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A Perspective on Approaches for Data Sharing

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A Perspective on Approaches for Data Sharing

This paper will discuss data sharing approaches used by the US Department of Defense, North Atlantic Treaty Organization (NATO), and Internet communities. For the last 20 years, in an attempt to standardize command and control data exchanges for multinational land operations, the NATO/Multilateral Interoperability Programme (MIP) community has invested in the Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM). This effort is focused on creating a single standard for data exchange within a large community, and risks the “tyranny of the common data model.” The US DoD data strategy has since shifted to smaller vocabularies created by Communities of Interest (COI). Social networks on the Internet use light weight vocabularies with minimal data fields and code values to share information. Recent US government-led initiatives such as Universal Core (UCore) are attempting to build a shared understanding for common concepts. Nevertheless, different approaches are used to implement core vocabularies in the NATO, US DoD, and Internet communities.

Introduction

A Core Vocabulary is a set of concepts that persists across community exchanges. These concepts represent the pieces of information disseminated in every information exchange. For example, the metadata for a newspaper article always includes the publication date, the name of the author, and the retrieval location. The same information might also appear as part of the article content. While information on primary concepts of who, where, what, and when is commonly exchanged across communities and business domains, how the information is shared varies among communities.

Figure 1 shows a conceptual diagram for Core Vocabularies [3]. At the center of the diagram are the primary concepts (discussed above). The second layer is specific to a domain. In military operations this domain includes Event, Equipment, and Units. Events are planned or unplanned activities scheduled to occur at a given time and location. An event can also be an occurrence, such as a natural disaster or a political crisis. Military events include training exercises or affairs related to an operation. Units and equipment often participate in many of these events. Additionally, a plan is often prepared to identify the set of tasks needed to execute activities resulting from an event.

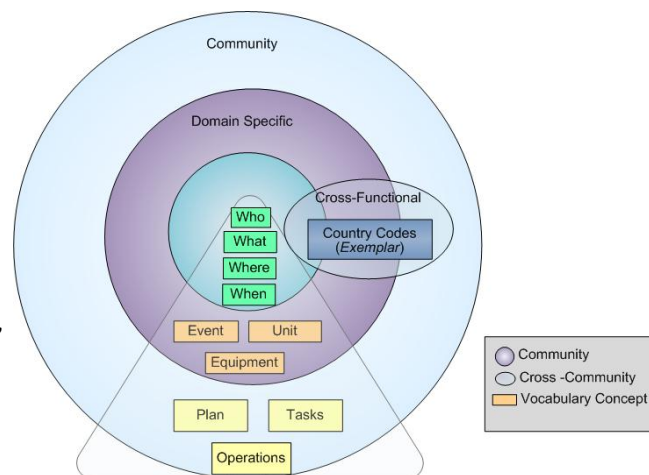


Figure 1. Core Vocabularies

To further demonstrate how these concepts are represented, we will use a humanitarian mission case as an illustrative tool. In this context, we will also discuss what is needed to share this information across communities from different domains (i.e., non-government organizations and local authorities) that often need to collaborate in relief operations.

Information exchanges are processed by machines and the data is processed before being presented to the user in a readable format. The data can be encoded in various text formats using different separators such as commas, white spaces, or tabs. These text messages contain data values that needed to be processed by a program that understands what each value represents. For example, a message containing the location, time and description for an event looks like this:

Benefit Concert | April 30 2010 | Baltimore MD

The Extensible Markup Language (XML) has revolutionized the processing of electronic messages. XML messages contain not only data values, but also what those values represent. The XML tags define the meaning or semantics of the data. The same text message for the Benefit Concert event will be encoded in XML as this:

```
<event>
  <Title>Benefit Concert </Title>
  <Date> April 30 2010 </Date>
  <Location> Baltimore, MD </Location>
</event>
```

Data models define the semantics and structure for an information exchange using XML technologies. We will use XML throughout this paper to demonstrate how different data models represent the same information.

In launching a relief operation, those involved in planning first must identify the units and equipment needed to support the rescue activities [8]. These units must be assembled in a central location to be transported to the rescue site. Planners must also prepare the logistics for provisions needed to support the rescue personnel; thus, the plan should include tasks needed to assemble, transport, and support the humanitarian operation.

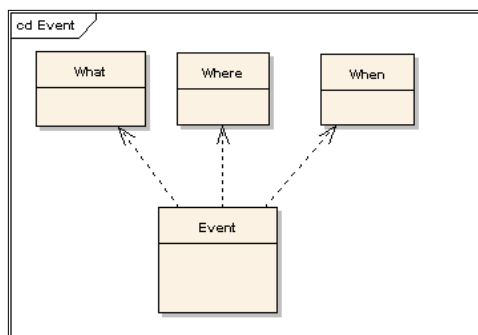


Figure 2. Event Information

The description of the event defines *what* the event is; the location name, address, or coordinates define *where* the event occurred; the time and date for the event define *when* it happened. The *what*, *where* and *when* can defined as attributes

or as data elements. For example, the tsunami that occurred in the Pacific in 2004 could be defined in the XML fragment shown below:

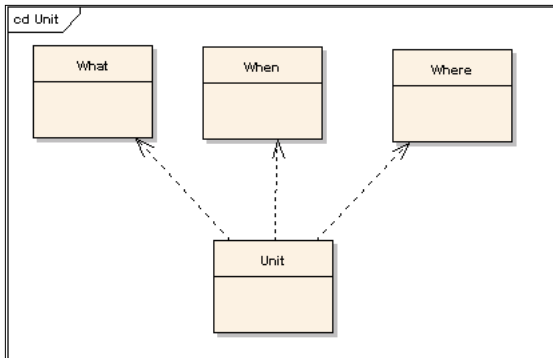


Figure 3. Unit Information

```
<ts:Event what="Tsunami" where="Sumatra, Indonesia"
when="00:58:53 UTC on December 26, 2004"/>
```

According to a press conference [8], the Pacific Command (PACOM) was chosen to lead the relief efforts, being the military command with the closest military presence to the location where the tsunami occurred. The *what*, *where*, and *when* attributes are also used to define the command responsible for organizing the rescue operations, its location, and the reporting date:

```
<ts:Unit what="U.S. Pacific Command" where="Hawaii, US" when="Dec 30, 2004"/>
```

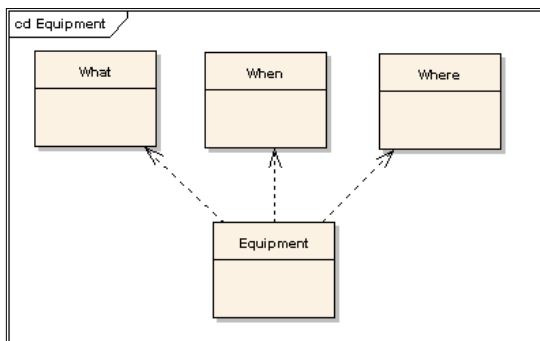


Figure 4. Equipment Information

The equipment sent to support the humanitarian operation included nine P-3s, ten C-130s, and approximately twelve ships. In addition, eight commercial cargo ships were available to carry food, fresh water supplies, and also had the ability to produce fresh water onboard. One military group involved in the operation was the U.S.S. Abraham Lincoln. The Lincoln carrier striker group was in close proximity to the Indian Ocean. The Striker group was led by the Abraham Lincoln aircraft carrier. The following XML tag shows where the carrier was located on the date when the disaster occurred:

```
<ts:Equipment what="Navy Carrier Abraham Lincoln" where="South East Asia"
when="December 30, 2004">
```

```
</ts:Equipment>
```

