**Defense Information Systems Agency**

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# Core Taxonomy Stubbing Exercise

## An Examination of Connecting Community-of-Interest Taxonomies To a Core Taxonomy

**Version 0.95**

**March 2005**

# Revision History

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# Needs to be completed:

1. Registration process

Prepared for
**The Defense Information Systems Agency**
**DISA**
By The Taxonomy Focus Group
(TaxFG)
A sub-group of the
Core Enterprise Services Metadata Working Group
**(CESMWG)**

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## Abstract

*In an effort to provide a way to instill intelligent information semantics between various communities of interests (COIs) and their resources, the Taxonomy Focus Group designed and implemented a Core Taxonomy to provide a conduit between numerous DoD and other community-specific taxonomies. The Core Taxonomy or CoreTax was deliberately designed to be "wide and shallow" with only high-level concepts in place to ensure that the semantically detailed information sought by users remained at the COI level. By keeping the CoreTax sufficiently generic, COI taxonomies could connect or "stub" to the core at several points and provide multiple pathways to their resources. This is a prototype effort. Its design was purposefully limited in the number of abstract elements used due to manpower and time limitations. The exercise was also designed as a proof-of-concept effort and intended only as a baseline to a more purposeful and complete process to expand the Core Taxonomy into a DoD-wide effort.*

# 1 Introduction

With the events that took place on September 11th, 2001 in both New York City and Washington D.C., our nation's security forces have demanded better Command and Control process to coordinate efforts to fight terrorism both in-country and abroad. One of the largest proposed changes to our military is the idea of an information infrastructure that moves from systems to data centric architecture. As the demands of a global fighting force have increased to require a totally integrated military, the Department of Defense (DoD) has determined that services, data, and collaborative knowledge must be universally available and complete. The Net Centric Enterprise Services (NCES), coupled with the Global Information Grid (GIG), will enact a revolution in how military users and institutions view the information environment. This enterprise system will make crucial knowledge readily and easily available to those who are "qualified to know" the information regardless of their physical location or organization. The premise is that an extremely high-bandwidth, wireless, secure, and global network will permit real-time collaboration and knowledge discovery from top to bottom of the military structure, and across all agencies and institutions contained within the Defense Department's purview.

Part of the NCES infrastructure is a set of central or core services that provide support across the enterprise. One of these core enterprise services (CES) is a discovery capability which allows users in the NCES to search for information across the entire enterprise. By using a federated search capability, a user can find information about resources that span the various organizations within the DoD and other communities. Finding those resources can be aided by organizing the resource information in a manner that makes sense to both the publisher of the information and the subscriber of the service.

Categorizing each community's information in a manner that is understandable to the user is essential for quality searches. One way to categorize information and make it more understandable is through taxonomy. Taxonomy is defined as: "A classification of ideas in an orderly hierarchy that indicates a natural or organizational relationship."[1]

Most organizations have a formal hierarchy displayed as an organizational chart. That organization also collects data to support that organization's internal and external requirements and usually stores that data in a way that makes sense to the members of the organization. In most cases, to make that data useful and reusable, an organization will place data within their databases using data models. Taxonomies are another form of information organization that can define relationships between data. Whether the organization builds the taxonomy from the ground up using taxonomic processes and subject matter experts to complete the process or they use an automated set of tools to categorize information, the result is an orderly representation of the data that suits the need of the organization and brings an intelligence to the collection and categorization of the data.

NCES users will also need to understand each resource listed in their search results in the "context" it is being used by the publishing organization. Providing that semantic uniqueness helps the users and their automated tools decide which resources found in a federated search best fits their needs, and can help pinpoint the most appropriate resources. Using taxonomies to represent logic and order is one form of building intelligence into the search and providing the semantic understanding behind each resource.

The CES taxonomy focus group was chartered by the Core Enterprise Services Metadata Working Group (CES MWG) to examine the usefulness of a central or "core" taxonomy. This core taxonomy would provide a high-level set of information categories that community-of-interest (COI) taxonomies could use to allow other organizations to see their information. The core taxonomy or "CoreTax" would be used as a conduit to tie COI taxonomies together and provide the hierarchical infrastructure needed to support the federated search service in NCES.

[1] Wordnet version 2.0 (August 2003), An Electronic Lexical Database by MIT Press

The taxonomy focus group (TaxFG) spent over nine months building and refining the core taxonomy to ensure the core was sufficiently “wide and shallow” and remained generic enough to allow as many COI taxonomies as possible to connect to the core. By keeping the CoreTax sufficiently generic, COI taxonomies could connect or “stub” to the core in as many points within the core and provide multiple pathways to their resources. After several iterations, the core taxonomy was baselined for use by the Horizontal Fusion pilot program in Quantum Leap II. The focus group also realized they were building the core as a initial baseline taxonomy and purposefully limited the number of abstract elements due to manpower and time limitations.

The focus group’s final requirement was an exercise to test the connectivity or stubbing process between the core and various COI taxonomies. Prior to the exercise, the focus group provided the Horizontal Fusion (HF) program with a custom taxonomy built from the initial version of the core taxonomy and HF-specific information into a custom taxonomy. The HF taxonomy proved very successful for the Quantum Leap pilot and provided the catalyst for the “stubbing” exercise. By the time the core reached its more stable “beta” form in May of 2004, the focus group was ready to formally test the “stubbing” process.

The focus group began looking for taxonomies from established COIs to ensure the information was available and, by using established taxonomies, ensure the exercise could be completed in the allotted time. The focus group looked for and found four communities of interest that could provide taxonomies for the exercise. Once the taxonomies were found, teams were created and chartered to stub their respective taxonomy into the core using the following rules found in section 2.3 in this document.

# 2 Exercise Process and Business Rules

## 2.1 Exercise Mission

Certain team members were assigned to match or map three key concepts (or nodes) of an assigned COI taxonomy to corresponding or closely related nodes of the Core Taxonomy. This mapping process, which is called stubbing, is a means of joining Community-of-Interest (COI) taxonomies to a central taxonomy called the Core Taxonomy. This Core Taxonomy acts as a hub to which all COI taxonomies will be systematically linked and will be referred to in this process description as the hub.

To understand the motivation for stubbing, we first need to understand the eventual goal toward which we are working and the prerequisite steps toward that goal. That goal is to provide improved ease, accuracy, and completeness to

the discovery of registered resources. [2] The goal is to eventually provide federated searches across all DoD data sources similar to the way Google provides source listings across the Internet with the emphasis of providing listings of as many resources as possible based on the user's clearance.

To achieve the desired result of increased resolution and precision in a federated search, a COI-based taxonomy should not be a general purpose taxonomy, but rather, a well engineered description of the processes and hierarchical infrastructure within the organization. The taxonomy be a meaningful and descriptive index into COI-related resources of interest. Finding resources is much easier when using one's own familiar COI taxonomy. But since COI needs vary, the same resource may be sought in different COI taxonomies. Relating or mapping the nodes of salient COI taxonomies to some central hub facilitates this goal by linking identical and similar nodes. What we call complete mapping– mapping of every COI node to the corresponding nodes of the hub is eventually required to meet that goal.[3]

Stubbing is a minimal form of mapping the nodes of the COI taxonomies to the central hub. It provides a navigational path from the general hub taxonomy to all stubbed COI taxonomies. This allows resource discovery by those unfamiliar with the existence of details within particular COI taxonomies. Such a hub-based network of stubbed COI taxonomies allows COI members to begin registering their data against the COI taxonomies of their choice. This early registration would be in anticipation of the more thorough mapping that would support high-precision/high-recall search as an evolutionary part of the process. Figure 1 is a graphical presentation of two COIs using the Core taxonomy to present their information to each other. The stubbing process provides a consistent path for finding metadata information via the core. The focus group's exercise was to find and document at least three points where the COI taxonomy can connect to the core or hub to provide this ability to make their information available to others.

[2] Peterson, E., Justifying Semantic-Web-based Resource Registration and Discovery, Second Semantic Technologies for eGov, McLean, VA, 2004.

[3] Peterson, E., Customized Resource Discovery: Linking Formalized Web Taxonomies to a Web Ontology Hub, AAAI Workshop on Semantic Web Personalization, San Diego, CA, 2004

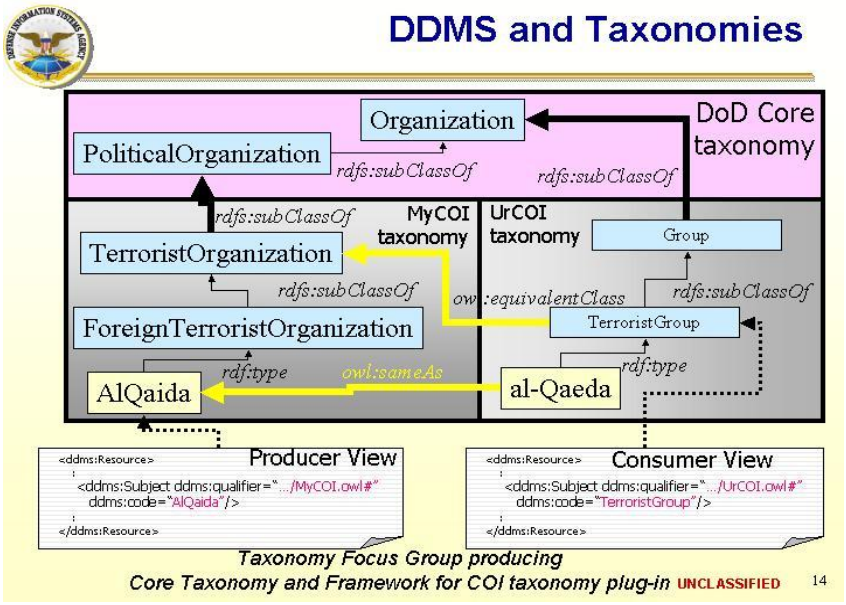


**Figure 1: Stubbing representation to Core. (Graphic by Dr. Hayes)**

## 2.2 Exercise Process

### 2.2.1 Choosing which COI Nodes to Stub

A well structured COI Taxonomy will have one top node or concept that is more general than all the other nodes. This taxonomy's nodes will be linked to one another in a hierarchy. In that case, the top node is the obvious stub point if only one stub point is chosen.

Some taxonomies are actually organized as a "forest" of taxonomies where there is no one stated top node. Rather, they have some number of top nodes from which separate taxonomies descend. An effective stubbing requires that each top node be mapped to the hub. Omitting the mapping of any of these nodes will leave portions of the COI taxonomy undiscoverable by navigation from the hub.

The selected stubbing nodes as described above will very likely be the most important nodes to be stubbed. But beyond this initial stubbing, mapping in a way to support more ambitious use cases becomes much more involved. Any addition of a small number of other mappings will be just starting a larger process and leaving it unfinished.

### 2.2.2 Stubbing the Chosen Nodes

After having selected the COI nodes to stub to the hub taxonomy, the actual

stubbing or mapping of the individual nodes is the next step in the process. In attempting to map an individual COI node to the hub, follow the process provided below:

1. *Attempt to Find an Exact Match:* The first step in individual node mapping is finding an exactly matching node in the hub for the COI node in question. The meaning of the COI node must be provided in its name as semantically explained in an accompanying detailed definition. The same is true of the meaning of the hub node. The meanings of the two nodes must precisely match in order to characterize the mapping by the "sameAs" relation. To find such an exact match the hub nodes can be searched for node string matches backed up with definition matches. Failing an initial search for like nodes, a top down navigation of the hub hierarchy may find a match if it exists. If such an exact match is found, then the mapping of that COI node is complete.

2. *Find All Superclass nodes:* If an exact match search does not provide nodes, the next option is a subclass-to-superclass mapping search. The process is to find a hub node element that is considered a superclass or parent category of the COI node being considered. If automating this process the program must search for more general terms rather than exact terms. The individual(s) doing the analysis or “mapper(s)” must come up with such general terms. Please use the following test sentence to determine if one concept is the superclass of another: “*A* is the superclass of *B* if *B* is a kind of *A*.” Since concepts can fit in more than one hub category, the hub may have more than one superclass per COI node. Mappers need to emphasize finding as many superclass-to-subclass connections as possible so federated searches, or resource discovery, has multiple paths to find valid resources. All mapped COI nodes that are not exact matches should have at least one superclass mapping to the hub.

3. *Find All Whole Nodes:* If the COI node represents a part, component, or portion of some concept represented in the hub, use the "partOf" relation to map the COI node to the hub node. There may be more than one such mapping for a given COI node.

4. *Find Relevant Related Nodes:* For those situations where the node does not exactly fit a “sameAs”, “subclassOf”, or “partOf” relationship, other options may be considered. The "sameAs" and "partOf" relations do not always occur in the mapping process, and the "subclassOf" relation often does not capture the real essence of the COI node. In cases where the relationship is more tentative or nebulous, the mappers may be forced to use the "relatedTo" relation. This is a catch-all relation that is more general than the other three relations and allows the mapper to loosely tie the node to one or more hub nodes in a less than optimal way. Use this relationship only when the other three relationships do not

tell the whole story and it is essential that a node be tied to the hub. The "relatedTo" options provide an alternative relationship between two nodes when no other relationship works.

(NOTE: Use "relatedTo" as a last alternative when building relationships between nodes. The "relatedTo" option was adopted by our focus group by a narrow majority of members with a significant minority considering it too nebulous for actual coding in an OWL representation of the taxonomy. Once a node is categorized as "relatedTo" continue your analysis and work to find a more substantial relationship or build a new superclass that provides a more substantial relationship. Over time, work to move all "relatedTo" nodes to "subClass", "partOf" or "sameAs" relationships.)

(Each particular COI spreadsheet representation is given in Appendix A.)

## 2.3 Exercise Business Rules

The following are the business rules used to connect or "stub" a community of interest (COI) taxonomy element to the Core Taxonomy:

1. The focus group will only use taxonomies adopted by the entire focus group.
2. Each team will be assigned taxonomy. The exercise is successful if the team finds a minimum of three connection or stub points between the COI taxonomy and the Core taxonomy.
3. When connecting the two taxonomy elements, the team will stub the COI element to the Core element, not the Core element to the COI. (All arguments must be one way. Determine how the COI's node relates to the Core node. The relationship can only be applied in one direction.)
4. When determining where a COI element is connected, the team will pick the appropriate Core element that is the closest to the top-level element.
5. COI elements can be connected to multiple core elements.

# 3 Individual COI Backgrounds

As mentioned before, the focus group or TaxFG decided to use taxonomies from known sources in the exercise to minimize processing time. This section provides a limited background on those four communities to help the reader understand where the information is derived and how it is used.

## 3.1 Army & Marine Training Initiative

An initial analysis of The Army-Marine Corps Training and Doctrinal (AMTD) taxonomy, a combined taxonomy with three distinct areas, has 1,200 entities in the Army segment with ten hierarchical levels. The Marine Corps segment has 100 entries with eight data levels. The final section is Environment with 300 entries at seven data levels. The taxonomy is the work of a combined group of Army and Marine subject matter experts from the respective training and doctrinal commands combined with dedicated taxonomists. Their mission was to provide a taxonomic structure of every element presented in the training materials available to the soldier and marine. The taxonomy would become the organizational structure for providing information from the respective Army and Marine training command. In essence the AMTD became the U.S. land forces centralized training taxonomy. Once the definitions are added, this taxonomy can be used as land battle taxonomy.

## 3.2 Community Command & Control Information Exchange Data Model (C2IEDM)

This data model was developed by warfighters to facilitate the exchange of information between warfighters' command and control computer systems. While C2IEDM was developed with a focus on the exchange of command and control information between the systems of allies and coalition partners, it is as useful for the exchange of information between US systems. C2IEDM is a product of the analysis of a wide spectrum of allied information exchange requirements. It models the information commanders need to exchange (both vertically and horizontally). It serves as the common interface specification for the exchange of essential battle-space information.

The administrative advocate for the C2IEDM is the Multilateral Interoperability Program (MIP), which is a cooperative organization comprising 32 members including the U.S. "The MIP emphasis is to provide international interoperability of Command and Control Information Systems (C2IS) at all levels of tactical and strategic multinational, combined and joint operations."[4] To date, the thirty-two nations supporting MIP have integrated the C2IEDM data model into the command and control systems used in NATO, coalition and European community (EU) C2 information systems with the intent to provide interoperability among and between various nations C2IS.

The means to achieve this is known as the MIP solution, which includes the MIP specifications, Standard Operation Procedures and other documentation that is required for implementation of the specifications and for use of the MIP Common Interface (MCI).

[4] The Multilateral interoperability Program (MIP), http://www.mip-site.org. , C2IEDM MAIN – UK – DMWG Edition 6.15, 1 Oct, 2004.

The MIP solution enables information exchange between cooperating C2 systems from multiple nations. “The MIP solution enables C2IS to C2IS information exchange and allows users to decide what information is exchanged, to whom it flows, and when.”[5]

The extent of the requirements agreed to by MIP nations is to define only the information that is to be exchanged, rather than model all of the information that would normally be required by a national system. Consequently, C2IEDM is first and foremost an *information exchange data model*. The model can also serve as a coherent basis for other information exchange mechanisms currently lacking a unified information structure such as message formats.

### 3.2.1 Data Modeling Tool

The diagrams for the model documentation were created using ERwin™ Version 3.5.2 software from Computer Associates International, Inc and IDEF1X notation.

