NEXT GENERATION FIRST RESPONDER
CASE STUDY
SENSOR AND EVENT ALERTS

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EXECUTIVE SUMMARY

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) launched the Next Generation First Responder (NGFR) Apex program to help tomorrow's first responder become better protected, connected and fully aware. DHS S&T has held a series of NGFR Integration Demonstrations to incrementally test and evaluate interoperable technologies currently in development. These demonstrations have evolved from tabletop integrations to field exercises with partner public safety agencies and have involved increasingly complex technology integration.

DHS S&T partnered with Harris County, Texas, and the City of Houston to host the first major urban NGFR Integration Demonstration in December 2018. The NGFR – Harris County Operational Experimentation (OpEx) involved testing a variety of integrated technologies in an operational environment with participating first responders from Harris County, City of Houston, U.S Coast Guard (USCG), SouthEast Texas Regional Advisory Council, Cy-Fair Volunteer Fire Department and the Atascocita Fire Department.

During the OpEx, Harris County, Houston-area responders and federal partners used integrated responder technologies to enhance their mission capabilities in a HAZMAT scenario that included a simulated gas leak from a USCG Cutter (USCGC) vessel in the Port of Houston. Together, responders and DHS S&T evaluated how DHS-funded and commercial technologies integrated with existing public safety systems using open standards and how those integrated capabilities enhanced emergency communications, increased operational coordination, improved responder safety and augmented situational awareness.

The NGFR – Harris County OpEx included 23 different DHS and industry-provided technologies, including six Internet of Things (IoT) sensors, five situational awareness applications and platforms, and live-stream video feeds. Additional OpEx technologies included body-worn cameras, deployable communications systems, and real-time data aggregation and access across multiple agencies.

This case study identifies and explains how DHS S&T standardized sensor and event alert messages to facilitate integration and provide situational awareness during the OpEx and discusses how nationwide public safety agencies could implement standardized alerting to improve sensor data integration.

DHS S&T's technical team, DHS-funded and industry partners provided the sensors and integration work to support the OpEx, incorporating the feeds from multiple sensors to multiple situational awareness applications. The OpEx scenario provided sufficient realistic opportunities to assess the technologies and allowed participating responders to identify gaps and required enhancements to improve the participating technologies.

Figure 1. Participants Conduct Simulated Emergency Response Activities During the NGFR - Harris County OpEx

DHS S&T and partners brought new situational awareness capabilities to Houston-area responders. By integrating data from multiple sensor types into unified situational awareness applications and standardizing the format of alert messaging across these platforms, the NGFR Apex program enhanced operational communications, increased operational coordination, improved responder safety and augmented situational awareness. The OpEx demonstrated that the first responders, incident commanders and emergency managers were able to maintain enhanced situational awareness during the scenario by interacting with the real-time data and alerts displayed on the various situational awareness platforms provided for the OpEx.

Administrative and Handling Instructions

The title of this document is the "Next Generation First Responder Case Study: Sensor and Event Alerts." This document provides public safety agencies with an overview of how DHS S&T implemented standardized sensor and event alerts during the NGFR – Harris County OpEx and provides some areas that an agency may consider if they chose to implement the capability within their organization. All preparation and documentation for the NGFR – Harris County OpEx is unclassified.

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If you have any questions about this case study, or to request more information about the NGFR – Harris County OpEx, please contact NGFR@hq.dhs.gov. Public release of information is at the discretion of DHS S&T.

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INTRODUCTION

Next Generation First Responder Apex Program

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) works with America's first responders to ensure they are more effective and safer—regardless of the hazards they face. DHS S&T develops and adapts innovative technologies that help first responders make communities more secure and resilient, because homeland security truly starts with hometown security.

The Next Generation First Responder (NGFR) Apex program is a five-year program that began in January 2015 and is part of a longer-term DHS S&T commitment to envision and assist the responder of the future. The NGFR program works to make responders better protected, connected and fully aware by developing, adopting and integrating cutting-edge first responder technologies using open standards. This complex, multi-disciplinary program consists of a diverse but related portfolio of projects that span from basic research to advanced technology development, and an initiative to define a common set of open standards for technology integration. These open standards enable industry partners to develop standards-based solutions that easily plug-and-play into an interoperable responder ecosystem, including legacy systems. This approach opens doors to industry while lowering costs and increasing choices for public safety organizations, helping them rapidly adapt to changing environments and evolving threats as they secure communities nationwide.

NGFR Integration Demonstrations

Since 2016, DHS S&T has held a series of NGFR Integration Demonstrations to incrementally test and evaluate interoperable technologies currently in development. These demonstrations have evolved from tabletop integrations to field exercises with partner public safety agencies, including the rural 2017 Grant County—DHS S&T NGFR Apex Program Technology Experiment. This case study highlights the efforts, lessons-learned and guidance from the NGFR – Harris County Operational Experimentation (OpEx) that was held in December 2018 in Houston, Texas, to demonstrate the interoperability of DHS S&T and industry-developed responder technology and increase community resilience.

DHS S&T has incorporated the results and responder feedback from the NGFR Integration Demonstrations into the NGFR Integration Handbook, which outlines a standards-based environment that enables commercially-developed technologies to integrate with existing first responder infrastructure. Using the lessons learned and responder feedback from these integration demonstrations, DHS S&T has also produced materials to help public safety agencies implement new technologies that address their operational priorities, such as the NGFR Case Study series, which this document is part of.

NGFR Operational Experimentation in Harris County, Texas

DHS S&T collaborated with public safety agencies from Harris County and the Houston area to host the NGFR – Harris County OpEx from December 4-5, 2018, at the Port of Houston. Participating agencies included Harris County (Fire Marshal's Office, Sheriff's Office Marine Unit, Office of Homeland Security and Emergency Management, Central Technology Services, and Community Emergency Response Team), the City of Houston (Fire Department, Police Department Marine Unit, and Information Technology Services), Port of Houston Authority (Emergency Management, Fire Department, Police Department), SouthEast Texas Regional Advisory Council, Cy-Fair Volunteer Fire

Department, Atascocita Fire Department, U.S. Coast Guard Sector Houston-Galveston, DHS Federal Emergency Management Agency's Integrated Public Alert and Warning System Office, and DHS Cybersecurity and Infrastructure Security Agency's Emergency Communications Division.

The goal of this OpEx was to integrate and demonstrate a variety of cutting-edge responder technologies, assist Houston-area response organizations in incorporating them into their daily operations, gather responder feedback to help improve both individual DHS-funded and industry technologies, and demonstrate the value of the NGFR Apex program. During the OpEx, Houston-area responders and federal partners used integrated responder technologies to enhance their mission capabilities in a HAZMAT and mass casualty incident response scenario in the Houston Ship Channel. Together, responders and DHS S&T evaluated how selected S&T-developed and commercial technologies integrated with existing public safety systems using open standards and how those integrated capabilities enhanced emergency communications, increased operational coordination, improved responder safety and augmented situational awareness.

Purpose of this Case Study

This case study describes how DHS S&T identified and applied sensor and event alerting standards during the NGFR – Harris County OpEx, taking real-time data from numerous sensors, assessing it against pre-established thresholds, displaying it on unified situational awareness applications, and issuing alerts when the sensor readings exceeded the thresholds. Alerting gives the Incident Commander, command staff and first responders the right information at the right time to make life-saving decisions. It provides an overview of the systems used, the challenges encountered and the solution implemented for the OpEx, as well as considerations that any public safety agency should think through if they intend to implement sensor and event alerting for their organization.

OpEx OVERVIEW

OpEx Objectives

DHS S&T hosted the OpEx to validate and advance the Next Generation First Responder Apex program, as well as benefit Houston-area public safety and technology provider partners. The OpEx integrated NGFR technologies to support an operationally-relevant, mission-based scenario centered on HAZMAT and mass casualty response operations. The goal of this OpEx was to demonstrate the capabilities of new technologies and provide a proof of concept to participating responders to illustrate how the technologies could be incorporated into daily operations and existing systems. By gathering feedback from first responders on the technologies and how they did or did not augment public safety emergency response capabilities, the NGFR Apex program seeks to better ensure new technologies fully meet responder needs.

Figure 2. Cy-Fair Volunteer Fire Department personnel connect physiological sensors to an OpEx "patient" prior to transport

OpEx Requirements

Initial discussions with Harris County resulted in the identification of the following technology requirements for the OpEx:

- Geo-location of first responder personnel in three dimensions on map displays provided to the Incident Commander, the command staff and on smartphones carried by responders.

- Capability to monitor patients' physiological condition and send the data wirelessly to the Incident Commander and command staff for viewing using a visual "dashboard" on a monitor and/or smartphone.
- Remote monitoring of HAZMAT using body-worn gas sensors transmitting alerts to the Incident Commander and command staff.
- Integration of all sensor feeds into one data feed provided to multiple situational awareness applications, especially the two existing applications in place or planned for use by Harris County and the Port of Houston (Intrepid Response and CommandBridge, respectively).

