



Universal Core Semantic Layer (UCore SL)

An Ontology-Based Supporting Layer for UCore 2.0

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Barry Smith
Lowell Vizenor
Jim Schoening



Universal Core Semantic Layer (UCore SL)

**Sponsored by US Army Net-
Centric Data Strategy (ANCDS)
Center of Excellence**



DoD Net-Centric Data Strategy

The DoD Net-Centric Data Strategy, issued by the DoD CIO May 9, 2003, is the plan to make the Department's information resources:

Visible	Is an information resource discoverable by most users?
Accessible	Is it available on the network, and are tools readily available to use it?
Understandable	Can it be intelligibly used? Are the semantics well documented?
Trusted	Are the source, security level and access controls of the data available to users?
Interoperable	Can it be combined or compared with other information? Can it be mediated?
Responsive	Is the data what users need? Are robust user feedback mechanisms in place to improve it?

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TRANSITION GUIDE



JANUARY 2009



UCore Initiative



- The UCore initiative focused on improving national readiness and international security by developing a common technical approach and vocabulary that will enable information sharing between Federal, state, regional, and local governments, including the IC, and including civil and non-governmental organizations
- move to include also U. S. coalition partners and allies



UCore Taxonomy

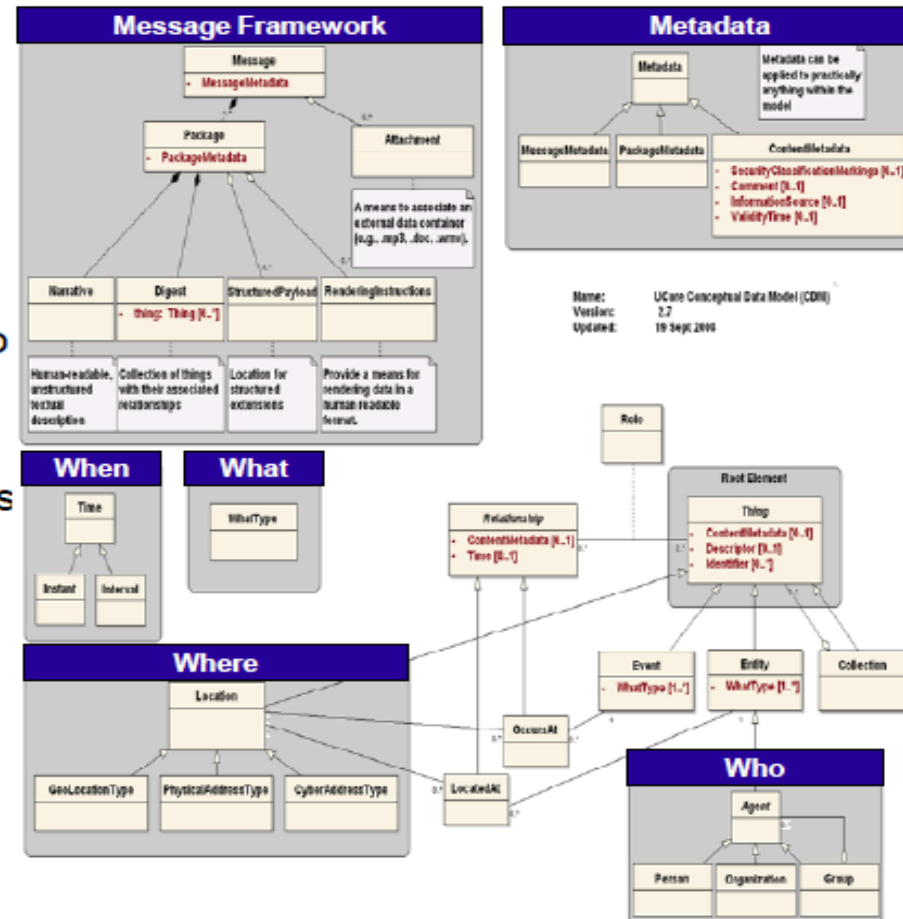


- An XML schema was defined containing agreed-upon representations for the most commonly shared and **“universally understood concepts of who, what, when, and where”** in order to promote Federal information sharing.

What is the Universal Core (UCore)?

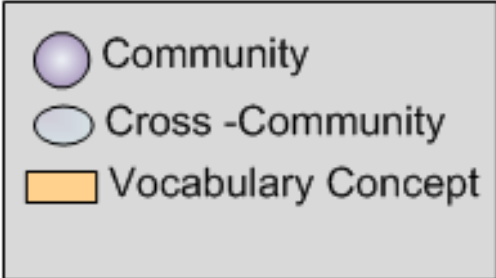
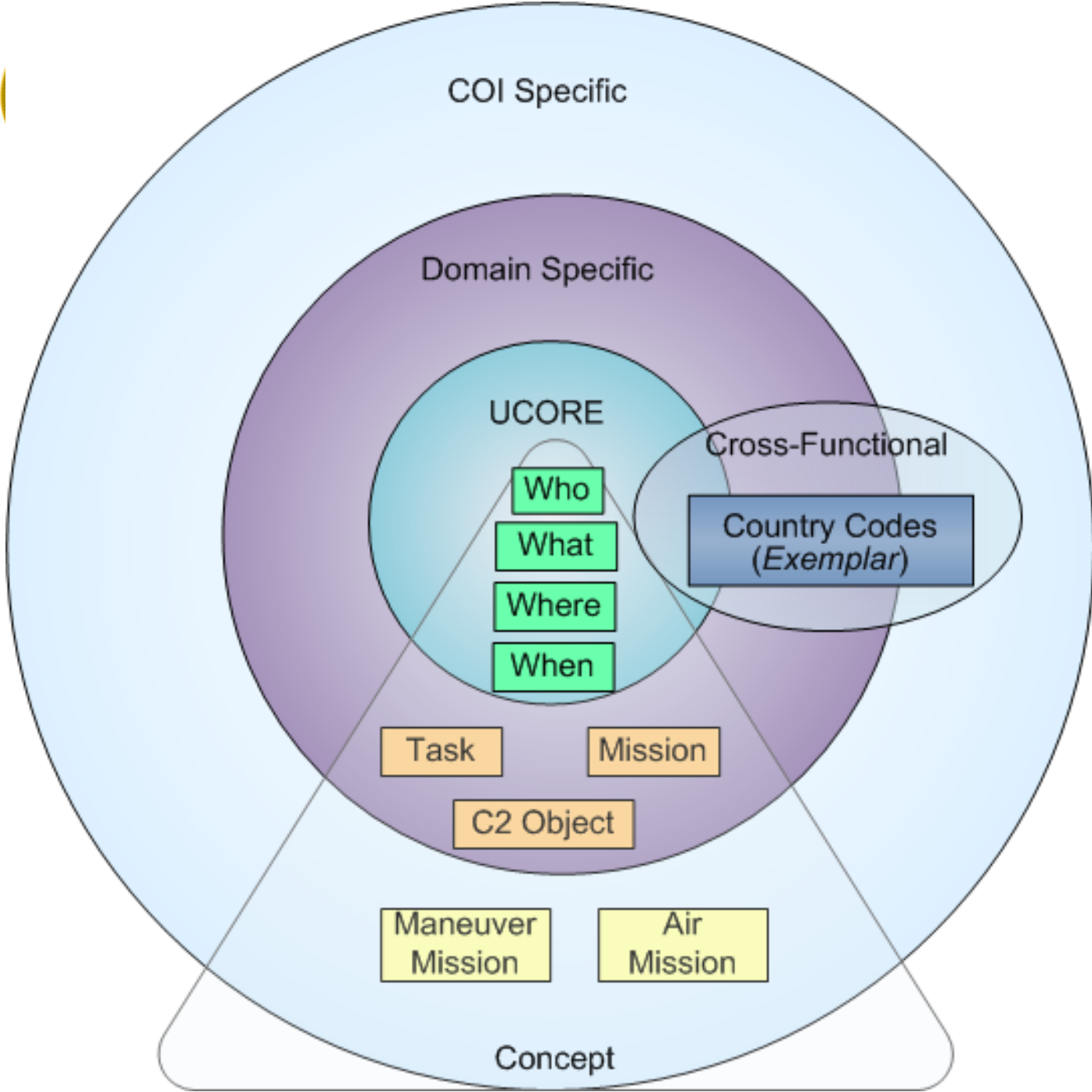
- An information exchange specification and Implementation profile
 - Vocabulary
 - Of most commonly exchanged concepts: Who, What, When, Where
 - XML representation of the concepts
 - Guidance for extension to permit tailoring to specific mission areas
 - Security markings to permit controlled access electronic tear lines
 - Messaging framework to package and unpack the content consistently