An operational plan defines the units and equipment needed to complete the activities outlined for an event. The plan also contains the logistics to transport units and equipment from their home location to the deployed area. Figure 5 demonstrates how core concepts are used not only on the domain concepts of Unit and Equipment, but also for community concepts like military planning. A military plan outlines

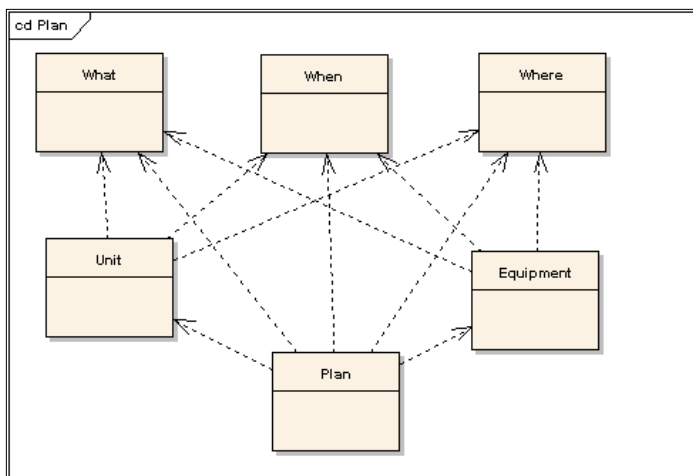


Figure 5. Plan Information

and Equipment, but also for community concepts like military planning. A military plan outlines

activities that need to be performed by military units. This plan might also include civilian and non-government agencies (i.e., Red Cross). The XML shown below defines the *what*, *where*, and *when* attributes not only for the plan, but also for the units:

```
<ts:Plan what="Tsunami Relief" where="Indonesian Ocean" when="December 2004"/>
  <ts:Unit what="U.S. Pacific Command" where="Hawaii, US", when="Dec 30, 2004"/>
  <ts:Unit what="Joint Task Force" where="Utapao, Thailand" when="Dec 25, 2004"/>
  <ts:Unit what="Assessment Team" where="Thailand" when="Dec 30, 2004"/>
  <ts:Unit what="Disaster Relief Assessment Team" where="Thailand" when="Dec 30, 2004"/>
  <ts:Unit what="Assessment Team" where="Indonesia" when="Dec 31, 2004"/>
  <ts:Unit what="Disaster Relief Assessment Team" where="Thailand" when="Dec 31, 2004"/>
  <ts:Unit what="Assessment Team" where="Sri Lanka" when="Dec 29, 2004"/>
  <ts:Unit what="Disaster Relief Assessment Team" where="Thailand" when="Dec 29, 2004"/>
```

The next XML fragment shows the equipment available for the rescue operations:

```
<ts:Equipment what="Commercial Ships" where="Guam"/>
<ts:Equipment what="Commercial Ships" where="Diego Garcia"/>
<ts:Equipment what="MPS ships"/>
```

</ts:Plan>

A plan outlines specific operations. Within an operation, there is a set of tasks performed by military units. For example, the commercial ships leased by Military Sealift command were used as floatable warehouses to deliver food and water. Often, these supplies are handed out by the military to international relief agencies or to host nations who, in turn, delivered the supplies to the victims. At

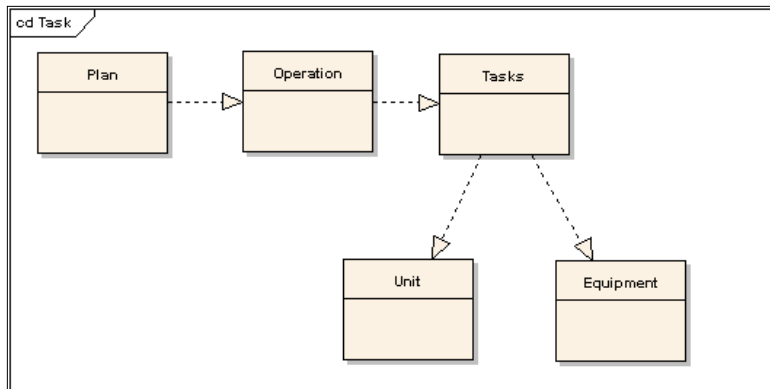


Figure 6 Plan Components

other times, the supplies are picked up by helicopters and dropped off in remote locations or locations without accessible driving roads.

Next, this humanitarian relief operation case will be used to demonstrate how information exchange messages can be built using three different data models: Universal Core (UCore), Joint Consultation, Command and Control Information

Exchange Data Model (JC3IEDM), and Internet Social Networks. UCore is specifically designed to share information across US government agencies and the military. JC3IEDM is designed to share command and control data for multi-national operations. The data model used by the Internet Social Networks can be used to add semantics to HTML pages that can be shared with non-government organizations or units from nations.

UCore

Universal Core (UCore) is a US federal initiative to improve information sharing across government agencies [10]. UCore enables information sharing by defining an implementable specification (XML Schema) containing agreed upon representations for the most commonly shared and universally understood concepts of *Who*, *What*, *When*, and *Where*[1]. UCore is composed of two components: a vocabulary and a message framework. The main components of the UCore message framework are the Digest and the Structure Payload. The Digest is the part of the framework that all producers and consumers understand. The Digest provides a high-level summary of the message content. The *What*, *Where*, and *When* concepts are required in the Digest and the operational message is included in the Structured Payload. The Structured Payload is the container where Communities of Interest (COI) or applications put their operational messages using their own vocabularies. The information contained in the Digest is understood by all communities; however, the information in the Structured Payload is only understood by providers and consumers from a particular community.

The UCore diagrams are represented using UML notation. The *What* is defined by the class Thing and any subclasses inherit its attributes. The main subclasses for the Thing are an Event and an Entity. The *Where* concept is defined with a Location class, which is a subclass of Thing. There are four types of locations: GeoLocation, PhysicalAddress, RelativeLocation, and CyberAddress. The relative location is defined using a relationship. The *Who* is a concept represented with an Agent class, which is also a subclass of Thing. An Agent is further classified as a person, organization, or group. A critical component of the UCore vocabulary is the association mechanism needed to relate things, locations, and events appearing in the UCore Digest. Things are associated via the XML data element Relationship [1]. The types of relationship are defined in a separate schema [11].

