

Civil Information Integration and Interoperability

Pilot Research Utilizing the National Information Exchange Model (NIEM) in the US Department of Defense (DoD)

Gerard J. Christman
Femme Comp Incorporated
Sr. Systems Engineer
Contractor Support to the
US Department of Defense
Chantilly, VA 20151
gerard.j.christman.ctr@mail.mil

Brian D. Fila
MPMS-Oahu, LLC
Owner, President
Kaneohe, HI 96744
brian@briandfila.com

Abstract— the Department of Defense (DoD) Chief Information Officer (CIO) published a memorandum declaring that the Department will adopt the National Information Exchange Model (NIEM) in Fiscal Year (FY) 2015. The document established the role of pilot work in FY14 as a risk mitigation technique and to garner lessons learned. NIEM provides a foundation for information exchange between federal, state, local, and tribal agencies as well as international and industry partners. Pilot work was undertaken where, for the first time, took tactical level disaster assessment information from a Civil Affairs information system named Civil Information Management (CIM) Data Processing System (DPS) and expressed it in a NIEM conformant manner. The NIEM objects were then shared and integrated across four separate systems reaching a wide variety of stakeholders. This methodological approach takes critically important disaster information and integrates it into systems in order to promote better situational awareness, to enable operations, to plan disaster response, coordinate disaster management. The same approach can be leveraged to enable humanitarian aid project planning as it ingests live project data across multiple development sectors. (*Abstract*)

Keywords— disaster response, disaster management, project planning, interoperable information, National Information Exchange Model, NIEM, humanitarian assistance, data models (*key words*)

I. INTRODUCTION

By law, US foreign disaster assistance is led by the US Agency for International Development (USAID). When called upon, the US military supports the assistance efforts as it has a large logistical support capacity. Specializing in this area within the military is the US Army Civil Affairs branch. Currently the US military has one information system for Civil-Military information management that is the primary system for the Civil Affairs branch—the branch that gets involved in disaster response. This system is the Civil Information Management Data Processing System (CIM DPS). Security regulations preclude access to the system by others not directly involved with the US military [1]. Unless the content is shared outside the system boundaries, this dramatically limits access to the information that is of value to a wide variety of mission partners including Host Nation, other

militaries, non-governmental organizations, international organizations, first responders, etc.

The All Partner Access Network (APAN) was established by the DoD in 2009 to serve as a collaboration portal for these various mission partners in an unencumbered, unclassified network environment. It is a collaboration suite for support to Humanitarian Assistance/Disaster Relief amongst other missions. It became operational coincident to the devastating earthquake in Port-au-Prince, Haiti. In summary, if one were able to express the releasable content of the classified Civil Affairs system into APAN then a much broader set of consumers could be served.

Although DoD had been involved in the use of NIEM amongst several domains for some time, it had not embraced NIEM as a wholesale standards-based information exchange model as work had been underway to create other competing standards. A decision to provide no further support to these competing standards and to adopt NIEM was signaled in a memorandum published by the DoD CIO announced in March 2013 [2]. The focus of this research was to create NIEM objects in the form of Information Exchange Package Documentation (IEPD) based upon the Civil Affairs system content. These objects were then shared using Web services to four major situational awareness and information sharing platforms previously developed to reach an extensive set of stakeholders that were keen to gain awareness of disaster information. This created an information exchange means heretofore non-existent with content expressed in an interoperable manner that is critical to improving overall efficiency of the response. This process enables and benefits the Whole of Government approach where the Defense Department recognizes it must undergo operations with its other governmental partners such as the State Department and the US Agency for International Development for example. Other federal agencies and departments have agreed to adopt in future, or have already adopted NIEM.

When elements of the Civil Affairs branch deploy to support a disaster operation, they take mobile IT equipment that permits them to operate in the field and to interconnect back to their home station. There have been some techniques developed over time to ensure Really Simple Syndication type

of feeds to various systems to improve information sharing local to the disaster. This has been helpful but the thrust of this research is to demonstrate how it can be improved. Generally data is developed by Civil Affairs personnel performing assessments through recording details of their observations in the operating environment such as the condition or status of roads, bridges, hospitals, airports, sea ports, etc. In all there are 22 types of assessments possible in the system. The assessment information they collect must be shared with the other mission partners (e.g., host nation, International Organization, Non-Governmental Organization, etc.) that have established an account in APAN on a common workspace. The goal now is to generate this assessment data in a NIEM conforming manner so as to be interoperable with the other governmental agencies that have or will adopt NIEM. This would posture the assessment information in a common area where the assessment is expressed via a common information exchange model. This constitutes a radical change from how the information flows today and how that flow impacts collaboration with the responder community.

There is no Humanitarian Assistance/Disaster Relief domain in NIEM at the present time. The authors encourage the USAID to create and sponsor such a domain and guide the generation of NIEM objects that would populate the domain. Until then the US military will generate NIEM objects and register them with the MilOps domain that was established concurrent with NIEM 3.0. [3].