### 3.2.2 The Notion of a C2 Data Model as a Hub

A C2 data model of necessity must encompass information from multiple functional areas in the domain of military operations. Consequently, a C2 data model serves as a “hub” for unifying information concepts that are embodied in the data specifications of functional areas. The concept of interdependence between the C2 data model and the specialty subjects represented by functional areas is illustrated in Figure 2 below.

“The desired goal in the long-run would be a federation of data specifications that use the C2 data model as the basis for functional area models. This would ensure that the data that is common between the spokes and the hub is viewed and structured in a standard way and that the data model views can be readily integrated into coherent structures wherever such integration is needed.”[6]

Within the United States, the C2IEDM is being used by many efforts including:

1. The DoD Modeling and Simulation Office
2. Net-Centric Capabilities Pilot (NCCP)
3. Family of Interoperability Pictures (FIOP)

[5] The Multilateral interoperability Program (MIP), http://www.mip-site.org. , C2IEDM MAIN – UK – DMWG Edition 6.15, 1 Oct, 2004.

[6] The Multilateral interoperability Program (MIP), http://www.mip-site.org. , C2IEDM MAIN – UK – DMWG Edition 6.15, 1 Oct, 2004.

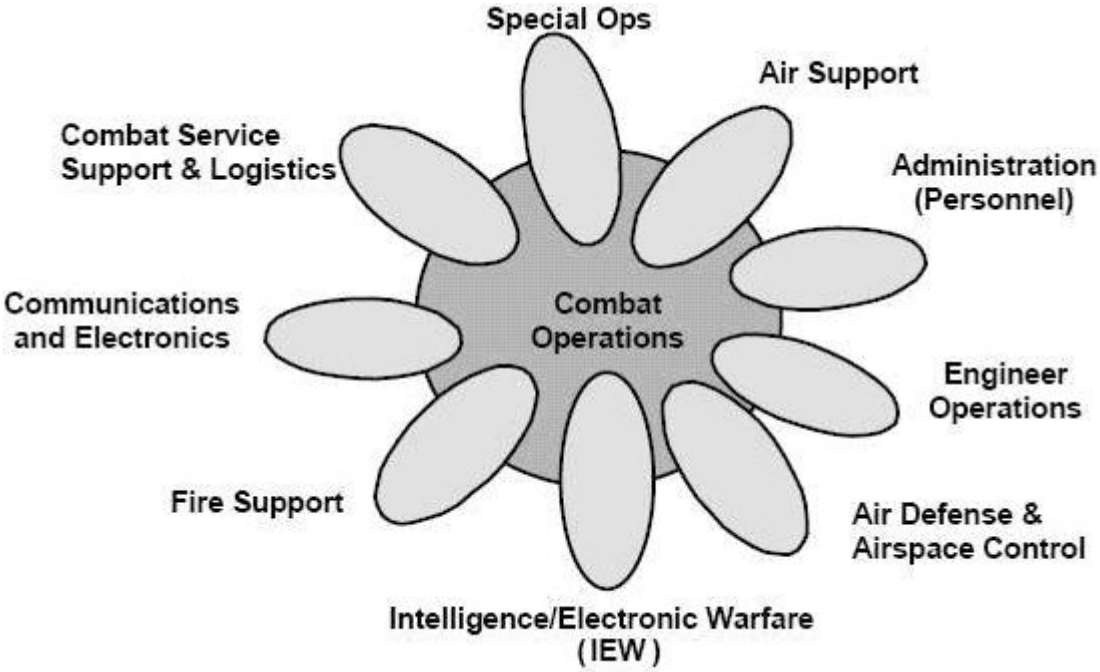


**Figure 2: C2 Data WRT Functional Area**

## 3.3 Defense Technical Information Center (DTIC)

"The Defense Technical Information Center (DTIC) is the premier provider of DoD technical information to U.S. Government, Academic and commercial organizations in support of Department of Defense research and development efforts. DTIC serves as a vital link in the transfer of information among DoD personnel, DoD contractors and potential contractors and other U.S. Government agency personnel and their contractors. DTIC is a DoD Field Activity under the Under Secretary of Defense for Acquisition, Technology and Logistics, reporting to the Director, Defense Research & Engineering (DDR&E). <http://www.dod.mil/ddre/>.

DTIC is chartered to:

- Provide direct information to the warfighter.
- Provide technical information support to DoD weapons and information systems development processes
- Leverage the multi billion dollar investment in DoD scientific and technical research so that it can be used by citizens at large.
- Prevent unnecessary or redundant research from being performed at taxpayer expense.

- Allow for future research to be built upon existing completed research.

DTIC provides support to customers and fulfills its charter by:

- Providing a staff of DoD-funded researchers to search DTIC's collections of technical reports and summaries and provide information to qualified individuals and organizations about ongoing federal research.
- Ensuring no unnecessary research is undertaken at tax payer's expense.
- Provides reports to OMB on any federally funded projects deemed unnecessary or redundant.

"DTIC also has leading edge expertise in hosting Web sites, collecting and categorizing technical data and analyzing technical information. DTIC has provided web site design and implementation support to over 100 federal web sites for various DoD programs. DTIC also manages eleven Information Analysis Centers chartered to assist qualified customers in locating, analyzing and using scientific and technical information in specialized subject areas.

DTIC provides public, limited and classified versions of a scientific and technical information network known as STINET. The general public has access to DTIC's publicly accessible collections of technical information via the 'Public STINET'. Individuals can display and/or download unclassified scientific and technical information collected from various federal research and development programs using the public STINET.

DTIC also makes sensitive and classified information available to eligible individuals provided they have the proper security clearances and are given access rights to either the Private or Calssified STINET. DTIC provides classified information to most DoD and Intelligence community organizations requiring background information on current and archived research.

The Limited portion of DTIC's STINET provides DTIC registered users with a more complete version of DTIC's Technical Reports Collection than the Public STINET site, plus access to a database on current DoD research. Among the features available to the defense community, including government employees and contractors, are citations to limited distribution documents and an extensive full-text report collection. Private STINET also provides free access to two online database services that index thousands of international journals and conference proceedings. With free registration, Private STINET can provide extensive access to classified but sensitive technical research." [7]

[7] Defense Technical Information Center (DTIC), http://www.dtic.mil. , DTIC , 6 October 2004

The Classified portion of DTIC's STINET provides the capabilities of Private STINET's databases, but includes classified information, up to Secret, for those goveenment and contractor users who have access.

## 3.4 Meteorological and Oceanographic Community (METOC)

METOC is defined as: "A term used to convey all meteorological (weather) and oceanographic (physical oceanography) factors as provided by DoD Service components." "These factors include the whole range of atmospheric and oceanographic phenomena from the sub-bottom of the earth's oceans up to the space environment (space weather)."[8]

The METOC community is comprised of the organizations and personnel tasked with providing meteorological and oceanographic support to DoD operations, and includes the collection of electronically connected, shore-based meteorological and oceanographic (METOC) production facilities that includes centers such as Air Force Weather Agency, Navy Fleet Numerical METOC Center, 55th Space Weather Squadron, Naval Oceanographic Office, Warfighting Support Center, Air Force Combat Climatology Center, Fleet Numerical METOC Center Detachment, and the Air Force and Navy theater and/or regional METOC production activities. METOC facilities are also known as Meteorological Forecasting Centers or MFCs. These facilities consist of jointly supported operations of meteorological and oceanographic personnel and equipment formed to provide support to any and all joint operations around the world.

Organizations such as the Air Force Weather Agency are chartered to deliver timely, accurate, reliable weather products. The agency ensures that Air Force weather procedures, practices and equipment are standardized to the degree practical, while leaving units with sufficient flexibility to support a diverse, worldwide customer base.

The Navy Fleet Numerical METOC Center (Fleet Numerical) is the principal weather and ocean prediction center within the Department of Defense (DoD). Fleet Numerical has a well-established and time-tested infrastructure for around-the-clock computer systems support; observational data decoding and quality control; meteorological satellite data processing; data management; numerical weather and ocean model production run management; and product visualization, quality control and distribution.

[8] Joint Pub 3-59, 23 March 1999, "Joint Doctrine, Tactics, Techniques, and Procedures for Meteorological and Oceanographic Support"

The Defense Meteorological Satellite Program (DMSP) mission is to generate terrestrial and space weather data for operational forces worldwide. The Air Force is the Department of Defense's executive agent for this program. The data from this program is also furnished to the civilian community through the Department of Commerce NOAA. Data from these satellites can help identify, locate and determine the intensity of severe weather such as thunderstorms, hurricanes and typhoons. It also can be used to form three-dimensional cloud analyses, which are the basis for computer forecast models to meet unique military requirements.

# 4 Technical Transformation of Taxonomies to Web Ontology Language Files

## 4.1 COI Taxonomy Representation Formats

Taxonomies, being simpler than ontologies, can easily be represented in a formal ontology language such as the web ontology language or OWL. But how those ontologies are best represented in OWL can vary according to the nature of the taxonomy. With that thought in mind, we can characterize taxonomies as *strict* or *informal*. We characterize a strict ontology as one in which all *taxon/subtaxon* relations are class/subclass relations. Linnaeus' biotaxononmy is an example of a strict taxonomy. An informal taxonomy provides larger degrees of separation in the relationships between elements and do not follow the strict *taxon/subtaxon* requirements. Examples of both types of encoding are found in the Appendix C.

## 4.2 Encoding Formal Taxonomies

Formal taxonomies are easily encoded in OWL. One simply encodes the taxonomic nodes as classes and links the class nodes together via the *rdfs:subclassOf* relation into an hierarchy. Please note that formal or strict taxonomies cannot properly represent topics and instances that are represented in less formal (informal) taxonomies such as Cyc. (The relationships are too structured to include similar but less defined relationships between ideas.) More to the point, most taxonomies have a looser notion of the relationships that link nodes in the hierarchy. Their taxonomic relationship will encompass a variety of additional relations such as "*partOf"* to explain connections between ideas.

## 4.3 Encoding Informal Taxonomies

This group has not chosen to represent informal taxonomies with more general and simple schemes where taxonomy is simply a hierarchy of things. As such the taxonomic nodes are more formally tied to each other rather than "things" or instances of class *Thing* loosely connected. In this exercise, all items used are directly tied to the military and a military mission. The relationship that links these things into a hierarchy is a specific relation. The group chose not to use the

relation *subTaxonOf*. It can mean *subclassOf*, *partOf,* or any other hierarchical relationship imaginable in a more informal environment, but in this exercise, the *isSubTaxonOf* option was removed because the group felt they had neither the expertise nor the manpower to effectively research informal relations in the narrow time allotted.

When building your own COI taxonomy, your group of experts will have to decide if you should use this simpler scheme. The determining factor will be if the taxons relationships are determined to be loosely defined, or not known to be well defined. If your group chooses to use loosely defined relationships to build your taxonomy, efforts should be made over time to analyze and discover stricter subclass relationships when possible to allow the group to formalize as many concepts as possible.

# 5 Technical Transformation of Taxonomies to Web Ontology Language Files

Since OWL is a relatively new format, and ontologies are similarly new, legacy taxonomies are not likely to be expressed in OWL, and the translation of a variety of legacy taxonomic formats into OWL was part of the task.

For METOC and C2IEDM the models originally resided in Erwin 3.52 as class hierarchies within data models. Erwin output the models in a proprietary binary format and comma separated values (CSV). The CSV format was used to import the information into the official spreadsheet format of the CES MWG. (Dr. Glenda Hayes provided a means to manipulate the Erwin data and make it readable in Excel. See section 5.1 Repurposing Metadata for more information.) Spreadsheet example snippets are provided in Table 1 (METOC) and Table 2 (C2IEDM). In both cases, the COI element ID and title are presented and the mapping or triple represents the relationship between the COI element and the core abstract.

**Table 1: Example METOC spreadsheet**

| COI term ID | COI term Label | COI term Definition | Mapping(s) |
|---|---|---|---|
| aadt_cd-1 | ASTROLABE | Astrolabe - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aadt_cd-2 | ASTRONOMIC THEODOLITE | Astronomic theodolite - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aadt_cd-3 | BC-4 CAMERA | Bc-4 camera - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aadt_cd-4 | OPTICAL TELESCOPE | Optical telescope - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |

**Table 2: Example C2IEDM spreadsheet**

| Taxonomy Term label | Parent Term | Mapping(s) |
|---|---|---|
| ACTION | ACTION | (subclassOf, this, Action) |
| ACTION-EVENT | ACTION | (subclassOf, this, Action) |
| Abdication | ACTION-EVENT | (subclassOf, this, Action-event) |
| Accident | ACTION-EVENT | (subclassOf, this, Action-event) |
| Accident, mine | ACTION-EVENT | (subclassOf, this, Action-event) |
| Accident, traffic | ACTION-EVENT | (subclassOf, this, Action-event) |

## 5.1 Repurposing Metadata

The DoD has developed many IDEF 1x models, created as a function of a data standardization activity or created to manage a database implementation. The question arises, “Can the metadata (terms, definitions, relationships, and valid values) recorded in an IDEF1x model be repurposed as a taxonomy for discovery?” To answer this question, we used two IDEF1x models: C2IEDM and METOC. We repurposed the metadata from each of these 2 models and analyzed the resulting taxonomies. Whereas the C2IEDM possessed a number of entities that contained subtypes, the METOC had significantly fewer (and thus did not make for a very deep taxonomy). The inclusion of valid values produces a very rich taxonomy that spans from the very generic (e.g., object-type) down to the very specific (e.g., barracks). This effort illustrates that some of the investment in data modeling can be repurposed to create a COI taxonomy, thus saving development time and effort while benefiting from reusing a coordinated set of terminology and relationships.

The general process that was used for both these examples was to manipulate the model information (via custom application code) to:

1. Include all entities (name & definition) that contain a subtype (see Figure 3 below for an example portion of the C2IEDM)

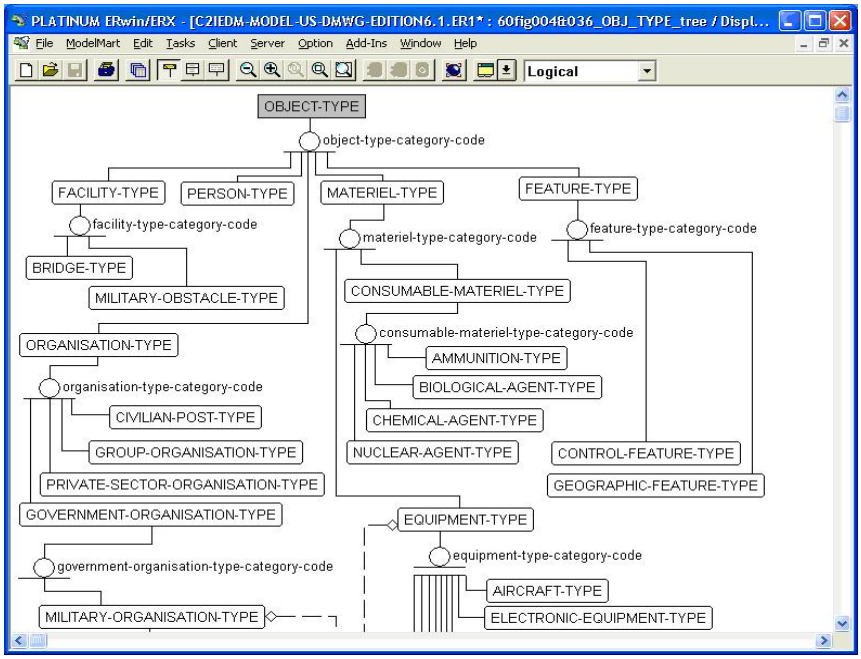


**Figure 3: Subtypes of OBJECT-TYPE**

2. For each of these entities, include the subtypes and the domain values for any attributes that are restricted to a defined set of valid values (enumerated domain). (Figure 4 below focuses on the examination of valid values for the Facility item type.)

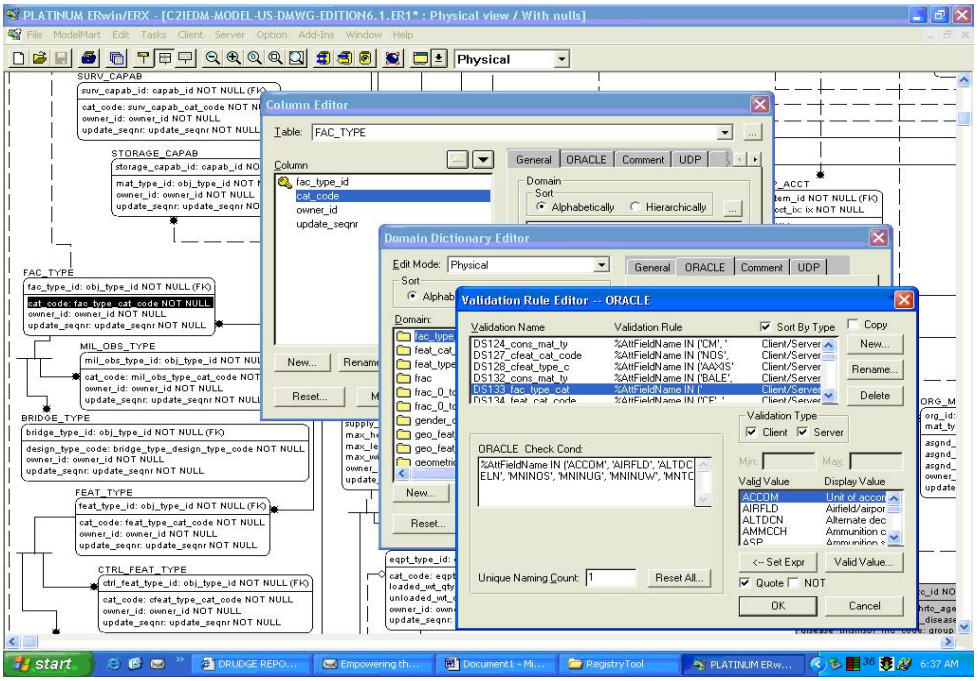


**Figure 4: Subtypes of FACILITY-TYPE**

3. Filter out the domain value sets that don't provide further specializations of the entity
4. Save the resulting information using the OWL notation, adorned with resource metadata to self-describe the taxonomy for registration (see Figure 5 below).

