A Survey of Schema Standards and Portals for Emergency Management and Collaboration

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ABSTRACT

We survey several emergency management related data structures and portals designed or adopted by standard bodies such as Organization for the Advancement of Structured Information Standards (OASIS) and Institute of Electrical and Electronics Engineers (IEEE), as well as standards designed or adopted by government agencies in the US and in the UK. The survey is by no means an exhaustive list of such standards and portals, but it gives a fair representation of the current state of affairs and resources to practitioners and researchers alike.

Keywords

Data Structures, Standards, Data Integration.

INTRODUCTION

The main aspect covered by emergency management related standards expressed as data structures concerns the possibility to manage, maintain, and control communication between arbitrary emergency end-systems connected to a common data exchange network, such as the Internet. A wide range of emergency related data structure standards have been developed, in each case leading to the special focus of various working bodies or vendors. Most of today's data structure standards are still in the progress of definition or standardization. We surveyed several emergency management related data structures and portals designed or adopted by either standard bodies such as OASIS and IEEE, as well as standards designed or adopted by government agencies in the US and in the UK. The survey is by no means an exhaustive list of such standards and portals, but it gives a fair representation of the current state of affairs and resources to practitioners and researchers alike.

We have selected ten emergency related standards expressed in a variety of data definition language, and three portals that display or exchange emergency related data. Each standard has its own unique data structure or an entire set of data structures. Several of the standards have been update since their inception, while others have been entirely replaced, usually due to statutory regulations that required drastically enhanced technical support. Table 1 lists the standards and portals we selected to review in this work.

No	Name	Purpose	Origin	Type
1	ANML	Advisory and Notification Markup Language facilitating emanation of data relating to software vulnerabilities	US	Schema
2	CAP	Common Alerting Protocol to collect and relay instantaneously and automatically all types of hazard warnings and reports locally, regionally and nationally for input into a wide variety of dissemination systems	US	Schema
3	EDXL	Facilitate emergency information sharing and data exchange across the local, state, tribal, national and non-governmental organizations of different professions that provide emergency response and management services	US	Schema
4	HSIS	Homeland Security Information Service web-based portal that can be used by a variety of organizations to share their mission-critical information. HSIS also provides services to manipulate that information.	US	Portal
5	IEEE 1512	A family of standard messages for traffic incident management, public safety, hazardous material incident, and management of entities external to centers.	US	Schema

6	LGCL	A controlled vocabulary for local government and community resources categorized in a hierarchical structure under headings familiar to citizens.	UK	Schema
7	IPSV	The Integrated Public Sector Vocabulary is an 'encoding scheme' for populating the e-Government Metadata Standard (e-GMS) subject element of metadata.	UK	Schema
8	RWE	Notification of Road Works and Highway related Events among local and central government, emergency services and the media	UK	Schema
9	SDEP	Street events Data Exchange Protocol	UK	Schema
10	HCCHE	A schema that enables electronic exchange of highway related inquiries and problem reports received from the public.	UK	Portal and Schema
11	RTA	Facilitates the exchange of road traffic accident data between the Compensation Recovery Unit and the National Health Service for the recovery of insurance compensation to injured parties.	UK	Portal and Schema

Table 1: Emergency Schemas and Portals

EMERGENCY STANDARDS AND PORTALS IN THE UNITED STATES OF AMERICA

ANML - Advisory and Notifications for Security and Systems Administrators

Software and hardware companies utilize propriety schemas to disseminate information relating to their wares. Vendors use different terminology to explain identical concepts; many broadcast their information in a manner that is not machine-readable, which creates an additional burden on security or systems administrators. A grassroots coalition of security and systems administrators entitled *The Open Security Project* began developing the Advisory and Notification Markup Language (ANML) in 2003. The schema is intended to solve the inconsistent use of terminology by software vendors in their advisories and make it easy for applications to read and respond to these advisories (OpenSec 2003).

ANML contains sixty seven data elements. An ANML message entity is called an Advisory, and consists of seven clusters of information, as follows: Description, Status, Affected, Assessments, Update, Verify, and Revision History. Each of the seven clusters may contain sub-elements and additional attributes.

CAP – Common Alerting Protocol

The US based working group on *Natural Disaster Information Systems* issued its “Effective Disaster Warnings" report in November, 2000. It recommended standardizing the content of alerts and notifications across all hazards, including law enforcement and public safety as well as natural hazards such as severe weather, fires, earthquakes, and tsunami. The working group created the Common Alerting Protocol (CAP) - an open, non-proprietary standard data interchange format that can be used to collect all types of hazard warnings and reports locally, regionally and nationally (CAP 2003). In 2003 the national non-profit *Partnership for Public Warning* (PPW) endorsed the CAP effort and sponsored its submission to the OASIS eXtensible Markup Language (XML) standards process. The PPW Board of Trustees announced on March 21, 2005 that the Partnership has been dissolved (PPW 2005). The OASIS Emergency Management XML Technical Committee has accepted the contribution of the CAP draft standard in 2004. OASIS issued an update (CAP 1.1) on October 2005 (OASIS 2005).