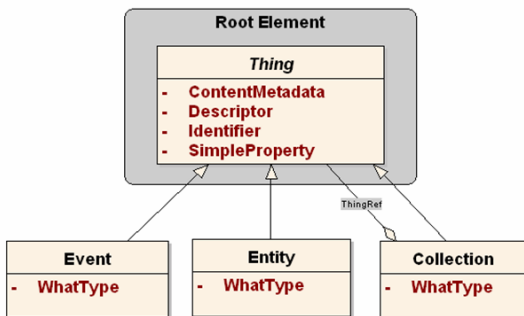


Figure 7. UCore Representation of *What* the object is

Figure 7 shows the attributes and subclasses for *Thing*. As an abstract class, *Thing* will never appear as a tag name in an XML fragment; however, the main subclasses of *Thing*, *Event* and *Entity* will appear. Entities consist of physical objects, conceptual objects, and agents. The *Thing* class has optional elements for the metadata and a descriptor. Each *Thing* has a unique identifier, and a simple property is included to add additional data elements. The time stamp and security markings are part of the content metadata, which is an attribute of *Thing*. The location class is also derived from the *Thing*

class. An event is associated with a location using the OccursAt Relationship while an Event is associated with HasDestinationOf, HasOriginOf or LocatedAt. There are other relationships available to link things appearing in the Digest.

We will continue to use the Tsunami Relief Operations Use case to illustrate how UCore messages can be constructed to share information pertaining to the relief operation activities.

Let's start by defining what the event is about. The Tsunami relief is an Event defined as follows:

```
<ucore:Event id="PacificTsunami">
  <ucore:Descriptor>Tsunami in the Pacific</ucore:Descriptor>
  <ucore:Identifier ucore:label="Type">Tsunami</ucore:Identifier>
  <ucore:SimpleProperty ucore:label="Operation">Humanitarian
  Relief</ucore:SimpleProperty>
  <ucore:What ucore:code="NaturalEvent"
  ucore:codespace="http://ucore.gov/ucore/2.0/codespace/">
  <ucore:What ucore:code="DisasterEvent"
  ucore:codespace="http://ucore.gov/ucore/2.0/codespace/">
</ucore:Event>
```

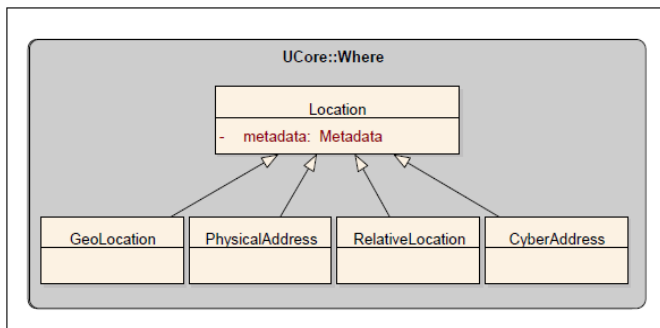


Figure 8. UCore Representation of *Where*

The *Where* concept is defined with the Location class, which is a subclass of Thing [1]. There are four types of locations: GeoLocation, PhysicalAddress, RelativeLocation, and CyberAddress. A relative location is defined using a relationship. Since location element extends from the Thing type, it inherits the id, metadata, and descriptor elements. To define the location where the tsunami occurred, two entities are needed, one for the location and another one for the event:

```
<ucore:Location id="TsunamiLocation">
  <ucore:GeoLocation>
  <ucore:BoundingBox>
    <gml:boundingBox>
      <gml:pos>-180.0 -90.0</gml:pos>
      <gml:pos>180.0 90.0</gml:pos>
    </gml:boundingBox>
  </ucore:BoundingBox>
</ucore:GeoLocation>
</ucore:Location>
```

Next, we need to relate the Location and the Event by defining a relationship with Located At. The Event and its Location are associated by including the object reference within the association:

```
<ucore:LocatedAt>
  <ucore:metadata>
    <ucore:validityTime>
```

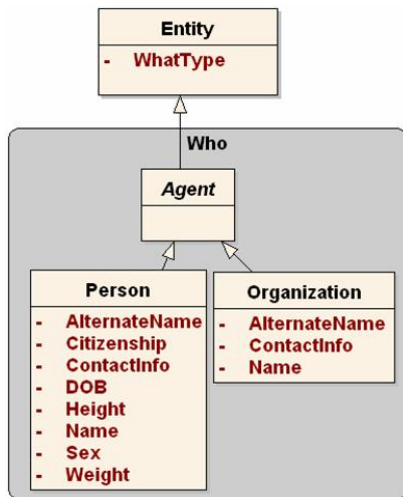


Figure 9. UCore representation of Entity

```

<ucore:instant>
<ucore:dateTime>2004-12-12T04:00:00Z</ucore:dateTime>
</ucore:instant>
</ucore:validityTime>
</ucore:metadata>
<ucore:entityRef ref=" PacificTsunami " />
<ucore:locationRef ref=" TsunamiLocation " />
</ucore:LocatedAt>
  
```

The *Who* concept is represented with the Agent class, which is a subclass of the Entity class. An Agent is further classified as a person, organization, or group. An Agent can also be an organization, such as a military unit:

```

<ucore:Organization id="PACOM">
<ucore:What ucore:code="Organization"
ucore:codespace="http://ucore.gov/ucore/2.0/codespace"/>
<ucore:Name>
<ucore:Value>Pacific Command</ucore:Value>
</ucore:Name>
</ucore:Organization>
  
```

Figure 9 shows the Agent class taxonomy. The Agent class inherits the metadata and description elements, and the id attribute from the Entity Class. The ucore:what data element has an attribute to classify the object, and the object can have more than one object classification [10]; however, at least one classification must come from the UCore taxonomy. The UCore classification code for the PACOM military unit is defined with the attribute ucore:code="Organization."

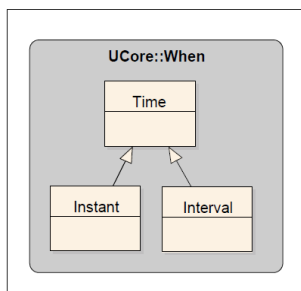


Figure 10. UCore Representation of When

The *When* concept is a part of the metadata class, and is defined with the Validity data element, as shown in Figure 10. Time is defined as either an instant or an interval. The ucore:Time defines the temporal information for an Event or a Thing.

```

<ucore:Time>
  <ucore:TimeInstant>
    <ucore:Value>2004-12-24T06:00:00Z</ucore:Value>
  </ucore:TimeInstant>
</ucore:Time>
  
```


A critical component of the UCore vocabulary is the association mechanism needed to relate Things. Things are associated via the XML data element Relationship [10]. The types of relationship are defined in a separate schema. Relationships define the links among entities, events, and locations.

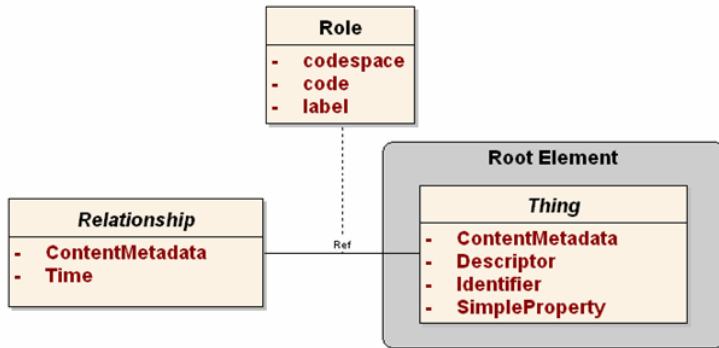


Figure 11. UCore Relationships

A subordinate relationship (i.e., a commanding unit and its reporting units) is defined using the AffiliatedWith relationship. The relationship between the units and the events, as well as the relationships between the units and their equipment, must also be defined.