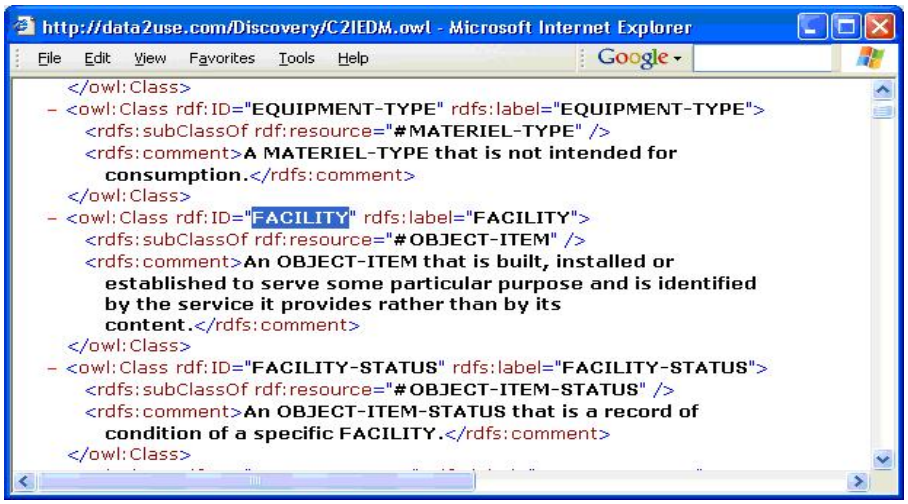


**Figure 5 - C2IEDM taxonomy encoded in OWL syntax**

The end result is a taxonomy (each node containing id, label, and definition) that can be navigated as shown in the series of three screen captures below (Figure 6, Figure 7, and Figure 8):

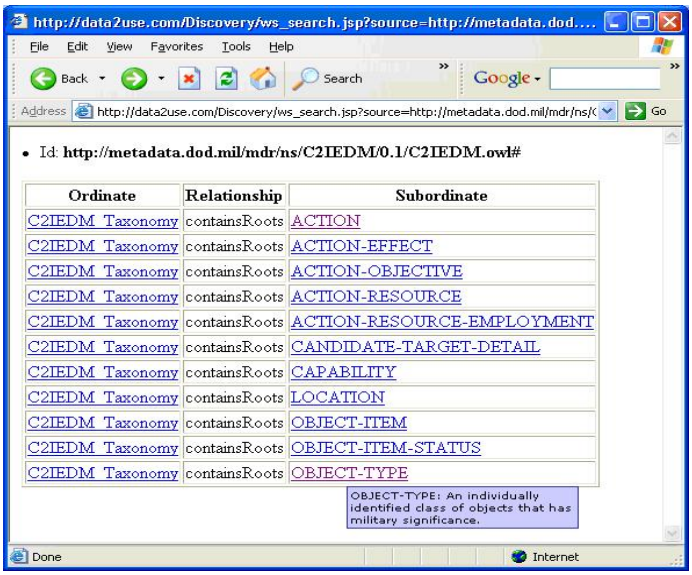


**Figure 6 - Uppermost level of C2IEDM Taxonomy**

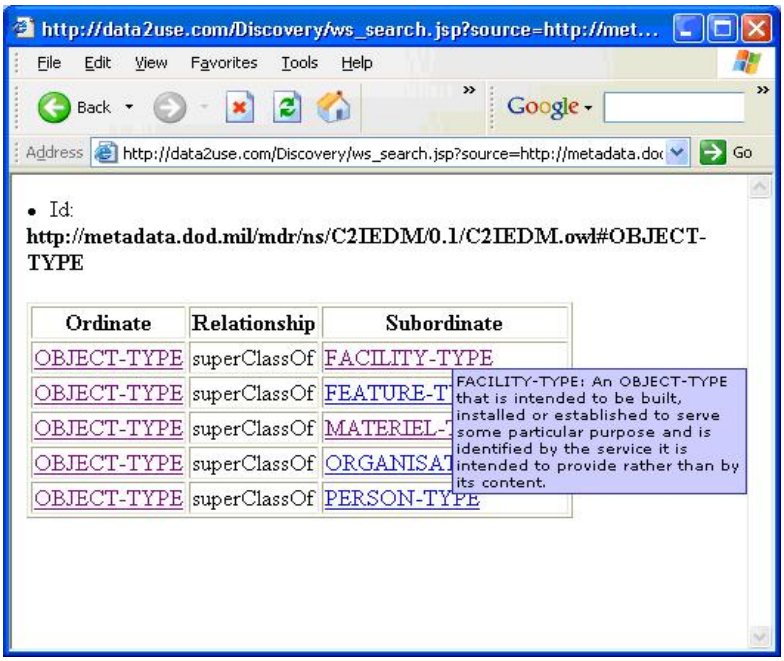


**Figure 7 - Drill down from Root-level to OBJECT-TYPE**

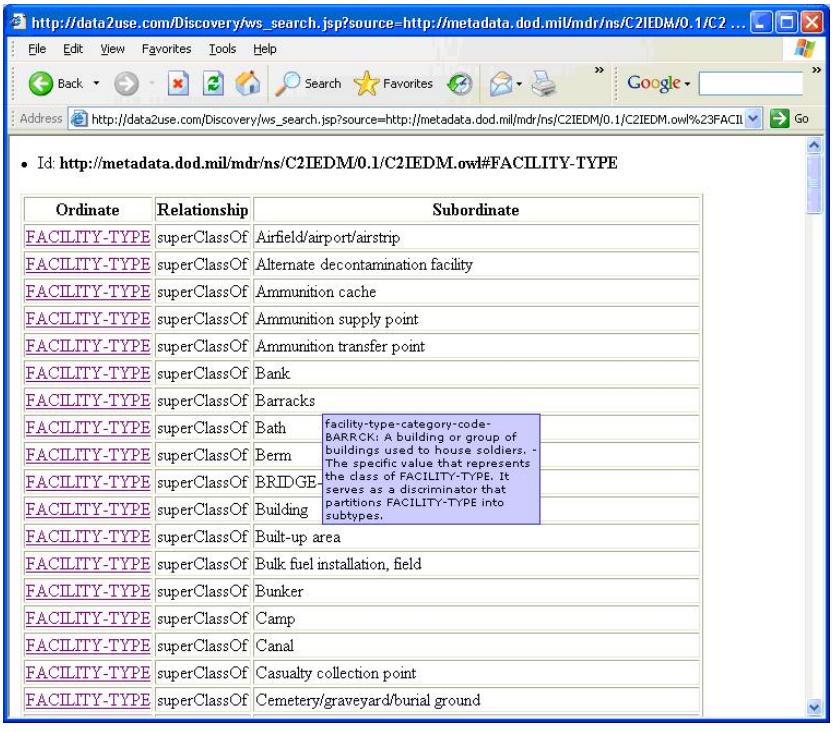


**Figure 8 - Leaf-level nodes under FACILITY-TYPE**

# 6 Conversion of Spreadsheet Information

Because each team was assigned a specific taxonomy with a different design, it was essential that information be presented in a standard presentation. Dr. Hayes proposed the following "standard" presentation in an example spreadsheet; see Table 3 below, as a way to standardize each team's information.

**Table 3: Example spreadsheet for the COI taxonomy exercise**

| COI Taxonomy term ID | COI Taxonomy term Definition | Mapping(s) |
|---|---|---|
| | | |
| ORGANISATION | An OBJECT-ITEM that is an administrative or functional structure. | (sameAs, Core, Organization ) |
| CONVOY | An ORGANIZATION that is a group of vehicles organized for the purpose of control and orderly movement with or without escort protection. | (subclassOf, this, ORGANIZATION) |
| UNIT | {definition} | (subclassOf, this, ORGANIZATION) |

When building your spreadsheet use the following columns as a minimum for showing your work:

a. COI taxonomy term ID

b. COI taxonomy term definition

c. COI taxonomy mappings

The information presented in each column provides a useful explanation of each term being considered. The three items are the "term ID" or title, the "term definition" to clarify the term and the "taxonomy mapping trilogy" or triple. (Example: subclassOf, this, GRAVITY-METER.)

The triple consists of three parts:

a. The relationship. (Example: "PartOf")

b. The reference taxonomy (Usually "Core" or "this"[taxonomy])

c. Parent term (Body part.)

Example relationships are:

a. SubclassOf (specialization of reference term)

b. PartOf (part of whole)

c. instanceOf or SameAs (substitute for reference term)

Building the reference spreadsheet with this format provides the user with a listing of those elements that are stubbed to the Core by listing the 2nd item in the triple as "Core". Stub points can easily be found in the spreadsheet using this format.

## 6.1 Conversion to OWL

OWL is the form chosen by the focus group to provide the relationships between the various elements used to build the taxonomy. OWL is the W3C preferred format for representing ontologic relationships between the taxonomic nodes.

The best way to build an OWL file is to use a semantic tool such as Protégé, XMLSPY, or Xerces, but individuals are not limited to those products. A good ASCII editor is sufficient for building the file.

OWL is an extremely capable and extensible language and the examples shown in this paper are simply introduction into its capability. For more information about OWL please go to http://xml.coverpages.org/owl.html or http://xml.coverpages.org/ni2004-12-01-a.html .

For our group, OWL files were built using Protégé and XMLSPY design tools. The following are examples taken from the team's efforts to build the Core taxonomy.

The examples used in this section are taken from the core taxonomy using elements from the "Account" abstract.

The OWL file is an XML representation of the taxonomy. The initial portion of the file provides background information and points-of-contact. The format uses elements from the DDMS to make the file discoverable to other users. The following is an example of the introductory section of the file:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:ddms="http://metadata.dod.mil/mdr/ns/DDMS/1.0/ddms.owl#" xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:sumo="http://reliant.teknowledge.com/DAML/SUMO.owl#"
xmlns="http://metadata.dod.mil/mdr/ns/TaxFG/0.75c/Core_Tax_0.75c.owl#">
    <owl:Ontology rdf:about="">
        <rdfs:comment>
            <ddms:Resource>
                <ddms:identifier
qualifier="http://metadata.dod.mil/mdr/ns/MDR/1.0/MDR.owl#GovernanceNamespace" value="ENT.CES"/>
```

```
<ddms:identifier qualifier="Version" value="0.75c"/>
<ddms:title>DoD Core taxonomy</ddms:title>
<ddms:description>Beta DOD core taxonomy, to be used as the baseline taxonomy for the NCES discovery capability</ddms:description>
<ddms:dates ddms:posted="2005-01-11"/>
<ddms:creator>
    <ddms:Organization>
        <ddms:name>Core Taxonomy Focus Group</ddms:name>
        <ddms:email>ghayes@mitre.org (Glenda Hayes)</ddms:email>
    </ddms:Organization>
</ddms:creator>
<ddms:publisher>
    <ddms:Organization>
        <ddms:name>MITRE</ddms:name>
        <ddms:phone>703-883-7175</ddms:phone>
        <ddms:email>ghayes@mitre.org (Glenda Hayes)</ddms:email>
    </ddms:Organization>
</ddms:publisher>
<ddms:format>
    <ddms:Media>
        <ddms:mimeType>text/xml</ddms:mimeType>
        <ddms:medium>digital</ddms:medium>
    </ddms:Media>
</ddms:format>
<ddms:subjectCoverage>
    <ddms:Subject>
        <ddms:category ddms:qualifier="http://metadata.dod.mil/mdr/ns/TBD/1.0/core.owl#" ddms:code="InformationManagement"/>
    </ddms:Subject>
</ddms:subjectCoverage>
<ddms:temporalCoverage>
    <ddms:TimePeriod>
        <ddms:start>2004-07-06</ddms:start>
        <ddms:end>2004-12-31</ddms:end>
```

```
                    </ddms:TimePeriod>
                </ddms:temporalCoverage>
                <ddms:geospatialCoverage>
                    <ddms:Place>
                        <ddms:name>Virtual</ddms:name>
                    </ddms:Place>
                </ddms:geospatialCoverage>
                <ddms:protectedBy>
                    <ddms:Security>
                        <ddms:classification>U</ddms:classification>
                    </ddms:Security>
                </ddms:protectedBy>
            </ddms:Resource>
        </rdfs:comment>
    </owl:Ontology>
```

Notice in the 10th line, the Namespace “ENT.CES” is provided to show where the file is registered within the DoD Metadata registry. Having a namespace is crutial for registrying your work. When building the file ensure you have a namespace POC provide you with the proper information to register this file in the metadata registry. If you don’t add the namespace reference, you won’t be able to connect to the Core taxonomy and other registered taxonomy files.

Finally, the section with the actual elements within the taxonomy and their relationships is next. The following example takes the top-level abstract “Account” and the first two elements, “Federal fund account” and “General federal fund account”. (The group agreed on a common naming format of capitalizing only the first item in each title followed by all lower case words.) The following example presents the element found in the spreadsheet followed by the actual XML code found in the OWL file.

Element found in the Excel Spreadsheet.

| | | | |
|---|---|---|---|
| Federal fund account | 1.1 | Accounts composed of moneys collected and spent by the Federal government other than those designated as trust funds. | GAO/AFMD2.1.1 |

Code for same element found in the OWL file.

```
<owl:Class rdf:ID="_1.1" rdfs:label="Federal fund account">
```

<rdfs:subClassOf rdf:resource="#_1"/>

<owl:comment>Accounts composed of moneys collected and spent by the Federal government other than those designated as trust funds. {Source: GAO/AFMD2.1.1}</owl:comment>

</owl:Class>

Here is the example for the next element “General federal fund account”. Notice both the element definition and a source are provided to help individuals using the information understand the semantic framework in which the element is being used.

Element found in Excel Spreadsheet.

| | | | |
|---|---|---|---|
| General federal fund account | 1.1.1 | Federal fund accounts composed of all federal money not allocated to any other fund account. | GAO/AFMD2.1.1 |

Code provided in the OWL file.

<owl:Class rdf:ID="_1.1.1" rdfs:label="General federal fund account">

<rdfs:subClassOf rdf:resource="#_1.1"/>

<owl:comment>Federal fund accounts composed of all federal money not allocated to any other fund account. {Source: GAO/AFMD2.1.1}</owl:comment>

</owl:Class>

In both examples, the relationship to the top-level abstract “Account” is a direct parent-child relationship found on the second line. The relationship (subClassOf) and the position number (1.1) is provided to show where the element falls within the taxonomic heirachy.

A visual presentation of these elements is shown in figure 3.

```
<?xml version="1.0" ?>
- <rdf:RDF xmlns:owl="http://www.w3.org/2002/07/owl#"
    xmlns:ddms="http://metadata.dod.mil/mdr/ns/DDMS/1.0/ddms.owl#" xmlns:rdfs="http://www.w3.org/2000/01/rdf-
    schema#" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:sumo="http://reliant.teknowledge.com/DAML/SUMO.owl#"
    xmlns="http://metadata.dod.mil/mdr/ns/TaxFG/0.75b/Core_Tax_0.75b.owl#">
  + <owl:Ontology rdf:about="">
  - <owl:Class rdf:ID="_1" rdfs:label="Account">
      <rdfs:comment>A separate financial reporting unit for budget, management, and or accounting proposes. {Source:
        GAO/AFMD2.1.1}</rdfs:comment>
    </owl:Class>
  - <owl:Class rdf:ID="_1.1" rdfs:label="Federal fund account">
      <rdfs:subClassOf rdf:resource="#_1" />
      <rdfs:comment>Accounts composed of moneys collected and spent by the Federal government other than those
        designated as trust funds. {Source: GAO/AFMD2.1.1}</rdfs:comment>
    </owl:Class>
  - <owl:Class rdf:ID="_1.1.1" rdfs:label="General federal fund account">
      <rdfs:subClassOf rdf:resource="#_1.1" />
      <rdfs:comment>Federal fund accounts composed of all federal money not allocated to any other fund account. {Source:
        GAO/AFMD2.1.1}</rdfs:comment>
    </owl:Class>
```

**Figure 9: OWL file example.**

The same example with the comments and source definitions minimized is presented in figure 4.