II. NATIONAL INFORMATION EXCHANGE MODEL

There are twelve fully-formed communities and another 5 emerging communities currently in NIEM 3.0. As stated earlier there is no humanitarian-focused domain in the model. The authors contend that there should be with USAID as the sponsor. In addition, in order to further interoperability with the United Nations Office of the Commissioner for Humanitarian Affairs (OCHA) – the lead international body for humanitarian operations – an in-depth analysis of their data model called Humanitarian eXchange Language (HXL) should be undertaken to determine what could and should be re-used from it in order to achieve interoperability with this model [4]. The alternative is to map from one model to the other but this means mediation and mediation can tend to be lossy. Briefly pause for moment and consider the power inherent in a model with elements in common between the US DoD, the US Whole of Government, and the UN. This would constitute a radical change in the humanitarian space from today.

A. MilOps Domain

The DoD CIO, the Joint Staff, and the Military Departments will coordinate on the content of the MilOps domain through internal DoD processes. The NIEM IEPDs developed for the pilot work in this paper have not been elevated for consideration as bona fide Information Exchange Packages in NIEM. However, they could be as they conform to the model's naming and design rules. The goal of the pilot was to establish a proof of principle and registering new NIEM content was never a requirement of the project.

B. Information Integration

The goal of information integration was to overcome the limitations imposed by information systems security regulations. Integration meaning in this instance to take the data, mediate it, and then through Web services share the data into 4 other platforms that are either collaboration, planning, or situational awareness capabilities that were developed to meet the needs of America's Geographic Combatant Commanders. This enabled the NIEM objects to be shared with Coast Guard, Department of Homeland Security, Customs and Border Patrol, NGOs, IOs, US and other Government Agencies that are on the critical path for disaster response and management. In summary, all of the typical partners the DoD would seek to exchange information with if this pilot were a real world disaster. It simplifies the enterprise architecture for the DoD since it re-uses enterprise service bus capabilities and associated Web services to integrate the data.

These findings are in line with earlier research that was focused on integrating assessment information that was sponsored by the Assistant Secretary of Defense (Networks and Information Integration) during a Stability Operations Community of Interest (COI) Pilot project [5]

III. HIGH LEVEL ARCHITECTURE

Figure 1 is best parsed from lower left through the middle level and then towards the top. Civil Affairs personnel go out into the operational area, observe and then characterize people, places and things, using 22 assessment areas in their information system. There are free text areas as well as pick lists, and drop down menus that assist the personnel in providing responses. In this pilot, the assessment area "Port" was the focus. The information, once collected was both saved as nominal data base system data as well as being mediated to a NIEM object. From there, Web services were used to publish the NIEM object to APAN, Regional Domain Awareness, Coastal Surveillance System, and Unity platforms thus reaching a wide variety of stakeholders in the scenario.

IV. NIEM OBJECT DEVELOPMENT

A team from the Institute for Defense Analysis developed the "Port" IEPD for the pilot. It was accomplished following NIEM naming and design rules.[6] One assessment area was the focus for this effort due to time and budget resources. Since this pilot was conceived toward the end of the fiscal year, the budget was developed using relatively meager year-end funds. Although there was only one assessment area "Port", it was more that successful in demonstrating and proving the concept. Thus far this paper has focused on integrating Civil Affairs -based information using NIEM as a structure. It is helpful to reflect on the fact that during any operation, one will encounter unstructured data as well.

V. STRUCTURED VERSUS UNSTRUCTURED

This pilot will contribute to the empirical record documenting the value of data models like NIEM in the exchange of structured information across a diverse set of disaster response and humanitarian assistance information

producers and consumers. The positive progress enabled by models like NIEM will establish a foundation of shared information across a spectrum of scenarios especially as the pool of adopters/users increases over time.

An area requiring additional research is the nexus between structured and unstructured data in disaster response, coordination of disaster management, and the enablement of humanitarian aid projects. With 90 percent of all existing data generated in the past two years, and 2.5 quintillion bytes of data added each day, the majority of which is unstructured, it is essential that this unstructured data be exploited to augment the expert-reported structured data exchanged via models like NIEM. [8]

The relationship between structured and unstructured data is analogous to Joy's Law in the high-tech industry. According to Sun Microsystems co-founder Bill Joy, "no matter who you are, most of the smartest people work for someone else". [10] With today's worldwide technology penetration rates, it now is possible to state that when it comes to human populations encountering complex disaster and humanitarian environments, no matter who you are, most of the people reporting on a situation are not experts. In today's ubiquitous communications environment, more reporting will be created by nonexperts because by definition they always outnumber the responders. The roots of this assertion are found in the seminal work of economist Friedrich Hayek [11] concerning the distribution of knowledge across a community. The research challenge is to maximize the utilization of this unstructured data before its value is displaced by expert-based reporting. While the structured data exchanged via NIEM-like models will always possess greater precision than crowd produced unstructured data, maximizing the use of both may unlock unprecedented decision-making in the areas of disaster relief and humanitarian assistance.

