Urban Operational Experimentation hosted by the
National Urban Security Technology Laboratory (NUSTL)

Tridion™-9 Report

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Executive Summary

Operational experimentation (OpEx) of PerkinElmers' Tridion™-9 was conducted on July 30, 2015, at the New York City Police Department Floyd Bennett Field facility in Brooklyn, New York. Six responders with hazmat experience from New York, New Jersey, Washington, D.C., and Massachusetts participated in this event with the Tridion-9.

Tridion-9 is a portable gas chromatography/mass spectrometry system that can analyze volatiles and semi-volatiles for chemical warfare agents and other substances to determine what is present at an emergency incident. PerkinElmer also provided their solid-phase microextraction sampling devices that are intended to be used with the instrument.

The participating responders attended a short introduction and training presentation on the Tridion-9, and then used the instrument in a mock hazmat scenario where commercially available products containing hazardous materials (rubbing alcohol, spray lubricant, and spray adhesive) were sampled and analyzed. PerkinElmer's representatives provided the training and were available during the OpEx scenario to give direction as necessary. Data collectors gathered first responders' feedback during the event and interviewed the responders following the use of the system. A debrief was held to wrap up the experience and collate final feedback.

Most of the feedback recorded by the data collectors documented positive aspects of the Tridion-9. The participating first responders seemed to see a need for such a device in hazmat incidents and found the Tridion-9 easy to use even when wearing Level B hazmat personal protective equipment (PPE). They noted this system has a relevant application in emergency response that is currently lacking, but that it is not something that covers all their needs for identification of chemical hazards. There were recommendations to better evaluate the battery life's adequacy in hazmat responses, design shock mounting for the operation of the device in moving emergency response vehicles, provide 24/7 support to operators in the field, and consider more closely the use of the system with other PPE, particularly with different gloves.

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1 Introduction

The Department of Homeland Security (DHS) Science and Technology Directorate's (S&T) Urban Operational Experimentation (OpEx), hosted by the National Urban Security Technology Laboratory (NUSTL), brings together first responders and product developers to experiment with emerging technologies in operational conditions. The technologies selected addressed capability gaps identified in Project Responder 4 (1). Project Responder 4 is the result of focus groups involving the First Responder Resource Group (FRRG), which includes more than 250 federal, state, and local emergency responders, as well as responder associations and technical subject matter experts from industry, academia, and the national laboratories. Responder input before products come to market could influence design improvements that address operational needs. During the Urban OpEx, responders learned about emerging technologies that could enhance their mission capabilities, and S&T gained a better understanding of responder needs and gaps to guide future homeland security investments.

New York City Fire Department (FDNY), New York City Emergency Management, New York City Police Department (NYPD), and Port Authority of New York and New Jersey (PANYNJ) subject matter experts supported this Urban OpEx by selecting the technologies and working with NUSTL scientists to plan the experimentation scenarios and arrange test venues. Responders from these agencies and members of the FRRG experimented with the technologies and provided feedback and observations. Table 1 lists all the technologies that were included in this event.

Table 1. Technologies included in OpEx 2015

Product Name Manufacturer	**Description**
Tridion™-9 PerkinElmer	Portable Gas Chromatography/Mass Spectrometry (GC/MS) system that provides identification of volatile and semi-volatile organic hazards in the field in less than three minutes
BioFlash-E Biological Identifier PathSensors	Portable and rapid aerosol sample collection and identification of up to 16 biological threat agents
Fido B2 IBAC FLIR	Networked array of portable biosensors
Internet of Things for First Responders BAE Systems	Networked sensors that use a long-range wireless protocol capable of concrete penetration to send signals through a network aggregator
Knight Robot/HAZPROBE WM Robots	All-terrain robot with a manipulator arm, cameras, and a boring and inspecting device that can drill through walls for bomb tech personnel to inspect suspect abandoned vehicles or objects
RepKnight ADI Technologies	Monitors and analyzes social media with geolocation feature
Situational Head Up Display Avon Protection Systems	Software that monitors and analyzes social media with geolocation feature
X-ray Scanning Rover Smart Imaging Systems Inc.	An X-ray scanner integrated into a custom-built robot that is designed to rapidly screen suspicious left-behind bags or parcels on the ground

1.1 Purpose

The purpose of the Tridion™-9 operational experimentation was to provide feedback on the prototype technology in typical hazmat response operations. By bringing together emergency responders and product developers during technology development, design changes can be effected early, responders can learn about emerging technologies to enhance mission capabilities, and S&T can gain a better understanding of responder needs and gaps to guide future homeland security investments.

1.2 Objective

This experimentation was designed to allow responders to experience the use of the Tridion-9 in an operationally realistic setting, and to offer feedback and suggestions to the developers to enhance the product capabilities and usability for responder operations.

