The Center for Secure and Resilient Maritime Commerce

Summer Research Institute Team

CRISIS SIMULATION REPORT

July 11th, 2011

July 2011
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INTRODUCTION & EXERCISE DESCRIPTION

The 2011 Summer Research Institute (SRI) at Stevens Institute of Technology (SIT) is comprised of a 21-member group of undergraduate and graduate students assigned with the task of tackling critical issues in maritime security and emergency response. The group is divided into two teams:

1. Sensors and Technology Applications in Port Security (STAPS)
2. Consequence Assessment and Management (CAM)

For the purposes of this report, it should be noted that CAM is further divided into two sub-teams:

1. Impact on Supply Chain (ISC)
2. Modeling and Response (MR)

At 1605 (GMT-4) on the afternoon of July 11, 2011, without warning, the entire SRI team received a bulletin for the purposes of running a hypothetical, real-time exercise. The bulletin contained the following information:

Notification issued 7/11/11 at 1605 (GMT-4): At 1600, a boat detonated a bomb in the Hudson River, exploding itself and releasing an oil spill into the river. Nearby radiation sensors are indicating this may have been a dirty bomb, releasing a radioactive contaminant into the air. The event occurred on the west side of the river, between Hoboken and Manhattan. The Coast Guard (USCG) and NYC Office of Emergency Management (OEM) and Hoboken police (HPD) have begun evacuating a 500 meter radius around the site and are telling people inside buildings to shelter in place for the time being.

The release occurred at position
40.74007N, 74.02331W

With this information, the SRI team was tasked with helping to manage the disaster by performing several different functions, including promoting situational awareness through remote sensing and computer modeling of the aftermath. The SRI team also performed a real-time assessment of the short and long term effects on regional supply chains. Ultimately, it is the goal of the SRI team to facilitate efficient and
well-informed decision making in the event of a real-life, catastrophic event. The following sections of this report outline the individual team responses to the exercise, including successes and failures, as well as recommendations for improvement.

INDIVIDUAL TEAM RESPONSE

Sensors and Technology Applications in Port Security (STAPS):

On the afternoon of the exercise, STAPS was operating out of the Maritime Security Laboratory (MSL) at SIT. The team was busy monitoring vessel traffic on the Hudson River and collecting data from multiple sensor systems to advance research on vessel identification and classification. Vessels seen throughout the morning included, but were not limited to, tugs, barges, ferries, tankers, cruise vessels, and pleasure craft such as sailboats and fishing vessels. The following is a list of sensor technologies that were being implemented during the afternoon of the exercise:

- Stevens Passive Acoustic Detection System (SPADES)—based in the MSL
- High-Frequency (HF) Radar—based at Rutgers University
- Bridgemaster™ Microwave Radar System
- Synthetic Aperture Radar (SAR) and optical satellite imagery downloaded to the University of Miami’s Center for Southeastern Tropical Advanced Remote Sensing (CSTARS)
- Automatic Identification Systems (AIS), including data from Marinetraffic.com, the U.S. Coast Guard, Rutgers University, and TRANSAS™ (a marine surveillance system at implemented at SIT)
- Optical Closed-Circuit Television (CCTV) cameras
- Intermittent human watch detail on the MSL building (the Babbio Center at SIT)
- Real-time environmental sensors that provide salinity, water temperature, and wind velocity information

At approximately 1535, the human watch detail spotted a suspicious vessel. The vessel was actually SIT’s research vessel, the R/V Savitsky, posing as a suspicious craft. It approached along the western bank of the Hudson River, unusually close to the shoreline. The vessel’s movements were documented on video by the watchman, who subsequently reported the position of the suspicious craft via shortwave radio to the rest of the STAPS team. The vessel showed no signs of distress or mechanical failure, and
was therefore deemed to be a legitimate threat. Soon after being notified, the STAPS team operating the monitoring console in the MSL was able to confirm the incoming target on CCTV. The track of the vessel was detected using SPADES. SPADES was also used in an unsuccessful attempt to categorize the vessel. Due to the small size of the target, attempts to acquire its position using radar were unsuccessful as well. AIS signals from the target were not picked up during the exercise because of a settings error in the AIS receiver system. Environmental conditions were documented and the target was given an active file number for documentation. Though the signal-to-noise ratio of the acoustic data was too small to conduct identification or categorization, STAPS was still able to confirm and track the target as it entered what was designated a hypothetical “restricted area,” where the attack eventually took place.