The Digest is the part of the message that is intended to be understood by all providers and consumers [1]. The Digest

communicates the content of the message at a high level. The data objects described in the Digest, and further defined in the Payload, are related using the SameAsPayload and SameAsDigest associations [10]. The Structure Payload allows for the insertion of community-based vocabularies that provide additional details for the information summarized in the Digest. The data objects in the Payload can be associated to the Digest using the relationship mechanism and the xsd:id.

A UCore Digest for a military operational plan would include the entities involved in the planning of any activities outlined in the plan, including the transportation requirements for moving the units from the embarkation to disembarkation points. The planning data must be modeled against the UCore model; however, only systems that have implemented an interface to process UCore messages will be able to understand the contents of the digest.

It is possible that the first UCore message was produced to first alert the occurrence of the tsunami, and then other Digests were produced to report other responses to the event. The XML fragment in Appendix A, shows a UCore Digest with information on the assessment and rescue teams assigned to the rescue operations.

UCore provides communities that have implemented interfaces to process UCore messages with the ability to participate in information sharing. Though the content of the UCore Digest is not intended for human consumption, the framework contains a summary section to provide a textual description of the message content. So, in our example, UCore will not help share information on the rescue operations with units coming from civilian organizations, NGOs, or other nations unless those organizations have an interface to process UCore messages. However, these tools and more will become more accessible as federal government agencies and other non-government entities that conduct business with the government continue to adopt UCore. Until then, Providers must transform

their data into a format that complies with the UCore data model and messaging framework. Sometimes, the data produced by the Provider will not be semantically equivalent to UCore concepts.

JC3IEDM

Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM) is a Command and Control information exchange model for sharing information related to military operations among nations. JC3IEDM has a rigorous semantic model with 19 independent concepts (depicted in Figure 12). Figure 12 also shows the relationships among these entities. Some of the relationships add additional specifications to the definition of the independent entities [5]. A full implementation of this model requires breaking down many of these relationships and further redefining the concepts using an entity relationship model. Some of the 19 JC3IEDM entities represent the *What* concept in a

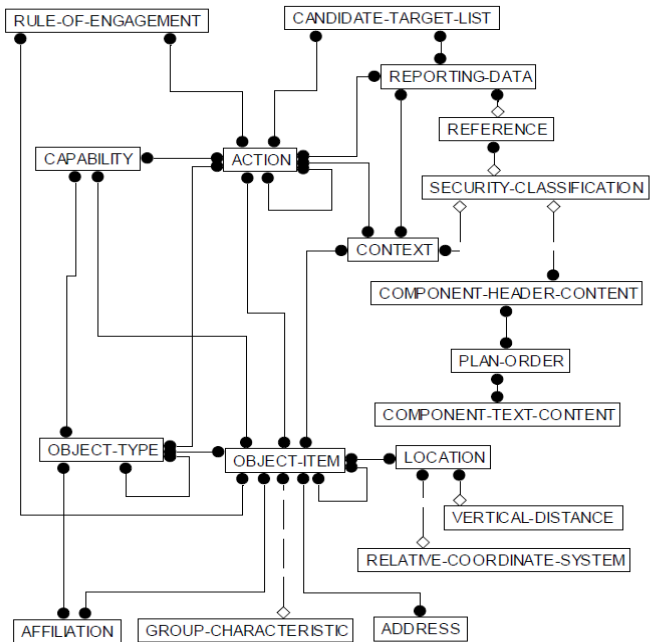


Figure 12. Action Taxonomy

message, while the *Where* is represented with the Location entity. The Location for an entity is associated with the Location class using one of the JC3IEDM relationships. The REPORTING_DATA entity is used to report temporal information on any entity. The REPORTING_DATA is part of an entity's metadata to report *When* things are scheduled to occur or have occurred. The Object entity taxonomy defines the *Who* concept.

To construct a JC3IEDM message, a map must first be created between the operational data concepts and the JC3IEDM concepts. For example, to represent the information needed to support the humanitarian relief

operation, a data modeler must

semantically map the data attributes for the Unit, Event, Equipment, and Plan with the corresponding JC3IEDM entities. The relationships among these entities must also be defined following the rules specified in the model [6]. The UCore entities to define who or what the message is about are equivalent to the JC3IEDM entities related to units, events and organizations.

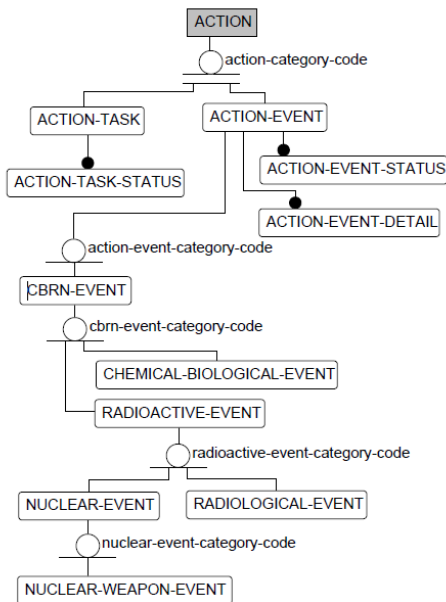


Figure 13. Action Taxonomy

Following the taxonomy for an action as shown in Figure 13, one can see that an event falls under this category. The XML tag names have the same taxonomical structure. A tag name for an event is ACT_EVENT, which encodes the Action-Event structure. The tsunami event is represented as an action-event:

```
<ACT_EVENT>
  <ACT_EVENT_ID>PacificTsunami</ACT_EVENT_ID>
  <CAT_CODE>Natural-Disaster</CAT_CODE>
  <CREATOR_ID/>
  <UPDATE_SEQNR/>
</ACT_EVENT>
```

Some of the code values used to represent the entity attributes are also part of the model. For example, the category code for the event comes from the

ActionEventCategoryCode enumerated list, but JC3IEDM does not have an event code value for a Tsunami. The closest semantic code value for a Tsunami is a Natural_Disaster. Additional information for the Tsunami will have to be defined using the Action-Event-Detail:

```
<ACT_EVENT_DET>
  <CLSFC_CODE>DISAST</CLSFC_CODE>
  <TXT>Natural Disaster</TXT>
  </RPTD_ID>
</ACT_EVENT>
```

The ActionEvent taxonomy does not include a class or attribute to define a location. A location for an action can be defined by adding a relationship to other entities such as an ActionResource (ActionResources are ObjectTypes). The UCore Where concept maps to the JC3IEDM location entity, and the Location is also associated to any of the other entities in the model. The Location is defined as a separate entity and then is associated with a unit using an ObjectItemAssociation.