UCore V2.0 Conceptual Data Model



UCore is Common Point of Departure

with
acknowledgements
to Jaci Knudson
NECC Data
Strategy Lead





UCore 2.0 Taxonomy



uc:Entity

uc:Cargo
uc:CollectionOfThings
uc:CyberAgent
uc:Document
uc:Environment
uc:Equipment
uc:Facility
uc:FinancialInstrument
uc:GeographicFeature
uc:GroupOfOrganizations
uc:GroupOfPersons
uc:InformationSource
uc:Infrastructure

uc:LivingThing
uc:Animal
uc:Person
uc:MicroOrganism
uc:Plant
uc:Organization
uc:PoliticalEntity
uc:Sensor
uc:Vehicle
uc:Aircraft
uc:GroundVehicle
uc:Spacecraft
uc:Watercraft

uc:Event

uc:AlertEvent
uc:CommunicationEvent
uc:CriminalEvent
uc:CyberSpaceEvent
uc:DisasterEvent
uc:EconomicEvent
uc:EmergencyEvent
uc:EnvironmentalEvent
uc:EvacuationEvent
uc:ExerciseEvent
uc:FinancialEvent
uc:HazardousEvent
uc:HumanitarianAssistanceEvent
uc:InfrastructureEvent

uc:LawEnforcementEvent
uc:MigrationEvent
uc:MilitaryEvent
uc:NaturalEvent
uc:ObservationEvent
uc:PlannedEvent
uc:PoliticalEvent
uc:PublicHealthEvent
uc:SecurityEvent
uc:SocialEvent
uc:TerroristEvent
uc:TransportationEvent
uc:WeatherEvent



UCore SL



- An incremental strategy for achieving semantic interoperability
- Leaves UCore 2.0 as is, but provides a logical definition for each term in UCore 2.0 taxonomy and for each UCore 2.0 relation
- UCore SL is designed to work behind the scenes in UCore 2.0 application environments as a logical supplement to the UCore messaging standard



UCore SL



- Initiative of NCOR and Army Net-Centric Data Strategy Center of Excellence with contributions from the Intelligence Community and multiple Army COIs