```
<?xml version="1.0" ?>
<!--  edited with XMLSPY v5 rel. 4 U (http://www.xmlspy.com) by Michael Fontaine (McDonald Bradley, Inc)   -->
- <rdf:RDF xmlns:owl="http://www.w3.org/2002/07/owl#" xmlns:ddms="http://xml.dod.mil/ddms/1.0/ddms#"
    xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:sumo="http://reliant.teknowledge.com/DAML/SUMO.owl#"
    xmlns="http://tax.dod.mil/DoD/0.1/0.7.owl#">
  + <owl:Ontology rdf:about="http://tax.dod.mil/DoD/0.1/0.7.owl#">
  + <owl:ObjectProperty rdf:ID="contains">
    <owl:ObjectProperty rdf:ID="isPartOf" />
  + <owl:Class rdf:ID="_1" rdfs:label="Account">
  + <owl:Class rdf:ID="_1.1" rdfs:label="Federal fund account">
  + <owl:Class rdf:ID="_1.1.1" rdfs:label="General federal fund account">
  </rdf:RDF>
```

**Figure 10: OWL file example. (With definitions suppressed)**

During development, the positioning codes prove essential for placement and maneuverability. However, the final version of any COI taxonomy must be free of position codes to allow the federated search engine to query element names and not be impacted by duplication positioning numbers from multiple COI files. Please remember to remove all positioning numbers witthin the final OWL file prior to sending the file to the Metadata registry.

Figure 5 represents the same OWL code as in figure 3 but without the positioning codes.

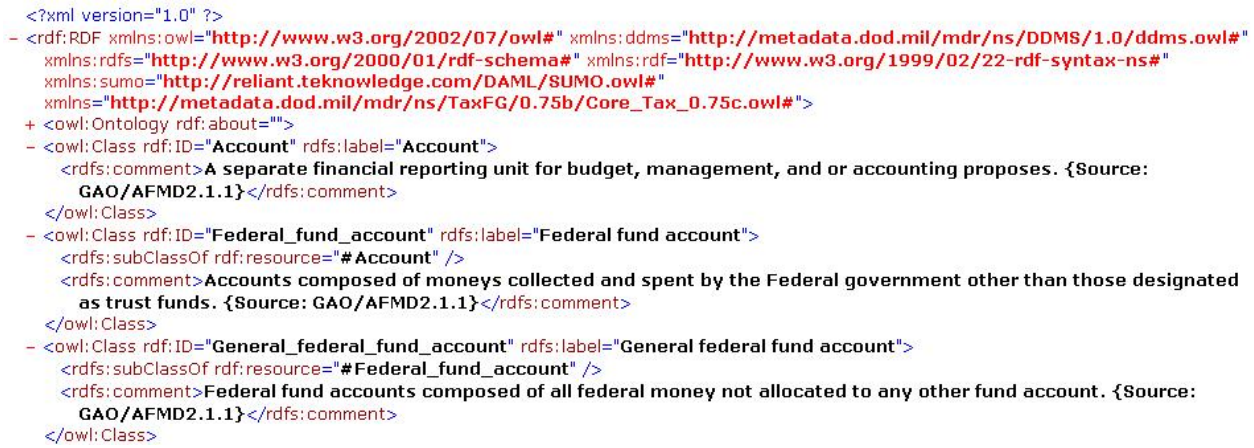


**Figure 11: OWL file example. (With position codes removed)**

The code for figure 11 is shown below:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:ddms="http://metadata.dod.mil/mdr/ns/DDMS/1.0/ddms.owl#" xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:sumo="http://reliant.teknowledge.com/DAML/SUMO.owl#"
xmlns="http://metadata.dod.mil/mdr/ns/TaxFG/0.75c/Core_Tax_0.75c.owl#">
    <owl:Ontology rdf:about="">
        <rdfs:comment>
            <ddms:Resource>
                <ddms:identifier
qualifier="http://metadata.dod.mil/mdr/ns/MDR/1.0/MDR.owl#GovernanceNamespace" value="ENT.CES"/>
                <ddms:identifier qualifier="Version" value="0.75c"/>
                <ddms:title>DoD Core taxonomy</ddms:title>
                <ddms:description>Beta DOD core taxonomy, to be used as the baseline
taxonomy for the NCES discovery capability</ddms:description>
                <ddms:dates ddms:posted="2005-01-11"/>
                <ddms:creator>
                    <ddms:Organization>
                        <ddms:name>Core Taxonomy Focus Group</ddms:name>
                        <ddms:email>ghayes@mitre.org (Glenda
Hayes)</ddms:email>
                    </ddms:Organization>
                </ddms:creator>
                <ddms:publisher>
```

```
                    <ddms:Organization>
                        <ddms:name>MITRE</ddms:name>
                        <ddms:phone>703-883-7175</ddms:phone>
                        <ddms:email>ghayes@mitre.org (Glenda
Hayes)</ddms:email>
                    </ddms:Organization>
                </ddms:publisher>
                <ddms:format>
                    <ddms:Media>
                        <ddms:mimeType>text/xml</ddms:mimeType>
                        <ddms:medium>digital</ddms:medium>
                    </ddms:Media>
                </ddms:format>
                <ddms:subjectCoverage>
                    <ddms:Subject>
                        <ddms:category
ddms:qualifier="http://metadata.dod.mil/mdr/ns/TBD/1.0/core.owl#" ddms:code="InformationManagement"/>
                    </ddms:Subject>
                </ddms:subjectCoverage>
                <ddms:temporalCoverage>
                    <ddms:TimePeriod>
                        <ddms:start>2004-07-06</ddms:start>
                        <ddms:end>2004-12-31</ddms:end>
                    </ddms:TimePeriod>
                </ddms:temporalCoverage>
                <ddms:geospatialCoverage>
                    <ddms:Place>
                        <ddms:name>Virtual</ddms:name>
                    </ddms:Place>
                </ddms:geospatialCoverage>
                <ddms:protectedBy>
                    <ddms:Security>
                        <ddms:classification>U</ddms:classification>
                    </ddms:Security>
                </ddms:protectedBy>
            </ddms:Resource>
```

```
        </rdfs:comment>
    </owl:Ontology>
    <owl:Class rdf:ID="Account" rdfs:label="Account">
        <rdfs:comment>A separate financial reporting unit for budget, management, and or accounting proposes. {Source: GAO/AFMD2.1.1}</rdfs:comment>
    </owl:Class>
    <owl:Class rdf:ID="Federal_fund_account" rdfs:label="Federal fund account">
        <rdfs:subClassOf rdf:resource="#Account"/>
        <rdfs:comment>Accounts composed of moneys collected and spent by the Federal government other than those designated as trust funds. {Source: GAO/AFMD2.1.1}</rdfs:comment>
    </owl:Class>
    <owl:Class rdf:ID="General_federal_fund_account" rdfs:label="General federal fund account">
        <rdfs:subClassOf rdf:resource="#Federal_fund_account"/>
        <rdfs:comment>Federal fund accounts composed of all federal money not allocated to any other fund account. {Source: GAO/AFMD2.1.1}</rdfs:comment>
    </owl:Class>
```

Here is the entire example file used to present the information in Figures 9 and 10:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:ddms="http://metadata.dod.mil/mdr/ns/DDMS/1.0/ddms.owl#" xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:sumo="http://reliant.teknowledge.com/DAML/SUMO.owl#"
xmlns="http://metadata.dod.mil/mdr/ns/TaxFG/0.75b/Core_Tax_0.75b.owl#">
    <owl:Ontology rdf:about="">
        <rdfs:comment>
            <ddms:Resource>
                <ddms:identifier
qualifier="http://metadata.dod.mil/mdr/ns/MDR/1.0/MDR.owl#GovernanceNamespace" value="ENT.CES"/>
                <ddms:identifier qualifier="Version" value="0.75b"/>
                <ddms:title>DoD Core taxonomy</ddms:title>
                <ddms:description>Beta DOD core taxonomy, to be used as the baseline taxonomy for the NCES discovery capability</ddms:description>
                <ddms:dates ddms:posted="2005-01-11"/>
                <ddms:creator>
                    <ddms:Organization>
                        <ddms:name>Core Taxonomy Focus Group</ddms:name>
```

```
                                        <ddms:email>ghayes@mitre.org (Glenda
Hayes)</ddms:email>
                                    </ddms:Organization>
                                </ddms:creator>
                                <ddms:publisher>
                                    <ddms:Organization>
                                        <ddms:name>MITRE</ddms:name>
                                        <ddms:phone>703-883-7175</ddms:phone>
                                        <ddms:email>ghayes@mitre.org (Glenda
Hayes)</ddms:email>
                                    </ddms:Organization>
                                </ddms:publisher>
                                <ddms:format>
                                    <ddms:Media>
                                        <ddms:mimeType>text/xml</ddms:mimeType>
                                        <ddms:medium>digital</ddms:medium>
                                    </ddms:Media>
                                </ddms:format>
                                <ddms:subjectCoverage>
                                    <ddms:Subject>
                                        <ddms:category
ddms:qualifier="http://metadata.dod.mil/mdr/ns/TBD/1.0/core.owl#" ddms:code="InformationManagement"/>
                                    </ddms:Subject>
                                </ddms:subjectCoverage>
                                <ddms:temporalCoverage>
                                    <ddms:TimePeriod>
                                        <ddms:start>2004-07-06</ddms:start>
                                        <ddms:end>2004-12-31</ddms:end>
                                    </ddms:TimePeriod>
                                </ddms:temporalCoverage>
                                <ddms:geospatialCoverage>
                                    <ddms:Place>
                                        <ddms:name>Virtual</ddms:name>
                                    </ddms:Place>
                                </ddms:geospatialCoverage>
                                <ddms:protectedBy>
```