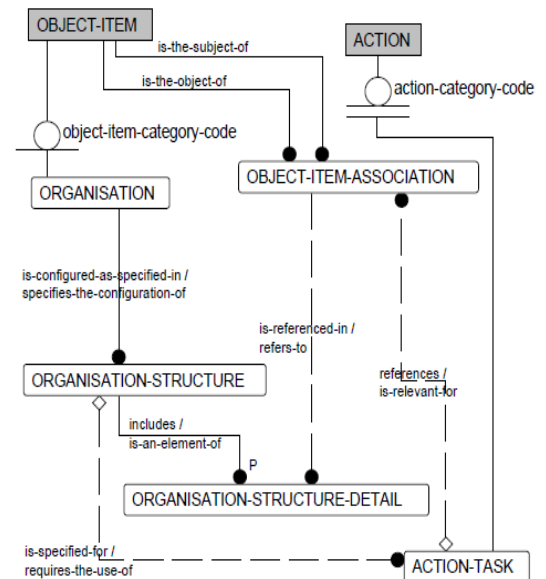


Figure 14. Organization Structure

A unit is an organization that falls under the OBJECT-ITEM hierarchy. An organization has an organization-structure and an organization-structure-detail, as shown in Figure 14. The attributes used to define the units for the Tsunami Relief Operation must comply with the attributes defined in the

JC3IEDM model. The enumerated values used for these attributes must also come from the JC3IEDM controlled value code lists. Every entity must have a unique identifier from the application producing the XML message.

If we want to define the top-level military organization responsible for the Humanitarian Operation, the XML definition for an organization will look like this:

```
<ORGANIZATION>
  <ORG_ID> 1</ORG_ID <CAT_CODE>GOVERNMENT_ORGANIZATION_TYPE </CAT_CODE>
  <CREATOR_ID/>
  <UPDATE_SEQNR/>
</ORGANIZATION>
```

The organization id (ORG_ID) is a reference pointer to the OBJECT_ITEM used to define the actual organization; in this case the PACOM id will point to a XML ObjectItem structure like this:

```
<ObjectItem>
  <OBJ_ITEM_ID>1</OBJ_ITEM_ID>
  <CAT_CODE>ORGANIZATION</CAT_CODE>
  <NAME_TXT>PACOM</NAME_TXT>
</ObjectItem>
```

The subordinate units will also have their own <OBJECT_ITEM>, as shown below:

```
<ObjectItem>
  <OBJ_ITEM_ID>10</OBJ_ITEM_ID>
  <CAT_CODE>ORGANIZATION</CAT_CODE>
  <NAME_TXT>PACOM</NAME_TXT>
</ObjectItem>
<ObjectItem>
  <OBJ_ITEM_ID>100</OBJ_ITEM_ID>
  <CAT_CODE>ORGANIZATION</CAT_CODE>
  <NAME_TXT>JTF</NAME_TXT>
</ObjectItem>
```

The command relationship for these units is represented with an ORGANISATION_STRUCTURE. The ORGANISATION_STRUCTURE_DETAIL defines the hierarchical association between a unit and its subordinate units using an OBJECT_ITEM-ASSOCIATION. For the Tsunami relief, the organization structure could be graphically depicted as follows:

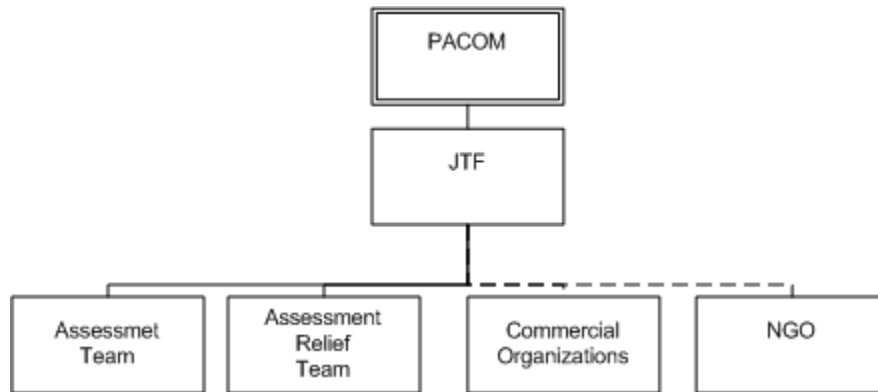


Figure 15. PACOM Organizational Structure for Relief Operations

The following XML fragments show the command and control associations between PACOM and JTF, and JTF and the assessment team.

First, the association between the objects must be identified:

```

<ObjectItemAssociation>
  <SUBJ_OBJ_ITEM_ID>10 (PACOM) </SUBJ_OBJ_ITEM_ID>
  <OBJ_OBJ_ITEM_ID>100 (JTF) </OBJ_OBJ_ITEM_ID>
  <OBJ_ITEM_ASSOC_IX>1 </OBJ_ITEM_ASSOC_IX>
  <CAT_CODE>Command and Control </CAT_CODE>
  <SUBCAT_CODE>Has Operational Control</SUBCAT_CODE>
  <ACTION_TASK_ID/>
</ObjectItemAssociation>
  
```

```

<ObjectItemAssociation>
  <SUBJ_OBJ_ITEM_ID>100 (JTF) </SUBJ_OBJ_ITEM_ID>
  <OBJ_OBJ_ITEM_ID>200 (Assessment Team) </OBJ_OBJ_ITEM_ID>
  <OBJ_ITEM_ASSOC_IX>2 </OBJ_ITEM_ASSOC_IX>
  <CAT_CODE>Command and Control</CAT_CODE>
  <SUBCAT_CODE>Has Operational Control</SUBCAT_CODE>
  <ACTION_TASK_ID/>
</ObjectItemAssociation>
  
```

```

<ObjectItemAssociation>
  <SUBJ_OBJ_ITEM_ID>100 (JTF) </SUBJ_OBJ_ITEM_ID>
  <OBJ_OBJ_ITEM_ID>300 (NGOs) </OBJ_OBJ_ITEM_ID>
  <OBJ_ITEM_ASSOC_IX>2</OBJ_ITEM_ASSOC_IX>
  <CAT_CODE>Rates or Assesses </CAT_CODE>
  <SUBCAT_CODE>Is Cooperating_With </SUBCAT_CODE>
  <ACTION_TASK_ID/>
</ObjectItemAssociation>
  
```

Second, the organization detail structure is built (for the sake of brevity, only one of the JTF stood up to handle the relief operation):

```
< OrganisationStructureDetail>
  <ORG_STRUCT_ROOT_ORG_ID> 1 (PACOM) </ORG_STRUCT_ROOT_ORG_ID>
  <ORG_STRUCT_IX> 122 </ORG_STRUCT_IX>
  <ORG_STRUCT_DET_IX>PACOM_ORG_STRUCT</ORG_STRUCT_DET_IX>
  <SUBJ_OBJ_ITEM_ID> 1<SUBJ_OBJ_ITEM_ID>
  <OBJ_OBJ_ITEM_ID>100 (JTF) </OBJ_OBJ_ITEM_ID>
  <OBJ_OBJ_ITEM_ID>1</OBJ_OBJ_ITEM_ID>
  <CREATOR_ID/>
  <UPDATE_SEQNR/>
</OrganisationStructureDetail>
```