XML vs. OWL DL

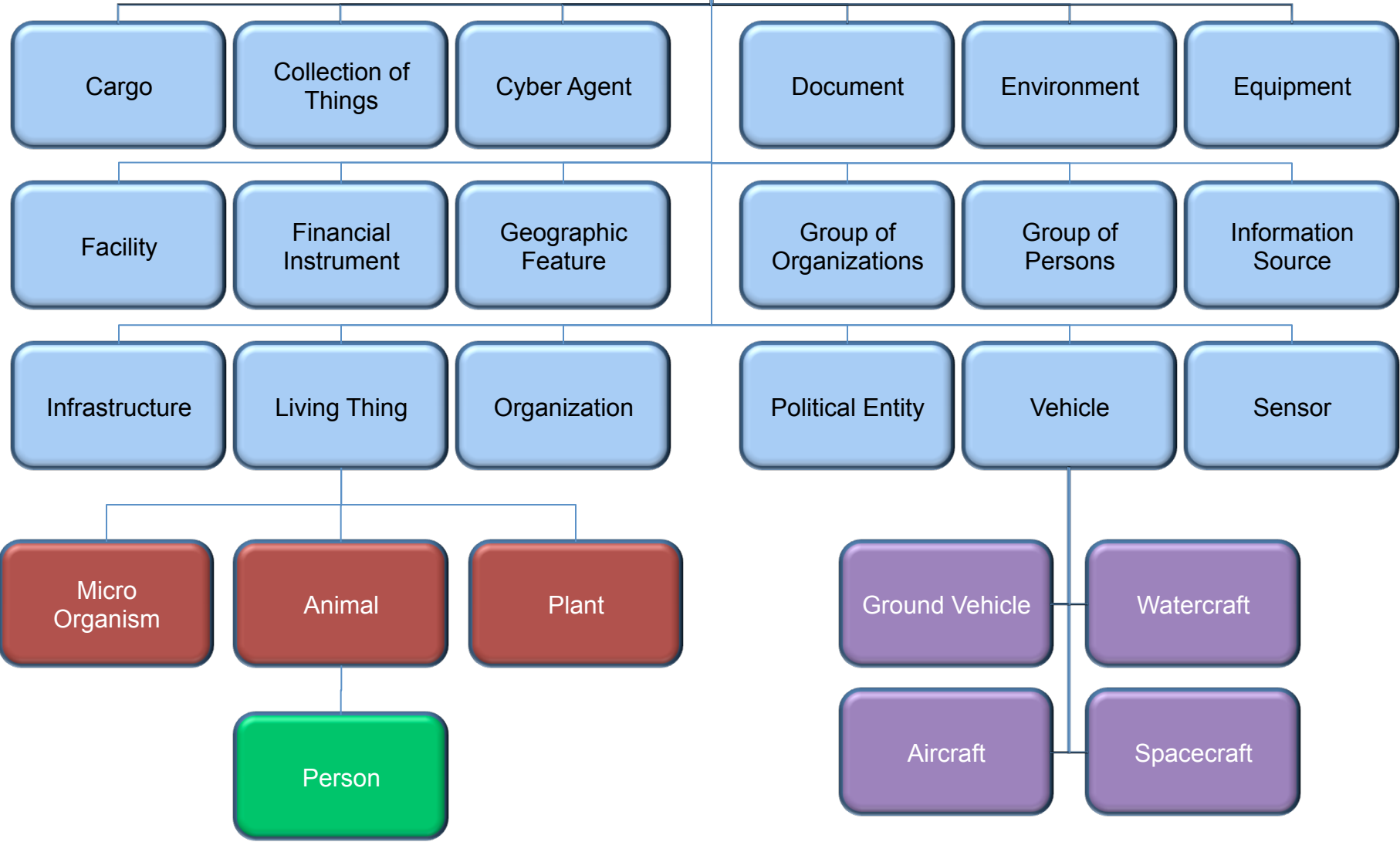


XML → *syntactic interoperability*

OWL DL → *semantic interoperability*

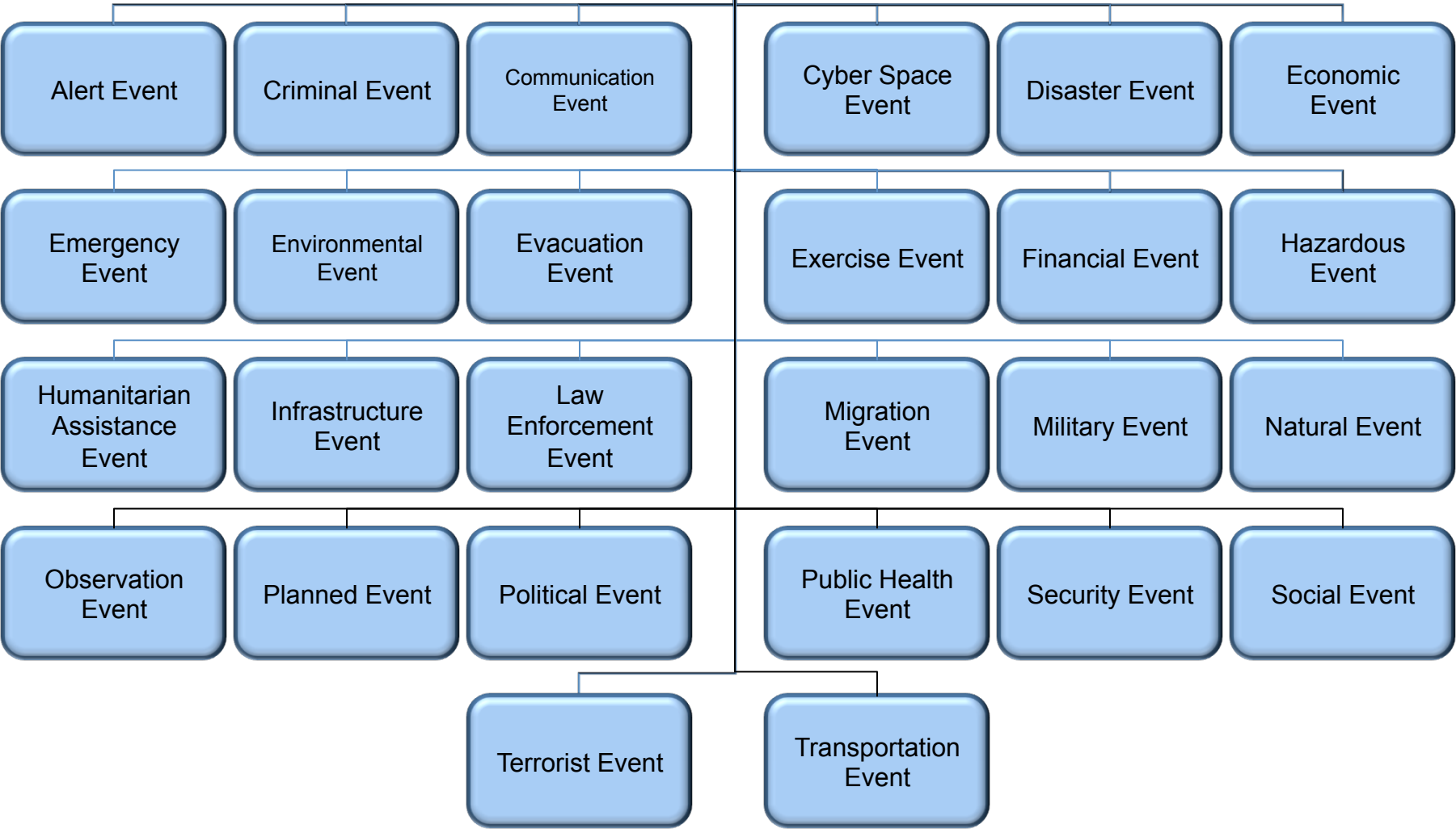


UCore Entity Taxonomy





UCore Event Taxonomy



fragment of UCore 2.0 Taxonomy

uc:Entity

uc:Cargo

uc:CollectionOfThings

uc:CyberAgent

uc:Document

uc:Environment

uc:Equipment

uc:Facility

uc:FinancialInstrument

uc:GeographicFeature

uc:GroupOfOrganizations

uc:GroupOfPersons

uc:InformationSource

uc:Event

uc:AlertEvent

uc:CommunicationEvent

uc:CriminalEvent

uc:CyberSpaceEvent

uc:DisasterEvent

uc:EconomicEvent

uc:EmergencyEvent

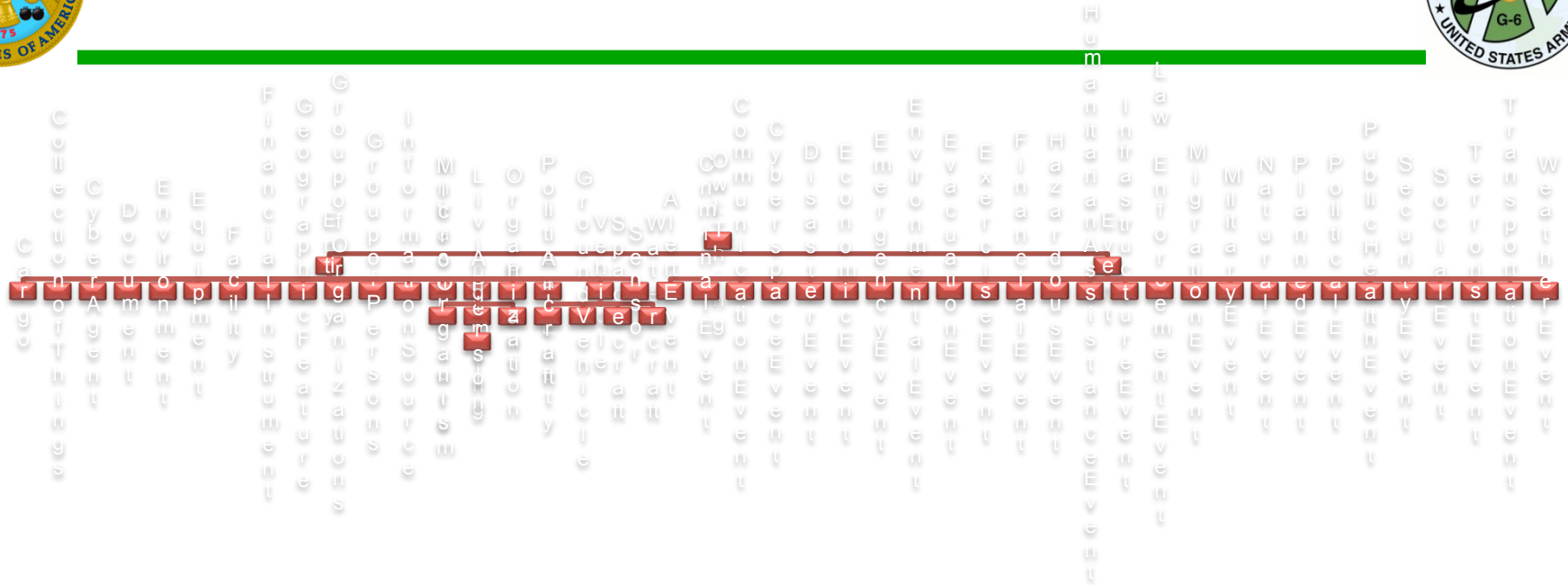
uc:EnvironmentalEvent

uc:EvacuationEvent

uc:ExerciseEvent

uc:FinancialEvent

uc:HazardousEvent



UCore 2.0 Taxonomy

fragment of UCore SL Taxonomy

sl:Entity

sl:InformationContentEntity

sl:Analysis

sl:Objective

sl:ObjectiveSpecification

sl:Opinion

sl:Plan

sl:TaskSpecification

sl:PhysicalEntity

sl:Agent

sl:Artifact

sl:ArtificialAgent

sl:Equipment

sl:Facility

sl:Sensor

sl:Environment

sl:GeographicFeature

sl:GeospatialBoundary

sl:Infrastructure

sl:Materiel

sl:Consumable

sl:Organization

sl:Government

sl:PhysicalObject

sl:LivingThing

sl:Animal

sl:Person

sl:InfectiousOrganism

sl:MicroOrganism

sl:Plant

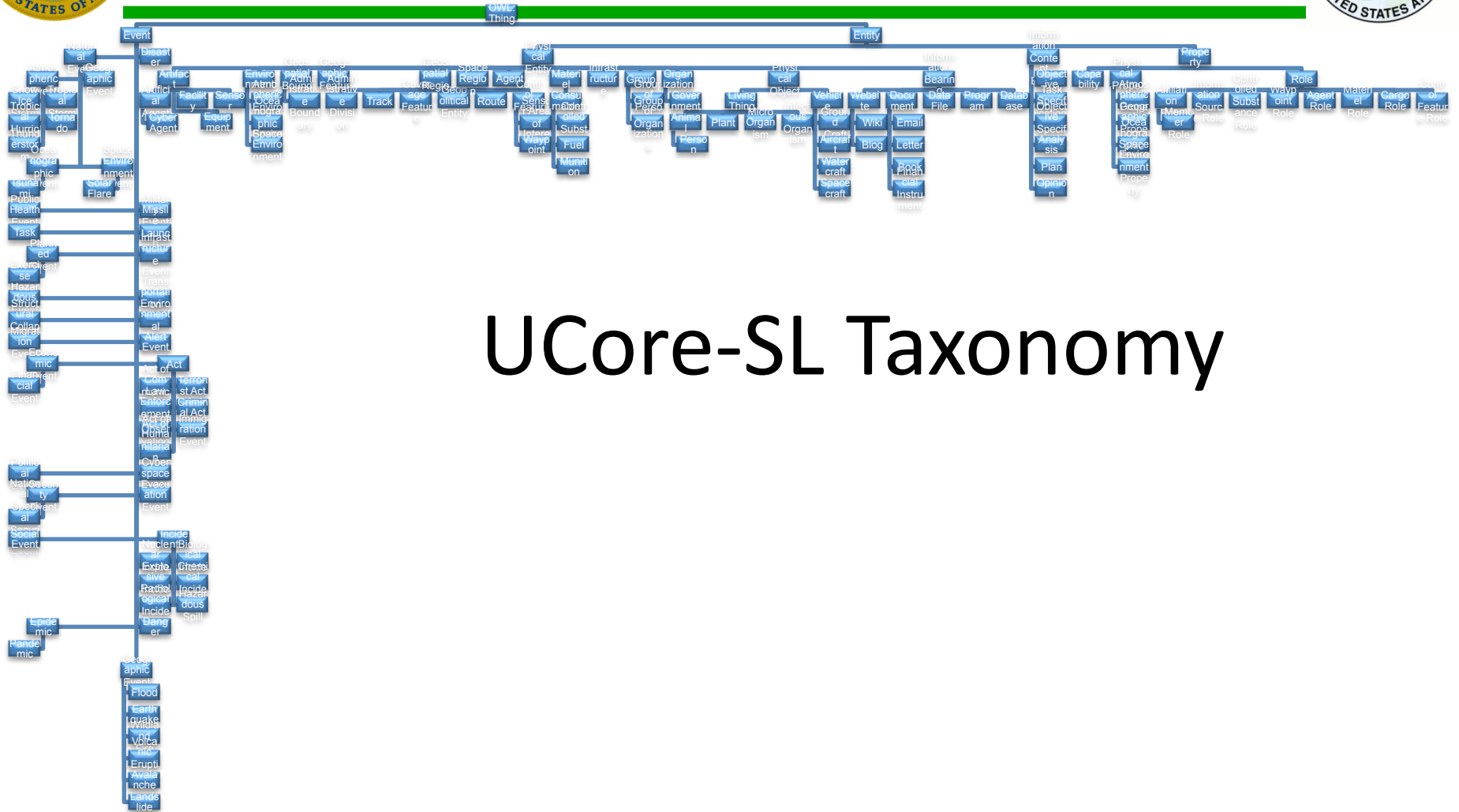
sl:Vehicle

sl:SpaceRegion

sl:Property

sl:Capability

sl:PhysicalProperty



UCore-SL Taxonomy



OWL DL allows uses of UCore SL



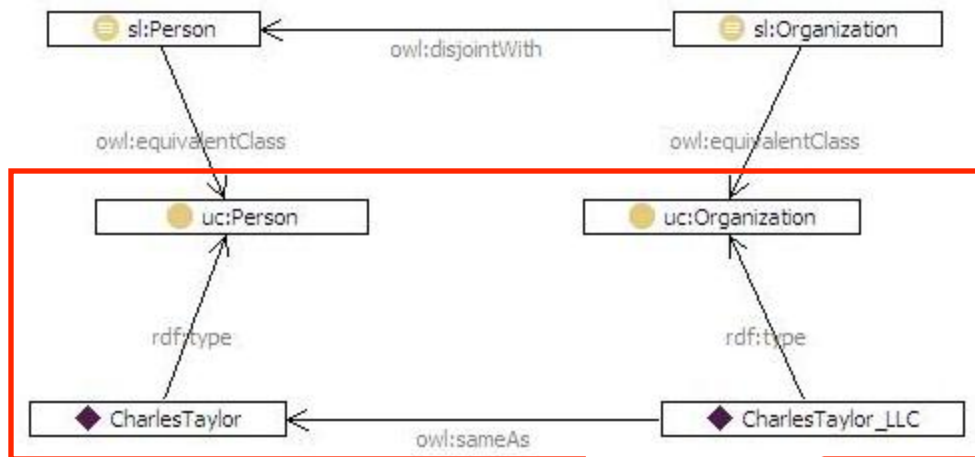
- to leverage UCore 2.0 by facilitating consistent merging with other OWL DL resources