```
                                        <ddms:Security>
                                            <ddms:classification>U</ddms:classification>
                                        </ddms:Security>
                                    </ddms:protectedBy>
                                </ddms:Resource>
                            </rdfs:comment>
                        </owl:Ontology>
                        <owl:Class rdf:ID="_1" rdfs:label="Account">
                            <rdfs:comment>A separate financial reporting unit for budget, management, and or accounting proposes. {Source: GAO/AFMD2.1.1}</rdfs:comment>
                        <owl:Class rdf:ID="_1.1" rdfs:label="Federal fund account">
                            <rdfs:subClassOf rdf:resource="#_1"/>
                            <owl:comment>Accounts composed of moneys collected and spent by the Federal government other than those designated as trust funds. {Source: GAO/AFMD2.1.1}</owl:comment>
                    </owl:Class>
                        <owl:Class rdf:ID="_1.1.1" rdfs:label="General federal fund account">
                            <rdfs:subClassOf rdf:resource="#_1.1"/>
                            <rdfs:comment>Federal fund accounts composed of all federal money not allocated to any other fund account. {Source: GAO/AFMD2.1.1}</rdfs:comment>
                        </owl:Class>
                    </rdf:RDF>
```

As mentioned before, this code can be created on a simple text editor such as notepad, but those building an actual OWL file will want the control and ease of an actual XML tool that builds and understands OWL format. Some suggestions are XMLSPY, Protégé and Xerces. Your XML development group may actually prefer one of these tools or may have found others. Regardless, of which tool you use, building the file is a team effort requiring the support of XML software coders and subject matter experts. Both play a key part in the design and development of the taxonomy and the associated files.

When building the taxonomy, do not be surprised if you go through several iterations before adopting the final product. This process is built on experience and understanding. In most cases, the level of understanding needed by the design group and the actual users requires multiple reviews of the product to ensure it "fits" the need. This process also allows for product maturing and expansion. Which means, once you have a baseline taxonomy/ontology, you will find eventual changes are in order to allow corrections in the process or organization you are representing. When the updates are suggested, embrace the requirement and make the changes. Your efforts will provide the users with important information and improved performance. What is key to success is the research used by the team to develop a taxonomy that captures the processes used by your organization and the semantic representation of each element. When building the taxonomy and adopting any element, ask yourself, "Does the definition of this item provide enough information for someone outside the organization to understand what this element is? Does it sufficiently portray what the element does in our process?" If you have answered both these questions in the affirmative, the semantic richness is in place to allow you to share your knowledge with others and to allow them to use your data correctly.

# 7 Exercise Methodology

This section will discuss unique properties and process techniques discovered by each team. The lessons are grouped by taxonomy to provide each team's interaction with their respective taxonomy.

## 7.1 Initial Conversion Issues

This exercise looked at stubbing four distinct taxonomies from four different communities in an effort to see if the process is:

a. Viable
b. Repeatable
c. Technically feasible

Understanding the requiremetns to test this process, each team began the process of taking what was available to them and tranforming the information into the standard format proposed by Dr. Hayes that allowed the focus gorup to determine if the taxonomic informtation met the three criteria mentioned above. Standardizing the process supports the second criteria (repeatability), and provides the user with an initial system for processing their respective information. This section provides background on what issues and challenges each team faced in initilizing the process of taking their raw information and converting it into a format that:

a. made sense
b. portrayed the community information and uniqueness
c. fit the parameters for stubbing

The result of their efforts was the successful integration of community taxonomic information with the core taxonomy. This, in turn, provided multiple avenues for access to the community's sharable information, and the opportunity, in time to improve discoverability to that information by other communities connected to the core.

### 7.1.1 AMTD Conversion Issues

The Army-Marine Corps Training and Doctrine (AMTD) taxonomy was initially presented to the team as a Hyper Text Markup Language (HTML) file. The file was ingested into Microsoft Word for review. A plain text ASCII file was created for initial analysis and later the ASCII file was imported to Microsoft Excel and converted to a comma separated value (CSV) file for further manipulation and analysis. The excel spreadsheet provided suitable separation of the information so team members could see that the taxonomy had three distinct areas:

1.) Army elements,

2.) Marine elements

3.) Environmental elements.

Once the distinction was made, heirarchical position numbers were added to allow the focus group to "flatten" the hierarchy of the taxonomy without losing the parent-child relationship between the elements. With the position numbers in place, the team began looking for elements that provided useful stubbing options.

As described before, the Army-Marine Corps TRADOC (Training and Doctrine Command) taxonomy structure revealed three distinct segments. The Army segment was the largest with 1,200 entries with ten hierarchical levels. The Marine Corps portion has 100 entries with eight hierarchical levels. The final section is titled Environment with 300 entries and seven hierarchical levels

The team working with the AMTD found ample connection points between the two taxonomies to demonstrate the viability of the latest version of the TaxFG product. However, the total absence of definitions in the AMTD Taxonomy created uncertainty in matching AMTD nodes with Core nodes. A liberal amount of "intuitive logic" was applied in the process to connect AMTD nodes to the core. In fact the team relied predominately on its more than 75 years of combined DoD experience to work through any issues when the analysts/reviewer determined what taxonomy nodes were valid stub point candidates. (Lesson learned: When building taxonomies, make sure each element has a viable and representative definition to help the user understand the meaning behind the respective node.)

### 7.1.2 C2IEDM Conversion Issues

The initial data set for the C2IEDM taxonomy was taken from the ErWin representation of the data model. A CSV file of the model was used to build the Excel spreadsheet version of the taxonomy. Limited definitions were available for the spreadsheet, but the team members had extensive backgrounds in the data model and used their experience to determine the stubbing candidates for this exercise. Since the C2IEDM is so large, the team decided to find the minimum three stub points from the numerous candidates and let the C2IEDM subject matter experts determine and publish the remaining stub point candidates. The team decided to limit their efforts because they felt the C2IEDM experts should pick the most optimum candidates for stubbing and therefore provided only the minimum number of candidates to complete the exercise. Without C2IEDM subject matter experts, it would be challenging to identify all appropriate linkages and may unduly bias any work the COI experts do in the future on the taxonomy. The team also presented their information to the United States MIPS representative and encouraged them to expand the work done here to provide as many stub points as possible and not limit their findings to the three relationships used in this exercise.

### 7.1.3 DTIC Conversion Issues

DTIC's original taxonomy grew into the DTIC Thesaurus, and its current taxonomy was developed from the Committee On Scientific And Technical Information (COSATI) taxonomy developed in 1964 with the taxonomic structure adopted in 1986. The same taxonomy has been in use since 1986 and DTIC is currently considering a second revision to its taxonomy to fit internal changes in data collection. The thesaurus is broken into 25 fields, which are further broken into 251 groups and subgroups. Currently no cataloging or searching is done at the field level. Consequently, no scope notes are applied to the fields in the defining document.

This stubbing effort was carried out by a single person, and as a result bears a bias based on some 30 years of efforts using the taxonomy. The links are developed from the analyst's individual understanding of each element's definition within the DTIC taxonomy and matched to the Core taxonomy terms using definitions as the matching source.

All of the field-level terms are linked to the Core, and most of the group and subgroup terms are linked initially to some other DTIC Term. Approximately ten terms have multiple links. Somewhat more than half the links lead either directly or indirectly to a single Core term - Scientific and Technological Research and Innovation Function.

Table 5 denotes link types.

**Table 4: Link Types**

| Fields | |
|---|---|
| Top terms linking to Scientific and Technical Research and Innovation Function | 13 |
| Top terms with other links | 12 |
| Top terms with Multiple links | 1 |
| Groups and sub-Groups Lower terms linked to top term TT is S&TR&I Function | 107 |
| Groups and sub-Groups Lower terms linked to top term TT not S&TR&I Function | 91 |
| Lower term linked to Core | 52 |
| Lower term with multiple links | 9 |

### 7.1.4 METOC Conversion Issues

The conversion process for the METOC taxonomy began with a portion of the METOC data model, specifically the area of sensors and their collectable information. The ErWin file was converted to a CSV file. Once the team had the CSV file, they imported the information into Excel to build a spreadsheet. The file contained the element title, the element ID and the element definition. A fourth column was added for the reference information found in the "triple".

## 7.2 Finding Useful and Meaningful Relationships

When charged with the requirement to design and implement an exercise that tested the notion of connecting COI taxonomies to the core, the team was faced with the realization that they did not have the time, talent, or funds to fully test all relationship options. They also had a limited core or hub taxonomy that may not have sufficient abstracts to create one-for-one, parent-children relationships. For the sake of this exercise, the focus group agreed to limit the number of relationships. The group agreed to use only "sameAs", PartOf" and "subclassOf" relationships in the exercise. For the sake of the exercise all elements were matched to one of the designated three relationships provided. Use of other relationships (See section 8.2.3 for more information) was out of the scope of this exercise.

## 7.3 Finding Meaningful "Stub" Points

This section provides a description of the decision process used by each team to determine what elements would become the designated "stub" point for connection to the core taxonomy. Each team worked independently and used various tacks in completing the assignment, but all four teams provided the same

results.

### 7.3.1 AMTD Stub Points

The crafters of the AMTD Taxonomy created clear, logical relationships and delineations from top to bottom. Broad term abstractions were used in progressively greater detail to the atomic or leaf levels in an effort to show parent-to-child, whole-to-part, and book-to-chapter relationship schemes. There were no definitions for any of the taxons in the initial packages, which made the process more difficult. As a result the team concluded that the AMTD developers had not finished their work. Still the taxonomy was sufficiently completed to use in the exercise.

The stubbing rules and OWL notation provided by the TaxFG, and published by Dr. Hayes, were used in this portion of the exercise. The four members of the AMTD stubbing crew separated the three areas within the taxonomy and searched for equivalent taxons and relationships in the Core. The team determined that there were enough matches to continue the process. The minimum three relations needed to validate the stubbing process were found. Team members used their collective experience in Army and Marine doctrine to find elements in the AMTD that were sufficiently strong enough to make a match.

The team then created a notation for all elements of the taxonomy using the comma-delimited triple to describe the two entities being compared and the relationship for each element. (See section 6 for more information on the triple.) The team then created a matrix for recording the stubbing effort with several primary column headings as shown below in table 5. Columns were titled: COI Taxonomy term (COI previously defined in paper), COI term location, COI Taxonomy term Identification, COI taxonomy term definition, Source of definition, Core term, Core location and Mapping. Later the columns were collapsed to fit the format provided by Dr. Hayes.

**Table 5: AMTD Initial suport spreadsheet example**

| COI Term | COI Location | COI Term Id | COI term Definition | Definition Source | Core Term | Core Location | Mapping |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Table 6 provides an example of the Army elements and their position codes. Notice the position codes vs. the formal definitions. The positions codes were left in the spreadsheet to provide the user a reference point for each element. Definitions were not provided and that column was omited.

**Table 6: Army/Marine Taxonomy spreadsheet example**

| AMTD Term ID | Position # | Mapping(s) |
|---|---|---|
| Army | 1.1 | (subclassOf, this, General) |
| Operations | 1.1.1 | (subclassOf, this, Army) |
| Offense | 1.1.1.1 | (subclassOf, this, Operations) |
| Movement to Contact | 1.1.1.1.1 | (subclassOf, this, Offense) |
| Meeting Engagement | 1.1.1.1.1.1 | (subclassOf, this, Movement to Contact) |
| Search and Attack | 1.1.1.1.1.2 | (subclassOf, this, Movement to Contact) |
| Attack | 1.1.1.1.2 | (subclassOf, this, Offense) |

The three primary candidate stub points used to complete the exercise are provided below. Other possible candidates are presented below the three primary elements.

For the Army portion:

“Operations” in AMTD is a subclass of Core element “Military activity”.

“Operations” in AMTD is a subclass of Core element “Military Capability”.

“Operations” in AMTD is a subclass of Core element “Strategic national and theater defense”.

“Operations” in AMTD is a subclass of Core element “Tactical defense”.

For the Marine portion:

“Marine corps warfighting functions” in AMTD is a subclass of Core element “Military activity”.

“Marine corps warfighting functions” in AMTD is a subclass of Core element “Military capability”.

“Marine corps warfighting functions” in AMTD is a subclass of Core element “Defense and national security”.

For the Environment portion:

“Physical environment” in AMTD is the same as Core element “Natural environment”.

Since the AMTD taxonomy was comprised of three separate sections, the team and the focus group determined the requirement of having a minimum of three separate stubb points was fulfilled with finding one stub point for each section. Other stub point candidates were available within each portion of the taxonomy, but without definitions, the team was not comfortable presenting them as prospective candidates. This taxonomy illustrates the situation where a single COI node can be connected to the core at multiple places.

### 7.3.2 C2IEDM Stub Points

The team working on the C2IEDM were quickly taken by the complexity and size of the taxonomy. With 15 major abstract fields and over 3300 individual elements, the team spent much of its time gettng familiar with the taxonomy. The team also came to the conclusion that without C2IEDM subject matter experts, the team could pick stub candidates that do not fit properly. To complete the exercise, the team provided three candidates at the highest level of the taxonomy and declared victory. The three stub candidates used in this portion of the exercise are:

“ORGANISATION” in C2IEDM is the same as Core element “Organization”.

“CAPABILITY” in C2IEDM is a subclass of Core element “Capability”

“ACTION-EVENT” in C2IEDM is a subclass of Core element “Action”.

Other candidates were listed and considered, but the three elements mentioned above had the best “fit” for the exercise. Without subject matter experts available for confirmation, several candidate relationships were dropped from the listing. (Lesson learned: Ensure the development team has the proper mix of technical developers and subject matter experts to help formulate the final product.)

### 7.3.3 DTIC Stub Points

Finding meaningful connections or stub points required a review of each major area and a determination as to which element in each major category had an acceptable relation with the parent element in the Core taxonomy. The following steps were used to find and document the stub points:

1. Assign the effort to one person or a very small team to study the issues.
2. Link the top COI taxonomy terms to the Core taxonomy first.
3. Find a way to link lower level COI taxonomy terms directly or indirectly to top COI taxonomy terms before linking to the DoD Core taxonomy.
4. Allow for multiple links.
5. Test links by reading the definitions of the taxonomy terms and consider whether the taxonomy link is true (e.g. is a part of, or, is a subset of).

6. Send your effort out for review and thoughtfully consider each suggestion. (Hopefully 10% of your links will receive 90% of the suggestions.)
7. Once your team receives suggested changes or new terms, weigh and prioritize the information and work with your team to determine the usefulness and appropriateness of each suggestion.
8. Make changes as needed from the suggestions.
9. Periodically review the taxonomy to ensure the COI terms remain current and viable.

**Table 7: DTIC Taxonomy spreadsheet example**

| Title | F/G # | Definition | Mappings |
|---|---|---|---|
| Aviation technology | 010000 | The science and technology of mechanical flight. | (subclassOf, Core, Scientific and technological research and innovation function) |
| Aerodynamics | 010100 | Flight characteristics and problems of full-scale or model aircraft and their components as they are affected by the dynamics of air; Flight testing and wind tunnel testing. Includes theoretical and experimental aerodynamics as applied to aircraft. | (subclassOf, this, Aviation technology) |
| Military aircraft operations | 010200 | Military aircraft operations such as takeoff Operations and landing, air traffic, all weather and night flight, taxiing, approach, and inflight refueling; Flight safety; Ground safety; Aviation accident studies; Aircraft simulators and training devices. | (subclassOf, Core, Force application action)(subclassOf, this, Aviation technology) |

The example candidate stub points for the DTIC taxonomy are provided below:

“Aviation technology” in DTIC is a subclass of Core element “Scientific and technological research and innovation function”.

“Military aircraft operations” in DTIC is a subclass of Core element “Force application action”.

“Aircraft” in DTIC is a subclass of Core element “Equipment”.

“Terminal flight facilities” is a subclass of Core element “Facilities”.

“Agriculture” is a subclass of Core element “Scientific and technological research and innovation function”.

“Aircraft” in DTIC is a subclass of Core element “Equipment”.

"Aeronomy and astrophysics" is a subclass of Core element "Scientific and technological research and innovation function".

"Atmospheric sciences" is a subclass of Core element "Scientific and technological research and innovation function".

"Meteorology" is a subclass of Core element "Meteorological environment"

"Behavioral and social sciences" is a subclass of Core element "Account".

"Behavioral and social sciences" is a subclass of Core element "Capability".

(More candidates are available but not presented in this section. To see all the candidates, review the listing "Complete Stubbing Candidates List by Taxonomy" in Appendix A.)

The DTIC exercise provided the most candidates due the the background knowledge of the individual determining the candidates and the close relationship the taxonomy has to several sections within the core. (Lesson learned: Subject matter experts are critical members of the development team.)

### 7.3.4 METOC Stub Points

Data elements used in the METOC exercise were taken directly from the METOC data model. Because the definitions provided in the model are general definitions, the relationship between each element did not always fit well into the "sameAs", "partOf" or "subclassOf" relationships used in the exercise. Additional inspections were made to find areas in the model that provided useful information for the project. Where possible the elements were matched against the posted three relationships. Others were either dropped or given other less restrictive relationships to include them in the effort. (See Section 8.2.3, Other Relationships, to find out more about additional relationship options that can be used in taxonomy development.)

Using the three relationships mentioned above provided several stubbing candidates. Three high level examples are:

- "LOCATION" is subclass of Core element "Place".
- "METOC" is subclass of Core element "Natural environment".
- "INFORMATION-ASSET" is subclass of Core element "Intellectual asset".

The items' definitions were used to confirm their placement with the core element.

Other elements within the taxonomy that qualify as stubbing candidates are:

- "ASTROMETRIC-ELEMENT" is part of Core element "Environment".
- "DATUM-TRANSFORMATION" is subclass of Core element "intellectual asset".

- “DEVICE-ACOUSTIC-MEASUREMENT-ASSOCIATION” is subclass of Core element “intellectual asset”.
- “DOPPLER-WEATHER-RADAR-BASE-IMAGE” is subclass of Core element “intellectual asset”.
- “DOPPLER-WEATHER-RADAR-CROSS-SECTION-IMAGE” is subclass of Core element “intellectual asset”.
- “DOPPLER-WEATHER-RADAR-PRECIPITATION-IMAGE “is subclass of Core element “intellectual asset”.
- “DOPPLER-WEATHER-RADAR-RASTER-IMAGE” is subclass of Core element “intellectual asset”.
- “GEOPHYSICAL-DEVICE-MAINTENANCE-LOG-ENTRY” is subclass of Core element “intellectual asset”.

The problem is determining which ones to stub and which ones to drop, since the team does not consider themselves subject matter experts in this area. The team identified multiple candidates and adopted only the three candidates. The others are left to the subject matter experts to decide. (Again, subject matter experts will have a pivotal role in deciding how the taxonomy evolves.)

Other elements that were designated stubbing candidates but were not listed because their relationships did not fit the “standard” three designated options are:

- “GEOPHYSICAL-DEVICE-MAINTENANCE-LOG-ENTRY” is subclass of Core element “intellectual asset”; is subtaxon of Core element “Equipment”; and is subtaxon of Core element “Environment”
- “GEOPHYSICAL-LAYER” is part of Core element “Environment”; and is subclass of Core element “Geographical area”.
- “GEOPHYSICAL-MEASURING-DEVICE” is subtaxon of Core element “Environment”; and subclass of Core element “Equipment”.
- “GEOPHYSICAL-MEASURING-DEVICE-TYPE” is subtaxon of Core element “Equipment”; and is subtaxon of Core element “Environment”.

These stubbing candidates all have multiple stubbing points and each need to be weighted and prioritized to determine their roll in the taxonomy and later the ontology. Regardless of where they are used in the process, all play an important part in determining the precision of a federated search.

# 8 Way Ahead

## 8.1 From Stubbing to Full Mapping

As stated before, to understand the motivation for stubbing, we first need to understand the eventual goal toward which we are working, and the prerequisite steps. The goal is easy, accurate, and complete discovery of registered resources. The mapping is much easier when the analysts are familiar with the subject taxonomy. But since requirements vary with each situation, the same topic resource may be seen differently in different COI taxonomies. (Example: A runway means different things to different groups in the DoD. The Air Force bomber pilot's idea of a runway may be very different from a Navy Carrier pilot's view of a runway.) Relating or mapping the nodes of relevant COI taxonomies to some central hub's formalized taxonomy facilitates that goal. What we call complete mapping is required to meet that goal. (May want to provide a defintion of complete mapping or at least a refresher)

## 8.2 The Stubbing Process

The assignment that various team members received was to relate or map three key nodes of their assigned COI taxonomy to the Core taxonomy. This agreed upon mapping process, which we call "stubbing", is a means of joining COI taxonomies to a central artifact called the Core taxonomy. This Core taxonomy acts as a hub to which all COI taxonomies will be systematically related and will be referred to in this process description as the "hub".

### 8.2.1 Complete Mapping

Complete mapping of each COI node ensures that every node of the COI taxonomy is directly mapped to an appropriate node in the hub. Complete mapping guarantees that any resources registered against a node of one COI taxonomy node will be discoverable using any node within another COI taxonomy that contains an equivalent meaning. The concept is called "complete retrieval" and is the eventual goal sought by the federated search architecture. Until the semantic understanding of your COI nodes is matured enough to be understood by all other COI taxonomies in the enterprise, the hub taxonomy will provide the central conduit to connect an equivalent target for each COI node. (Semantic maturity may be an iterative process when introducing the idea of federated precision to the enterprise. Most organizations may have to build multiple versions of their enterprise taxonomic system before they get the precision they desire.)

### 8.2.2 Mapping into an Incomplete Hub

In most cases, your organization will be forced to map into an incomplete or immature hub, which means the hub lacks exact targets for all your nodes. Relations like “SameAs” may not provide the correct relationship between the hub and the COI stub point. In a complete mapping, the only relation required is called the "SameAs" relation. In most situations you will need to use less exact relations to present a more realistic connection. The use of the prescribed “partOf”, “SubclassOf” or “SameAs” can present a skewed relationship. Taxonomy teams will need to have a means of relating COI nodes to hub nodes that do not exactly match. To support taxonomic navigation, each COI node must be linked to one or more superclasses with a subclass relation. In a well structured COI taxonomy, such a superclass node will exist in the COI taxonomy. In most cases, not all appropriate superclasses are found in the hub, and your mappers will have to work with less than optimal relations.

Sometimes the superclass mappings do not capture enough meaning or are too narrowly defined to provide a correct relationship. Such nodes should be mapped with the "partOf" relations into the hub where possible. The general all-purpose relation that we call the "relatedTo" relationship can also be used to map the yet-to-be-captured or unmapped relationship between the COI node and the hub. Incomplete hubs limit "retrieval options" because using any relation other than “SameAs" looses meaning in the mapping. Mapping into an incomplete hub does, however, support top-down guaranteed discoverability of any subject node if the search process can execute a top down query into all subclass nodes to all connected COI taxonomies. This means a federated search using an incomplete hub can still provide some level of discoverability despite the hub’s limitations and the COI taxonomy’s minimal structure. More importantly, using the hub in its limited capacity still offers some level of retrieval for COI information while the Core team takes the time to mature the hub.

### 8.2.3 Other Relationships

Some focus group exercise teams selected only a small set of key relationships for use in the mapping to meet the exercise criteria and to prove the concept because of time and manpower limitations. When working with your actual COI effort, your team may choose to use the “relatedTo” relationship for your most general relation. Using this more general relation may be necessary to properly capture the essence of the taxon being mapped. The use of “relatedTo’” relation ensures that nodes can be mapped with the closest meaning to a hub node that is not a direct superclass of the COI node.

The small relation set used in this exercise provide a subset of relationships needed to properly stub the COI taxonomies to the core. Eventually, however, other existing relationships in the taxonomy will need to be defined and will not fit the “sameAs”, “part of”, or “subClassOf” mapping. Mapping with additional relations such as “relatedTo” expands the relations a COI taxon can use in connecting into the hub. Among those many new mapped relations that your team can expect to use sooner or later, the “instanceOf” and the “topicToClass*”* relations will play a part in determining the viability of your taxonomy. The *“*instanceOf *“* relationship will allow you to support COI taxonomies which contain instances in their hierarchies. The “instanceOf” relationship allows a document to be registered against an instance of “*MohamadAtta”* at the same time it is linked to the notion of “*Terrorist”* in the hub.

NOTE: as mentioned in section 2.2.2, Use “relatedTo” as a last alternative when building relationships between nodes. The “relatedTo” option was adopted by our focus group by a narrow majority of members with a significant minority considering it too nebulous for actual coding in an OWL representation of the taxonomy. Once a node is categorized as “relatedTo” continue your analysis and work to find a more substantial relationship or build a new superclass that provides a more substantial relationship. Over time, work to move all “relatedTo” nodes to “subClass”, “partOf” or “sameAs” relationships.

### 8.2.4 Choosing Candidate Stubbing Nodes

In a well structured COI taxonomy the one top node or concept remains as a general abstract term. All other nodes are linked to one another using class-to-subclass relations. In the well structured case, the top node is the obvious stub point for most COI taxonomies if only one stub point is chosen.

Some taxonomies are actually organized as a "forest" or grouping of taxonomies where there is no one top-level node. Instead, there are a number of top nodes from which separate taxonomies descend.

If all the top nodes in the taxonomy can be grouped under one superclass, then consider creating a superclass element above the group of top nodes and add your taxonomy via the newly created superclass element to the hub.

If an obvious superclass does not exists, map each top node to the hub separately. Omitting any of these nodes to the hub will leave portions of the COI taxonomy undiscoverable.

Choosing the proper stubbing candidate nodes as described above will usually be the most important part of the stubbing process. Beyond the initial stubbing, re-evaluating your taxonomic structure to support more ambitious use cases or to provide more precision to your hierarchy involves having a mature understanding of your organization and its processes. Correcting existing taxonomies can be costly for any processes or interfaces using the taxonomy. Take the time to weigh all the costs before making any additions, deletions or corrections to you taxonomy/ontology. Small corrections may actually result in other mappings and cause a snowballing effect on the project. If changes are required due to process additions, deletions or changes; use a pre-determined change cycle with published dates to allow developers to integrate the changes at known times. Using a more iterative process over time to build with published change dates helps construct a more complete taxonomy/ontology with richness and precision without causing major development issues with your projects.

## 8.3 From Taxonomies to Ontologies

COI and hub taxonomies can be either informal or formal. The extremely informal taxonomy is represented by a non-strict taxonomy as shown above, while the extremely formal is currently represented by an ontology expressed in full first-order. COIs will want to register as complete a taxonomy as possible to make their information as discoverable as possible. The TaxFG is using the OWL language to formalize the COI taxonomy effort, and W3C OWL standard supports both the informal and formal structures. The normal process for taxonomy development would be a movement from informal to formal. Optimally, as COI taxonomies become more formal over time, the Core taxonomy will also mature to a formal hub to maximize precision when retrieving COI resources during a federated search. A more mature hub and COI taxonomy allows a user to register documents and search for them from a higher level within the taxonomy. In fact an optimized ontology will allow a user to search for information using the hub because of the semantic richness within the ontology. In time, a mature hub offers more data nodes as registration sources which, in turn, increases the prospects of retrieving more information during a search.

## 8.4 Increased Performance

As COI members begin mapping the nodes of their taxonomies into the hub, as described above, there is no theoretical limit to the precision and recall of a metadata-based search. The actual key limiting factors are the number of topics in the hub and the way they are defined, combined with the care used by the user in registering resources against that hub. (i.e. How the individual registering the resource interprets where the resource is placed within the hierarchy.) For the maximum impact in a “publish and subscribe” environment, the hub needs to be “broad and deep” in its design to ensure search precision. A small “narrow

and shallow" hub can offer only correspondingly low search resolution. (Example: A "broad and deep" taxonomy might be a taxonomy showing all the part bins found in an automobile dealer's service department. A "narrow and shallow" example would be a taxonomy of the major shelves holding the bins.) To ensure proper precision in the future for the core taxonomy, follow-on work by either this focus group or another body is essential for maturing the Core to a point where it can accommodate all DoD requirements.

## 8.5 Registering Documents

This section left blank intentionally. Registration information will be posted when available.

# 9 Appendix A – Taxonomy Spreadsheets

## 9.1 Taxonomy Focus Group Core Taxonomy, version 0.75a (Page 1&2)

| | | | |
|---|---|---|---|
| Account | 1 | A separate financial reporting unit for budget, management, and or accounting proposes. | GAO/AFMD2.1.1 |
| Federal fund account | 1.1 | Accounts composed of moneys collected and spent by the Federal government other than those designated as trust funds. | GAO/AFMD2.1.1 |
| General federal fund account | 1.1.1 | Federal fund accounts composed of all federal money not allocated to any other fund account. | GAO/AFMD2.1.1 |
| Special federal fund account | 1.1.2 | Federal fund accounts earmarked by law for a specific purpose. | GAO/AFMD2.1.1 |
| Public federal fund account | 1.1.3 | Expenditure accounts authorized by law to be credited with offsetting collections, primarily form the public, that are generated by and earmarked to finance a continuing cycle of business-type operations. | GAO/AFMD2.1.1 |
| Intragovernmental federal fund account | 1.1.4 | Expenditure accounts authorized by law to facilitate financing transactions primarily within and between federal agencies on a revolving fund basis. | GAO/AFMD2.1.1 |
| Nonfederal account | 1.2 | All accounts that have their creation and management outside the Federal governmental. (Synonyms: Commercial Bank Accounts, Credit Union Accounts, Brokerage Accounts, Vendor Accounts etc.) | DFAS |

| | | | |
|---|---|---|---|
| Other nonfederal government account | 1.2.1 | All accounts that have their creation and management outside the Federal governmental that do not fall under 'Nonfederal accounts'. (Synonyms: Commercial Bank Accounts, Credit Union Accounts, Brokerage Accounts, Vendor Accounts etc.) | Investorwords.com |
| Financial institution nonfederal account | 1.2.2 | Accounts for an institution which collects funds from the public and places them in financial assets, such as deposits, loans, and bonds, rather than tangible property. | Investorwords.com |
| Commercial account | 1.2.3 | Accounts for commercial entities which collects funds. | Dictionary.com |
| Not for profit account | 1.2.4 | Accounts for not for profit entities which collects funds but the entity's main purpose is non profit. | Merriam Webster |
| Accounting account | 1.3 | One of a group of accounts used to carry out the legal requirement that federal agencies establish accounts for segregating revenues, other resources, related liabilities, obligations, and balances in order to carry out specific activities or achieve certain objectives in accordance with special regulations, restrictions, or limitations. | GAO/AFMD2.1.1 (adapted) |
| Budgetary fund account | 1.3.1 | One of a group of accounts which reflect budgetary operations and the conditions form the time appropriations are realized until they are expended. | FM, Bulletin # S2-94-01 (adapted) |
| Proprietary account | 1.3.2 | One of a group of accounts utilized to satisfy the requirement that federal agencies establish accounts and transactions for how operations are functioning and data for the equation that assets equals liabilities plus equity. | JFMIP (adapted) |

## 9.2 Army/Marine Training Taxonomy, version 1.0 (Page 1 for each section)

ARMY Example

| Term Label | Term location | Mapping(s) |
|---|---|---|
| **General** | **1** | |
| Army | 1.1 | (subclassOf, this, General) |
| Operations | 1.1.1 | (subclassOf, this, Army) |
| Offense | 1.1.1.1 | (subclassOf, this, Operations) |
| Movement to Contact | 1.1.1.1.1 | (subclassOf, this, Offense) |
| Meeting Engagement | 1.1.1.1.1.1 | (subclassOf, this, Movement to Contact) |
| Search and Attack | 1.1.1.1.1.2 | (subclassOf, this, Movement to Contact) |
| Attack | 1.1.1.1.2 | (subclassOf, this, Offense) |
| Ambush | 1.1.1.1.2.1 | (subclassOf, this, Attack) |
| Point Ambush | 1.1.1.1.2.1.1 | (subclassOf, Ambush) |
| Area Ambush | 1.1.1.1.2.1.2 | (subclassOf, Ambush) |
| Antiarmor Ambush | 1.1.1.1.2.1.3 | (subclassOf, Ambush) |
| Objective Assault | 1.1.1.1.2.2 | (subclassOf, this, Attack) |
| Counterattack | 1.1.1.1.2.3 | (subclassOf, this, Attack) |
| Demonstration | 1.1.1.1.2.4 | (subclassOf, this, Attack) |
| Feint | 1.1.1.1.2.5 | (subclassOf, this, Attack) |
| Raid | 1.1.1.1.2.6 | (subclassOf, this, Attack) |
| Spoiling Attack | 1.1.1.1.2.7 | (subclassOf, this, Attack) |
| Hasty Attack | 1.1.1.1.2.8 | (subclassOf, this, Attack) |
| Deliberate Attack | 1.1.1.1.2.9 | (subclassOf, this, Attack) |
| Exploitation | 1.1.1.1.3 | (subclassOf, this, Offense) |
| Pursuit | 1.1.1.1.4 | (subclassOf, this, Offense) |
| Forms of Maneuver | 1.1.1.1.5 | (subclassOf, this, Offense) |
| Envelopment | 1.1.1.1.5.1 | (subclassOf, this, Forms of Maneuver) |
| Conduct Airborne Assault | 1.1.1.1.5.1.1 | (subclassOf, this, Envelopment) |
| Conduct Air Assault | 1.1.1.1.5.1.2 | (subclassOf, this, Envelopment) |
| Conduct Amphibious Assault | 1.1.1.1.5.1.3 | (subclassOf, this, Envelopment) |
| Conduct an Encirclement | 1.1.1.1.5.1.4 | (subclassOf, this, Envelopment) |
| Turning Movement | 1.1.1.1.5.2 | (subclassOf, this, Forms of Maneuver) |
| Infiltration | 1.1.1.1.5.3 | (subclassOf, this, Forms of Maneuver) |

| | | |
|---|---|---|
| Penetration | 1.1.1.1.5.4 | (subclassOf, this, Forms of Maneuver) |
| Frontal Attack | 1.1.1.1.5.5 | (subclassOf, this, Forms of Maneuver) |
| Division Offensive Operations | 1.1.1.1.6 | (subclassOf, this, Offense) |
| Urban Offensive Operations | 1.1.1.1.7 | (subclassOf, this, Offense) |
| Characteristics of Urban Offensive OPS | 1.1.1.1.7.1 | (subclassOf, this, Urban Offensive Operations) |
| Urban Offensive Considerations | 1.1.1.1.7.2 | (subclassOf, this, Urban Offensive Operations) |
| The Basics of the Offense | 1.1.1.1.8 | (subclassOf, this, Offense) |
| Offensive Operations Planning Considerations | 1.1.1.1.9 | (subclassOf, this, Offense) |
| Transition Operations | 1.1.1.1.10 | (subclassOf, this, Offense) |
| Defense | 1.1.1.2 | (subclassOf, this, Operations) |
| Area Defense | 1.1.1.2.1 | (subclassOf, this, Defense) |
| Defend a Battle Position | 1.1.1.2.1.1 | (subclassOf, this, Area Defense |
| Strongpoint Defense | 1.1.1.2.1.1.1 | (subclassOf, this, Defend a Battle Position |
| Defend an Area of Operations | 1.1.1.2.1.2 | (subclassOf, this, Area Defense |
| Mobile Defense | 1.1.1.2.2 | (subclassOf, this, Defense) |
| Retrograde Operations | 1.1.1.2.3 | (subclassOf, this, Defense) |
| Delay | 1.1.1.2.3.1 | (subclassOf, this, Retrograde Operations |
| Withdrawal | 1.1.1.2.3.2 | (subclassOf, this, Retrograde Operations |
| Retirement | 1.1.1.2.3.3 | (subclassOf, this, Retrograde Operations |
| Denial Operations | 1.1.1.2.3.4 | (subclassOf, this, Retrograde Operations |
| Stay Behind Operations | 1.1.1.2.3.5 | (subclassOf, this, Retrograde Operations |
| Urban Defensive Operations | 1.1.1.2.4 | (subclassOf, this, Defense) |
| Characteristics of Urban Defensive Operations | 1.1.1.2.4.1 | (subclassOf, this, Urban Defensive Operations |
| Urban Defense Considerations | 1.1.1.2.4.2 | (subclassOf, this, Urban Defensive Operations |
| Planning Considerations | 1.1.1.2.5 | (subclassOf, this, Defense) |
| Sequence of the Defense | 1.1.1.2.6 | (subclassOf, this, Defense) |
| Stability Operations | 1.1.1.3 | (subclassOf, this, Operations) |
| Peace Operations | 1.1.1.3.1 | (subclassOf, this, Stability Operations) |
| Peacekeeping Operations | 1.1.1.3.1.1 | (subclassOf, this, Peace Operations) |
| Peace Enforcement | 1.1.1.3.1.2 | (subclassOf, this, Peace Operations) |
| Diplomatic Support Operations | 1.1.1.3.1.3 | (subclassOf, this, Peace Operations) |

| | | |
|---|---|---|
| Foreign Internal Defense | 1.1.1.3.2 | (subclassOf, this, Stability Operations) |
| Provide Indirect Support to Foreign Internal Defense | 1.1.1.3.2.1 | (subclassOf, this, Foreign Internal Defense) |
| Provide Direct Support to Foreign Internal Defense | 1.1.1.3.2.2 | (subclassOf, this, Foreign Internal Defense) |
| Conduct Combat Operations in Support of Foreign Internal Defense | 1.1.1.3.2.3 | (subclassOf, this, Foreign Internal Defense) |
| Security Assistance | 1.1.1.3.3 | (subclassOf, this, Stability Operations) |
| Humanitarian and Civic Assistance | 1.1.1.3.4 | (subclassOf, this, Stability Operations) |
| Support to Insurgencies | 1.1.1.3.5 | (subclassOf, this, Stability Operations) |
| Provide Operational, Logistic and Training Support to Insurgencies | 1.1.1.3.5.1 | (subclassOf, this, Support to Insurgencies) |