The REPORTING_DATA entity is used to report status and temporal information on these units and their current activities. The REPORTING_DATA is similar to the UCore metadata for reporting on the *When* concept. A unit can report on a specific action or an event. For example, PACOM could provide a general status report for the relief operation. The ReportingData entity specifies who is reporting the information and the ActionComment provides the textual information for the report.

```
<ReportingData>
  <ACC_CODE>1</ACC_CODE>
  <CAT_CODE> ASS</CAT_CODE>
  <CNTG_IND_CODE>YES</CNTG_IND_CODE>
  <CREDIBILITY_CODE>TRUSTWORTHY</CREDIBILITY_CODE>
  <RELIABILITY_CODE> A</RELIABILITY_CODE>
  <REP_DTTM>Dec 28 2004</REP_DTTM>
  <SOURCE_TYPE_CODE>OBSR</SOURCE_TYPE_CODE>
  <TIMING_CAT_CODE>RDRELT</TIMING_CAT_CODE>
  <REF_ID>REO102030 </REF_ID>
  <REP_ORG_ID>100</REP_ORG_ID>
  <ENT_CAT_CODE>ACTEVT</ENT_CAT_CODE>
  </CREATOR_ID>
  </UPDATE_SEQNR>
```

```
<ReportingData>
```

```
<ActionComment>
  <ACT_ID> PacificTsunami <ACT_ID>
  <SHORT_TXT>The US Lincoln carrier striker group has arrived to the Indonesia Ocean and started lifting relief
supplies and distributed to the Red Cross<SHORT_TXT>
  </LONG_TXT>
  <RPTD_ID> REP102093<RPTD_ID>
  </CREATOR_ID>
  </UPDATE_SEQNR>
</ActionComment>
```

The *Where* attribute is defined by establishing a relationship between a location and an OBJECT_ITEM_LOCATION. For example, the location for PACOM will look similar to this:

```
<LOCATION>
  <LOC_ID>20 </LOC_ID>
  <CAT_CODE>SURFACE</CAT_CODE>
</LOCATION>
```

The Location area is defined using a geospatial shape, point, or line. The attributes used to define the location depend on the location category type. The Location and the Item are associated with the ObjectItemLocation. For PACOM, the OBJ_ITEM_ID is 10 and the LOC_ID is 20:

```
<ObjectItemLocation>
  <OBJ_ITEM_ID>10</OBJ_ITEM_ID>
  <LOC_ID>20</LOC_ID>
  <OBJ_ITEM_LOC_IX/>
</ObjectItemLocation>
```

To report data on the equipment needed by the units, a different part of the model is used. Equipment falls under the materiel taxonomy. There are three classifications for materiel: MATERIEL-TYPE, EQUIPMENT-TYPE, and CONSUMABLE-MATERIEL-TYPE. Tasks that units are trained to perform are classified as capabilities. A unit must also require a certain type of equipment to complete a task. The relationship between the units, equipments, and tasks must be defined separately following the taxonomy shown in Figure 16.

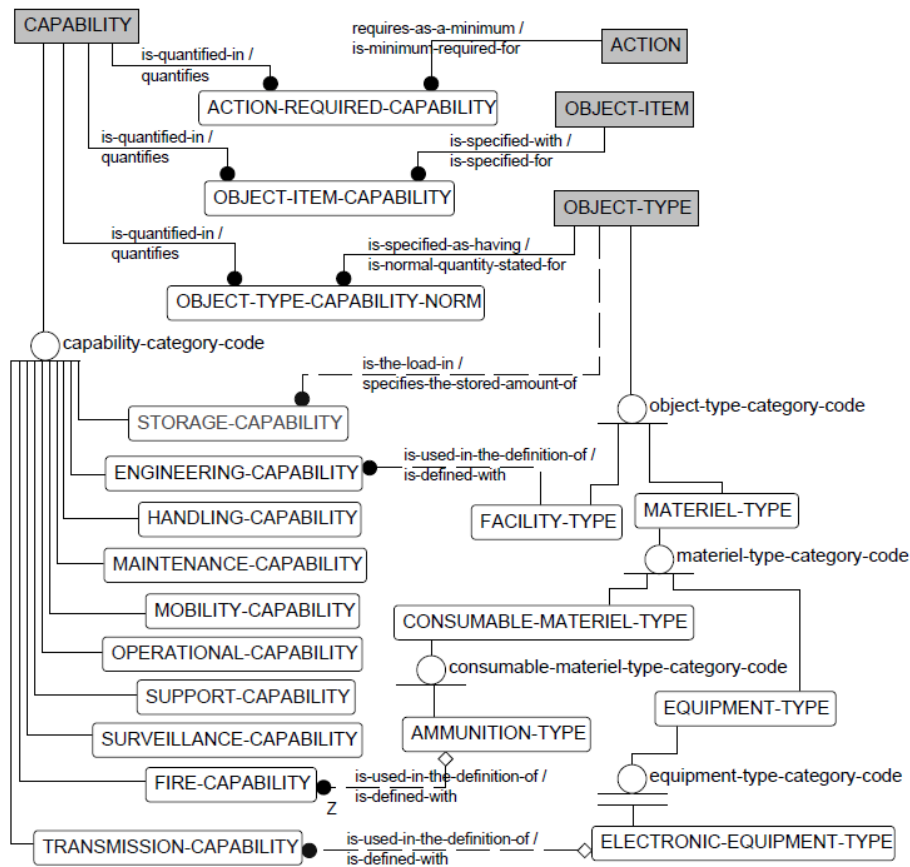


Figure 16 Capability Taxonomy

For example, to plan for activities to transport the relief and assessment teams, or to distribute medical supplies to the affected areas, actions must be first identified and then associated with the units and equipment needed to support those actions:

| Label | Resource | Activity | Objective |
|----------|------------------|-----------------|--|
| Action 1 | JTF | Coordinate | Command and Control joint military forces and civilian resources |
| Action 2 | Assessment Team | Reconnaissance | Assess damage |
| Action 3 | Commercial Ships | Relief_In_Place | Deliver bottled water |

| | | | |
|--------------|-------|-------|-------|
| Action | | | |
|--------------|-------|-------|-------|

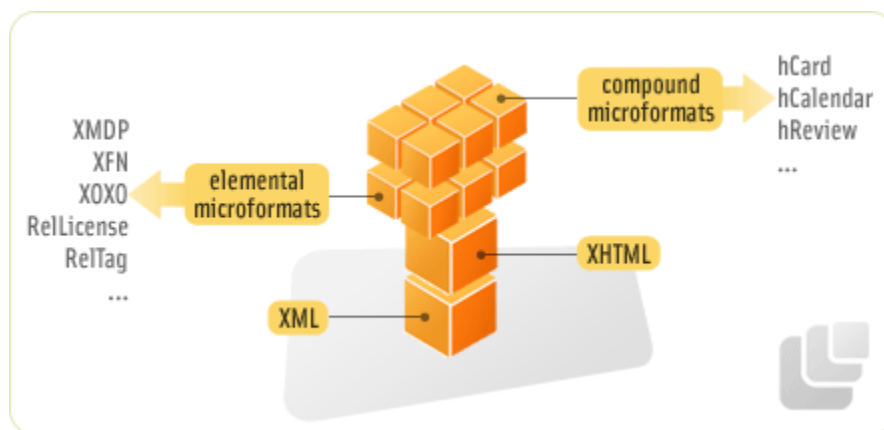
Each of these actions will have to be associated with the corresponding resource, activity, and objective. Tracking the execution of these activities requires creating more reporting status activities.