- to provide logically articulated definitions
- to support use of W3C-standards-based software allowing:
 - enhanced reasoning with UCore message content
 - enhanced quality assurance
 - consistent evolution of UCore
 - reliable and consistent extension modules



Provides Additional Logical Resources



Using UCore SL as a supporting layer makes it possible to identify that something cannot be both a Person and an Organization



Logically speaking, UCore 2.0 is too weak to detect simple inconsistencies.

Explanation for the inconsistent ontology:

Explanation:
Individual [CharlesTaylor](#) is forced to belong to class [sl:Organization](#) and its complement

Axioms:

- [\(sl:Person owl:disjointWith sl:Organization\)](#)
- [\(sl:Person owl:equivalentClass uc:Person\)](#)
- [\(sl:Organization owl:equivalentClass uc:Organization\)](#)
- [\(CharlesTaylor_LLC owl:sameAs CharlesTaylor\)](#)
- [\(CharlesTaylor rdf:type uc:Person\)](#)
- [\(CharlesTaylor_LLC rdf:type uc:Organization\)](#)



Potential Benefits for UCore 2.0



Provide automatic warnings e.g. for potential ambiguities in UCore 2.0 terms and definitions

Automatic consistency checking when extensions to UCore 2.0 are proposed

Identify logical gaps in UCore 2.0 taxonomy and relations

Allow integration of UCore 2.0 XML-based technology with W3C (Semantic Web) content



UCore 2.0 Taxonomy



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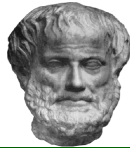
uc:Event

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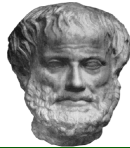