1.3 Responder Capability Need

Project Responder 4 describes the need for capabilities to detect, monitor, and analyze threats and hazards at incident scenes in real time (1). It includes improved standoff detection, identification of multiple hazards, and risk assessment and decision support to command. This was noted as a consistently identified need by first responders participating in the Project Responder studies. The Tridion-9 is an emerging technology that has the potential to address this capability need for hazmat incidents.

1.4 Prototype Description

The Tridion-9 (shown in Figure 1) is a portable high speed/high resolution gas chromatograph/mass spectrometer (GC/MS). It weighs 32 pounds and operates with AC power or an internal rechargeable battery (2.5 h battery life). Samples are obtained by solid-phase microextraction (SPME) or needle trap (see Figure 2). Tridion-9 can provide rapid screening in less than three minutes of chemicals, including volatiles and semivolatiles, chemical warfare agents, and other hazardous substances. Optional software (not assessed in this experimentation) provides additional information in support of hazmat and suspected terrorism operations involving unknown chemicals, including standoff/exclusion distance based on real-time data and suitable personal protective equipment (PPE). The instrument has both Ethernet and Wi-Fi data transmission capability. Data can be transferred from the device via a universal serial bus port as well. The information pulled from the Tridion-9 can be input to other software and databases to provide further identification of the chemicals present.

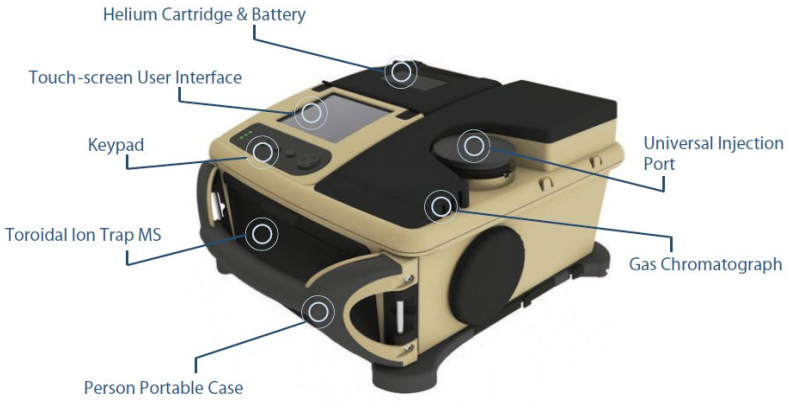

Figure 1 – Image of Tridion-9. The device is packaged into a single person portable case. Associated labels indicate some of its components.

Figure 2– Samples can be collected and introduced to the unit via PerkinElmer's SPME (A) or Custodian-NT (B) syringes.

2 Experimentation Design

The Experimentation Plan for Tridion-9 (2) contains a full description of the experimentation design that was followed for this technology, with the exception of a few impromptu changes. The responders did not work in teams as noted in the experimentation plan, but rather performed all of the tasks individually. Four of the six responders experimenting in the scenario did not have PPE, so they performed tasks without any and could not provide any feedback on the usability of the system with PPE. The scenario used in this event was developed with input from New York City first responders and the technology vendor, PerkinElmer, such that the Tridion-9 could be inserted in a manner that closely emulates its expected use.

2.1 Event Design

This experimentation convened a group of experienced hazmat first responders to experiment with this technology in a simulated operational field environment and provide feedback. The experimentation location included a simulated hazmat scene inside of a trailer. Three jars with commercial products containing hazardous materials (rubbing alcohol, spray lubricant, and spray adhesive) were positioned on the floor along a wall inside the trailer. The Tridion-9 was placed on a table under a canopy about 15 meters from the entrance to the trailer. Features demonstrated included concept of operation, sampling technique, system preparation, and sample analysis and results. NUSTL data collectors recorded responder comments during the scenario execution, solicited feedback following the use of the system using a questionnaire (see the Experimentation Plan (2)) as a guide, and captured information exchanged in subsequent group discussions.

2.2 Summary of the Experimentation

This Urban OpEx event took place at an NYPD facility at Floyd Bennett Field in Brooklyn, New York, on July 30, 2015. In attendance were first responder representatives from NYPD, FDNY, New York City Office of Health and Mental Hygiene, PANYNJ Police, Montgomery County Fire and Rescue (Maryland), and Boston Fire Department (Massachusetts).