The CAP structure consists of a header-type container entitled ALERT. It may contain zero or more data elements entitled INFO, which in turn may include zero or more AREA elements and zero or more RESOURCES elements. The ALERT provides the message purpose, its source, status, a unique message identifier and links to related CAP messages. The INFO segment describes the event (either anticipated or actual) in terms of its urgency (time available to prepare), severity (intensity of impact) and certainty (confidence in the observation or prediction). The INFO segment may contain response instructions and various additional details. The AREA segment describes a geographic area pertaining to the event described in the INFO segment. Reference to additional information related

to the INFO data, such as a URL to an image, can be provided in the RESOURCE segment. All together there are forty six data elements in the CAP schema.

EDXL – Emergency Data Exchange Language Schema

The U.S. Department of Homeland Security (DHS) and the Emergency Interoperability Consortium (EIC) executed a Memorandum of Agreement containing a suite of specifications entitled "Emergency Data Exchange Language" (EDXL). The memorandum promotes "the design, development, release and use of XML schema-based standards or other standards, tools, and processes that will help solve data sharing problems" related to emergency information. The Disaster Management eGov Initiative develops the high-level functional requirements. The EIC was in charge of coordinating the prototyping and proof-of-concept testing. The OASIS Emergency Management Technical Committee participates in the design of format specifications (e.g., XML Schemas) based upon the technical requirements provided by DHS and EIC.

EDXL is only one part in a larger US plan to manage disasters. A second part is the Disaster Management Interoperability Services. It provides alerts, national maps, specific needs request, and tactical information exchange to subscribers who manage or respond to emergencies. The third part is a Web Portal to information and services (https://www.disasterhelp.gov/). Currently EDXL has one significant component entitled *EDXLdistribution* which serves for message routing only. The other pieces of information that may be sent with EDXL are CAP elements, described earlier in this paper. The EDXLdistribution is comprised of six data elements: distributionID, senderID, dateTimeSent, distributionStatus, distributionType, combinedConfidentiality. The EDXL specifications elaborate on the content and permissible values each element may assume (OASIS 2006).

HSIS - Homeland Security Information Service Portal

The aforementioned Disaster Help portal was preceded by a customizable Web-based portal entitled *the Homeland Security Information Service* (HSIS). The MITRE Corporation staff began developing it in 2000 as part of a solution addressing indications and warnings for asymmetric threats. HSIS provides military, federal, state, and local agencies the ability to share information and collaborate to prevent, detect, and react to local, state, and national emergencies. “Watch Categories” implemented in HSIS were: critical disease, critical infrastructure, hazardous material, natural disasters, terrorism, and water contamination. HSIS was used as the information gateway for the 2001 Presidential Inauguration and the 2002 Boston Marathon. We were unable to find any import or export interface schema. The internal schema of HSIS has not been made public. Responding to a request we made in the summer of 2006, MITRE provided us with a hard copy of Homeland Defense Portal-Integration Framework E-Services Developer’s Guide dated October 2001. This guide makes extensive references to Web Services one may interact with. The services are: Watch List, FAQ, Thesaurus, Web Forms, Web CAM, US Earthquakes, Intel Gazette, How to Contact Others, My Links, Phonebook, Search, Fast Jump, Top News Stories, Weather, and Discovery Service. Invoking a service requires passing ten variables (parameters) through the service’s URL. It appears the project was abandoned. MITRE posted an update on its website on June 2006 announced that the U.S. Northern Command (USNORTHCOM) “consolidates several previously independent homeland defense and civil support missions” as a remedy to emergency management problems exposed during the hurricane Katrina event. MITRE announced that “several federal agencies are engaged in an intensive effort to modernize communication links and promote collaboration within the United States—a critical step toward improving the effectiveness of disaster response.” “Ten MITRE engineers provide enterprise architecture, communications enterprise integration, and systems engineering support” to USNORTHCOM (Lee, Maria S. 2006).

IEEE 1512 - Incident and Traffic Management Schemas

The goal of the IEEE-1512 standard is to create efficient communication for real-time interagency management of transportation-related events that require an immediate response, coordination, and support The 1512 standard is a key part of the US Intelligent Transportation system initiative (IEEE 2004). The IEEE 1512 Family of Standards consists of a Base Standard and a set of companion volumes, as follows:

- 1512-2000 is the Base Standard and constitutes the foundation of the family of related standards that address the intercommunication needs of emergency management centers and other types of centers engaged in traffic incident management.
- 1512.1 Traffic Incident Management: focuses primarily on the coordination and exchange of information supporting real-time traffic incident management between traffic management centers.