DHS Core Capabilities Alignment

The NGFR – Harris County OpEx was shaped around critical requirements identified by operational partners from Harris County, the City of Houston, Port of Houston Authority, U.S. Coast Guard, SouthEast Texas Regional Advisory Council, Cy-Fair Volunteer Fire Department and Atascocita Fire Department. These requirements included helping fill gaps identified during the response to Hurricane Harvey in 2017, particularly gaps around information sharing and multi-jurisdictional coordination. The planning process included joint identification of OpEx objectives and targeted DHS Core Capabilities, which included:

- Operational Communications;
- Operational Coordination;
- Environmental Response/Health and Safety;
- Intelligence and Information Sharing;
- Access Control and Identity Verification;
- Mass Search and Rescue Operations;
- On Scene Security, Protection and Law Enforcement;
- First Responder Safety; and
- Situational Awareness.

OpEx technologies were selected to meet these Core Capabilities and the scenario was developed to test the technologies and the associated operational capabilities.

Figure 3. A DHS Data Collector Observes the Harris County HAZMAT Team During the OpEx

OpEx Scenario

The OpEx scenario provided sufficient realistic opportunities to assess the various technologies' utility and integration with existing systems (technical and human). The scenario also provided opportunities for participating first responders to identify gaps and required enhancements to improve the participating technologies. The evaluation team was able to verify that the NGFR system architecture implemented and configured at the Port of Houston was easy to install, easy to use and provided capabilities that were valued by the first responders.

The NGFR – Harris County OpEx consisted of an operational scenario divided into three vignettes:

- **Vignette A**: A HAZMAT spill occurs on USCGC Hatchet and the resulting gas cloud also affects the civilian vessel, the M/V Sam Houston, following in its wake. The vessels moor across Buffalo Bayou and HAZMAT teams are activated from the Port of Houston, Harris County, and the City of Houston as well as EMS units from the City of Houston, Atascocita Fire Department and the CyFair Volunteer Fire Department. Harris County and the City of Houston marine units respond, as well as the Port of Houston Fireboat 1 and a USCG Response Boat Small (RB-S).

All HAZMAT and marine units arrive on scene at the Sam Houston Pavilion and the Battalion Chief from the Port of Houston establishes Incident Command to evaluate the situation.

- **Vignette B**: The Harris County HAZMAT crew sets up a decontamination station at the Sam Houston pavilion, boards the M/V Sam Houston, and starts evaluating the passengers and crew. HAZMAT crews from the Port of Houston and City of Houston board Fireboat 1 and are transported across the bayou to USCGC Hatchet. They board the vessel to evaluate the crew and identify the source and nature of the HAZMAT spill. They also note that one of the crewmembers is unaccounted and is assumed to have fallen overboard prior to mooring.
- **Vignette C**: Victims from civilian vessel M/V Sam Houston undergo technical decontamination, triage and treatment, and are prepared for transport. Victims from USCGC Hatchet undergo gross decontamination and are then transported by Fireboat 1 over to the pavilion, where they undergo technical decontamination, triage and treatment. The USCG crew and a helicopter search for and find the missing crewman in the bayou, the RB-S crew retrieves him and returns him to the pavilion for decontamination, triage and treatment.

OpEx Technologies

DHS S&T worked with federal, industry and on-contract performers to provide 23 technologies, many of which were integrated to increase information sharing and situational awareness during the OpEx. DHS S&T and partners used sensor data and event alert messaging standards to facilitate technology integration, including the Sensor Things server running their Open Geospatial Consortium (OGC) standard Application Program Interface (API), and Message Queuing Telemetry Transport (MQTT). Full descriptions of all OpEx technologies are available in the NGFR – Harris County OpEx Playbook and After Action Report listed in the References and Recommended Reading section. Note that the following descriptions were current as of the NGFR – Harris County OpEx in December 2018, and that throughout this document, technologies are frequently referred to by the name of the company rather than the name of the technology. OpEx technologies relevant to this case study include:

Ardent Management Consulting, Inc.

Vortex Router with the Esri Ops Dashboard

The Esri Ops Dashboard is an Esri-based situational dashboard that uses Esri Portal and ArcGIS awareness to display and help visualize the data collected in the Vortex Router from both personnel and vehicles for use in emergency situations. The Vortex Router aggregates and translates messages encoded with the Emergency Data Exchange Language (EDXL) Distribution Element (DE) standards and uses a REST API to allow for easy third-party integration and to encourage interoperability. Ardent Management Consulting, Inc. (Ardent MC) was funded by DHS S&T for this technology.

ARES Security Corp.

CommandBridge

CommandBridge is an intelligent situational awareness and management platform that provides collaborative situational awareness by allowing each user to select the information sources and layers they need to understand and manage events as they unfold. CommandBridge ingests and visualizes data from virtually any sensor—including chemical sensors, biometric sensors, cameras, radar, access control and alarm systems—to manage all security information through a single user interface.

Centrex Solutions LLC

Nightjar

The Nightjar platform connects devices with systems and people, over a variety of long-range, low-power wireless technologies, allowing connectivity beyond cellular coverage areas. During the OpEx, first responders will be using Nightjar handheld, wearable and vehicle-mounted flammable gas sensors. These devices can detect a wide range of volatile substances in a single sensor and deliver that data over the Nightjar network to existing situational awareness applications used by incident command.

Haystax, a Fishtech Group Company

Haystax Constellation

Haystax Constellation for safety and security helps first responders prepare and respond with confidence, using a cloud-based platform for early threat detection, situational awareness and information sharing. Haystax Constellation gives first responders advanced analytics to automatically score the highest-priority threat signals and rapidly deliver them to the right people at the right time and provides a tightly-integrated ecosystem of web and mobile apps that enables users to manage their critical assets and respond effectively to incidents and natural hazards.

Integrated Solutions for Systems, Inc. (IS4S)

Communication Hub

The Communication Hub (CommsHub) is a body-worn, smart router that interconnects multiple communications systems (e.g., LMR, LTE, FirstNet) with the variety of sensors and electronics (e.g., location, vitals) worn or carried by the user. It intelligently, efficiently, securely and resiliently routes data between first responders and commanders using the best available communication link, removing the burden of handling increasing amounts of data, so first responders can focus on the task at hand. IS4S was funded by DHS S&T under the Small Business Innovation Research program for this technology.

Intrepid Networks, LLC

Intrepid Response

Intrepid Response is a mobile application that enables enhanced situational awareness by providing live responder locations and static locations of interest with a simple user interface. Open API architecture provides integration capability for higher level command and control tools or other platforms.

Keys Net LLC

Keys IoT Watch App

With the Keys IoT Watch App, first responders can leverage the devices they already own to provide location, heart rate and other sensor data into their current operational systems, as well as receive incident alerts (visual/audio/vibration), select sensor data, and view an incident / team map from their smart watch. Keys IoT Watch App is a software-based solution that utilizes mass-market consumer wearables (such as the Apple Watch) to both send and receive location, sensor data and alert notifications. Keys Net LLC was previously funded by DHS S&T for this technology.

N5 Sensors, Inc.

Compact Multi-Gas and Particulate Matter Detector

A compact, low-cost gas and particulate detector leveraging N5's patented chip-scale nanoengineered gas sensor technology. It provides real-time detection of multiple of toxic and fire gases along with

particulate matter counts in a wide range of environmental conditions. N5 Sensors, Inc. was funded by DHS S&T under the Small Business Innovation Research program for this technology.

National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory

AUDREY – Assistant for Understanding Data through Reasoning, Extraction and Synthesis

AUDREY is a state-of-the-art human-like Artificial Intelligence (AI) system designed to assist first responders in reducing the data overload problems and providing life-saving actionable intelligence by automatically analyzing relevant sensor data and synthesizing high-level situational awareness information while at the scene of an emergency. NASA Jet Propulsion Laboratory was funded by DHS S&T for this technology.

Pacific Northwest National Laboratory (PNNL)

VitalTag

VitalTag is a small, disposable suite of sensors that securely detects and communicates vital sign data in real-time to first responders. This information helps first responders more effectively triage, treat and transmit patients during a mass casualty event. PNNL was funded by DHS S&T for this technology.

SensorUp, Inc.

SensorThings

SensorUp provides the Internet of Things platform for customers who rely on geospatial in their IoT Implementations. SensorUp is here to help make sense of data. Combine all different sensors into one easily-managed visualizer and get the bigger picture. SensorThings technology rapidly aggregates and coordinates disparate sensors and IoT systems transforming them into actionable insights. SensorThings provides the primary sensor integration platform for the OpEx by connecting and aggregating various sensors and providing that actionable information to situational awareness tools. SensorUp, Inc. was funded by DHS S&T through a subcontract for this technology.