The first responders received an introduction and brief training on the system by the vendor representative as a group in a classroom setting. Training was summarized into a 45-minute presentation for the OpEx, with the expectation that the vendor would walk the user through the operation as needed during the OpEx scenario. Following training, six experienced hazmat emergency responders took the opportunity to use the system in a simulated, operational field environment (shown in Figure 3). Two of the responders wore Level B hazmat suits [1] and proceeded to a room in a trailer to obtain samples from the mock hazmat scene. The Tridion-9 was powered on by other first responders and prepped to run samples. The samples were then analyzed on the system. Vendor representatives were present to offer guidance as the hazmat operators performed the tasks. Each participating responder was able to collect, inject, and review results of samples on the system using each sampling device. Data collectors were present to record comments and other relevant information during the experimentation. Once a responder completed the experimentation, they then met with a data collector to discuss their experience and provide feedback.

At the completion of the experimentation, the group reconvened for a debriefing led by the experimentation director. The debriefing provided an opportunity for more frank discussions of the features of the system and its relevance to hazmat responses. This information was also captured by data collectors and is documented, along with all other information collected, in the Results section of this report.

Figure 3 - First Responders Preparing to Inject a Sample into the Tridion-9 during the OpEx Event.

[1] Hazmat responders have established four levels of personal protective equipment, with Level A as the highest level of protection and Level D as the lowest. Level B is a full body suit with a self-contained breathing apparatus for respiratory protection.

3 Results

Feedback from the first responders is summarized below. These results are based on comments made during the OpEx and are grouped by the category they address. There are some comments that apply to multiple categories, but they are only listed in the most appropriate category. The feedback is summarized in tabular form in the Appendix.

3.1 User Feedback

Usability:

Many comments addressed usability aspects of the Tridion-9. A frequent comment was that the system was intuitive and easy to operate. One operator said that, although this instrument is easy to use, more extensive training would be warranted before someone should use a GC/MS during an operational response. There is more extensive training available; the vendor offers courses from two to five days, depending on how much detail the user desires. With regard to the training, users felt that it would be possible to incorporate the necessary training into their agency's programs for the anticipated operators. There was also a related comment that noted the Tridion-9 can be operated by responders with varying levels of expertise. The hazmat operators, including those who used the Tridion-9 with level B PPE, did not encounter any issues while using the sampling device, injecting the sample into the instrument or operating the instrument. There was a suggestion made that the operation of Tridion-9 should be further evaluated using other gloves. The responder noted gloves are usually a factor that significantly affects what can be accomplished; however, the responder thought that collecting the samples and running the instrument did not require a high degree of dexterity. Therefore, wearing other gloves would probably not substantially affect the ability to perform these tasks. Glare on the touch screen of the unit was identified as making the information on it difficult to read. One operator accepted glare as an unavoidable consequence of using the unit in an outdoor environment and did not consider it a significant issue. Other comments addressing the usability of the Tridion-9 were that the device had reasonable ergonomics, the menu was easy to navigate, the touch screen was a nice feature, and having the stylus to make selections on the screen was a good feature when using it with gloves.

Capability:

There were also several comments about the capabilities of the Tridion-9. Comments ranged from general, such as responders liked the device and thought they could use the product, to much more specific comments about deployability and operations as noted below. Users felt the information displayed on the instrument was appropriate. One responder liked that the technology provided very definitive results upon completion of the sample analysis, but another mentioned the GC/MS technique has "blind spots," implying the device has limitations that would need to be addressed by using other instruments or approaches for chemical analysis. There was a comment that indicated the library of chemicals in the system provided a needed capability. The vendor indicated that data could be exported to a laptop to perform a more comprehensive search of chemicals matching the analysis results. Most of the evaluators and observers that witnessed or initiated the system start-up found it could be accomplished in a reasonable amount of time and well within the time the responders are used to, but one responder felt the start-up took too long. It was also recognized that the time to perform the

analysis, and for the Tridion-9 to recover before another sample can be injected, was sufficient to meet the anticipated need. On the topic of data storage and moving data, this capability was deemed acceptable, and a user mentioned he liked that data could be downloaded via a USB port as opposed to needing to bring a laptop into the field and sending emails from there. The system diagnostics were found to be useful for alerting the user and aiding the resolution of any operating issues.

Deployability:
Another category of comments focused on the deployability of the system. The main feedback concerned the power specifications, portability, and ruggedness of the device. The operators indicated the service time on battery power, a couple of hours, is an important factor to consider and believed it would be sufficient for most situations. There was also an expectation that the device could be mounted on and powered by an emergency response vehicle. The Tridion-9 was accepted as being portable. The ruggedness of the system was questioned by a responder, though the instrument was considered durable enough for field use. The responders mentioned a need for the instrument to be rugged enough to use on a moving emergency vehicle. The vendor expressed a desire to build shock mounting for the device so the Tridion-9 could be mounted on a vehicle.