UCore 2.0 Proposed Change #1

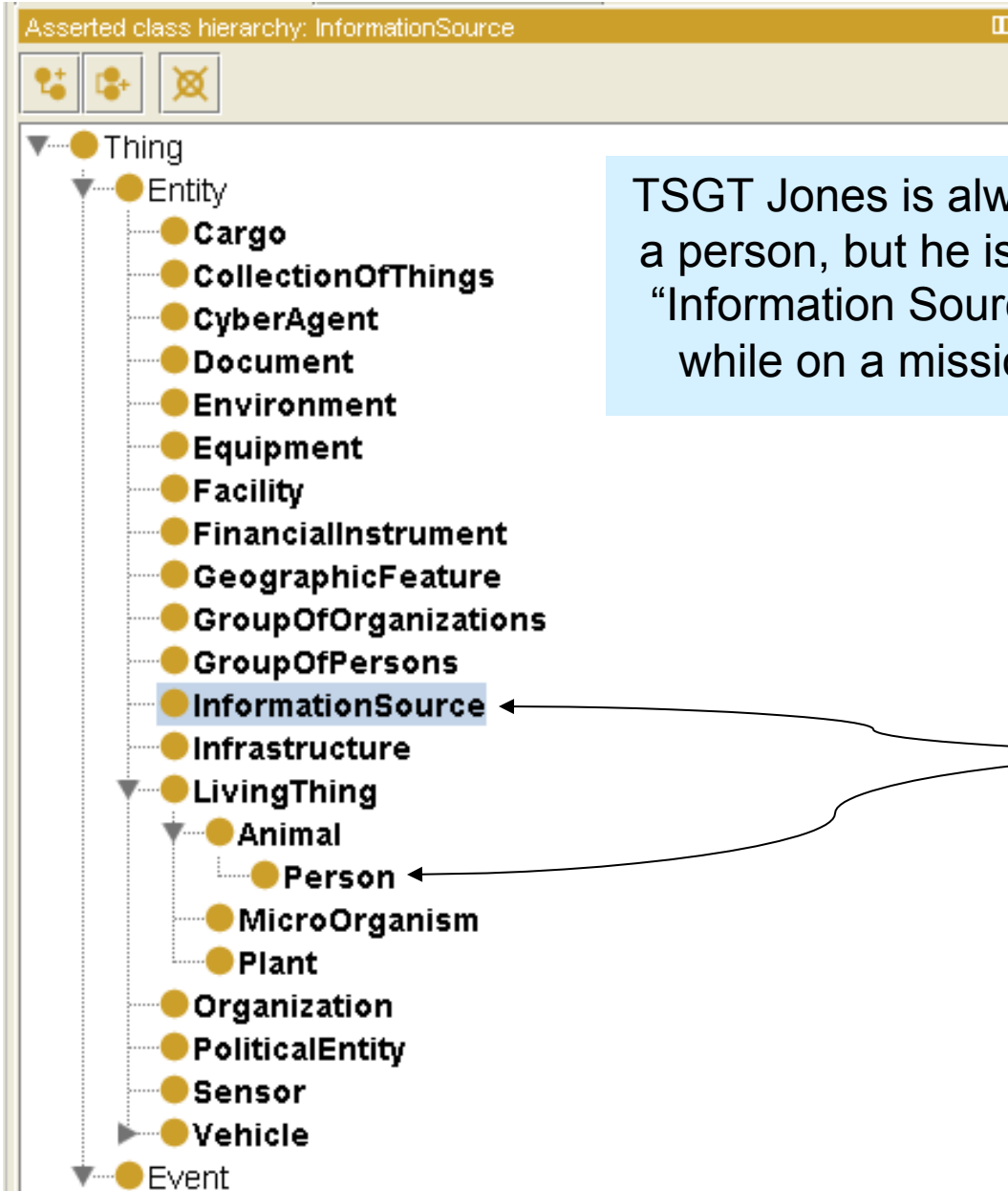
- **Temporally Bounded Attributes**
 - **Location**
 - **Capability**
 - **Function**
 - **Role**



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Entities and their Roles



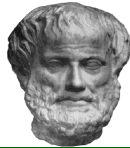
TSGT Jones is always a person, but he is an "Information Source" while on a mission



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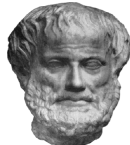


In other words...

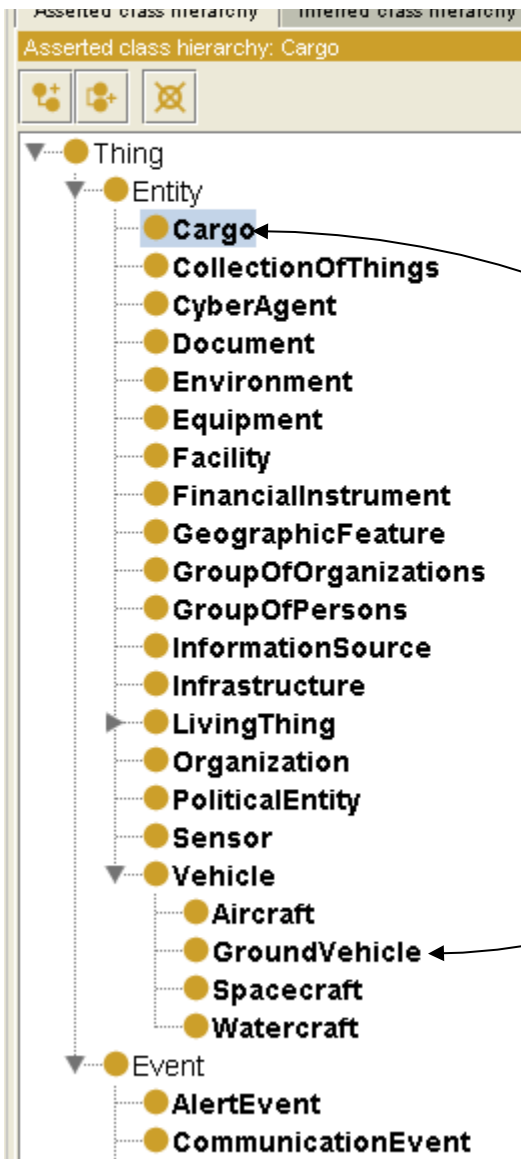
- The current UCore Entity hierarchy makes no distinction between entities that bear attributes and the attributes themselves
- The UCore 2.0 set of relationships does not include the needed Entity-Entity relationship for binding an attribute to its bearer
- But, the UCore treatment of location is instructive on how to remedy this



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Multiple Inheritance



This tank is always a type of "Ground Vehicle"
At "Time T" it was also "Cargo"

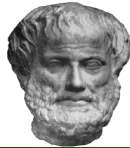
As COI's extend UCore 2.0 to provide more specific coverage of their domains, entities will be sub-typed under multiple parent terms in order to accommodate the attributes they acquire during their participation in events.



Such multiple inheritance leads to difficulties when attempting to merge ontologies.



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Proposed Solution

- **Entity**

- **Object**

- **Dependent Entity**

- **Capability**

- **Function**

- **Property**

- **Role**

- **Command Role**

- **Cargo Role**

- **Information Source Role**

- **Target Role**

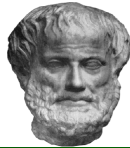


Photo from: <http://www.army.mil/-news/2009/02/02/16332-innovation-saves-thousands-to-ship-damaged-track-vehicles/>

Leading Army Data Transformation



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Proposed Solution

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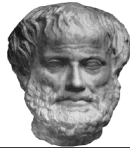
This building was an insurgent safe-house.

At the time this picture was taken it also took on the "Role" of a "Target".





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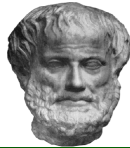
What this gets us

observation report submitted by TSgt. John Jones containing the information of the presence of an opposition force armored personnel carrier.