TRX Systems, Inc.

NEON Personnel Tracker and NEON Command

NEON Personnel Tracker delivers indoor and outdoor location, improving operational efficiency, command effectiveness and safety for security, public safety and industrial applications. NEON Personnel Tracker is an Android application tightly integrated with the NEON Command where a suite of patented algorithms fuse inertial sensor data. TRX Systems, Inc. was previously funded by DHS S&T for indoor tracking solutions under the Firefighter Accountability and Proximity Systems project.

OpEx Constraints and Limitations

DHS S&T identified the following constraints and limitations for the OpEx:

- Most of the technology providers were identified through a Request for Information process and worked under Cooperative Research and Development Agreements (CRADAs) with DHS S&T, which did not include funding. This constrained the scope of their participation.
- DHS S&T could not interface with existing Computer Aided Dispatch (CAD) systems for the City of Houston, Port of Houston or Harris County, so the sensor feeds had to be aggregated, normalized and sent to situational awareness applications entirely outside of the local CAD systems.
- The primary situational awareness solutions used—CommandBridge, Intrepid Response and Haystax Constellation—were selected because they were already in use (or planned for use) by Harris County and the Port of Houston.

- Participation by IS4S was considerably delayed due to contracting issues; they were unable to participate in integration work until a few weeks before the OpEx. This significantly limited the number of systems that were integrated for data routing through the Communication Hub.
- Due to time limitations, the sensor data for each responder was consolidated at the server level instead of the on-body (controller) level as recommended in the NGFR Integration Handbook. This expedited the configuration of the data flow from each type of sensor but made the matching of sensor data to the appropriate responder more complex.

OpEx Communications Architecture

Based upon site visits, a baseline technology assessment of all participating agencies and ongoing collaboration with Harris County and other participants, DHS S&T developed a notional architecture. This established the foundation for the OpEx architecture, as well as to ensure consistency with the expectations and needs of participating public safety organizations, as shown in Figure 4.

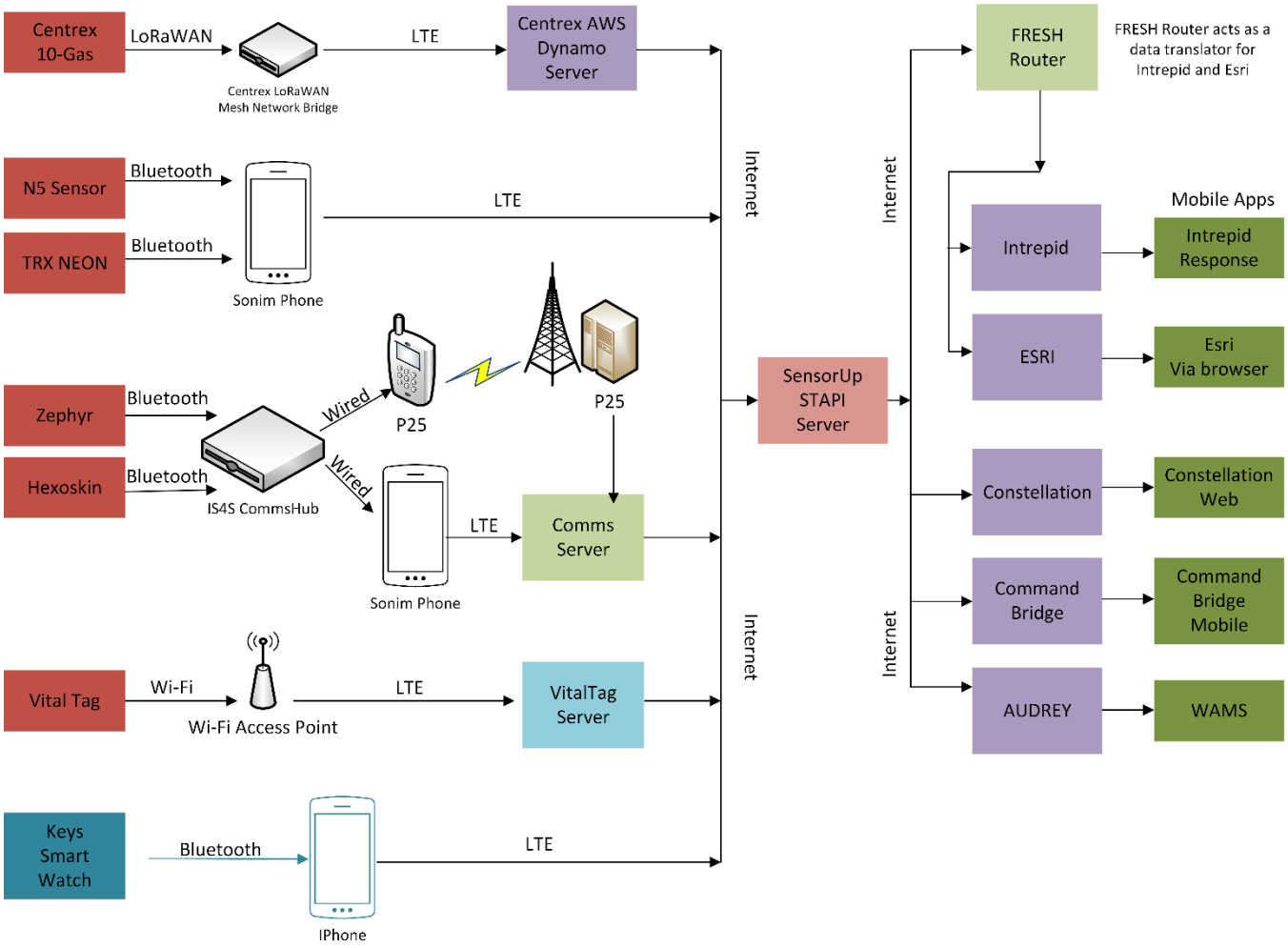

Figure 4. OpEx Communications Architecture with Central SensorUp Data Integration Point

Implementing Sensor and Event Alert Solutions

It is crucial for public safety agencies to understand the types of sensor and event alerts they are planning to incorporate into their enterprise architecture and be able to identify integration and data exchange points for that data. These are required back-end components that make situational awareness

systems work and able to share meaningful, real-time sensor data to improve emergency response decision making.

Over the span of the NGFR Apex program, and particularly while preparing for the NGFR – Harris County OpEx, DHS S&T realized that sensor and event alert standards must be added to the NFGR Integration Handbook to ensure that it is a useful guide for vendors to create modular on-body sensor and communications solutions. For the OpEx, DHS S&T was unable to closely follow the Handbook data architecture standards regarding where sensor data was aggregated on the on-body controller. Instead, the technical team fed sensor data from the sensors via various routes to the central SensorUp server, at which point the data was matched with the appropriate responder and sent on to the situational awareness platforms.

Figure 5. The DHS S&T OpEx Team Monitors the CommandBridge Dashboard During the OpEx

Sensor and Event Alert Requirements

Sensor and event alert requirements are closely related to the overall OpEx situational awareness requirements. To effectively develop and implement a first responder enhanced situational awareness solution, DHS S&T and participating public safety agencies assessed their mission needs for the situational awareness systems and arrived at the following requirements:

- The situational awareness system that receives data from first responder sensors shall include CommandBridge (for the Port of Houston) and both Intrepid Response and Haystax Constellation (for Harris County);
- The situational awareness system shall incorporate and display the sensor data from gas sensors, physiological sensors, location sensors, and video analysis and alerting; and
- The situational awareness system shall associate the sensor data with the corresponding responder and display any alerts for sensor readings that exceed configurable parameters.

Based upon earlier experiments and integration events, the OpEx technical team identified specific sensor and event alert requirements to ensure all OpEx systems work together, including the need to develop:

- Standard sensor data "data dictionary;"
- Standard sensor message payload; and
- Standard alerting message payload.

Baseline Assessment of Existing Capabilities

Participating public safety agencies did not have baseline sensor and event alert standards for real-time sensor data, nor an existing environment capable of passing sensor data on to their situational awareness applications without additional development. Harris County did not have any active sensors deployed that could connect their existing situational awareness tools and therefore no existing sensor and alerting data message requirements or implementations. The Port of Houston did not have any active sensors deployed that could connect their existing situational awareness tools and therefore no existing sensor and alerting data message requirements or implementations.

OpEx Sensor and Event Alert Configuration

To implement sensor and alerting data message requirements that would align with broader industry implementations, DHS S&T selected MQTT as the transport layer protocol. The Open Geospatial Consortium SensorThings API was selected as the data framework and SensorUp provided the data aggregation server. To keep data messages as compact as possible, the JavaScript Object Notation (JSON) data format was chosen. With this framework, a consistent standard was developed that would facilitate the interchange of data.