Based on the assumption that the sensor systems in place would not have been destroyed in the attack, STAPS continued to monitor vessel traffic in the harbor with all its technologies in order to maximize marine domain awareness in the area, and to provide as much warning as possible in the event of a follow-up attack. A line of communication was established with CAM, and information regarding the primary characteristics of the perpetrating vessel was relayed.

**INDIVIDUAL TEAM RESPONSE**

**Consequence Assessment and Management (CAM) – Modeling & Response (MR):**

Upon receiving notification of the explosion, the Modeling and Response division of CAM immediately began using the known data to visually depict the scene of the event. The only useful data in hand at this point were the location and time of the blast and the fact that a 500-meter evacuation radius had been implemented. The first step for the MR team was to generate the map seen in Figure 1 below. It shows a Google Earth image of the incident site with overlays showing the precise location of the explosion as well as the approximate 500-meter radius. The evacuation radius was shaped to account for features of the urban environment. This map was then shared with the ISC team. It was of some interest that the Hoboken police station and the Hoboken train station, while not within the 500-meter radius, are located just outside this area and would probably have to be evacuated shortly after such an event.

MR then began the critical process of modeling the spill and atmospheric plume despite the fact that they had very little information about the size of the blast or the contents of the vessel. SCIPUFF and GNOME are the software programs that were used to generate the plume and spill models, respectively. Wind and current information at the blast location was available at the time, but the lack of information
regarding the vessel itself made generating spill and plume models difficult. A line of communication was opened with STAPS in order to receive any new information which might be useful in this respect.

At approximately 1715, STAPS was contacted and provided the MR team with primary dimensions and cargo/fuel capacities of the vessel. The estimates provided were as follows: the vessel used in the attack had a 40-foot length, a 15-foot beam, a cargo capacity of 6,000 pounds, and a 150-gallon diesel fuel tank. In order to gain an understanding of worst-case scenarios, models were generated for a 6,000-pound plume and for a 6,000-pound oil spill with 150 gallons of diesel included. There were some problems experienced with running the software, including a system crash. In all it took over two hours to gather information and develop models, and these were only as reliable as the information that was received. Finally, all information was shared with the ISC team.

![Figure 1. Map of the site of the attack, including the exact location of the explosion and 500-meter evacuation radius](image1)

![Figure 2. Image of GNOME modeling of the oil spill caused by the explosion](image2)
Figure 2 above shows GNOME modeling of the oil spill with 6,000 pounds of crude oil and 150 gallons of diesel. The model was run for a 24-hour period. The figure shows the time at which the spill was projected to make first landfall, 45 minutes after the explosion. A similar model was run which shows the shape, size, and direction of travel of the radioactive plume through the atmosphere, also over a 24-hour period. The resulting plume can be seen in Figure 3 below.

![Image of GNOME modeling of the oil spill](image1.png)

**Figure 3. Image of SCIPUFF modeling of the atmospheric plume at two different points in time after the attack**

**INDIVIDUAL TEAM RESPONSE**

**Consequence Assessment and Management (CAM) – Impact on Supply Chain (ISC):**

The ISC sub-team began their response process by developing a diagram to visualize the immediate effects caused by the explosion. The analysis period corresponds to the first four hours after the incident. It considers the plume and spill forecasts developed by the MR sub-team and the effects of that outcome on regional supply chains. The focus of the report was on four related categories: Evacuation, mass transport, impact on communication networks, and impact on ports and airports.