- 1512.2 Public Safety Incident Management
- 1512.3 Hazardous Material Incident
- 1512.4 Mobile Equipment Incident

"Traffic incident management consists of managing available resources of various agencies to address the incident in an efficient and appropriate manner. A traffic incident includes any transportation-related event that is received by an emergency management system, including planned roadway closures at special events, whether or not the incident actually affects traffic flow, and whether or not a response is required" (Ogden, Michael A. 2004). Parts of the standard have been deployed in many major metropolitans including Washington DC, New York City, Milwaukee, and San Diego.

EMERGENCY STANDARDS AND PORTALS IN THE UNITED KINGDOM

The government of the United Kingdom (UK) decided it should provide its services to the citizen in electronic form when applicable aiming to deliver better quality services to the public. It published *The Modernizing Government White Paper* in March 1999 laying out the UK government's vision for modernizing public services and the government's commitment to exploit new technology to offer opportunities and choice in the delivery of public services (UK Government 2005). It resulted in the creation of the office of Electronic Services Delivery (ESD). ESD provides the electronic interfacing among government agencies (including local governments) and the Private Sector to logically store and retrieve information in a central, secure, and consistent manner. This effort is being facilitated by the Office of the Deputy Prime Minister (ODPM) through it e-Government initiatives. E-Government promotes the integrated Services of Government agencies for the delivery of faster customer oriented services. E-Government incorporates a set of E-Standards (a baseline set of rules to assist local government in developing their ESD initiatives).

As part of this undertaking, several government bodies in the UK developed vocabularies and schemas to support EDS. Surprisingly, none of the vocabularies we investigated are dedicated to management of emergency events. There are only a few emergency related terms sprinkled in the vocabularies we inspected. For example, the LGCL standard (see below) contains the term "Emergency contacts" (under the concept Council, Government and Democracy); Under the concept Policing and Public Safety there are six words, of which only three relate to emergency events: emergency phone numbers, emergency planning, and floods. There are several vocabularies that could be used for certain emergencies, similar to the IEEE 1512 standards. They are: 1. Road Works / Events (RWE) 2. Hampshire County Council Highway Enquiries (HCCHE) 3. Street events Data Exchange Protocol (SDEP) and, 4. Road Traffic Accident (RTA). We will address each of these schemas separately.

The number of vocabularies and schemas produced by the EDS project created a need to map between parts of vocabularies and schemas. For example, the XML document *lgcslgslmapping* contains hundreds of mappings between the LGCS vocabulary and the LGSL vocabulary (Records Management Society of Great Britain 2005).

LGCL - Local Government Category List

The Local Government Category List (LGCL) vocabulary focus primarily on the description of local authority services, although it does reference other services and issues on which citizens might seek information through a local authority website. LGCL has a range of 2-6 levels of category in different areas. It has 1,397 preferred terms and 2,227 non-preferred terms (AskKen, Knowledgebase 2007). The top level LGCL has thirteen headings as follows: business community and living; council, government and democracy; education and learning environment; health and social care; housing; jobs and careers; legal services; leisure and culture; policing and public safety; social issues; transport and streets (LGCL 2004). The LGCL vocabulary was replaced by the Integrated Public Sector Vocabulary (IPSV) vocabulary.

IPSV - Integrated Public Sector Vocabulary

The IPSV is an encoding scheme for populating the e-Government Metadata Standard (e-GMS) subject elements. It is fully compliant with ISO 2788 whose objective is "to ensure consistent practice within a single indexing agency, or between different agencies" (ISO2788 1986). IPSV is also compliant with BS 8723, the International and British Standards for monolingual thesauri. The vocabulary was developed with the backing of the Office of the Deputy Prime Minister. Version 1.00 was released in April 2005; Version 2.00 supersedes it, as of 3 April 2006. Version 1 was developed by merging three earlier lists: the Government Category List (GCL) and the aforementioned LGCL,

as well as the seamlessUK taxonomy (seamlessUK 2004). The latest version of the seamlessUK taxonomy is ISO 2788 compliant, and has 2,611 preferred terms, 1,179 non-preferred terms, 15 top terms and a range of up to 8 levels in different areas. The seamlessUK scope is matters of community interest, including many services provided by national or local authorities, or the voluntary sector.

Version 1 of IPSV had 2,732 preferred terms and 4,230 non-preferred. Version 2 is much bigger, with 3,080 preferred terms and 4,843 non-preferred. IPSV now covers internal-facing as well as public-oriented topics (IPSV 2006).

RWE - Road Works & Events Schema

The Road Works & Events XML Schema (RWE) seeks to improve the notification of road works and highway related events among "local government, central government, emergency services and the media, using the electronic-Government Interoperability Framework (e-GIF) compliant XML schema" (RWE 2004). It was replaced on April 2006 with a new schema entitled Street events Data Exchange Protocol (SDEP).