The technical team worked towards developing and implementing these standards, with limited success. SensorUp played a critical role in supporting this standardization effort. These topics are explored further in the Harris County Case Studies, "NGFR Case Study: Enhanced Situational Awareness," "NGFR Case Study: Sensors," and "NGFR Case Study: Data Integration." For more information, see the References and Recommended Reading section.

The proposed communications and sensor architecture for the OpEx matched the sensor and event alert requirements presented in the NGFR Integration Handbook. One opportunity provided was to use the Harris County P25 land mobile radio data infrastructure to pass short data messages (primarily alerts, but also sensor data) to the situational awareness applications, including via the IS4S Communication Hub. Figure 6 shows the notional view of the connections among the various sensors, the SensorUp STAPI server and the situational awareness tools.

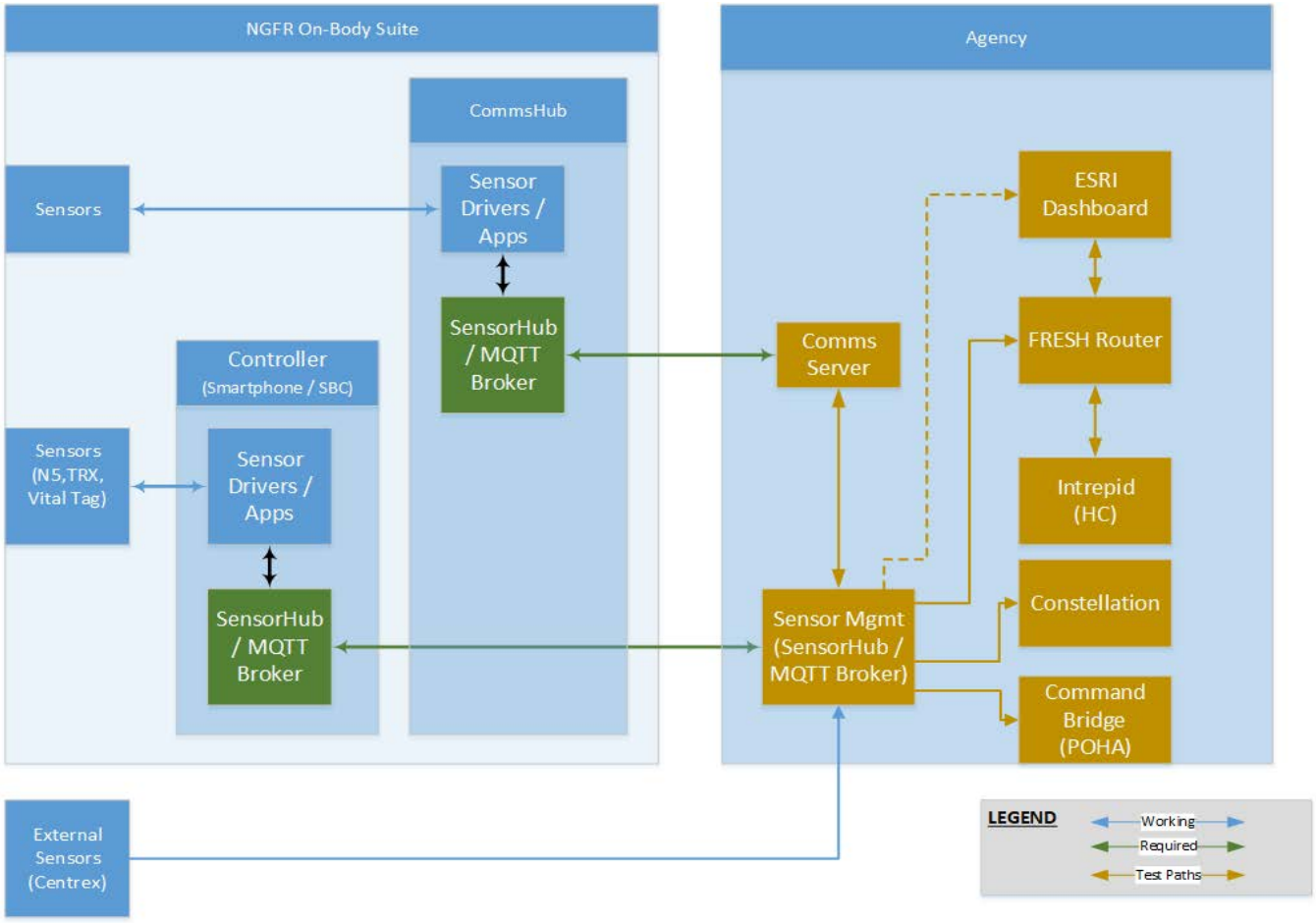

Figure 6. Harris County Notional Data Collection

OpEx sensors included location sensors (including indoor location capabilities), gas / chemical sensors, and physiological sensors (responder and patient). It was determined that the sensor telemetry would be

supported primarily using FirstNet and Sonim XP8 phones, but the Centrex Nightjar mesh communications system was also employed to transmit Nightjar gas sensor data and event alerts.

The sensor and event alerts that were passed via OpEx systems were formatted using the following:

- The sensor data used the MQTT standard for transport. The MQTT topics used were developed during past NGFR Integration Demonstrations and are provided in Table 1. The MQTT topics were organized as ResponderID / sensortype / observation. This format allowed the situational awareness platforms to display appropriate data associated with a given responder.
- The sensor data from each sensor source (manufacturer) was different, as shown in Table 1, but loosely adhered to the data payload standard also developed during past NGFR experiments and integration events. The sensor data passed through the SensorUp Sensor Things API server and was transmitted on to the situational awareness platforms. For the Intrepid Response situational awareness platform, the data was sent from the SensorUp server to the ArdentMC Vortex server, which then passed the data on to Intrepid.
- All sensor alerting data was simplified and sent to a specific MQTT topic for use by all situational awareness platforms. Each "Thing" (i.e., first responder) had a specific "Datastream" created for alerts (i.e., Hazmat Responder 1 had a Datastream called Hazmat Responder 1 – Alerts). A Datastream contains MQTT endpoints for Observations, FeaturesOfInterest, etc. A Datastream also enables full SensorThings API HTTP access to that Datastream. In the case of AUDREY, Alerts were not associated with a single Thing; instead, an "Alerts – General" Datastream was created to address alerts generated by AUDREY.

OpEx Standard Sensor Data Dictionary

To develop a standard sensor data dictionary, the first step was to identify the data elements that different types of sensors might send.

NGFR Sensor Data Elements

The following lists the data elements identified from Project Responder 4 requirements—which served as the basis for NGFR Apex program requirements—associated with specific types of sensors. This is not a comprehensive list of all data elements that these types of sensors may measure, but only those from the source document. This data needs keyword and value pairs defined for JSON and XML data schemas.

- **Physiological Sensor Modules Measurements**
  - Temperature Measurements
    - Body Temperature
    - Temperature Unit of Measure (°F)
    - Other vendor specific data (optional)
  - Pulse / Heart Rate Measurements
    - Pulse / Heart Rate
    - Beats per minute (BPM)
    - Other vendor specific data (optional)
  - Hydration Measurements
    - Electrolyte Content
      - Sodium (Na)
      - Potassium (K)
      - Magnesium (Mg)
    - Other vendor specific data (optional)
  - Blood Pressure Measurements

        - Blood Pressure (mmHg)
    - Respiration Measurements
        - Respiration Rate
    - Oxygen Saturation Measurements
        - Oxygen Saturation (SpO2)
    - Blood Sugar Level Measurements
        - Blood Sugar Level (mg/Gl)
- **Chemical Sensor Modules Measurements**
    - Carbon Monoxide (CO) (ppm)
    - Methane (ppm)
    - Hydrogen Cyanide (ppm)
    - Acid gases (ppm)
    - Ammonia (ppm)
    - Basic gases (ppm)
    - Chlorine (ppm)
    - Diborane (ppm)
    - Hydrogen Fluoride (ppm)
    - Hydrogen Sulfide (ppm)
    - Iodine gas (ppm)
    - Nitrogen Dioxide (NO2) (ppm)
    - Phosgene (ppm)
    - Phosphine (ppm)
    - Sulfur Dioxide (SO2) (ppm)
    - Atmospheric Oxygen (ppm)
- **Biological Agent Sensor Modules Measurements**
    - Tularemia
    - Anthrax
    - Smallpox
    - Botulism
    - Bubonic Plague
    - Hemorrhagic Fever
    - Other Agents
- **Explosive Compounds Sensor Modules Measurements**
    - Explosive Family
    - Explosive Precursors
- **Radiological Particles Sensor Measurements**
    - Ionizing Radiation
    - Alpha Particles (cps, isotope specific)
    - Beta Particles (cps, isotope specific)
    - Gamma Particles (cps, isotope specific)
    - Neutron Particles (cps, isotope specific)
- **Location Sensors**
    - Controller-based
    - Independent Sensor
- **Camera Sensors**
    - Controller-based
    - Independent Sensor

- **Gunshot Detection Sensors**
  - Latitude/Longitude or address of gunshot detected
  - Probability ellipse for location of gunshot
  - Major axis of ellipse

Based on the types of sensors in the OpEx, only some of these data elements were necessary.

