International Association of Fire Chiefs

White Paper on Data Standardization for Hazardous Materials Response

Executive Summary

Over the past several years, the landscape of the "smart emergency responder" has been defined and priorities have been identified[1] in support of a common operating picture (COP). A common theme across the broad studies has been the need for standardization in the data formats driving both system compatibility and interoperability. The goal of this strategy is to define a road map of how the International Association of Fire Chiefs (IAFC) and its partners will implement a standardized approach to data transmission from multiple types of sensors capturing both discrete and continuous data streams in a hazardous materials environment. The standardization of data transmission will allow for the advancement of data ingest products capable of digesting the large amounts of data and displaying it in operationally relevant context.

Hazardous materials teams utilize a variety of sensors ranging from weather data to physiological data to cameras to chemical sensor systems and others. The sensors are based upon both discrete and continuous measures. This data, when combined, paints a picture of the operational environment which is vital to incident analysis and critical decision-making efforts. Currently, data is generally displayed on a proprietary display inherent to the device. Many products also incorporate wireless systems within their product lines but often include a proprietary display software to make the data usable. The current trend for most manufacturers is the display of the data on the instrument screen but also allowing for an output jack or data broadcast in an independent format. This approach challenges the development of software data interpretation tools and displays to assist the command element in making informed decisions based on the data The data could be displayed, mapped, input into forms, tracked, and analyzed.

> *"Knowledge is power and harvesting the data important to fire fighters is empowering the smart fire fighter of the future."*[1]

The need for wireless receiving and processing of data is growing rapidly. It is not practical nor operationally suitable for a hazardous materials team to have separate computer-based receiver and display points for each manufacturer or sensor product. In addition, the procurement of separate "translator" hardware and software is an inefficient use of funds.

> *"Give responders the right information at the right time to make the hard decisions to keep our communities safe, while not interrupting their mission response."*[2]

The proposed establishment of JavaScript Object Notation (JSON) as the standard output language for all sensors intended for use in the hazardous materials community will allow the end user to access data output from all wireless-enabled detectors operating at an incident. This will allow for the development of data analysis tools unfettered by data format incompatibilities to assist in the interpretation and visualization of the data thereby increasing the operational utility of the instrumentation and the safety of the community and the first responders by making operationally relevant data available to command staff quickly and efficiently.

Key Findings

The International Association of Fire Chief's (IAFC) Hazardous Materials Committees hosted a discussion open to all vendors and manufacturers of hazardous materials related instrumentation equipment, broadcast infrastructure, and receiving/processing software. Meetings were held between March and June of 2018 in San Diego (CA), College Station (TX), and Baltimore (MD). The goal of the meetings was to agree upon a standard data output language to be used industry-wide. The consensus of the participants was to move forward with JavaScript Object Notation (JSON) as the standard output language. JSON is a lightweight, compressible data-interchange format.

> *"Responders are overburdened with data and devices, so throwing more technologies at the problem does more harm than good. Instead, responders need smarter, seamless technologies that increase their ability to focus on the mission, rather than distract from it."*[2]

JSON and Extensible Markup Language (XML) are the two most common formats for data interchange used today. The Open Geospatial Consortium (OGC) has a best practices document on JSON Encoding Rules that are available for simple conversions between XML and JSON representations. JSON is a text syntax that facilitates structured data interchange between all programming languages. XML is more suited towards the inclusion of metadata-heavy information. JSON uses less resources and is much faster than XML. As sensors and sensing systems become smaller and more mobile, and therefore have less on-board computing power, JSON will be preferable.

Recommendation

The IAFC recommends this data standard for the efficient acquisition, management, and dissemination of sensor data for use in a hazardous materials response environment. Specific recommendations include:

1. JSON will be the approved language for sensor data transmission.
2. All sensors shall have the ability to transfer data using the JSON format.
3. Data that is actionable shall be accepted by telemetry.

For advanced analytical instrument where spectral information or imagery is captured, a simple data set may be transmitted via JSON format with full spectral or imagery information available for direct analysis later. These larger data sets should be linked and available for transmission and processing in an efficient, non-proprietary format (i.e., XML, cloud transfer, others).

Implementation Strategy

The IAFC Hazardous Materials Committee will work with hazardous materials teams, instrument manufacturers, software developers, and others to develop an implementation strategy that is scalable and accessible to all.

	Timeline	Department Implementation	Manufacturer/ Developer Expectations	Standards Coordination
Goal 1: Pilot and Refine	18 months	Request JSON language be available on new devices as an *objective requirement*.	JSON available as an option on devices.	Provide public input to NFPA 950, specifically section 5.3.3 Data Exchange recommending JSON language.
Goal 2: Scale Up	36 months	Require JSON language be available on new devices as a *threshold requirement*.	JSON required as standard data exchange language on devices.	Implementation of JSON into NFPA 950 as a recommended best practice.
Goal 3: Review and Refine	48 months	Full implementation of the JSON language standard across the board from sensor to processing software to data analytics and COP displays.		

As with any technical solution, it is critical that the standards are evaluated periodically to ensure that the standard is not surpassed by new technologies. It is recommended that a meeting is held every five (5) years amongst practitioners, developers, and vendors to ensure that the strategy is working. This meeting should precede the next NFPA 950 standards cycle to allow for timely input to that document as technological changes occur.

Future expansion and use of the data produced from these sensors and devices will need continued guidance from the hazmat community and the fire service leadership to create usable platforms and displays of the data. It is further recommended that working groups be established representing the hazmat response community to give input to the development of software and hardware to best serve the response community with the imagination and forethought into the future and potential needs. The establishment of a standardized output language is only the first step to allow for and enable the future development of a truly common operating platform for hazardous materials incident management. The IAFC's Hazmat and Technology committees are primed to provide leadership and contributions to these discussions and to influence the appropriate end-user requirements for this type of platform and interface.

References

[1]Grant, Hamins, Bryner, Jones, and Koepke. Research Roadmap for Smart Fire Fighting. National Institute of Standards and Technology Special Publication 1191, May 2015.

[2]Next Generation First Responder Integration Handbook, Part 1: Introduction, Version 2.0, February 2018. Department of Homeland Security.