Evacuating Hoboken would be a challenging process given the small number of routes out of the city. Ferry services would likely be suspended, while Port Authority Trans-Hudson (PATH) trains would become quickly overwhelmed with people. Depending on the direction of the resulting radiological plume, roads may be closed, leading to traffic jams for cars and buses. Communications failures may
result as cellular networks become inundated with traffic. Information released to the general public would have to be carefully controlled to prevent widespread panic.

POSSIBLE IMPROVEMENTS

Sensors and Technology Applications in Port Security (STAPS):

Most improvements to the STAPS team need to be in the area of logistics. The network of technologies should be expanded to get as much information as possible about any and all maritime incidents on the Hudson River. The reliability of the system also needs to be improved. Usually, SRI would have access to HF radar, located in Sea Bright, NJ, to track vessels entering New York harbor. However, the HF radar was undergoing maintenance the day of the simulation. SRI students can also access images from optical and SAR satellites, though satellite passes must be scheduled in advanced through CSTARS in Miami. Not having reliable data from HF radar and satellites hindered the team’s ability to detect and identify suspicious vessels. In order to fill gaps in capability, the STAPS team should look into adding a marine VHF radio base station to the MSL. This would allow for more effective communication during a drill and provide access to USCG emergency broadcasts. The addition of chemical, biological and radiation (CBR) sensors to the network would provide critical information to the CAM team.

Redundancy in the sensor network could improve data availability. Sensors could have been damaged if a real detonation occurred. Therefore, creating and implementing back-up sensor systems would improve resiliency and enhance local marine domain awareness. At Rutgers University, faculty and staff are able to access HF radar computers from various locations using a computer program that accesses and remotely controls other computers. In the event that one HF radar in Rutgers University’s network fails, other radars compensate by expanding their ranges to ensure uninterrupted coverage. This level of redundancy and accessibility would greatly improve the functionality of the sensor network.

The simulation was conducted on a system of sensors that is still under development. Moreover, the system architecture is focused on research, not operational surveillance, limiting its performance in a drill capacity. For example, an operational MDA system would have multiple radars and hydrophone arrays installed, allowing it to triangulate exact positions of targets and provide uniform coverage. SPADES uses only one hydrophone array, limiting its effective range and accuracy. While SPADES can pick up the presence of vessels, it has an effective range of less than three kilometers and can only determine the target’s bearing but not its range. It is also unable to differentiate the unique acoustic signatures of
multiple targets simultaneously. While HF radar is useful for tracking vessels that are entering the Hudson River, its large range (about 290 km) makes distinguishing smaller targets from noise quite problematic. Ideally, multiple sensors would be covering each area of interest, and the range of HF radar would be adjustable to suit any given situation.

STAPS needs to improve the information flow both internally and in its interaction with other organizations and teams. STAPS also needs to document an official procedure for response. Immediately following the attack, all STAPS could do was wait for orders from OEM. STAPS was not provided with a pre-determined point of contact to the CAM team or the U.S. Coast Guard in case of an emergency. There was also no record of the information required by the CAM team in order to complete its modeling output. Contact between the two teams was not made until about 45 minutes into the simulation, implying that the CAM team either did not know who to contact or could not get a hold of anybody from the STAPS team. A proper operational plan for STAPS should include contact procedures for both the CAM team and the USCG. STAPS also needs to establish a standard data set to provide the CAM team with vital information. Finally STAPS’ plan needs an established hierarchy of control, including a clear chain of command. These improvements will help the combined teams of the SRI to provide a more effective warning and response infrastructure in the event of an attack.