NGFR Sensor Data Dictionary

DHS S&T developed a data dictionary, which is shown in Table 1, to accommodate participating OpEx sensors and their data elements.

Table 1. NGFR Data Dictionary for the NGFR - Harris County OpEx

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Chemical - Hydrogen	Hydrogen	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	hydrogen	hydrogen - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Methane	Methane	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	methane	methane - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - AirTemperature	Air Temperature	double	degrees fahrenheit	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	airTemperature	airTemperature - nightjar - gas-field_stm-003	degF	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - Humidity	Humidity	double	percentage	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	humidity	humidity - nightjar - gas-field_stm-003	%	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Alert - HighTemperature	High Temperature	string	unitless	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	alert	alert - nightjar - gas-field_stm-003	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too high - nightjar - gas-field_stm-003	
Alert - LowTemperature	Low Temperature	string	unitless	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	alert	alert - nightjar - gas-field_stm-003	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too low - nightjar - gas-field_stm-003	
Chemical - Butane	Butane	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	butane	butane - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Ethane	Ethane	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	ethane	ethane - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Chemical - Ethylene	Ethylene	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	ethylene	ethylene - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Hexane	Hexane	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	hexane	hexane - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Isopropanol	Isopropanol	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	isopropanol	isopropanol - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Pentane	Pentane	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	pentane	pentane - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Propane	Propane	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	propane	propane - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Propylene	Propylene	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	propylene	propylene - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Toluene	Toluene	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	toluene	toluene - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Xylene	Xylene	double	parts per million	Centrex Solutions	nightjar	gas-field_stm-003	nightjar - gas-field_stm-003	nightjar	xylene	xylene - nightjar - gas-field_stm-003	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Position - Position	Position	string	unitless	Keys	keys	Apple Watch 2	keys - Apple Watch 2	keys	position	position - keys - Apple Watch 2	unitless		0	{"feature": {"type": "Point", "coordinates": [<longitude>,

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
														<latitude>] }
Position - Altitude	Altitude	decimal	meters	Keys	keys	Apple Watch 2	keys - Apple Watch 2	keys	altitude	altitude - keys - Apple Watch 2	m	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Physiological - HeartRate	Heart Rate	integer	beats per minute	Keys	keys	Apple Watch 2	keys - Apple Watch 2	keys	heartRate	heartRate - keys - Apple Watch 2	beats/minute	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CountObservation	<result>	
Alert - HeartRateECG	Heart Rate ECG	string	unitless	Keys	keys	Apple Watch 2	keys - Apple Watch 2	keys	alert	alert - keys - Apple Watch 2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - questionable heart rate ECG - keys - Apple Watch 2	
Chemical - Chlorine	Chlorine	double	parts per million	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	chlorine	chlorine - n5 - DA:91:F9:D8:14:F2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - HydrogenCyanide	Hydrogen Cyanide	double	parts per million	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	hydrogenCyanide	hydrogenCyanide - n5 - DA:91:F9:D8:14:F2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Hydrogen	Hydrogen	double	parts per million	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	hydrogen	hydrogen - n5 - DA:91:F9:D8:14:F2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - SulfurDioxide	Sulfur Dioxide	double	parts per million	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	sulfurDioxide	sulfurDioxide - n5 - DA:91:F9:D8:14:F2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - VOC	VOC	double	parts per million	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	voc	voc - n5 - DA:91:F9:D8:14:F2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - NitrogenDioxide	Nitrogen Dioxide	double	parts per million	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	nitrogenDioxide	nitrogenDioxide - n5 - DA:91:F9:D8:14:F2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Oxygen	Oxygen	double	parts per million	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	oxygen	oxygen - n5 - DA:91:F9:D8:14:F2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - AirTemperature	Air Temperature	double	degrees fahrenheit	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	airTemperature	airTemperature - n5 - DA:91:F9:D8:14:F2	degF	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Environmental - Humidity	Humidity	double	percentage	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	humidity	humidity - n5 - DA:91:F9:D8:14:F2	%	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - PM2.5	PM25	double	micrograms per cubic meter	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	pm25	pm25 - n5 - DA:91:F9:D8:14:F2	ug/m3	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - PM10	PM10	double	micrograms per cubic meter	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	pm10	pm10 - n5 - DA:91:F9:D8:14:F2	ug/m3	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Physiological - BloodPressure	Blood Pressure	integer	millimeter of mercury	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	bloodPressure	bloodPressure - vitaltag - b8:27:eb:d1:b6:67	mmHg	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CountObservation	<result>	
Physiological - HeartRate	Heart Rate	integer	beats per minute	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	heartRate	heartRate - vitaltag - b8:27:eb:d1:b6:67	beats/minute	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CountObservation	<result>	
Physiological - Oximetry	Oximetry	double	percentage	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	oximetry	oximetry - vitaltag - b8:27:eb:d1:b6:67	%	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Physiological - Respiration	Respiration	integer		PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	respiration	respiration - vitaltag - b8:27:eb:d1:b6:67	breaths/min	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_CountObservation	<result>	
Physiological - Temperature	Temperature	double	degrees fahrenheit	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	bodyTemperature	bodyTemperature - vitaltag - b8:27:eb:d1:b6:67	degF	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Alert - Shock	Shock	string	unitless	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	alert	alert - vitaltag - b8:27:eb:d1:b6:67	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - suspected patient shock - vitaltag - b8:27:eb:d1:b6:67	
Alert - LowTemperature	Low Temperature	string	unitless	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	alert	alert - vitaltag - b8:27:eb:d1:b6:67	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too low - vitaltag - b8:27:eb:d1:b6:67	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Alert - HighTemperature	High Temperature	string	unitless	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	alert	alert - vitaltag - b8:27:eb:d1:b6:67	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too high - vitaltag - b8:27:eb:d1:b6:67	
Alert - HeartRateECG	Heart Rate ECG	string	unitless	PNNL VitalTag	vitaltag	b8:27:eb:d1:b6:67	vitaltag - b8:27:eb:d1:b6:67	vitaltag	alert	alert - vitaltag - b8:27:eb:d1:b6:67	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - questionable heart rate ECG - vitaltag - b8:27:eb:d1:b6:67	
Position - Position	Position	string	unitless	TRX	trx	915D	trx - 915D	trx	position	position - trx - 915D	unitless		0	{"feature": {"type": "Point", "coordinates": [<longitude>, <latitude>] }
Position - Error	Error	decimal	unitless	TRX	trx	915D	trx - 915D	trx	error	error - trx - 915D	m	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Position - Heading	Heading	decimal	degrees	TRX	trx	915D	trx - 915D	trx	heading	heading - trx - 915D	degrees	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Position - Altitude	Altitude	decimal	meters	TRX	trx	915D	trx - 915D	trx	altitude	altitude - trx - 915D	m	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Position - Floor	Floor	decimal	unitless	TRX	trx	915D	trx - 915D	trx	floor	floor - trx - 915D	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Alert - Unknown Chemical	Unknown Chemical	string	unitless	N5 Sensors Inc.	n5	C0:3A:85:D4:66:B5	n5 - C0:3A:85:D4:66:B5	n5	alert	alert - n5 - C0:3A:85:D4:66:B5	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - unknown chemical detected - n5 - C0:3A:85:D4:66:B5	
Alert - Unknown Chemical	Unknown Chemical	string	unitless	N5 Sensors Inc.	n5	D5:80:57:2F:D9:A0	n5 - D5:80:57:2F:D9:A0	n5	alert	alert - n5 - D5:80:57:2F:D9:A0	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - unknown chemical detected - n5 - D5:80:57:2F:D9:A0	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Alert - Unknown Chemical	Unknown Chemical	string	unitless	N5 Sensors Inc.	n5	C3:BD:11:9E:C7:AD	n5 - C3:BD:11:9E:C7:AD	n5	alert	alert - n5 - C3:BD:11:9E:C7:AD	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - unknown chemical detected - n5 - C3:BD:11:9E:C7:AD	
Alert - Unknown Chemical	Unknown Chemical	string	unitless	N5 Sensors Inc.	n5	E1:FD:F6:69:EA:9C	n5 - E1:FD:F6:69:EA:9C	n5	alert	alert - n5 - E1:FD:F6:69:EA:9C	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - unknown chemical detected - n5 - E1:FD:F6:69:EA:9C	
Alert - Unknown Chemical	Unknown Chemical	string	unitless	N5 Sensors Inc.	n5	DA:91:F9:D8:14:F2	n5 - DA:91:F9:D8:14:F2	n5	alert	alert - n5 - DA:91:F9:D8:14:F2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - unknown chemical detected - n5 - DA:91:F9:D8:14:F2	
Position - Position	Position	string	unitless	Centrex Solutions	nightjar	gas-field_stm-001	nightjar - gas-field_stm-001	nightjar	position	position - nightjar - gas-field_stm-001	unitless		0	{"feature": {"type": "Point", "coordinates": [<longitude>, <latitude>] }
Chemical - Chlorine	Chlorine	double	parts per million	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	chlorine	chlorine - n5 - backup1	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - HydrogenCyanide	Hydrogen Cyanide	double	parts per million	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	hydrogenCyanide	hydrogenCyanide - n5 - backup1	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Hydrogen	Hydrogen	double	parts per million	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	hydrogen	hydrogen - n5 - backup1	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - SulfurDioxide	Sulfur Dioxide	double	parts per million	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	sulfurDioxide	sulfurDioxide - n5 - backup1	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Chemical - VOC	VOC	double	parts per million	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	voc	voc - n5 - backup1	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - NitrogenDioxide	Nitrogen Dioxide	double	parts per million	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	nitrogenDioxide	nitrogenDioxide - n5 - backup1	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Oxygen	Oxygen	double	parts per million	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	oxygen	oxygen - n5 - backup1	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - AirTemperature	Air Temperature	double	degrees fahrenheit	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	airTemperature	airTemperature - n5 - backup1	degF	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - Humidity	Humidity	double	percentage	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	humidity	humidity - n5 - backup1	%	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - PM2.5	PM25	double	micrograms per cubic meter	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	pm25	pm25 - n5 - backup1	ug/m3	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - PM10	PM10	double	micrograms per cubic meter	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	pm10	pm10 - n5 - backup1	ug/m3	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Alert - Chlorine	Chlorine	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - chlorine gas detected - n5 - backup1	
Alert - HydrogenCyanide	Hydrogen Cyanide	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - hydrogen cyanide gas detected - n5 - backup1	
Alert - Hydrogen	Hydrogen	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - hydrogen gas detected - n5 - backup1	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Alert - SulfurDioxide	Sulfur Dioxide	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - sulfur dioxide detected - n5 - backup1	
Alert - NitrogenDioxide	Nitrogen Dioxide	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - nitrogen dioxide detected - n5 - backup1	
Alert - HighOxygen	High Oxygen	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - high oxygen levels - n5 - backup1	
Alert - LowOxygen	Low Oxygen	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - low oxygen levels - n5 - backup1	
Alert - VOC	VOC High	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - high voc levels - n5 - backup1	
Alert - LowTemperature	Low Temperature	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too low - n5 - backup1	
Alert - HighTemperature	High Temperature	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too high - n5 - backup1	
Alert - Unknown Chemical	Unknown Chemical	string	unitless	N5 Sensors Inc.	n5	backup1	n5 - backup1	n5	alert	alert - n5 - backup1	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - unknown chemical detected - n5 - backup1	
							0			0				0
Chemical - Chlorine	Chlorine	double	parts per million	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	chlorine	chlorine - n5 - backup2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - HydrogenCyanide	Hydrogen Cyanide	double	parts per million	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	hydrogenCyanide	hydrogenCyanide - n5 - backup2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Chemical - Hydrogen	Hydrogen	double	parts per million	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	hydrogen	hydrogen - n5 - backup2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - SulfurDioxide	Sulfur Dioxide	double	parts per million	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	sulfurDioxide	sulfurDioxide - n5 - backup2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - VOC	VOC	double	parts per million	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	voc	voc - n5 - backup2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - NitrogenDioxide	Nitrogen Dioxide	double	parts per million	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	nitrogenDioxide	nitrogenDioxide - n5 - backup2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Chemical - Oxygen	Oxygen	double	parts per million	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	oxygen	oxygen - n5 - backup2	ppm	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - AirTemperature	Air Temperature	double	degrees fahrenheit	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	airTemperature	airTemperature - n5 - backup2	degF	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - Humidity	Humidity	double	percentage	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	humidity	humidity - n5 - backup2	%	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - PM2.5	PM25	double	micrograms per cubic meter	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	pm25	pm25 - n5 - backup2	ug/m3	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Environmental - PM10	PM10	double	micrograms per cubic meter	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	pm10	pm10 - n5 - backup2	ug/m3	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Measurement	<result>	
Alert - Chlorine	Chlorine	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - chlorine gas detected - n5 - backup2	
Alert - HydrogenCyanide	Hydrogen Cyanide	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - hydrogen cyanide gas detected - n5 - backup2	