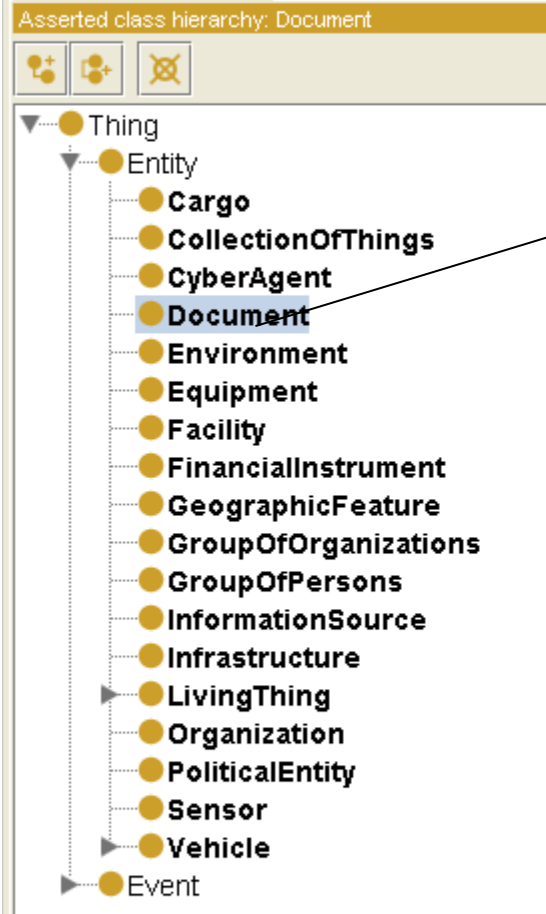
- **UCore.Person = John Jones**
- **UCore.Role = Tech Sergeant**
- **UCore.Role = Information Source Role**
- **UCore.Organization = Opposition Force**
- **UCore.GroundVehicle = Personnel Carrier**
- **UCore.Property = Armored**



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Information Content Entities



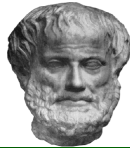
UCore 2.0 is limited to “Document” as the bearer of all Information Content Entities

Net-Enabled Command Capability (NECC) Terms		
Air Force Unit Mobilization History	USMC Unit OPS Tempo History	Army Maneuver Plan
Air Force Unit Readiness History	Army Combat Support Requirements	Naval Fires Plan
Air Sea Port Information	USMC Combat Support Requirements	OPLAN
Passenger Movement Information	USMC Unit Sustainment Requirements	USMC Fires Plan
Army Unit Mobilization History	Army Fires Plan	USMC Maneuver Plan

Examples



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UCore 2.0 Proposed Change #2

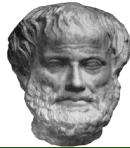
UCore 2.0 “Document” needs to be augmented

Add Information Content Entity to UCore 2.0

Add Information Bearing Entity to UCore 2.0



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UCore 2.0 Proposed Change #2

- **Information Content Entities**

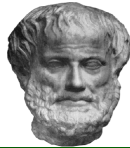
- Standing Procedures (Written & Unwritten)
- Standing Orders (Unwritten)
- Ad Hoc (undocumented) Plans
- Verbal Commands
- Verbal Guidance
- Verbal Reports

- **Information Bearing Entities**

- Documents
- Computer Files
- Sound-waves (verbal)
- Hard Drives
- Pictures/Images
- Drawings
- Maps



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Proposed Change

- **Thing**

- **Entity**

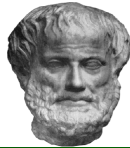
- **Geographic Feature**
- **Group Of Organizations**
- **Group Of Persons**
- **Information Bearing Entity**
- **Information Content Entity**

Definition: A Physical Entity
in which some Information
Content Entity inheres.

Definition: An entity which consists of
information and which inheres in
some information bearing entity.



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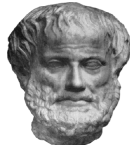
UCore 2.0 Proposed Change # 3

- **Title: Sub-Categories**

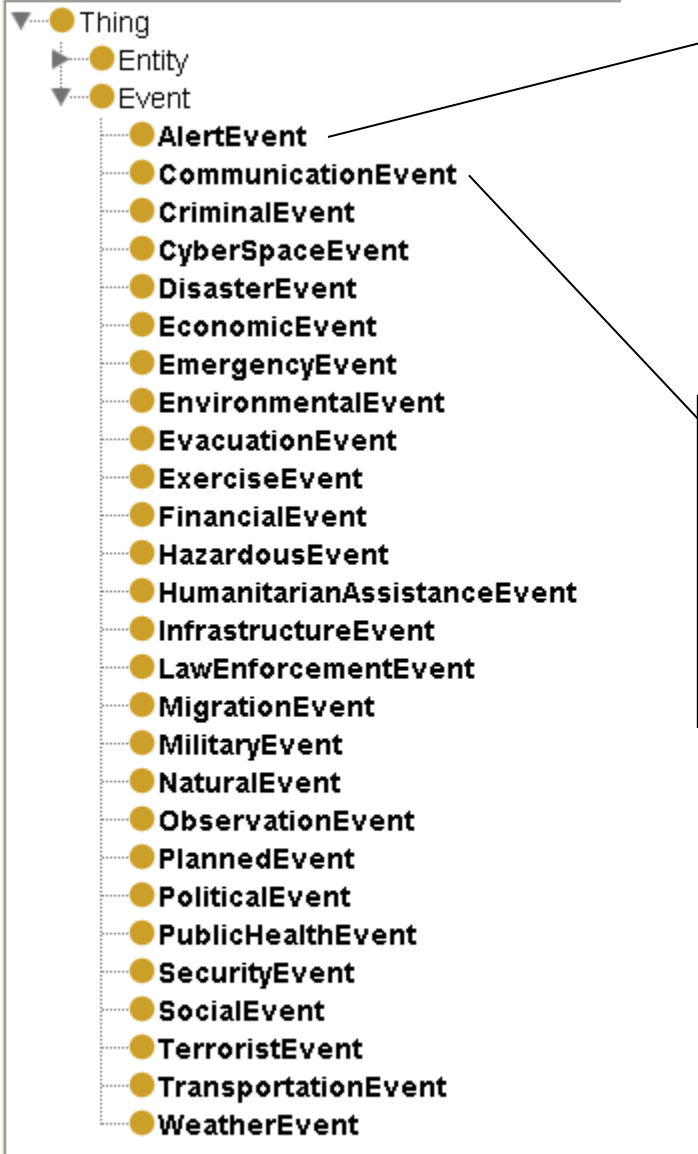
- 1. Alert Event → sub-category Communication Event.
- 2. Weather Event → sub-category of Natural Event.
- 3. Exercise Event → sub-category of Planned Event.
- 4. Financial Event → sub-category of Economic Event.
- 5. Financial Instrument → sub-category of Document.
- 6. Cyber Agent → sub-category of Agent.
 - The taxonomy should include Agent.
- 7. Political Entity → sub-category of Organization.