POSSIBLE IMPROVEMENTS

Consequence Assessment and Management (CAM) – Modeling & Response (MR):

Generally, the MR team was able to efficiently assess, gather, and analyze information. As mentioned previously, a map of the surrounding area and the 500-meter evacuation zone was generated within just a few minutes. Generating models of the spill and the plume, however, was a longer process, which could be streamlined with better information sharing and preparedness. Real-time oceanic and atmospheric data is readily available for the purposes of model-building. However, it was during this process that the MR team discovered some limitations. There was a lack of information about the exact nature of the vessel and its contents, which made generating an accurate model very difficult. Better communication between the two teams (CAM and STAPS) may have facilitated faster, more accurate modeling results. Information on the size of the vessel did not reach the CAM team until an hour and fifteen minutes after the explosion. Even then, the information provided about the vessel’s characteristics was only enough to make very loose assumptions about the size of the bomb, the amount of oil spilled, and the type and quantity of radiological material dispersed into the atmosphere. Due to the lack of sufficient information
concerning the nature of the device, many generalized assumptions had to be made before even an initial model could be generated.

Information regarding radiation levels in the area of the attack would be very useful to facilitate the evacuation and clean-up process. During the exercise, the MR team had no way to access this type of data. This information would have to come from the STAPS team, which would attain it from radiation sensing systems in the region.

In future exercises, several sets of models should be generated rather than just one. MR outlined two worst case scenarios – plume and spill. In reality, the chances that these models would accurately represent what is actually unfolding in the field are very small. In a real scenario, several models should be sequentially generated and studied. Constant communication between MR and the STAPS team should be used to gain up-to-date information and determine which model most accurately represents the real event as it unfolds.

POSSIBLE IMPROVEMENTS

Consequence Assessment and Management (CAM) – Impact on Supply Chain (ISC):

In the immediate wake of the hypothetical event, there was a lack of information detailing any specifics of the attack. The Impact on Supply Chain division of CAM found it difficult to make assumptions based on the minimal data provided. Among these assumptions are: type of radioactive material released, size of blast radius, and actions taken by first responders. In addition, it was unclear what role the ISC team should play in the overall response effort. Such information is essential to assess both immediate and long term impacts. CAM should develop a protocol for responding to such a situation. In addition, analyzing the behavior of individuals in an emergency situation would help to predict the psychological effects of an event on the populace. The implementation of these improvements will help the combined teams of the SRI to provide a more accurate assessment of the short and long-term effects of an attack in the NY Harbor region.

RECOMBINING EFFORTS

It is clear in the wake of the exercise that there are several areas of the SRI methodology in which there are room for improvement. The two SRI teams (STAPS and CAM) must make a concerted effort to
streamline intergroup communication, thereby hastening the sharing of information in the critical moments following an attack or natural disaster. While the individual research of each team has moved forward in a largely independent manner thus far, this exercise has exposed that in order to effectively respond to a crisis, efficiency in the area of information channeling is vital to responding appropriately to an event such as the hypothetical dirty bomb attack of July 11th.

Atmospheric plume and ocean contaminant models are chaotic by nature; that is, they depend on assumptions regarding initial conditions that can greatly affect a highly sensitive output. Just one faulty assumption can easily render the output useless. If the MR team fails to generate a reliable model, then the ISC team’s ability to make reliable predictions and decisions is greatly hindered. This, however, highlights a role easily filled by the STAPS team. Although the STAPS team’s primary function is to detect threats and prevent an attack, the information it gathers during and after an attack can be equally valuable. By comparing models and simulations to what is really happening in the field, the STAPS/CAM team relationship would prove to be invaluable during an actual catastrophic event. The necessity for this unhampered exchange of information makes clear the fact that that the two teams, STAPS and CAM, should not be considered as two separate entities working independently. Rather, they should be treated as two critical pieces of an overall human resource structure which must be integrated effectively if it is to perform its desired function.