NGFR HANDBOOK				SENSOR PROVIDER			Thing	Sensor	Observed Property	Datastream			Observation	FeatureOfInterest
	Field Name	Data Type	unit	Name	Short Name	Device Unique ID	.name	.name	.name	.name	.unitOfMeasurement	.observationType	.result	.feature
Alert - Hydrogen	Hydrogen	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - hydrogen gas detected - n5 - backup2	
Alert - SulfurDioxide	Sulfur Dioxide	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - sulfur dioxide detected - n5 - backup2	
Alert - NitrogenDioxide	Nitrogen Dioxide	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - nitrogen dioxide detected - n5 - backup2	
Alert - HighOxygen	High Oxygen	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - high oxygen levels - n5 - backup2	
Alert - LowOxygen	Low Oxygen	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - low oxygen levels - n5 - backup2	
Alert - VOC	VOC High	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - high voc levels - n5 - backup2	
Alert - LowTemperature	Low Temperature	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too low - n5 - backup2	
Alert - HighTemperature	High Temperature	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - temperature too high - n5 - backup2	
Alert - Unknown Chemical	Unknown Chemical	string	unitless	N5 Sensors Inc.	n5	backup2	n5 - backup2	n5	alert	alert - n5 - backup2	unitless	http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Observation	alert - unknown chemical detected - n5 - backup2	

NGFR Sensor Message Payload Standards

While one of the prime focuses outlined in the NGFR Integration Handbook is delivering sensor telemetry data to responders and an aggregation point in the agency, another critical component is delivering alert messages to responders and command staff to increase situational awareness. The next version of the NGFR Integration Handbook will contain the proposed alerting standard, which is based upon the Common Alerting Protocol (CAP) Extensible Markup Language (XML) standard. DHS S&T intends to use the CAP ontology as a starting framework for data elements but to use JSON-based markup and MQTT to allow lightweight data transport.

At a transport level, DHS S&T used sensor telemetry data with MQTT topics carrying JSON formatted data to deliver standard reporting data. DHS S&T used the SensorThings API to support on-demand and control functions. The alerts will be transported in a similar fashion but will follow the CAP XML standard as modified below. The full CAP standard is available here.

NGFR Alert Message Payload Standards

Upstream Messages (to Agency)

In reviewing the composition of the CAP Alert message, it becomes apparent that the Alert component of the message will be added at the agency level, which necessitates that all NGFR sensor telemetry equipment report in with a unique identifier of the controller. The expectation is that the resource management system (CAD or situational awareness platform) will add the agency resource and personnel information to the controller telemetry so that it can be presented meaningfully for situational awareness. Also, it is expected that location data will be included in any alert messages.

- **Alert**
  - Message ID (identifier)
  - Sender ID (sender) [sensor ID] [Thing ID]
  - Sent Date/Time (sent) [resultTime]
  - Message Status (status)
  - Message Type (msgType) [observationType]
  - Scope (scope) [FeatureOfInterest]
  - Info
    - Event Category (category)
    - Event Type (event)
    - Urgency (urgency)
    - Severity (severity)
    - Certainty (certainty)
    - Effective Date/Time (effective) [validTime]
    - Onset Date/Time (onset) [phenomenomTime]
    - Sender Name (senderName) [This is the unique controller ID described above.] [ThingID]
    - Resource
      - Description (resourceDesc) [plain language description of sensor]
    - Area
      - Area Description (areaDesc) [geo-location of sensor – lat/long] [FeatureOfInterest]

This is the necessary and sufficient information to be relayed back to the agency in terms of alerting.

Downstream Messages (from Agency)

Messages sent to the downstream NGFR sensor telemetry equipment will need to be minimalistic to avoid distraction to first responders having to process superfluous information. Downstream messages will need to be comprised of the data elements listed below.