Marine Example

| | | |
|---|---|---|
| US. Marine Corps Section | 1.2 | |
| Marine Corps Doctrinal Publications | 1.2.1 | (subclassOf,this,US Marine corps section) |
| Warfighting - MCDP | 1.2.1.1 | (subclassOf,this,Marine corps doctrinal pub) |
| Marine Corps Operations - MCDP 1-0 | 1.2.1.2 | (subclassOf,this,Marine corps doctrinal pub) |
| Strategy - MCDP 1-1 | 1.2.1.3 | (subclassOf,this,Marine corps doctrinal pub) |
| Campaigning - MCDP 1-2 | 1.2.1.4 | (subclassOf,this,Marine corps doctrinal pub) |
| Tactics - MCDP 1-3 | 1.2.1.5 | (subclassOf,this,Marine corps doctrinal pub) |
| Intelligence - MCDP 2 | 1.2.1.6 | (subclassOf,this,Marine corps doctrinal pub) |
| Expeditionary Operations - MCDP 3 | 1.2.1.7 | (subclassOf,this,Marine corps doctrinal pub) |
| Logistics - MCDP 4 | 1.2.1.8 | (subclassOf,this,Marine corps doctrinal pub) |
| Planning - MCDP 5 | 1.2.1.9 | (subclassOf,this,Marine corps doctrinal pub) |
| Command and Control - MCDP 6 | 1.2.1.10 | (subclassOf,this,Marine corps doctrinal pub) |

| | | |
|---|---|---|
| Marine corps warfighting functions | 1.2.2 | (subclassOf, this, Marine corps) 1.2, (subclassOf, Core, Military activity) 2.1, (subclassOf, Core, Military capability) 5.2, (subclassOf, Core, Strategic national and theater defense) 6.1.1, (subclassOf, Core, Tactical defense) 6.1.3, (subclassOf, Core, Tactical defense function) |
| Command and Control | 1.2.2.1 | (subclassOf, this, Marine corps warfighting function), (is subclassOf, Core, Military activity) 2.1, (is subclassOf, Core, Military capability) |
| Command and Control | 1.2.2.1.1 | (subclassOf, this, Marine corps C2) |
| Network Centric | 1.2.2.1.2 | (subclassOf, this, Marine corps C2) |
| Battlespace Awareness (Intelligence) | 1.2.2.2 | (subclassOf, this, Marine corps C2) |
| Series Lead Publication | 1.2.2.2.1 | (subclassOf, this, Marine corps C2/BA) |
| MCWP 2-1, Intelligence Operations | 1.2.2.2.1.1 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Chapter 1 - Fundamentals | 1.2.2.2.1.1.1 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Intelligence Objectives | 1.2.2.2.1.1.1.1 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Maneuver Warfare | 1.2.2.2.1.1.1.2 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Developing Intelligence | 1.2.2.2.1.1.1.3 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Intelligence Operations | 1.2.2.2.1.1.1.4 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Principles of Intelligence Operations | 1.2.2.2.1.1.1.5 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Intelligence Functions | 1.2.2.2.1.1.1.6 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| The Commander's Role in the Intelligence Process | 1.2.2.2.1.1.1.7 | (subclassOf, this, Marine corps C2/BA Lead pubs) |
| Information Operations | 1.2.2.2.1.1.1.8 | (subclassOf, this, Marine corps C2/BA Lead pubs) |

Environment Example

| Term Label | Term location | Mapping(s) |
|---|---|---|
| **Environment** | 1.3 | (subClassOf,this,General) |
| Physical Environment | 1.3.1 | (subClassOf,this,Environment), sameAs,core,Natural environment) |
| Land Environment | 1.3.1.1 | (subClassOf,this,Physical Environment) |
| Terrain | 1.3.1.1.1 | (subClassOf,this,Land Environment) |
| Terrain Relief Features | 1.3.1.1.1.1 | (subClassOf,this,Terrain) |
| Vegetation | 1.3.1.1.1.2 | (subClassOf,this,Terrain) |
| Landlocked Waters | 1.3.1.1.1.3 | (subClassOf,this,Terrain) |
| Terrain Traction | 1.3.1.1.1.4 | (subClassOf,this,Terrain) |
| Terrain Slope | 1.3.1.1.1.5 | (subClassOf,this,Terrain) |
| Terrain Elevation | 1.3.1.1.1.6 | (subClassOf,this,Terrain) |
| Terrain Firmness | 1.3.1.1.1.7 | (subClassOf,this,Terrain) |
| Terrain Relief | 1.3.1.1.1.8 | (subClassOf,this,Terrain) |
| Geological Features | 1.3.1.1.2 | (subClassOf,this,Land Environment) |
| Magnetic Variations | 1.3.1.1.2.1 | (subClassOf,this,Geological Features) |
| Subsurface Water | 1.3.1.1.2.2 | (subClassOf,this,Geological Features) |
| Geological Activity | 1.3.1.1.2.3 | (subClassOf,this,Geological Features) |
| Synthetic Terrain Features | 1.3.1.1.3 | (subClassOf,this,Land Environment) |
| Urban Centers | 1.3.1.1.3.1 | (subClassOf,thisSynthetic Terrain Features) |
| Civil Structures | 1.3.1.1.3.2 | (subClassOf,thisSynthetic Terrain Features) |
| Obstacles | 1.3.1.1.3.3 | (subClassOf,thisSynthetic Terrain Features) |
| Line of Communication | 1.3.1.1.3.4 | (subClassOf,thisSynthetic Terrain Features) |
| Urban Environment Characteristics | 1.3.1.1.4 | (subClassOf,this,Land Environment) |
| Sea Environment | 1.3.1.2 | (subClassOf,this,Physical Environment) |
| Ocean Waters | 1.3.1.2.1 | (subClassOf,this,Sea Environment |
| Ocean Depth | 1.3.1.2.1.1 | (subClassOf,this,Ocean Waters) |
| Ocean Current | 1.3.1.2.1.2 | (subClassOf,this,Ocean Waters) |
| Sea State | 1.3.1.2.1.3 | (subClassOf,this,Ocean Waters) |
| Ocean Temperature | 1.3.1.2.1.4 | (subClassOf,this,Ocean Waters) |

| | | |
|---|---|---|
| Saline Content | 1.3.1.2.1.5 | (subClassOf,this,Ocean Waters) |
| Ocean Features | 1.3.1.2.1.6 | (subClassOf,this,Ocean Waters) |
| Sea Room | 1.3.1.2.1.7 | (subClassOf,this,Ocean Waters) |
| Ocean Subsurface Characteristics | 1.3.1.2.2 | (subClassOf,this,Sea Environment) |
| Sea Bottom Contours | 1.3.1.2.2.1 | (subClassOf,this,Ocean subsruface Characteristics) |
| Sea Bottom Composition | 1.3.1.2.2.2 | (subClassOf,this,Ocean Subsruface Characteristics) |
| Harbor Capacity | 1.3.1.2.3 | (subClassOf,this,Sea Environment |
| Harbor Shelter | 1.3.1.2.3.1 | (subClassOf,this,Harbor Capacity) |
| Harbor Depth | 1.3.1.2.2.2 | (subClassOf,this,Harbor Capacity) |
| Harbor Currents | 1.3.1.2.2.3 | (subClassOf,this,Harbor Capacity) |

## 9.3 Command & Control Information Exchange Data Model (C2IEDM) taxonomy, version 1.0 (Page 1&2)

| Taxonomy Term label | Definition | Mapping(s) |
|---|---|---|
| ACTION | The specific value that represents the class of ACTION. It serves as a discriminator that partitions ACTION into subtypes. | Top level |
| ACTION-EVENT | An ACTION that is an incident, phenomenon, or occasion of military significance which has occurred or is occurring but for which planning is not known. | (subClassOf, this, Action |
| Abdication | The renouncement by a person of his official functions. | (subClassOf, this, Action-event |
| Accident | An unfortunate event, esp. one causing physical harm or damage, brought about unintentionally. | (subClassOf, this, Action-event |
| Accident, mine | An accident involving unexploded ordnance. | (subClassOf, this, Action-event |
| Accident, traffic | An accident involving at least one motor vehicle. | (subClassOf, this, Action-event |
| Accident, weapon | An accident involving a weapon. | (subClassOf, this, Action-event |
| Accident, workplace | An accident occurring at the workplace. | (subClassOf, this, Action-event |

| | | |
|---|---|---|
| Advancing | Moving towards an objective in some form of tactical formation. This is a transitional phase between operations that may or may not result in contact with the enemy. | (subClassOf, this, Action-event |
| Aerial engagement | The occurrence of a hostile encounter between military aircraft. | (subClassOf, this, Action-event |
| Aerial shoot down | The deliberate destruction of an aircraft. | (subClassOf, this, Action-event |
| Aircraft crash | The unforeseen loss, destruction or damage of an aircraft (and personnel). | (subClassOf, this, Action-event |
| Aircraft launch activity | The occurrence of one or more aircraft taking off. | (subClassOf, this, Action-event |
| Airspace violation | The invasion of the declared own airspace by an aircraft. | (subClassOf, this, Action-event |
| Alert cancellation | The end of a state of readiness. | (subClassOf, this, Action-event |
| Ambush | A surprise attack by fire or other destructive means from concealed positions on a moving or temporarily halted force or group of personnel. | (subClassOf, this, Action-event |
| Amphibious operation | Mounting an operation launched from the sea by naval and land forces against a hostile, or potentially hostile shore. | (subClassOf, this, Action-event |
| Air assault | Mounting an assault utilising a mixture of aviation and ground transport, the principal feature of which is the insertion of combat power. | (subClassOf, this, Action-event |
| Airborne assault | Mounting an airborne operation, a phase beginning with delivery by air of the assault echelon of the force into the objective area and extending through attack of assault objectives and consolidation of the initial airhead. | (subClassOf, this, Action-event |
| Arms production | An activity of, relating to or based on the production of arms. | (subClassOf, this, Action-event |

| | | |
|---|---|---|
| Arms trade | A happening of selling or buying of arms. | (subClassOf, this, Action-event |
| Arresting, legal | Seizing and detaining of a person under authority of the law. | (subClassOf, this, Action-event |
| Arresting/obstructing | Stopping or checking of the motion, progress, growth, or spread of something. | (subClassOf, this, Action-event |
| Arson | The crime of maliciously setting fire to the property of another or of burning one's own property for an improper purpose, as to collect insurance. | (subClassOf, this, Action-event |
| Artillery fire | [No definition given in APP-6A] | (subClassOf, this, Action-event |
| Assembling | Murder of a prominent person. | (subClassOf, this, Action-event |
| Assassination | Joining together of multiple objects in the same area. | (subClassOf, this, Action-event |
| Atmospheric pollution | Contamination of the atmosphere caused by a poison or toxin. | (subClassOf, this, Action-event |
| Attempted murder | The attempted act of unlawfully killing of one human being by another, especially with premeditated malice. | (subClassOf, this, Action-event |
| Attempted rape | The attempted act of forcing another person to submit to sexual intercourse. | (subClassOf, this, Action-event |
| Attempted robbery | The attempted act of robbing a person or place. | (subClassOf, this, Action-event |
| Attempted suicide | The attempted act of killing oneself intentionally. | (subClassOf, this, Action-event |
| Attack, not otherwise specified | Conducting an offensive operation characterised by coordinated employment of firepower and manoeuvre to close with and destroy or capture the enemy. | (subClassOf, this, Action-event |
| Attack, deliberate | Conducting an offensive operation characterized by pre-planned coordinated employment of firepower & maneuver to close, destroy or capture the enemy. | (subClassOf, this, Action-event |

| | | |
|---|---|---|
| Attack, diversion | Conducting an attack wherein a force attacks, or threatens to attack, a target other than the main target for the purpose of drawing enemy defences away from the main effort. | (subClassOf, this, Action-event |
| Attack, hasty | Conducting an offensive operation carried out at short notice, with limited planning and coordination, using firepower and manoeuvre to close with and destroy or capture the enemy. | (subClassOf, this, Action-event |
| Attack, main | Conducting the principal attack or effort into which the commander throws the full weight of the offensive power at his disposal. An attack directed against the chief objective of the campaign or battle. | (subClassOf, this, Action-event |
| Attack, supporting | Conducting an offensive operation carried out in conjunction with a main attack and designed to achieve one or more of the following: a. deceive the enemy; b. destroy or pin down enemy forces which could interfere with the main attack; c. control ground whose occupation by the enemy will hinder the main attack; or d. force the enemy to commit reserves prematurely or in an indecisive area. | (subClassOf, this, Action-event |

## 9.4 Defense Technical Information Center (DTIC) Taxonomy, version 1.0 (Page 1&2)

| Title | F/G # | Definition | Mappings |
|---|---|---|---|
| Aviation technology | 010000 | The science and technology of mechanical flight. | (subclassOf, Core, Scientific and technological research and innovation function) |
| Aerodynamics | 010100 | Flight characteristics and problems of full-scale or model aircraft and their components as they are affected by the dynamics of air; Flight testing and wind tunnel testing. Includes theoretical and experimental aerodynamics as applied to aircraft. | (subclassOf, this, Aviation technology) |
| Military aircraft operations | 010200 | Military aircraft operations such as takeoff Operations and landing, air traffic, all weather and night flight, taxiing, approach, and inflight refueling; Flight safety; Ground safety; Aviation accident studies; Aircraft simulators and training devices. | (subclassOf, Core, Force application action)(subclassOf, this, Aviation technology) |
| Aircraft | 010300 | Design, production, and maintenance of aircraft, aircraft components, and aircraft equipment; Structural studies of complete aircraft components such as airframes, bodies, and wings. Airworthiness; Crashworthiness; Aircraft damage assessment and vulnerability studies; effects of gunfire and blast on aircraft and flight equipment. | (subclassOf, Core, Equipment)(subclassOf, this, Aviation technology) |
| Helicopters | 010301 | Rotory winged aircraft used for transport, airborne battlefield command and control, troop insertion/extraction, fire support coordination, medical evacuation, search and rescue, armed escort/visual reconnaissance or utility roles. Includes attack helicopters. | (subclassOf, this, Aircraft) |
| Bombers | 010302 | Aircraft designed specifically to carry and deliver aerial ordinance to a designated target. | (subclassOf, this, Aircraft) |
| Attack and fighter aircraft | 010303 | Aircraft designed specifically to provide air-to-air combat and/or close air support . | (subclassOf, this, Aircraft) |

| | | | |
|---|---|---|---|
| Patrol and reconnaissance aircraft | 010304 | Aircraft designed for short and long range observation and data collection missions. Includes observation aircraft. | (subclassOf, this, Aircraft) |
| Transport aircraft | 010305 | Aircraft designed to carry and deliver large quantities of troops and supplies to forward operating areas. Includes tanker aircraft. | (subclassOf, this, Aircraft) |
| Training aircraft | 010306 | Aircraft designed specifically to provide initial, intermediate and advanced flight training support . | (subclassOf, this, Aircraft) |
| V/STOL | 010307 | Vertical and Short Takeoff and Landing (V/STOL) aircraft specifically designed to take off and land like a helicopter but fly with the efficiency of an airplane. | (subclassOf, this, Aircraft) |
| Gliders and parachutes | 010308 | Aircrafts and airfoils designed to fly without the use of motorized propulsion. Includes paragliders and kites, for both military and civilian applications. | (subclassOf, this, Aircraft) |
| Civilian aircraft | 010309 | Does not include aircraft modified for military use. | (subclassOf, this, Aircraft) |
| Pilotless aircraft | 010310 | Includes full size aircraft when configured as drones. | (subclassOf, this, Aircraft) |
| Lighter than air aircraft | 010311 | Airships, blimps, dirigibles, balloons, for both civilian and military applications. | (subclassOf, this, Aircraft) |
| Research and experimental aircraft | 010312 | Includes aerospace aircraft | (subclassOf, this, Aircraft) |
| Flight control and Instrumentation | 010400 | Instruments, sensors, displays and recorders necessary for control and monitoring the flight of an aircraft; Cockpit and cabin display devices and onboard checkout systems; Onboard navigation display devices; Automatic pilots; Stability and control systems; Boundary layer control systems; Dynamic and static control devices. If the application of a flight control system is apparent, see the field where the application is treated. | (subclassOf, this, Military aircraft operations) |
| Terminal flight facilities | 010500 | Airports; Military air bases; Runways; Hangars; Ground refueling systems; Heliports; Aircraft handling and maintenance equipment; Taxiways; Parking aprons; Crash and fire facilities. | (subclassOf,Core,Facilities) |
| Commercial and general aviation | 010600 | Civil aircraft operations, as described in 010200. Also includes civil airport passenger and vehicle traffic studies. | (subclassOf, this, Aviation technology) |

| | | | |
|---|---|---|---|
| Agriculture | 020000 | Studies related to plant cultivation. | (subclassOf, Core, Scientific and technological research and innovation function) |
| Agricultural chemistry | 020100 | The application of chemistry to the production and use of crops and livestock; Chemurgy; Fertilizers; Feeds; Pesticide chemistry. | (subclassOf, this, Agriculture) |
| Agricultural economics | 020200 | Economic conditions such as markets, production control and subsidies affecting agriculture; Farm management, finance, labor; Land economics; Surpluses, policies and programs; Food imports, exports, consumption and utilization; Prices and price control; Agribusiness; Crop surveys. | (subclassOf, this, Agriculture) |
| Agricultural engineering | 020300 | Design of agricultural machinery, tools and structures; Soil conservation; Agricultural soil erosion and its prevention; Irrigation systems; Water conservation; Agriculture facilities, equipment and supplies. | (subclassOf, this, Agriculture) |

## 9.5 Meteorological and Oceanographic Community (METOC) Taxonomy, version 1.0 (Page 1&2)

| Term ID | Term Label | Term Definition | Mapping(s) |
|---|---|---|---|
| aadt_cd-1 | Astrolabe | Astrolabe - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aadt_cd-2 | Astronomic theodolite | Astronomic theodolite - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aadt_cd-3 | Bc-4 camera | Bc-4 camera - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aadt_cd-4 | Optical telescope | Optical telescope - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aadt_cd-5 | Radio telescope | Radio telescope - the code that denotes the type of an astrometric-angle-device-type. | (subclassOf, this, ASTROMETRIC-ANGLE-DEVICE-TYPE) |
| aaf_airmass_cd-0 | Rural | Rural - the code that denotes the classification of an air mass as to aerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |

| | | | |
|---|---|---|---|
| aaf_airmass_cd-1 | Urban | Urban - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-10 | Maritime intermittent (0-10 knots) | Maritime intermittent (0-10 knots) - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-11 | Maritime intermittent (11-20 knots) | Maritime intermittent (11-20 knots) - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-12 | Maritime intermittent (>20 knots) | Maritime Intermittent (≫20 Knots) - The Code That Denotes The Classification Of An Air Mass As Toaerosol Composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-13 | Maritime continental (0-10 knots) | Maritime Continental (0-10 Knots) - The Code That Denotes The Classification Of An Air Mass As Toaerosol Composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-14 | Maritime continental (11-20 knots) | Maritime continental (11-20 knots) - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-15 | Maritime continental (>20 knots) | Maritime continental (>20 knots) - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-2 | Maritime | Maritime - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-3 | Tropospheric | Tropospheric - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-4 | Advection fog | Advection fog - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-5 | Radiation fog | Radiation fog - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-6 | Desert | Desert - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-7 | Maritime ocean (0-10 knots) | Maritime ocean (0-10 knots) - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |

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|---|---|---|---|
| aaf_airmass_cd-8 | Maritime ocean (11-20 knots) | Maritime ocean (11-20 knots) - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| aaf_airmass_cd-9 | Maritime ocean (>20 knots) | Maritime ocean (>20 knots) - the code that denotes the classification of an air mass as toaerosol composition. | (subclassOf, this, AEROSOL-ANALYSIS-FORECAST) |
| abmdle_cal_mthd_cd-BC | Bar check | Bar check - the code that denotes the method used for calibrating a devicewhichmeasures ocean floor depths. | (subclassOf, this, ACOUSTIC-BATHYMETRY-MEASURING-DEVICE-LOG-ENTRY) |
| abmdle_cal_mthd_cd-PT | Patch test | Patch test - the code that denotes the method used for calibrating a devicewhichmeasures ocean floor depths. | (subclassOf, this, ACOUSTIC-BATHYMETRY-MEASURING-DEVICE-LOG-ENTRY) |
| abmdle_cal_mthd_cd-SASS | Sass sonar | Sass sonar - the code that denotes the method used for calibrating a devicewhichmeasures ocean floor depths. | (subclassOf, this, ACOUSTIC-BATHYMETRY-MEASURING-DEVICE-LOG-ENTRY) |
| abmdle_cal_mthd_cd-SBM | Seabeam sonar | Seabeam sonar - the code that denotes the method used for calibrating a devicewhichmeasures ocean floor depths. | (subclassOf, this, ACOUSTIC-BATHYMETRY-MEASURING-DEVICE-LOG-ENTRY) |
| abmdle_cal_mthd_cd-SMRD | Simrad system | Simrad system - the code that denotes the method used for calibrating a devicewhichmeasures ocean floor depths. | (subclassOf, this, ACOUSTIC-BATHYMETRY-MEASURING-DEVICE-LOG-ENTRY) |
| ABSOLUTE-GRAVITY-MEASURING-DEVICE-LOG-ENTRY | Absolute-gravity-measuring-device-log-entry | A record of the results of calibrating an absolute gravity measuring device. | (subclassOf, this, GRAVITY-MEASURING-DEVICE-LOG-ENTRY) |
| ABSOLUTE-GRAVITY-METER | Absolute-gravity-meter | A device that measures the acceleration of gravity at a point. | (subclassOf, this, GRAVITY-METER) |
| ABSOLUTE-GRAVITY-METER-DEVICE-TYPE | Absolute-gravity-meter-device-type | A type of device that measures the acceleration of gravity at a point. | (subclassOf, this, GRAVITY-MEASURING-DEVICE-TYPE) |