Operational Aspects:
Another area addressed in the first responder comments was operational aspects. There was a comment made that one organization has the role to characterize what substances are present, but another agency has the responsibility of consequence management. More specific to the role the Tridion-9 would have in a hazmat response was a remark that samples would still need to be sent to a laboratory for confirmation, especially for criminal investigations. One responder felt the instrument would require availability of 24/7 support before any could be put in service since the level of expertise in GC/MS would be limited among the majority of the hazmat community.

Summary:
Overall, the above comments show the feedback was primarily positive, though some of the feedback indicated areas where the technology could be improved upon to make the Tridion-9 more useful for first responders. The ruggedness of the instrument was questioned, and the first responders felt it should be able to operate in a moving vehicle. Due to the nature of GC/MS analysis and the level of expertise that could be expected among first responders using this technology, there was a comment that 24/7 support would be needed. There were recommendations to further evaluate the ease of use of the system with different types of PPE, particularly gloves, and also to further consider whether the battery-life is sufficient. The first responders operating the Tridion-9 did not identify any malfunctions with its operation during the event. One responder also noted the OpEx was a good “exercise.”

4 Citations and Bibliography

1. **U.S. Department of Homeland Security.** *Project Responder 4 - 2014 National Technology Plan for Emergency Response to Catastrophic Incidents*. DHS Science and Technology, July 2014.

2. **NUSTL.** *Urban Operational Experimentation Plan for Tridion™-9*, OpEx-T-PL-3. July 2015.

5 Acronym List

DHS - Department of Homeland Security
FDNY - New York City Fire Department
FRRG - First Responder Resource Group
GC/MS - Gas Chromatograph/Mass Spectrometer
NYPD - New York City Police Department
OpEx - Operational Experimentation
PANYNJ - Port Authority of New York and New Jersey
PPE - Personal Protective Equipment
R-Tech - First Responders Technology Program
S&T - Science and Technology Directorate
SCBA - Self-Contained Breathing Apparatus
SPME - Solid-Phase Microextraction

Appendix

Table A-1 summarizes the feedback provided by the first responders that participated in the Urban OpEx with Tridion-9. Comments are grouped by the category they most closely fit.

Table A-1 Consolidated Data Collection Notes - responder comments grouped by topic.

Topic	Responder Comments
Usability	• System was intuitive and easy to operate. • Requires more extensive training before someone should use one operationally. • Possible to incorporate the necessary training into their programs for the anticipated operators. • Can be operated by responders with varying levels of expertise. • No issues using the sampling device, injecting the sample into the instrument or operating the instrument (including those that used the Tridion-9 with level B PPE). • Suggestion to further evaluate the operation of Tridion-9 using other gloves: o Noted gloves are usually a factor that significantly affects what they can accomplish, yet at the same time did not feel that collecting the samples and running the instrument requires a high degree of dexterity where it would be likely that wearing other gloves would greatly affect the ability to perform these tasks. • Glare on the touch screen of the unit was stated to make the screen difficult to read information. o One operator accepted glare as an unavoidable consequence of using the unit in an outdoor environment and did not consider that a significant issue. • Device had reasonable ergonomics. • Menu was easy to navigate. • Touch screen was a nice feature. • Stylus to make selections on the screen was a good feature when using it with gloves.
Capability	• Liked the device and thought they could use it. • Information displayed on the instrument was appropriate. • Liked that the technology provided very definitive results upon completion of the sample analysis. • GC/MS technique has “blind spots.” o Device has limitations that would need to be addressed by using other instruments or approaches for chemical analysis. • Library of chemicals in the system provides a needed capability: o Vendor indicated the data could be exported to a laptop to perform a more comprehensive search of chemicals matching the analysis results. • System start-up could be accomplished in a reasonable amount of time and well within the time that the responders are used to, but one responder felt the start-up took too long. • Time to perform the analysis and for the Tridion-9 to recover was sufficient to meet the anticipated need. • Data storage and moving data was deemed acceptable. • Liked that data could be downloaded via a USB port, as opposed to needing to bring a laptop into the field and sending emails from there. • System diagnostics useful for alerting the user and aiding the resolution of any operating issues.

Topic	Responder Comments
Deployability	• Battery power, lasting a couple of hours, sufficient for most cases. • Expectation that the device could be mounted on and powered by an emergency response vehicle. • Tridion-9 accepted as being portable. • Ruggedness called into question by a responder, though the instrument was considered durable enough for field use: o Need to be rugged enough to use on a moving emergency vehicle; the vendor expressed desire to build shock mounting for the instrument.
Operational Aspects	• One organization has the role to characterize substances present, then another has responsibility of consequence management. • Still need to send samples to a laboratory for confirmation, especially for criminal investigations. • Instrument would require availability of 24/7 support before any could be put in service: o Expertise in GC/MS would be limited among the majority of the hazmat community.