APPENDIX – EMERGENCY PROTOCOL INSTRUCTION SHEET

In the wake of the July 11th exercise, the biggest lessons learned were that critical breakdowns in communication occurred and that specific, step-by-step instructions should be outlined for both teams which provide guidance during a catastrophic event in the maritime domain. The following pages show an outline of this emergency response protocol, including a contact sheet with all pertinent.
SRI 2011 Protocol for Maritime-Based Port Threat
Last revised: July 13, 2011

Sensor Technology and Applications in Port Security (STAPS) Team:

A) Personnel on duty determine the situation is a threat scenario

B) Contact Coast Guard and Consequence Assessment Team below and relay known information:

- US Coast Guard Sector NY
  Address:
  212 COAST GUARD DR
  STATEN ISLAND, NY 10305
  Phone:
  Primary Phone: 718-354-4037
  Emergency Phone: 718-354-4353
  Fax Number: 718-354-4009
  VHF Radio:
  Channel 16
  Rescue 21 VHF DSC MMSI Number: 003669929
  Web/email:
  http://homeport.uscg.mil/newyork

- Consequence Assessment Team Leaders
  Chris (Kip) Francis---(201)-213 4649
  Lizbeth Concho-------(201) 238 4940

- Sensor Team Leaders
  Danielle Holden------(908)-319-6704
  Brandon Gorton-------(269)-277-4005

C) Fill out the Modeling response worksheet and send to the Consequence Assessment team as soon as possible
Maintain Contact with Consequence Assessment team

D) Assign following jobs to personnel:
  - Watchman- observes with binoculars and keep lookout over river and city
  - Communicator- works with exchanging data with USCG and Consequence Assessment team
  - Documenter- record all data with a computer
  - Acoustics Operator- responsible for detecting vessel signature and location
  - Radar Operator- responsible for AIS and HF radar vessel tracking
  - Camera Operator- responsible for documenting vessel/attack description

E) Maintain awareness and readiness for the possibility of following attacks
**Consequence Assessment and Management (CAM) Team**

**Modeling and Response and Impact on Supply Chain**

A) Establish Communication with STAPS Team
   Establish Communication with Impact on Supply Chain Sub-Team
   
   Consequence Assessment Team Leaders
   - Chris (Kip) Francis---(201)- 213 4649
   - Lizbeth Concho-------(201) 238 4940
   
   Sensor Team Leaders
   - Danielle Holden------(908)-319-6704
   - Brandon Gorton------(269)-277-4005

B) Gather all know data from the most current report and the other teams

C) Establish team leader and distribute jobs to teammates

   Jobs:
   - **Documenter** - record all data with a computer
   - **Ocean Modeling** - use GNOME to plot oil spill in water
   - **Atmospheric Modeling** - use SCIPUFF to track atmospheric plume
   - **Explosion/Plume Modeling** - use Hotspot to track explosion radius
   - **Communication** - relay data back to the sensor team such as model data to see if it is reasonable
   - **Google Earth** - find and plot terrorist attack location and evacuation radius
   - plot any incoming data (currents, tide, wind, etc)

D) Run the models with data received from the sensor team from the
   - Make sure all data is in units the model can use
   - Make sure the data being placed in the model is consistent with live data from other locations

E) Send model data out to sensor team for conformation of accuracy

F) Contact decision makers and explain situation
   (see contact sheet below)
Contact Sheet

New York Police Department (NYPD)