- **Alert**
  - Message ID (identifier)
  - Sender ID (sender) [sensor ID] [ThingID]
  - Sent Date/Time (sent) [resultTime]
  - Message Status (status)
  - Message Type (msgType) [observationType]
  - Scope (scope) [FeatureOfInterest]
  - Info
    - Event Category (category)
    - Event Type (event)
    - Urgency (urgency)
    - Severity (severity)
    - Certainty (certainty)
    - Effective Date/Time (effective) [validTime]
    - Onset Date/Time (onset) [phenomenomTime]
    - Expiration Date/Time (expires) [validTime]
    - Sender Name (senderName) [This is the unique controller ID described above.] [thingID]
    - Resource
      - Description (resourceDesc) [plain language description of sensor]
    - Area
      - Area Description (areaDesc) [geo-location of sensor – lat/long] [FeatureOfInterest]
      - Area Polygon (polygon) [effective alert area if polygon] [FeatureOfInterest]
      - AreaCircle (circle) [effective alert area if circle] [FeatureOfInterest]

NGFR Alert Types

The following is a brief list of NGFR alert types and some of the values associated with them. These must be aligned to CAP categories to facilitate ease of distribution via CAP XML at the agency level.

- Type (chemical, biological, physiological, mayday, evacuate, etc.)
- Priority (high, medium, low)
- Urgency (action required, information only)
- Alert trigger (above/below normal levels)
- Primary notification method (aural, visual, haptic)
- Secondary notification method (aural, visual, haptic)
- Tertiary notification method (aural, visual, haptic)
- Acknowledgement time (XX seconds)

Using Sensor and Data Alerting Standards During the OpEx

After bringing the components together, Figure 7 represents the working architecture used for the NGFR – Harris County OpEx. This architecture enabled SensorUp to create a Thing comprised of multiple datastreams from the disparate sensors, associate the sensor data with the corresponding responder and pass it on to the situational awareness platforms. Ultimately, the goal would be to consolidate the

multiple data streams on the on-body controller as per the NGFR Integration Handbook and output the multiple datastreams as a Thing associated with the Controller.

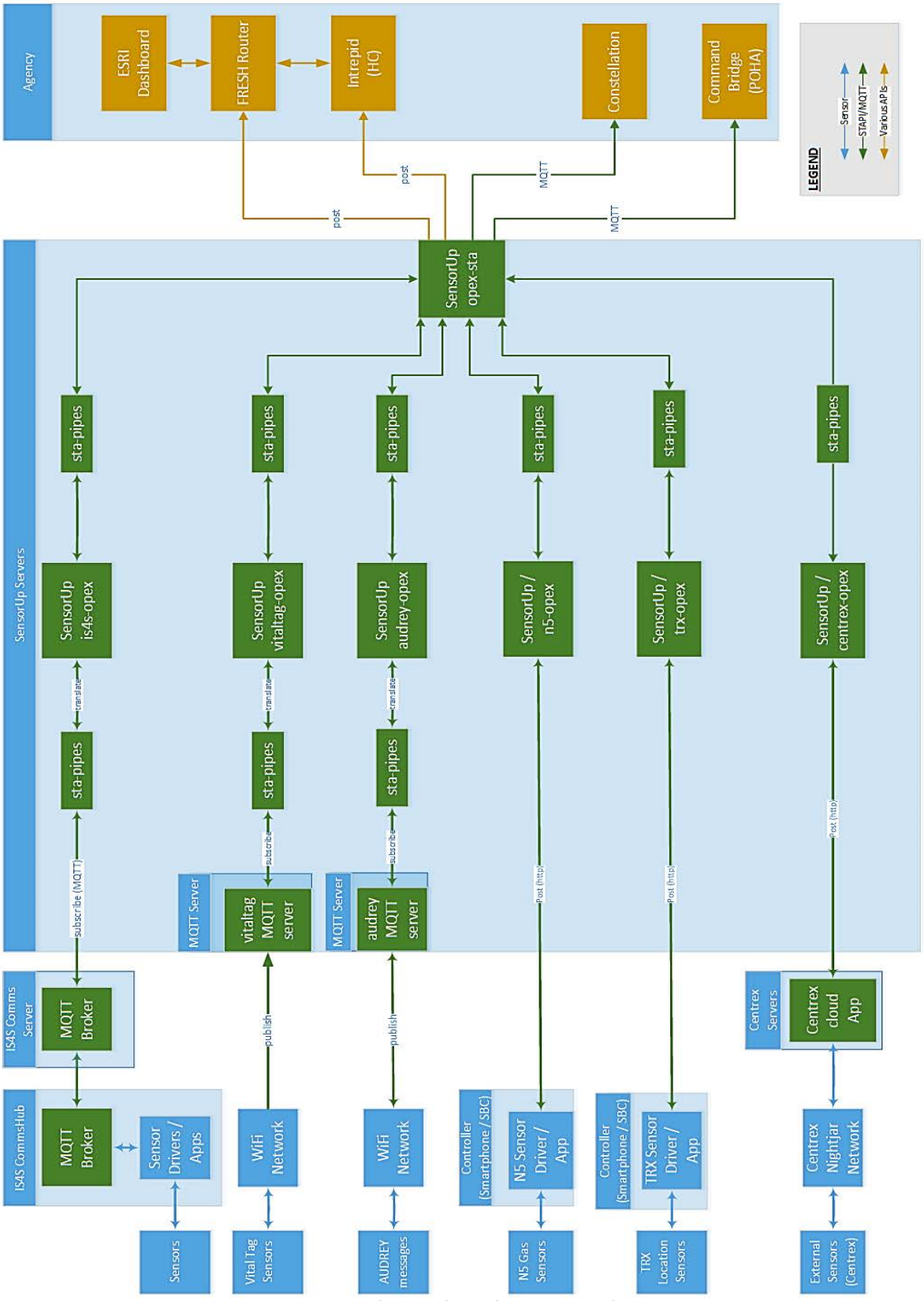

Figure 7. Harris County OpEx Sensor Data Collection

Note that each gas sensor (N5 and Centrex NightJar) had their own data standard, as did the location sources (TRX and Centrex/NightJar). The Apple SmartWatch and VitalTag provided location and physiological information in their datastreams, and all sensors provided alerts in some format.

Implementation Limitations to Consider

It is important for an agency to understand what the integration points are for the sensor data and understand what interfaces are available on the systems where the sensor data is required. It is also critical to understand the security policies in place and make sure the sensor data collection system can meet the agency's data security requirements. Many solutions are cloud-hosted and need to be evaluated to determine if this is an acceptable solution for agency use. Alternatively, agencies may wish to establish their own server within the agency's enterprise environment. Agencies should also consider FOIA requirements, privacy needs, evidentiary standards and data storage requirements.

OpEx RESULTS

The OpEx successfully demonstrated both the advantages of alerting and their shortfalls as currently implemented. All of the requirements were fulfilled with the delivered capabilities, but with varying degrees of success. The feedback from participating first responders was overwhelmingly favorable.

The Incident Commander, other command staff and first responders were very pleased to be able to view the location of all participating first responders, real-time sensor data and alerts on their smartphones, tablets and monitors. In addition, the Port of Houston and Harris County dispatchers who provided dispatcher services for the event were able to see the location of each first responder and their sensor data and alerts across the incident area, which the OpEx data integration work made possible. It was particularly important that they could see data and alerts from multiple response agencies and multiple jurisdictions in one place, which met several local requirements identified during the Hurricane Harvey after action review.

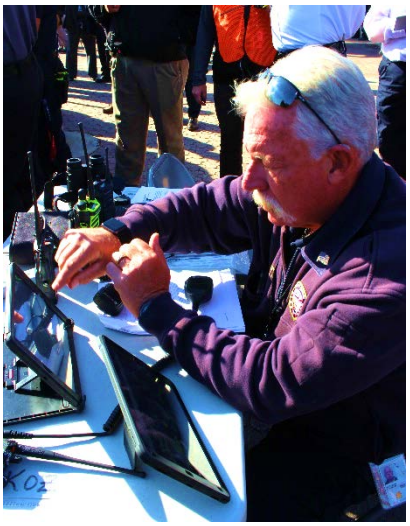

Figure 7. Port of Houston Fire Command Staff Views a Dashboard

Additional information can be found in sources listed in the References and Recommended Reading section. A complete NGFR – Harris County OpEx After Action Report is under development and will be posted at the DHS NGFR website and available upon request from NGFR@hq.dhs.gov.

IMPLEMENTATION FOR YOUR AGENCY

During the NGFR – Harris County OpEx, DHS S&T deployed an integrated suite of IoT devices and situational awareness platforms that enabled public safety decision makers with real-time incident information and alerts. How can your agency take apply this case study and best practices to improve your capabilities? DHS S&T has developed the following questions to help your agency and/or all of the public safety agencies in your community determine sensor and event alerting requirements, current capabilities, target capabilities, and implementation considerations. Please note that implementation of sensor and event alerts are closely tied to how your agency chooses to implement situational awareness and data integration solutions. DHS S&T recommends that your agency use this implementation discussion guide alongside the companion case studies for enhanced situational awareness and data integration.

