached by US State Department Bureau of Consular Affairs representative with a real world situation of suspected US Citizens who were requesting extraction from a hostile environment overseas via the US State Departments Facebook page. The State Department was concerned the individuals were not in fact US citizens and requested JVAB support to investigate whether these persons were in fact US citizens.

The Bureau of Consular Affairs provided JVAB with the named US citizens, and using only open source tools, JVAB began the cyber investigation to determine the validity of their claims so the Bureau of Consular Affairs could act upon their findings accordingly. Using the social networking aggregator sites, pipl.com and Spokeo.com, JVAB was able to correlate the named suspected citizens to a Facebook.com profile. Upon investigation of the Facebook profile, JVAB personnel were able to correlate family members to the person requesting extraction; at the same time increasing the level of confidence that the named individual was indeed a US citizen. Investigating the Facebook pages further revealed a timeline of when the Facebook pages were created. Using prior knowledge of adversary tactics, it was JVABs recommendation that, because of the span in which the pages were created and that the individual's information found on the Facebook pages corroborated their claims to US nationality, these were indeed US citizens.

Overall, this investigative assistance lasted approximately 35 minutes and the US State Department, Bureau of Consular Affairs, was able to act upon JVABs support to extract two US citizens from harm's way.