Using JC3IEDM requires modeling information exchanges and data concepts using not only taxonomical and naming rules, but also syntax and code values. JC3IEDM is a canonical model designed independently of any applications. Applications wishing to exchange data in this format must conform to the model. Some community vocabulary concepts cannot be easily matched to the concepts definitions provided in JC3IEDM; this in turn leads to imprecise semantic matching among community vocabularies.

Microformats

Microformats are small vocabularies used to mark up common things in HTML such as persons, events, reviews, and tags. One objective of the microformat community is to leverage existing data standards to increase semantic interoperability that does not require extensive reengineering of HTML interfaces. According to the microformats wiki, microformats intend to solve simpler problems by adapting to current behaviors and usage patterns (e.g. XHTML, blogging) [11].

Microformats are not extensible like UCore or JC3IEDM. On the contrary, microformats are based on small data standards that are widely adopted by others such as the RFC 2445 iCalendar. Microformats are designed for humans first, machines second. Microformats use existing standards as reusable blocks that can be combined to provide richer semantics [11]. The hCard microformat represents the *Who* concept, as this standard is used to identify persons and organizations. The hCalendar microformat is used to show *When* events are scheduled to occur. The hCalendar microformat includes an hCard to define event participants. The *What* concept is not explicitly defined; however, the base class for each microformat implicitly defines the attributes within the class container.



Approved for Publ **Figure 17. Microformats** bution Unlimited
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Information needed for the Humanitarian Relief Operation can be encoded using the hCard and hCalendar microformats [12]. The hCalendar microformat is used to add event information into an existing HTML or XML tag that defines calendaring events. hCalendar is based on the iCalendar standard (RFC2445). Some of the most popular tools (i.e., Outlook, Apple X) can import an iCalendar event defined in a HTML page, RSS or ATOM feeds, or from a message produced by a web service. The root class for hCalendar is vcalendar, but the class name that appears in the HTML markup is called vevent. The class vevent is the container class for events attributes, and a page can have multiple events and each one will have a vevent.

Any XML markup for an event can be taken and transformed into an hCalendar format to allow others to consume the event information without having to parse different event markups.

The events related to the Tsunami event could be published in a HTML markup using some of the following microformat markups:

| Original Markup | Microformat hCalendar |
|---|--|
| <pre><ts:Event what=" Tsunami" where="Sumatra, Indonesia" When=" 00:58:53 UTC on December 26, 2004"/></pre> | <pre><div class="vevent"> Tsunami : <abbr class="dtstart" title="2004-12- 26">December 26, 2004</abbr>- The Tsunami occurred in Sumatra, Indonesia </div></pre> |

The semantics for the event are defined within the HTML tags. The text for human consumption is not restricted by the iCalendar standard. The only mandatory fields for the vevent class are dtstart and summary. The dtstart attribute must have an ISO date. Optional attributes include location, url, dtend, duration, rdate, rrule, category, description, uid, geo (latitude, longitude) attendee (partstat, role), contact, organizer, attach, and status. The summary is a textual description for the event.

The *When*, *What*, and *Where* attributes for a Microformat event are defined as attributes within an HTML tag. When a parser sees a vevent class in an html element, that element becomes the container

for the properties defined within that element. Multiple events can be defined in the same page, but each event has its own container. The markup for each event starts with every declaration of vevent. When a parser sees another vevent then the parser knows a new event declaration has started. The *When* concept is defined with the dtstart attribute for start time and the dtend attribute for the end. An event can also have a duration attribute. The geocode or location attributes define *Where* the event takes place. The description and summary attribute defines *What* the event is all about.

hCard is a simple, open, distributed format for representing people, companies, organizations, and places, using a 1:1 representation of vCard (RFC2426) properties and values in HTML or XHTML [13]. By embedding hCard within HTML pages, spiders and aggregators can access contact information and export it into other applications or web services. For example, if vCards and hCards for units participating in different rescue events are embedded within HTML pages, an application can easily export this information into an Outlook calendar. This will allow event organizers to easily track who the participants are, and when and where they are located. The example below shows a hcard for the PACOM military unit. Using hcards can help share schedule information between military and civilian organization and the information can easily be imported into calendaring tools such as Outlook or Google Calendar.

| Original Markup | Microformat hCalendar |
|--|--|
| <pre><ts:Unit what="U.S. Pacific Command, where="Hawaii, US", when ="Dec 30, 2004"/></pre> | <pre><div class="vcard"> U.S. Pacific Command <div class="adr"> Military Unit: <abbr class="region" title="Hawaii">Hawaii</abbr> <div class="country-name">USA</div> </div> </div></pre> |

A vcard can be embedded with a vevent to add contact information to an event. For example, the following contact cards for different units can be added to the Tsunami event:

```
<div class="vevent">
```

Tsunami Relief OperationsOperations Plan for Tsunami
Humanitarian Relief

<abbr class="dtstart" title="2004-12-26">December 26, 2004</abbr>-

The Tsunami occurred in

Sumatra, Indonesia

The following units will support the following activities:

<div class="vcard">Tsunami Relief Joint Command

 Joint Task Force

Joint Task Force

<div class="adr">

Military Command Unit

Palo Alto

Thailand</abbr>

<div class="country-name">Thailand</div>

</div>

</div>

</div>

There are no microformats available to tag equipment or associate the equipment to an organization, nor are there any specifications for associating events, units, and equipments. However, the information contained in a web page can have links to other pages and those pages can be tagged using the rel-tag microformat. Rel-tag is a microformat that encodes metadata for a link embedded within a page [14]. Equipment information and other information can be visibly tagged to highlight links providing additional information.

Most browsers are now natively supporting microformats and there are many tools that can aggregate information embedded in HTML pages. Microformats can be used to share information easily in an open environment.

Conclusions

This paper demonstrated how universal concepts of *Who*, *What*, *Where*, and *When* are implemented by different communities using their own data models. The Relief Operation Use case was chosen because operations of this nature often require collaboration among military, civilian, NGOs, and other nations.

UCore is a US data initiative intent on improving information sharing across the federal government. It is a message framework that allows communities to share information with different levels of understanding. The UCore Digest is the part of the framework containing the information understood by all communities, while the Structure Payload is the container holding the operational message

understood by providers and consumers who need the information at a more granular level. UCore is a relatively new data initiative and has not yet been widely adopted outside the federal government; this is a drawback for sharing information with non-government agencies or other nations.

Unlike UCore, JC3IEDM is a data initiative sponsored by nations who participated in the Multilateral Interoperability Programme (MIP). JC3IEDM's intent is to improve data sharing to support military ground operations. JC3IEDM improves machine-to-machine interoperability by providing a rich data model that has a vast set of code values. JC3IEDM does not encompass all C2 data handled by many nations, but only data considered critical. National data exchanges must be reengineered in accordance to the model rules, and code values must be mapped with those available in JC3IEDM. The model can be extended; however, only those nations that have implemented the extension can process the messages that have data fields and code values defined in the extension. Sharing JC3IEDM messages with non-military agencies requires mediating the messages into a format more appropriate for human consumption. A critical point to consider for information sharing is that, in a crisis situation, machines might not be available for sharing information, and there may be no working network connections.