Phone:
Emergency: 911
Terrorism Hot-Line: 1-888-NYC-SAFE

<table>
<thead>
<tr>
<th>Manhattan Police Precinct</th>
<th>Phone #</th>
<th>Address</th>
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<tbody>
<tr>
<td>1st Precinct</td>
<td>(212) 334-0611</td>
<td>16 Ericsson Place</td>
</tr>
<tr>
<td>5th Precinct</td>
<td>(212) 334-0711</td>
<td>19 Elizabeth Street</td>
</tr>
<tr>
<td>6th Precinct</td>
<td>(212) 741-4811</td>
<td>233 West 10 Street</td>
</tr>
<tr>
<td>7th Precinct</td>
<td>(212) 477-7311</td>
<td>19 1/2 Pitt Street</td>
</tr>
<tr>
<td>9th Precinct</td>
<td>(212) 477-7811</td>
<td>130 Avenue C</td>
</tr>
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<td>10th Precinct</td>
<td>(212) 741-8211</td>
<td>230 West 20th Street</td>
</tr>
<tr>
<td>13th Precinct</td>
<td>(212) 477-7411</td>
<td>230 East 21st Street</td>
</tr>
<tr>
<td>Midtown So. Pct.</td>
<td>(212) 239-9811</td>
<td>357 West 35th Street</td>
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<tr>
<td>17th Precinct</td>
<td>(212) 826-3211</td>
<td>167 East 51st Street</td>
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<td>Midtown No. Pct.</td>
<td>(212) 767-8400</td>
<td>306 West 54th Street</td>
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<td>19th Precinct</td>
<td>(212) 452-0600</td>
<td>153 East 67th Street</td>
</tr>
<tr>
<td>20th Precinct</td>
<td>(212) 580-6411</td>
<td>120 West 82nd Street</td>
</tr>
<tr>
<td>Central Park Pct.</td>
<td>(212) 570-4820</td>
<td>86th St &amp; Transverse Road</td>
</tr>
<tr>
<td>23rd Precinct</td>
<td>(212) 860-6411</td>
<td>162 East 102nd Street</td>
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<tr>
<td>24th Precinct</td>
<td>(212) 678-1811</td>
<td>151 West 100th Street</td>
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<td>25th Precinct</td>
<td>(212) 860-6511</td>
<td>120 East 119th Street</td>
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<td>26th Precinct</td>
<td>(212) 678-1311</td>
<td>520 West 126th Street</td>
</tr>
<tr>
<td>28th Precinct</td>
<td>(212) 678-1611</td>
<td>2271-89 8th Avenue</td>
</tr>
<tr>
<td>30th Precinct</td>
<td>(212) 690-8811</td>
<td>451 West 151st Street</td>
</tr>
<tr>
<td>32nd Precinct</td>
<td>(212) 690-6311</td>
<td>250 West 135th Street</td>
</tr>
<tr>
<td>33rd Precinct</td>
<td>(212) 927-3200</td>
<td>2207 Amsterdam Avenue</td>
</tr>
<tr>
<td>34th Precinct</td>
<td>(212) 927-9711</td>
<td>4295 Broadway</td>
</tr>
</tbody>
</table>

U.S. Coast Guard (USCG) – Sector New York (01-37040)

Address:
212 COAST GUARD DR
STATEN ISLAND, NY 10305

Phone:
Primary Phone: 718-354-4037
Emergency Phone: 718-354-4353
Fax Number: 718-354-4009

VHF Radio:
Channel 16
Rescue 21 VHF DSC MMSI Number:003669929

Web/email:
http://homeport.uscg.mil/newyork
**U.S. Coast Guard (USCG) - Auxiliary**

**Address:**  
Flotilla 22 - Sandy Hook, NJ  
e/o US Coast Guard Station Sandy Hook  
20 Crispin Rd  
Highlands, NJ 07732  
**Phone:**  
(732) 872-3429  
**VHF Radio:**  
Channel 16  
**Web/email:**  
info@a0140202.uscggaux.info

**New York Fire Department (FDNY)**

**Phone:**  
Main: (718) 999-2000  
Emergency Medical Service Command  
(718) 999-2770/1753

**Office of Emergency Management (OEM)**

**Address:**  
165 Cadman Plaza East  
Brooklyn, NY 11201  
**Phone:**  
Public Inquiries in NYC: 311  
Public Inquiries outside NYC: 212-639-9675  
Press Inquiries: 718-422-4888  
**Web/email:**  
General correspondence (Contact the Commissioner):  
Ready New York inquiries (Contact the OEM Ready NY Coordinator)  
CERT inquiries (Contact the OEM CERT Coordinator)  