Harvesting unstructured crowd provided data is essential wherever and for however long it is available in the immediate hours after the onset of a disaster as it may be the only reporting available until experts arrive on scene, organize, and deploy or nation-states and commercial entities prepare reconnaissance sensors for collection. Harvesting this unstructured data and making it available to experts while they organize could provide an important jumpstart previously impossible before the advent of social media, increasingly disaster resilient cellular technology, and readily available unstructured data exploitation tools. The application of industry-established Big Data best practices that are used to ascertain business intelligence will likely make it possible to wring out every drop of value from this unstructured data. Further research is required to understand how a more holistic situational perspective can be acquired by complementing structured information enabled through models like NIEM, while new tools increase the harvesting of ubiquitous unstructured and heterogeneous information made available in today's information environment. [8] This research will need also to focus on tools that provide efficient text parsing and analytics, taxonomy and metadata management if the entire spectrum of data is to be exploited. [7] Today, the utility of such unstructured data is focused on establishing situational awareness for the victims and those in proximity to such crises.

In the future, the reverse will become true; the harvesting of unstructured data from those in proximity to the event will enable improved responder decision making. This dynamic is magnified by the continuing focus on immediate communications restoration methodologies prevalent in today's disaster relief and humanitarian assistance communities.

In the future, research will shift from how to establish interoperability through data sharing, to how best to move unstructured data into the enterprise relational data model of choice. [7] The most promising result may be in the combination of research on structured data interoperability and machine learning of unstructured heterogeneous data. Research in the area of pattern recognition across a large collection of data, both structured and unstructured is also needed.

VI. RESULTS

In short, the pilot successfully demonstrated how to express Civil Affairs information system content in a NIEM conformant manner then share the content with a variety of platforms where one can expect to encounter the responders and stakeholders in a humanitarian assistance/disaster relief scenario. Although this research focused on one assessment area "Port", it proved the concept that can be replicated for the other 22 areas such as bridge, road, school, hospital, airport, etc. While structure and interoperable data is critical to any operation, one should be aware that there will be much unstructured data as well. The results from this research find that a separate set of tools will need to be developed and integrated into the collaboration portal to enable responders to contend with that type of data. Structured data, modeled and supported by a resource description framework complete with Web Ontology Language (OWL) can lead to machine to machine interpretability. This can help the DoD contend with radical down-sizing of the force by shifting the cognitive burden off the human analyst and onto the machine that has been enabled with agent based and other tools to find the right information at the right time. With both structured and unstructured data being dealt with, the authors contend that response efficiency can be greatly improved over the status quo.

VII. FUTURE RESEARCH

The authors recommend further research in this area shifting slightly from a heavy emphasis in whether this can be achieved or not to how to do these exchanges in a manner consistent with what has been envisioned for a Web 2.0. This has strategic implications in that as staffs and the military generally gets smaller in overall end strength, there has to be some effort to shift the cognitive burden off the human analyst and on to the machine. By applying agreed ontological structures and other processes identified by the World Wide Web Consortium (w3c) may prove to be the way forward for dealing with structured aspects of data in this realm. In addition, the authors contend that much work needs to be done to develop a tool kit to leverage the knowledge of the crowd. Early in an operation, chances are that all will be available is unstructured data. How can that be leveraged to avoid an information gap until professional responders arrive on scene?

In short it will take structured and unstructured data tool kits and approaches to arrive at a thorough picture and the best situational awareness.

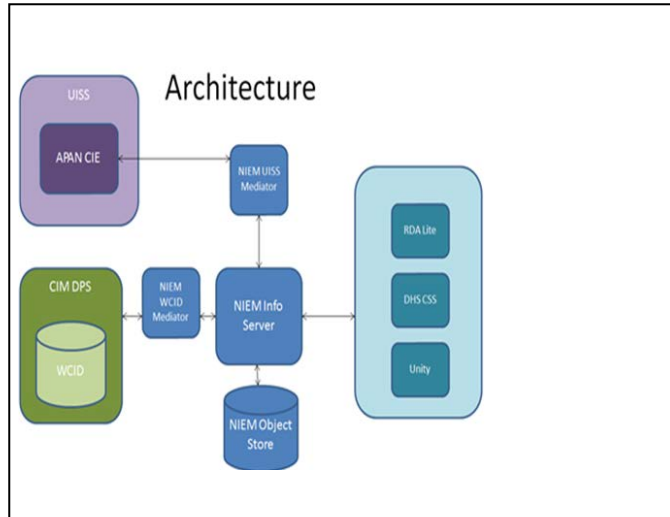


Figure 1. Architecture for the pilot

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