Microformats do not have a single data model or message framework. The Microformat community follows the direction of "pave the cow paths" by using current behaviors and usage patterns for selecting what information is widely shared and the format and attributes used for representation. Microformats insert critical pieces of information such as events, people, and reviews into HTML pages. These 'microformatted' nuggets of information can be aggregated using open source tools to mine the information or to mashup to be displayed in a map or a timeline. Microformats are not intended to provide precise semantic information that can be processed by machines or have metadata with security markings, pedigree, or provenance. However, there are other mechanisms that providers can use to encode metadata into an HTML page.

This paper has proven that there is not a single data model or information sharing approach that can fulfill data sharing requirements for all communities. However, there is still a universal need for sharing key concepts such as events, schedules, and news. The selection for using one model over the others should be driven by first identifying the communities that need to share data, and then the tools accessible to them. In many cases, data will have to be shared using more than one data format.

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- [14] Rel, Official Site, <http://microformats.org/wiki/rel-tag>

Appendix A

```
<-- What ---->
<ucore:Entity id="TsunamHumanitarianAssistance">
  <ucore:Descriptor>US Tsunami Relief OperationsPlan</ucore:Descriptor>
<ucore:What ucore:code="Document"
ucore:codespace="http://ucore.gov/ucore/2.0/codespace/" />
</ucore:Entity>
<ucore:What ucore:code="Plan"
ucore:codespace="http://dhs.gov/operations/codespace/" />
<ucore:What ucore:code="OPlan"
ucore:codespace="http://dod.mil/operations/planningcodespace/" />
</ucore:Entity>
<-- Where -->
<ucore:Location id="ASIA">
<ucore:Descriptor>South East Asia</ucore:Descriptor>
<ucore:GeoLocation>
  <ucore:BoundingBox>
    <gml:boundingBox>
      <gml:pos>-180.0 -90.0</gml:pos>
      <gml:pos>180.0 90.0</gml:pos>
    </gml:boundingBox>
```

```

    <ucore:BoundingBox>
</ucore:GeoLocation>
</ucore:Location>
<-- When -->
<ucore:OccursAt id="PlannningPeriod">
<ucore:Time>
<ucore:TimeInterval>
<ucore:StartTime>
<ucore:Value>2004-12-24T06:00:00Z</ucore:Value>
</ucore:StartTime>
<ucore:EndTime>
<ucore:Value>2005-01-31T10:00:00Z</ucore:Value>
</ucore:EndTime>
</ucore:TimeInterval>
</ucore:Time>
<ucore:EntityRef ref=" TsunamHumanitarianAssistance "/>
<ucore:LocationRef ref="ASIA"/>
<ucore:OccursAt/>
<---Units--->
<ucore:Organization id="PACOM">
<ucore:What ucore:code="Organization"
ucore:codespace="http://ucore.gov/ucore/2.0/codespace"/>
<ucore:Name>
<ucore:Value>Pacific Command</ucore:Value>
</ucore:Name>
</ucore:Organization>

<ucore:GeoLocation>
<ucore:Point>
<gml:Point gml:id="PACOMGeo"
srsName="http://metadata.dod.mil/mdr/ns/GSIP/crs/WGS84E_3D">
<gml:pos> 19.59009 -155.434143 </gml:pos>
</gml:Point>
</ucore:Point>
</ucore:GeoLocation>

<ucore:LocatedAt id="PACOM-LA">
<ucore:Time>
<ucore:TimeInstant>
<ucore:Value>2004-12-23T18:00:00Z</ucore:Value>
</ucore:TimeInstant>
</ucore:Time>
<ucore:OrganizationRef ref="PACOM"/>
<ucore:LocationRef ref="PACOMGeo"/>
</ucore:LocatedAt>
<ucore:Organization id="JTF">
<ucore:What ucore:code="Organization"
ucore:codespace="http://ucore.gov/ucore/2.0/codespace"/>
<ucore:Name>
<ucore:Value>Joint Task Force</ucore:Value>

```

```
</ucore:Name>
  <ucore:SimpleProperty ucore:label="Operation">Humanitarian Assistance Effort </ucore:SimpleProperty>
</ucore:Organization>
```

```
<ucore:GeoLocation>
<ucore:Point>
<gml:Point gml:id="UtapaoGeo "
srsName="http://metadata.dod.mil/mdr/ns/GSIP/crs/WGS84E_3D">
<gml:pos> 12.6778 101.009201 </gml:pos>
</gml:Point>
</ucore:Point>
</ucore:GeoLocation>
</ucore:Location>
```

```
<ucore:LocatedAt id="JTF-LA">
<ucore:Time>
<ucore:TimeInstant>
<ucore:Value>2004-12-23T18:00:00Z</ucore:Value>
</ucore:TimeInstant>
</ucore:Time>
<ucore:OrganizationRef ref="JTF"/>
<ucore:LocationRef ref="UtapaoGeo"/>
</ucore:LocatedAt>
```

```
<ucore:Organization id="LincolnCarrierGroup">
<ucore:What ucore:code="Organization"
ucore:codespace="http://ucore.gov/ucore/2.0/codespace"/>
<ucore:Name>
<ucore:Value>U.S.S. Abraham Lincoln carrier strike group </ucore:Value>
</ucore:Name>
</ucore:Organization>
```

```
<ucore:Organization id="LincolnCarrierGroup">
<ucore:What ucore:code="Organization"
ucore:codespace="http://ucore.gov/ucore/2.0/codespace"/>
<ucore:Name>
<ucore:Value>U.S.S. Abraham Lincoln carrier strike group </ucore:Value>
</ucore:Name>
</ucore:Organization>
```

```
<ucore:Entity id="Carrier">
<ucore:What ucore:codespace="http://ucore.gov/ucore/2.0/codespace/" ucore:code="WaterCraft"/>
<ucore:What usmtf:codespace="http://ucore.gov/ucore/2.0/codespace/" usmtf:code="USSLincoln"/>
</ucore:Entity>
```

```
<ucore:AffiliatedWith id="LincolnGroup">
<ucore:ThingRef ref="Carrier"/>
<ucore:ThingRef ref="LincolnCarrierGroup"/>
<ucore:Time>
<ucore:TimeInstant>
```


<ucore:Value>2004-12-24T18:00:00Z</ucore:Value>
</ucore:TimeInstant>
</ucore:Time>
<ucore:AffiliatedWith id="LincolnGroup">

<ucore:LocatedAt>
<ucore:EntityRef ref="C130"/>
<ucore:LocationRef ref="C130-Location"/>
<ucore:CourseOverGround angleUOM="degree [unit of angle]">285</ucore:CourseOverGround>
<ucore:Heading angleUOM="degree [unit of angle]">285</ucore:Heading>
<ucore:SpeedOverGround velocityUOM="mile per hour">230</ucore:SpeedOverGround>
</ucore:LocatedAt>