SDEP - Street Events Data Exchange Schema

It appears that the main reason for the replacement was an effort to meet the then forthcoming requirements of the UK Traffic Management Act. SDEP is comprised of an XML schema and includes web service conforming for exchanging street works and street events data between systems. It is written using the Web Services Description Language (WSDL) which is a set of rules outlining cross-platform transactions between a client and a server. SDEP includes Synchronized Multimedia Integration Language (SMIL) components. Authors can describe the temporal behavior of a multimedia presentation, associate hyperlinks with media objects and describe the layout of the presentation on a screen using SMIL (SDEP 2006). Technically, SDEP consists of over two dozen schema files, all expressed in XML Schema Definition (XSD).

HCCHE - Hampshire County Council Highway Portal

The HCCHE is a web portal intended to standardize the public's inquiry and reporting of roads and highways service in Hampshire, UK. The portal serves about 1.2 million residents. For example, the HCCHE has a form for the public to report "potholes, highway flooding, blocked gullies, overhanging trees and shrubs" (HCCHE 2004). There is a separate form for reporting faulty, broken or damages street lights. The portal is supported by a data structure created by the "Partner Local Authorities in Hampshire". The schema had several versions. The latest version and draft was July 2004. The draft was submitted "for consideration as a standard" for Hampshire County. That version of the schema contains 20 elements only.

RTA – Insurance Compensation for Road Traffic Accident Schema and Portal

Paying for medical expenses resulting from a road accident is the responsibility of the UK government. Some or all of the expenses are covered by insurance companies providing coverage for motorists. The UK Department of Health (DOH), Compensation Recovery Unit (CRU) commissioned a system in 1998 to process all recoveries from insurance companies compensating road traffic accident (RTA) victims. The system printed out batches of RTA forms after insurers notify the CRU that a claim had been made. The forms were then posted to individual National Health System (NHS) Trusts where they were completed by hand and sent back to the CRU for input into the CRU system. Circa 30,000 forms are issued by CRU monthly. The manual process has been replaced by new capabilities providing end to end electronic form transfer between insurance companies, the CRU, and the UK National Health Service (NHS) which is part of the Department of Health (CRU/NHS 2002), and all NHS hospitals. RTA data is made available, subject to need to know, security and privacy considerations, on the NHS portal.

The computerized data exchange is supported by a data schema. Version 1.0 of the schema was created by a partnership among several Department of Health providers and internal units, such as the CRU. The schema was published on September 2002 and contained 32 elements. The schema also incorporates other e-Gov standard schemas, such as *Citizen Details Structure* and the *Address UK Postal Structure*. The schema contains all the data elements found on the paper RTA form and additional elements required for the automation of the data exchange and the transformation of data to and from the respective internal structures of the systems involved in the process.

The project partners agreed to use the native format of the *United Nations Electronic Data Interchange for Administration, Commerce, and Transport* schema (EDIFACT) and an EDIFACT version expressed in XML to

cover the three main business transactions: claim notification, certificate request, and settlement notification. Those transactions are exchanged between DWP/CRU and the Compensators. The two different file formats allow future e-partners a choice based on their own preference for the technological standards available.

ANALYSIS AND CONCLUSIONS

The technology standardization initiatives we reviewed have a number of challenges; one of the most important is the size of the problem to focus on. Some standards are created to solve relatively narrow, specific problems, while others are broad and general. Additionally, government agencies and standardization bodies create competing standards. That is, standards whose domain and scope overlap substantially. Organizations who wish to develop or adapt emergency response management information systems (ERMIS) will not be able to guarantee seamless data exchange with other systems, a feature that is central to any well designed ERMIS.

We observed that interoperability between different schemas in the same domain cannot be easily achieved, if achievable at all. The schemas differ in their scope and level of detail. Some schemas have dozens of data elements and go eight levels deep, while other schemas have half that number of elements and do not exceed four levels of depth.

In the case of the UK, its GovTalk schema library contains 93 schemas as of January 2007. The schemas are divided unevenly between sixteen domains, such as Address and Personal Details, Education, Health, Local Government Services and more. We were unable to identify any e-Gov schemas dedicated to the management of emergency events. The UK has an extensive web site dedicate to the topic of "UK Resilience" (UKResilience 2006). However, we were unable to find any information pertaining to emergency data schemas that is publicly available. It appears that by using parts of existing schemas, organizations could develop or adapt ERMIS that support the management of emergency events. However, an approach based on patchwork is not likely to yield a stable and low maintenance system.

Our survey suggests that there is a severe shortage in data schemas dedicated to the management of emergency events. This presents an opportunity for standards bodies and researchers to step into the void and create a combination of schemas and web services that will support ERMIS.

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