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Communication Event Sub-Type



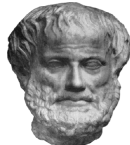
An event providing notification or warning. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]

An event by which information is exchanged between parties. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]

Alert Event is a sub-type of Communication Event



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Natural Event Sub-Type

- Thing
 - Entity
 - Event
 - AlertEvent
 - CommunicationEvent
 - CriminalEvent
 - CyberSpaceEvent
 - DisasterEvent
 - EconomicEvent
 - EmergencyEvent
 - EnvironmentalEvent
 - EvacuationEvent
 - ExerciseEvent
 - FinancialEvent
 - HazardousEvent
 - HumanitarianAssistanceEvent
 - InfrastructureEvent
 - LawEnforcementEvent
 - MigrationEvent
 - MilitaryEvent
 - NaturalEvent
 - ObservationEvent
 - PlannedEvent
 - PoliticalEvent
 - PublicHealthEvent
 - SecurityEvent
 - SocialEvent
 - TerroristEvent
 - TransportationEvent
 - WeatherEvent

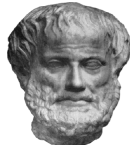
A Weather Event is a sub-type of Natural Event

Natural Event: An event existing in or derived from nature; not made, caused by, or processed by humankind. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]

Weather Event: An event regarding the state of the atmosphere at a place and time as regards temperature, wind, rain, etc. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]



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Planned Event Sub-Type

- Thing
- Entity
- Event
- AlertEvent
- CommunicationEvent
- CriminalEvent
- CyberSpaceEvent
- DisasterEvent
- EconomicEvent
- EmergencyEvent
- EnvironmentalEvent
- EvacuationEvent
- ExerciseEvent
- FinancialEvent
- HazardousEvent
- HumanitarianAssistanceEvent
- InfrastructureEvent
- LawEnforcementEvent
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- TransportationEvent
- WeatherEvent

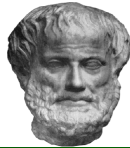
An **Exercise Event** is a sub-type of **Planned Event**

A maneuver or simulated operation involving planning, preparation, and execution carried out for the purpose of training and evaluation. [Derived from JCS Joint Publication 1-02, DOD Dictionary of Military and Associated Terms.]

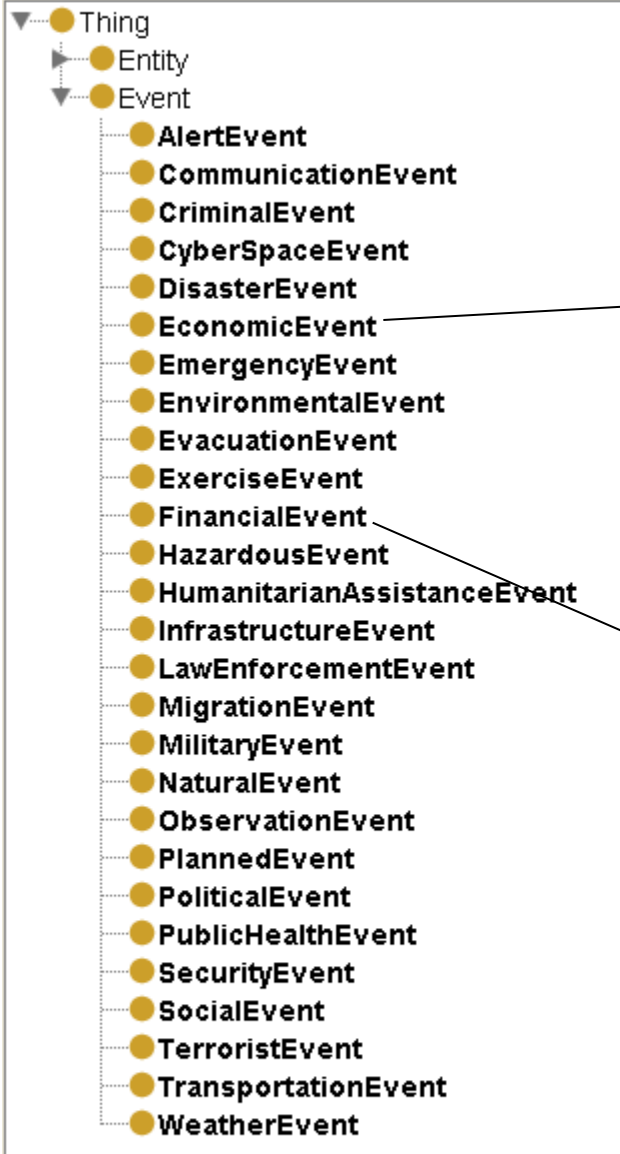
An event which has been decided upon and arranged in advance. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]



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Economic Event Sub-Type



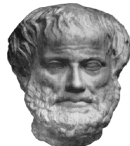
A Financial Event is a sub-type of Economic Event

An event relating to, or based on the production, distribution, and consumption of goods and services [Derived from Merriam-Webster's online (<https://www.merriam-webster.com/dictionary>)]

An event relating to financial instruments. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]



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Event Sub-Types

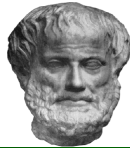
- Thing
 - Entity
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 - AlertEvent
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 - PlannedEvent
 - PoliticalEvent
 - PublicHealthEvent
 - SecurityEvent
 - SocialEvent
 - TerroristEvent
 - TransportationEvent
 - WeatherEvent

“Event” with proposed changes

- Event
 - Communication Event
 - Alert Event
 - Criminal Event
 - Cyberspace Event
 - Disaster Event
 - Economic Event
 - Financial Event
 - Emergency Event
 - Environmental Event
 - Evacuation Event
 - Financial Event
 - Hazardous Event
 - Humanitarian Assistance Event
 - Infrastructure Event
 - Law Enforcement Event
 - Migration Event
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 - Exercise Event

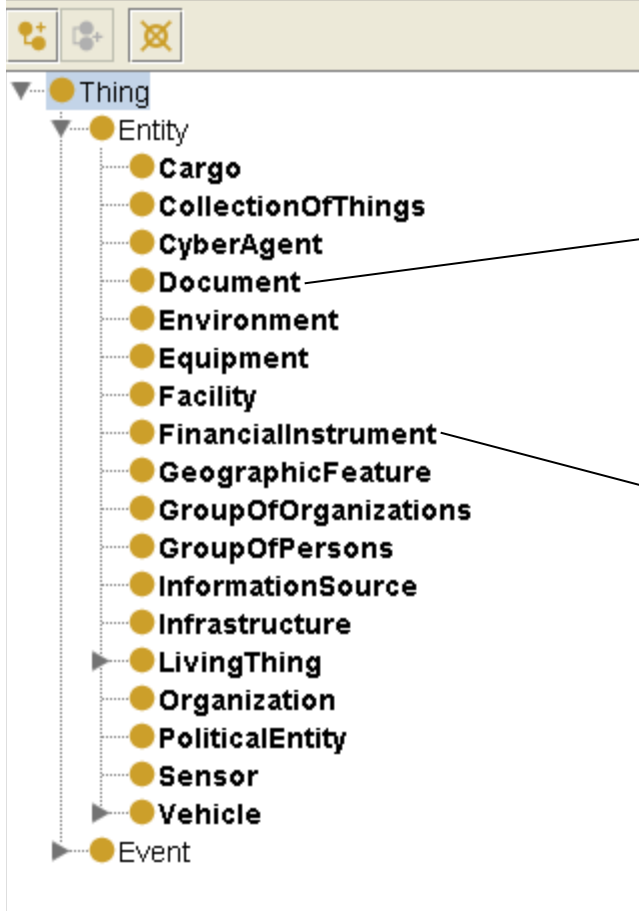


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Document Sub-Type

Asserted class hierarchy: Thing



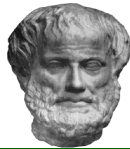
Financial Instrument is a sub-type of **Document**

A piece of written, printed, or electronic matter that provides information or evidence. [Verbatim from Concise Oxford English Dictionary, 11th Edition, 2008]