## 9.6 Complete Stubbing Candidates List by Taxonomy

| Title | Definition | Mappings |
|---|---|---|
| AMTD | | |
| Operations | The ability to perform a specific mission at Operational command level. | (subClassOf, Core, Military activity) 2.1, (is subClassOf, Core, Military capability) 5.2, (is subClassOf, Core, Strategic national and theater defense) 6.1.1, (is subClassOf, Core, Tactical defense) 6.1.3, (is subClassOf,core, |
| Marine corps warfighting functions | To conduct warfare that includes the launch of naval and land forces from sea against a hostile, or potentially hostile shore. | (subClassOf, this, Marine corps) 1.2, (subClassOf, Core, Military activity) 2.1, (subClassOf, Core, Military capability) 5.2, (subClassOf, Core, Strategic national and theater defense) 6.1.1, (subClassOf, Core, Tactical defense) 6.1.3, (subClassOf, Core, Tactical defense function) |
| Physical Environment | The circumstances, objects, or conditions by which one is surrounded. The complex of physical, chemical, and biotic factors (as climate, soil, and living things) that act upon an organism or ecological community and ultimately determine its form and survival. | (SubClassOf,this,Environment), is SameAs,Core,Natural environment) |
| C2IEDM | | |
| ORGANISATION | The specific value that represents the class of ORGANISATION. It serves as a discriminator that partitions ORGANISATION into subtypes. | (subClassOf, this, Object-Item, (is subClassOf, Core, Organization) |
| CAPABILITY | The specific value that represents the general class of a CAPABILITY. It serves as a discriminator that partitions CAPABILITY into subtypes. | (subClassOf,Core,Capability) |
| ACTION-EVENT | An ACTION that is an incident, phenomenon, or occasion of military significance which has occurred or is occurring but for which planning is not known. | (subClassOf, this, Action, (is subClassOf, Core, Action) |
| DTIC | | |

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|---|---|---|
| Aviation technology | The science and technology of mechanical flight. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Military aircraft operations | Military aircraft operations such as takeoff Operations and landing, air traffic, all weather and night flight, taxiing, approach, and inflight refueling; Flight safety; Ground safety; Aviation accident studies; Aircraft simulators and training devices. | (subClassOf, Core, Force application action)(subClassOf, this, Aviation technology) |
| Aircraft | Design, production, and maintenance of aircraft, aircraft components, and aircraft equipment; Structural studies of complete aircraft components such as airframes, bodies, and wings. Airworthiness; Crashworthiness; Aircraft damage assessment and vulnerability studies; effects of gunfire and blast on aircraft and flight equipment. | (subClassOf, Core, Equipment)(subClassOf, this, Aviation technology) |
| Terminal flight facilities | Airports; Military air bases; Runways; Hangars; Ground refueling systems; Heliports; Aircraft handling and maintenance equipment; Taxiways; Parking aprons; Crash and fire facilities. | (subClassOf,Core,Facilities) |
| Agriculture | Studies related to plant cultivation. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Aeronomy and astrophysics | The study of objects outside the earth's atosphers. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Atmospheric sciences | Study of phenomena occurring in the earth's atmosphere. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Meteorology | Weather observations, prediction, and modification of the atmosphere; Climatology; Meteorological modelling. | (subClassOf, Core, Meteorological environment) |
| Behavioral and social sciences | Activities involving business and the social sciences. | (subClassOf, Core, Account)(subClassOf, Core, Capability) |
| Administration and management | Management techniques; Planning; Budgeting; Public relations; Production planning; Organization coordination; Accounting; Cost control. Includes management information systems. For the administration and management of a specific subject area, see the group where the subject is treated. | (sameAs, Core, Administrative management function) |

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|---|---|---|
| Information science | Information processing such as acquisitions, cataloging, classifying, indexing and abstracting; Storing, retrieving, and distributing recorded information in hardcopy, microform or electronic form; Information storage and retrieval systems; Documentation centers; Library and information networks. For bibliographies, symposia, conferences, handbooks, patents, specific subject matter involved. | (sameAs, Core, Information and technology management function) |
| Economics and cost analysis | Econometrics; Economic history; Economic theory; Banking and finance; International economic relations; Trade and Commerce. Includes cost effectiveness studies, cost- benefit analysis, tradeoff factors, market research and production forecasts. | (subClassOf, Core, Economic environment) |
| Government and political science | Theory and practice of government; International relations; Political conditions. Includes treaties, arms control, and negotiations. | (subClassOf, Core, Political environment) |
| Sociology and law | Social relations; Sociometrics; Social concerns; Family life; Ethnology; Criminology; Demography; Military, civil and criminal law including codes, statutes and legal interpretations; Police methods; Riot control; Penalogy; Court administration. | (subClassOf, Core, Social environment) |
| Humanities and history | Philosophy; Religion; Literature; Art; Music; Drama; Archaeology; Educational philosophy and methods; Educational organizations. For the training aspects of a subject, see the group where the subject is treated. | (subClassOf, Core, Cultural environment) |
| Personnel management amd labor relations | Recruitment, selection, utilization and evaluation of civilian and military personnel; Manpower studies; Industrial relations; Wages; Benefits; Housing; Work measurement; Labor unions; Arbitration and bargaining; Job analysis; Job benefits; Job satisfaction; Career guidance. Includes physical fitness standards and examinations. | (subClassOf, Core, Human resource management function) |
| Biological and medical sciences | Studies of the biological and life sciences. | (subClassOf, Core, Scientific and technological research and innovation function) |

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|---|---|---|
| Anatomy and physiology | The study of the functions of cells, tissues, organs and systems in humans and animals by physical and chemical methods; Growth; Aging; Metabolism; Biological rhythm; Healing and repair; Sensation; Respiration; Electrophysiology; Neuroanatomy. | (subClassOf, Core, Health function) |
| Medicine and medical research | Prevention, diagnosis and therapy of diseases; Internal medicine; Pediatrics; Geriatrics; Dermatology; Opthalmology; Psychiatry; Dentistry; Nuclear medicine; Experimental medicine; Public health; Medical and paramedical training; Paramedical services. Includes nursing, first aid, medical technology, physical therapy and prosthesis. | (subClassOf, Core, Health function) |
| Medical facilities equipment and supplies | Medical facilities such as civilian and military hospitals and clinics; Equipment and supplies for hospital, laboratory and field use. For equipment and techniques for sustaining life in adverse environments, See 230500, Life Support Systems. | (subClassOf, Core, Health function) |
| Weapons effects(Biological) | Wound ballistic studies; Wounds, injuries or other conditions directly resulting from weapons. For effects of CBR weapons, see 150603. For the physiological effects of nuclear weapons, See 060700, Radiobiology. For the medical treatment of wounds and injuries, See 06050, Medicine and Medical Research. | (subClassOf, Core, Health function) |
| Pharmacology | The synthesis, composition, properties and physiological effects of drugs. Includes psychopharmacology. | (subClassOf, Core, Health function) |
| Chemistry | The science of the composition, structure, properties, and reactions of matter, especially of atomic and molecular systems. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Earth sciences and oceanography | Studies of the earth and its seas. | (subClassOf, Core, Scientific and technological research and innovation function) |

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|---|---|---|
| Physical and dynamic oceanography | Physical, chemical and dynamic properties of the oceans and seas; Topography, geochemistry and geophysics of the ocean bottom; Ocean waves; Currents; Tides; Ocean- air interactions; Beach and shore erosion and sediment transport. For sea ice phenomena and ice breaking operations, See 081200, Snow, Ice and Permafrost. For fresh water phenomena, See 080800, Hydrology, Limnology and Potamology. | (sameAs, Core, Oceanographic environment) |
| Geodesy | Geodetic surveying; Determination of position of points on the earth's surface; Shape and size of the earth; Variations of terrestrial gravity; Astronomical geodesy and geodesics. | (subClassOf, Core, Spatial region) |
| Geography | The study of the non-physical aspects of the natural and political divisions of the earth. Includes country and area studies. | (subClassOf, Core, Geographic environment) |
| Electrotechnology and fluidics | The study of electronic and fluidic systems. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Electrical and electronic equipment | Electrical and electronic components, systems and subsystems, such as electric motors, electron tubes, semiconductor devices, integrated circuits, electric switches, electric connectors, electric amplifiers and antennas where the application is not apparent or where there is more than one application. If the application is apparent, see the group where the application is treated. | (subClassOf, Core, Equipment) |
| Power production and energy conversion | Power engineering | (subClassOf, Core, Utilities asset) |
| Non-electrical energy conversion | Techniques and devices for the conversion of one form of energy to a form of non- electrical energy, but which do not primarily involve energy storage; General studies of energy conversion. If the application of a technique or a device is known, see the group where the application is treated. | (subClassOf, Core, Equipment) |

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| Electric power production and dist. | Techniques and devices used in the generation and distribution of electric power which do not primarily use energy storage. Includes electric power generators, transformers, converters, circuit breakers and electrical power transmission lines. | (subClassOf, Core, Equipment) |
| Materials | The study and description of materials. | (subClassOf, Core, Supply) |
| Mathematical and computer sciences | Studies of the languages of science and technology. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Mechanical industrial civil and marine engineering | The coverage of classic engineering fields. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Containers and packaging | Design, production, performance and testing of containers; Packaging methods; Storage tanks and accessories. | (subClassOf, Core, Equipment) |
| Couplers fasteners and joints | Design, performance and testing of bolts, screws, studs, rivets, hooks, couplers, and fittings; Bonded, soldered and welded joints. | (subClassOf, Core, Equipment) |
| Surface transportation and equipment | Design, operation, performance and maintenance of systems to transport passengers and cargo; Civilian passenger and cargo movement and handling; Passenger vehicles; Railroads; Rolling stock; Surface and rapid transit systems; Mass transportation systems; Moving sidewalks; Marine transportation; Merchant and marine shipping. Includes vehicle components. | (subClassOf, Core, Transportation function) |
| Machinery and tools | Design, production, performance and testing of machinery and tools; Machines and machine elements; Gears; Bearings; Clutches; Drives; Cams; Springs; Metal working tools; Wood working tools. | (subClassOf, Core, Equipment) |
| Marine engineering | Design, construction, maintenance, salvage, operation and performance of all types of ships, boats, and related equipment; Naval architecture; Ships and shipbuilding. Includes hydrofoil craft, SWATH ships and planing hull craft. | (subClassOf, Core, Transportation function) |

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|---|---|---|
| Pump filters pipes tubing and valves | Design, production, operation, performance and testing of pumps, filters, pipes, tubing, pipe fittings and valves. If the application of a device is apparant, see the group where the application is treated. | (subClassOf, Core, Equipment) |
| Test equipment research facilities and reprography | A filed covering photography reprography and laboratory equipment and techniques. | (subClassOf, Core, Facility) |
| Holography | Techniques and devices for producing holograms. Acoustic holography. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Test facilities equipment and methods | Laboratory and test facility design and operation; Measuring, testing and simulation devices with more than one application. For devices and facilities used for a single application, see the group where the application is treated. | (subClassOf, Core, Facility) (subClassOf, Core, Equipment) |
| Recording and playback devices | Techniques and devices for recording variable quantities. Includes magnetic, thermoplastic, electrostatic and electrooptical recording systems. For photographic recording, See 140400, Photography. For holographic recording, See 140100, Holography. For devices used for a single application, see the group where the application is treated. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Photography | Photographic techniques, equipment, processes and materials. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Printing and graphic arts | Lithography and Photolithography; Drawing; Engraving; Visual design; Xerography. | (subClassOf, Core, Scientific and technological research and innovation function) |
| Military sciences | The study of the science and art of war. | (subClassOf, Core, Military action) |
| Military forces and organizations | The organization and structure of United States or foreign military forces and organizations. Includes force mixes, force structures, force levels and tables of organization; NATO; Rapid deployment forces; Military reserves; Paramilitary forces such as the National Guard and Civil Air Patrol. | (subClassOf, Core, Facility)(subClassOf, Core, Military forces organization) |

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| Civil defense | Activities and measures designed to minimize the effects upon the civilian population caused by an enemy attack or a natural disaster, to deal with the immediate emergency conditions which would be created by such an attack or disaster, and to effect emergency repairs to, or the temporary restoration of, vital utilities and facilities destroyed or damaged by such an attack or disaster. Includes the protection of military bases and population from natural disasters. | (subClassOf, Core, Contingency support action) |
| Defense systems | Active and passive systems of military defense; Systems, structures and devices to provide area monitoring, security and terrain denial; Area and point defense; Antipersonnel and area defense through the use of remote sensors. Includes barbed wire, warning systems, barriers and other antiintrusion devices. | (subClassOf, Core, Force protection action) |
| Military intelligence | Techniques for collecting, evaluating and disseminating information concerning foreign or enemy activities needed for the purpose of national security. | (subClassOf, Core, Battlespace awareness action)(subClassOf, Core, Battlespace awareness capability) |
| Logistics military facilities and supplies | Logistics planning; Procurement, storage distribution, stock level controls and inventory techniques, issue, repair, reclamation, preventive and corrective maintenance, and replacement of military equipment and supplies; Design and testing of equipment such as clothing, field gear, and tents; Transportation of troops and military cargo; Industrial mobilization; Weapons and explosives storage facilities. | (subClassOf, Core, Logistical action) |
| Military operations strategy and tactics | Joint and combined operations; Campaigns; Battles; Invasions; Theater operations; Psychological warfare; Conventional warfare; Methods of attack and combat support; Tactical and strategic defense planning, policy and doctrine; War gaming; Military exercises; Threat evaluation; Types of warfare; Rapid deployment operations; Amphibious and riverine operations. | subClassOf,Core,Force application action) |
| Guided missile technology | | (subClassOf, Core, Ordnance) |

| METOC | | |
|---|---|---|
| Astrometric-element | An object which has a specific set of coordinates in the celestial reference system. | (partOf, Core, Environment) |
| Astrometric-element-orbit-ephemeris | An ephemeris for the orbit of an astrometric-element. | (subTaxonOf, Core, Environment) (subClassOf, Core, Intellectual_assets) |
| Datum-transformation | A set of parameters used to transform coordinates from one horizontal-reference-datum to another. | (subClassOf, Core, Intellectual_asset) |
| Device-acoustic-measurement-association | An association between an acoustic-propagation-measurement and a geophysical-measuring-device. | (subClassOf, Core, Intellectual_asset) (subTaxonOf, Core, Equipment) (subTaxonOf, Core, Environment) |
| Doppler-weather-radar-base-image | A digital radar image of parameters depicted by a doppler weather radar at a specific elevation angle of the radar. | (subClassOf, Core, Intellectual_asset) (subTaxonOf, Core, Equipment) (subTaxonOf, Core, Meteorological_environment) |
| Doppler-weather-radar-cross-section-image | A doppler weather radar image, in cartesian coordinates (row, column), for a vertical plane along a user-defined horizontal line through a weather radar volume scan. | (subClassOf, Core, Intellectual_asset) (subTaxonOf, Core, Equipment ) (subTaxonOf, Core, Meteorological_environment) |
| Doppler-weather-radar-precipitation-image | A weather radar image, in spherical coordinates, of the estimated rainfall accumulation for a specific time period and geographic area | (subClassOf, Core, Intellectual_asset) (subTaxonOf, Core, Equipment) (subTaxonOf, Core, Meteorological_environment) |
| Doppler-weather-radar-raster-image | A doppler radar image of meteorological phenomena in cartesian coordinates (row, column), for the area swept by a volume scan of a weather radar. | (subClassOf, Core, Intellectual_asset) (subTaxonOf, Core, Equipment) (subTaxonOf, Core, Meteorological_environment) |
| Doppler-weather-radar-window-image | A digital radar image window of parameters depicted by a doppler radar at a specific elevation angle centered on an azimuth at a distance from the radar. | (subClassOf, Core, Intellectual_asset) (subTaxonOf, Core, Equipment) (subTaxonOf, Core, Meteorological_environment) |
| Geological-analysis-forecast-element | An estimate of geological characteristics of the earth. | (subTaxonOf, Core, Environment) (subClassOf, Core, Intellectual_assets) |
| Geophysical-device-maintenance-log-entry | A record of maintenance, calibration, and related observations for a geophysical-measuring-device | (subClassOf, Core, Intellectual_asset) (subTaxonOf, Core, Equipment) (subTaxonOf, Core, Environment) |

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|---|---|---|
| Geophysical-layer | A specific layer within the vertical extent from the earth's Core to the top of the atmosphere. | (subPartOf, Core, Environment) (subClassOf, Core, Geographical_area) |
| Geophysical-measuring-device | A device for measuring geophysical characteristics | (subTaxonOf, Core, Environment) (subClassOf, Core, Equipment) |
| Geophysical-observation-platform | The platform from which a geophysical-point-observation was taken. | (subTaxonOf, Core, Environment) (subClassOf, Core, Equipment) |
| Grid-geometry-projection | The grid geometry of a map projection | (subTaxonOf, Core, Geographic_environment) (subClassOf, Core, Intellectual_assets) |
| Horizontal-coordinate-system-definition | A geospatial reference system for horizontal positions. | (subTaxonOf, Core, Geographic_environment) (subClassOf, Core, Intellectual_assets) |
| Information-asset | An information resource. | (subClassOf, Core, Intellectual_assets) |
| Internal-data-field | The lowest addressable unit of an internal record. | (subClassOf, Core, Intellectual_asset) |
| Location | A specific place. | (sameAs, Core, Place) |
| Meteorological-analysis-forecast-element | An estimate of characteristics of the atmosphere. | (subTaxonOf, Core, Meteorological_environment) (subClassOf, Core, Intellectual_asset) |
| Meteorological-radar-observation | An observation of meteorological phenomena from a radar. | (subTaxonOf, Core, Meteorological_environment) (subClassOf, Core, Intellectual_asset) |
| Ocean-ice-observation | A type of observation of ice on the surface of a body of water. | (subTaxonOf, Core, Oceanographic_environment) (subClassOf, Core, Intellectual_asset) |
| Oceanographic-analysis-forecast-element | An estimate of characteristics of the ocean | (subTaxonOf, Core, Oceanographic_environment) (subClassOf, Core, Intellectual_asset) |
| Ocean-profile-element | The oceanographic parameters measured at a specific depth of an ocean-profile. | (subTaxonOf, Core, Oceanographic_environment) (subClassOf, Core, Intellectual_asset) |
| Period | (1321) (a) interval of time | (sameAs, Core, Period) |

## Appendix B – Reference Material

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