One of the most important features of the NGFR – Harris County OpEx was getting the data for responders from different agencies and jurisdictions integrated into a unified situational awareness platform. If your agency regularly responds to multijurisdictional incidents, you would likely benefit from a similar unified multi-agency approach to sensor and event alerts implementation. Even if different agencies own different brands of equipment, with NGFR integration approaches the data and alerts can be shared through common situational awareness platforms. To plan for multijurisdictional interoperability, bring your regular public safety partners to the table when using this guidance to define your approach to sensor and event alert standards.

Due to the significant differences between agencies and their capabilities around the country, there is not a one-size-fits-all approach for sensor and event alerts or data integration. However, DHS S&T believes that these questions will help guide your agency and partners towards implementing and deploying sensor and event alert standards that are right for your community.

Determine Sensor and Event Alert Requirements

The first step for your agency is to assess your sensor and event alert requirements, for which you will need to know your sensor and situational awareness requirements. DHS S&T recommends involving a variety of responders at different levels of command in your requirements discussion to ensure all perspectives are considered. Discussion topics include:

- **Who**: Who needs access to sensor and event alerts? Public safety answering point (PSAP) and Dispatcher? Incident Commander? Other command staff? Frontline first responders? Think through all stages of an emergency from 9-1-1 call through conclusion and think about the different types of alerts each of these roles need at each stage of response.
- **What**: What is the scope of sensor and event alert solution—as part of a larger sensor and situational awareness solution—that your agency requires and has budget for? What information do your responders and commanders need real-time alerts about to make better decisions for responder and community safety? What types of sensor data best aligns with the high impact or high probability threats your community faces (e.g., HAZMAT sensors for cities with chemical manufacturing factories)? What details does your agency need an alert to include? Which sensor and alert data options are nice to have versus necessary, and how does your agency and partners prioritize the possibilities?
- **Where**: Where are sensor data and event alerts needed? Will an alerting solution be deployed to the edge (incident scene) or mostly used by command at a PSAP or station house? Will the capabilities be easily deployable for significant multijurisdictional incidents or mutual aid situations?
- **When**: Does your agency need a sensor and event alerting solution on a full-time or part-time basis? Is it a surge capability for major incidents, used to manage everyday incidents, or both?

Identify Current Sensor and Event Alert Capabilities

The second step is for your agency to determine your current capabilities for sensor and event alerts. Discussion topics include:

- What legacy systems do you have in operation that could use sensor data to improve situational awareness? Do these systems support interfaces that would allow them to use data from the sensor systems? Think of systems in the PSAP and in the field that provide real-time information about your personnel, resources, environment and hazards.
- What sensors are currently in use by your or other participating agencies? Think of networked and non-networked sensors, such as handheld HAZMAT detectors. Also think of other types of

sensors that might provide useful incident information, such as traffic cameras, in-building sensors and weather stations.

- What data elements and data standards do these sensors use?
- How customizable are the alerting thresholds for these sensors?
- What systems (e.g., smartphones, tablets, situational awareness applications) does your agency have that can send alerts to first responders? Are these systems capable of supporting data traffic as necessary? What are the interfaces these systems support?
- Does your agency have the capability to host or contract with a server-provider to integrate the sensor and event alerts data?
- Given your current capabilities, which of your previously-identified requirements remain unmet?

Identify Sensor and Event Alert Solutions

Once your agency has determined your sensor and event alert requirements and current capabilities, you need to identify which solutions can fulfill those gaps. Your agency should follow internal guidance to evaluate the costs of and functionality provided by each solution to determine which one(s) to select.

First, determine which types of sensors are necessary based on your requirements:

- Physiological sensors (For responders, patients or both?)
- HAZMAT sensors (Chemical gas and substance sensors? Radiation sensors?)
- Environmental sensors (Flashover heat levels? Weather conditions including wind direction? Floodwater depth and current sensors?)
- Location sensors (2D or 3D? Indoor/outdoor or just outdoor? Person, vehicle or both?)
- Video

Your agency then needs to identify legacy (or new) situational awareness platforms that you wish to display real-time sensor and event alerts on, considering:

- CAD systems
- Map-based situational awareness applications
- Collaboration and messaging applications

Then your agency should assess the types of sensor and event alert data these systems will use, including evaluating data elements, message content and formats, alert content and formats, and any known data standards that your selected sensors or situational awareness platforms use. A key aspect of this will be how—given the disparate devices and systems—a uniform data dictionary can be developed for use by all systems the data interfaces with. In lieu of this, every interface point between systems will require some customization, which is a broader issue in the IoT space. For the purposes of NGFR Integration Demonstrations, DHS S&T attempted to create a normalized data structure to the extent that was practical. Real-world operational deployment would require a similar approach.

Finally, your agency needs to consider the technical requirements of implementing sensor and event alert standards for real-time sensor integration onto situational awareness applications, including discussing:

- Solutions that could be deployed within the existing agency infrastructure;
- Cloud-based solutions that could be integrated into the agency's existing infrastructure while meeting security and privacy guidelines;
- Technical capabilities of agency-provided or bring-your-own-device smartphones, tablets and computers (ruggedization, storage, network access, data plans, processing power);

- Technical capabilities of internet access in the field, including bandwidth for pushing steady streams of sensor data and/or large packets of video and voice data;
- Location of the data integration server whether hosted by your agency or hosted by the server vendor; and
- Technical support staff for set-up, device management and troubleshooting.

Implement Solutions

Once your agency has selected the sensor and event alert solution(s), you should develop an implementation plan for the system(s). The plan would include processes for:

- Procurement of the software and hardware;
- Installation of the components;
- Configuration of the devices and associated applications;
- Training support personnel on the maintenance of the devices and applications; and
- Training the first responders on using the systems.

After implementing and testing sensor integration, your agency will be able to send and receive real-time sensor and event alert to first responders, incident commanders and emergency management personnel.

SUMMARY

This NGFR case study provided an overview of the NGFR – Harris County OpEx, with a focus on identification and implementation of sensor and data alerting standards to augment mission response through information sharing and common operating pictures. It also provided a discussion guide that may help your agency determine requirements, current capabilities, target capabilities and implementation considerations for sensor and data alerting.

If your agency finds this NGFR case study useful for improving your sensor and data alerting capabilities and solution implementation, DHS S&T would greatly appreciate your feedback. Please contact the NGFR team with stories from the field, questions or comments by emailing NGFR@hq.dhs.gov.

Figure 8. OpEx Director Sridhar Kowdley Describes How OpEx Technologies are Deployed

REFERENCES & RECOMMENDED READING

Next Generation First Responder Apex Program (https://dhs.gov/ngfr)

This website provides NGFR Apex program descriptions, updates, and knowledge products.

NGFR Integration Handbook (https://www.dhs.gov/science-and-technology/ngfr/handbook)

This three-part document provides technology developers with a standards-based architecture for developing and integrating interoperable first responder technologies.

NGFR – Harris County OpEx After Action Report, expected March 2020 (will be posted on the DHS NGFR website and available upon request from NGFR@hq.dhs.gov)

This document thoroughly describes the planning, execution and results of the NGFR – Harris County OpEx.

NGFR – Harris County OpEx Playbook, expected February 2020 (will be posted on the DHS NGFR website and available upon request from NGFR@hq.dhs.gov)

This document is the guide that was used to execute the NGFR – Harris County OpEx.

NGFR Case Study: Data Integration, expected February 2020 (will be posted on the DHS NGFR website and available upon request from NGFR@hq.dhs.gov)

This document describes sensor data integration during NGFR – Harris County OpEx.

NGFR Case Study: Enhanced Situational Awareness, expected February 2020 (will be posted on the DHS NGFR website and available upon request from NGFR@hq.dhs.gov)

This document describes how situational awareness platforms were used during NGFR – Harris County OpEx.

NGFR Case Study: Mobile Device Management, expected February 2020 (will be posted on the DHS NGFR website and available upon request from NGFR@hq.dhs.gov)

This document describes mobile device management during NGFR – Harris County OpEx.

NGFR Case Study: Patient Monitoring, expected February 2020 (will be posted on the DHS NGFR website and available upon request from NGFR@hq.dhs.gov)

This document describes patient monitoring during NGFR – Harris County OpEx.

NGFR Case Study: Sensors, expected February 2020 (will be posted on the DHS NGFR website and available upon request from NGFR@hq.dhs.gov)

This document describes various sensors used during NGFR – Harris County OpEx.