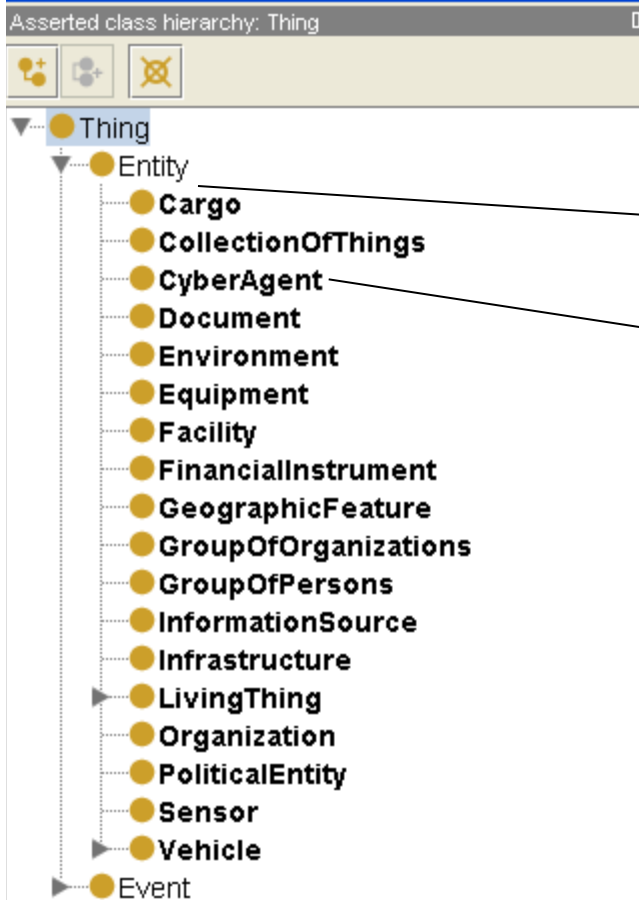
A document, real or virtual, having legal force and embodying or conveying monetary value. [Derived from: Deardorff's Glossary of International Economics (ISBN 978-981-256-628-7)]



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Agent Sub-Type



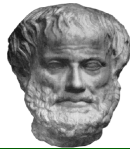
Cyber-Agent is a sub-type of Agent

Add **Agent** as a UCore Entity

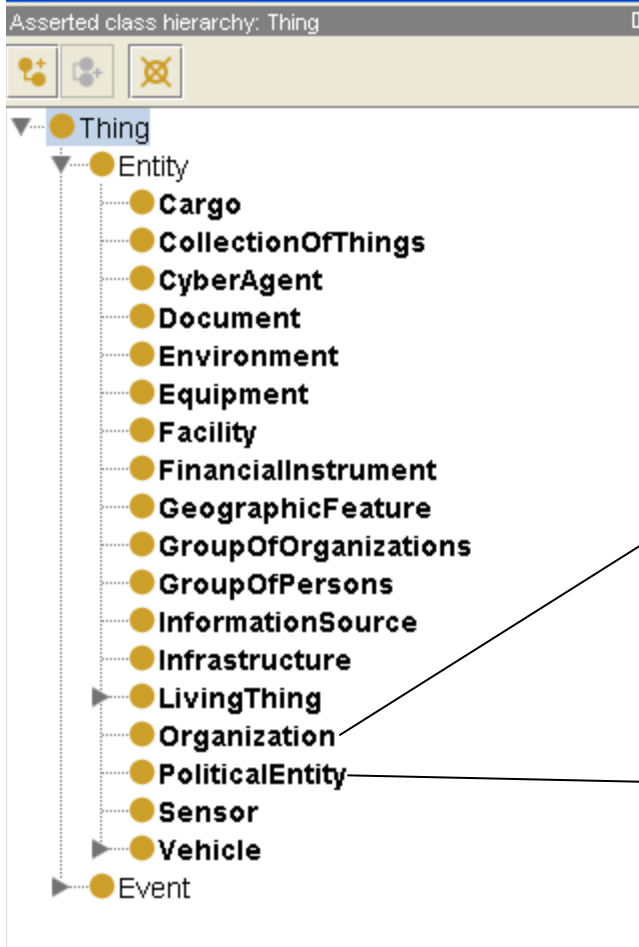
A piece of software that acts for a user or other program entity operating in the non-physical terrain created by computer systems.
[Derived from Webopedia, <http://www.webopedia.com>, 2009.]



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Organization Sub-Type



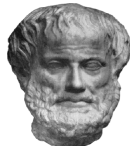
Political Entity is a sub-type of Organization

An organized body of people with a particular purpose, e.g. a business or government department. [Verbatim from Concise Oxford English Dictionary, 11th Edition, 2008]

An organized governing body with political responsibility in a given geographic region. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]



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Entity with Proposed Changes

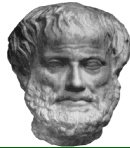


“Entity” with proposed changes

- Entity
 - Agent
 - Cyber Agent
 - Cargo
 - Collection of Things
 - Document
 - Financial Instrument
 - Environment
 - Equipment
 - Facility
 - Geographic Feature
 - Group of Organizations
 - Group of Persons
 - Information Source
 - Infrastructure
 - Living Thing
 - Organization
 - Political Entity
 - Sensor
 - Vehicle



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How UCore SL helps

These proposed changes to UCore 2.0 were generated automatically via a very simple error-checking process based on the logical relations incorporated into UCore SL

As UCore 2.x grows larger, and the number of extensions continues to grow, this facility for quality assurance will become ever more important



Potential Benefits for UCore Users



Provide flexible refactoring of UCore 2.0 for different (DoD, IC, DoJ, ...) purposes, while preserving interoperability

Allow development of standards-based tools to support and enhance verification of UCore messages for correctness

Application of more powerful logic-based tools e.g. in identifying referents of terms using in messages

Help UCore users work more effectively in retrieving and processing messages



Potential more global benefits



Provide basis for creating consistent extensions that work well across multiple domains

- Geospatial information
- Biometrics
- Infectious disease / Biosurveillance
- Signals data



Benefits of Coordination



Each new Community of Interest (COI)

- can profit from lessons learned at earlier stages and avoid common mistakes
- can more easily reuse tested software resources
- can collect data in forms which will make it automatically comparable with data already collected

No need to reinvent the wheel



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Example: Command and Control



- ★ The C2 Domain consists of 6 components:
 - Force Structure, Integration, Organization
 - Situational Awareness
 - Planning and Analysis
 - Decision Making and Direction
 - Operational Functions and Tasks
 - Monitoring Progress (Assessing)
- ★ C2 Core Ontology is based upon these elements
- ★ Vocabulary derived from Joint Doctrine

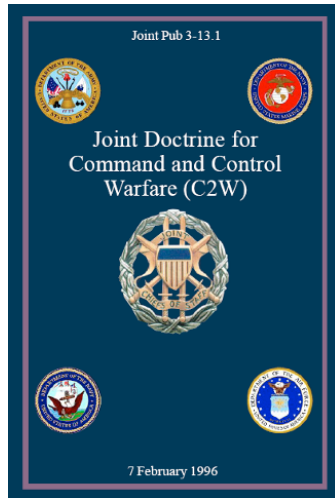
with thanks to Maj. Bill Mandrick

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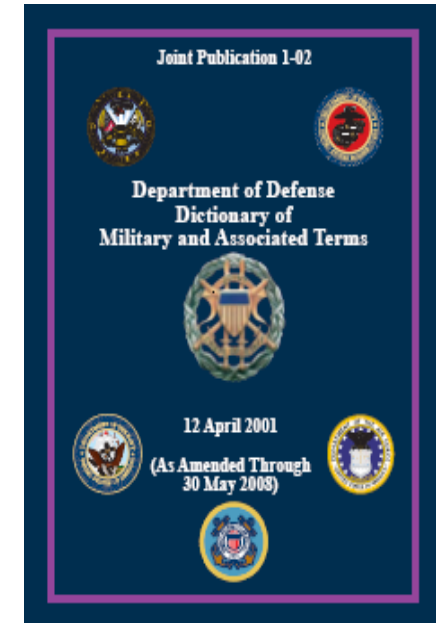
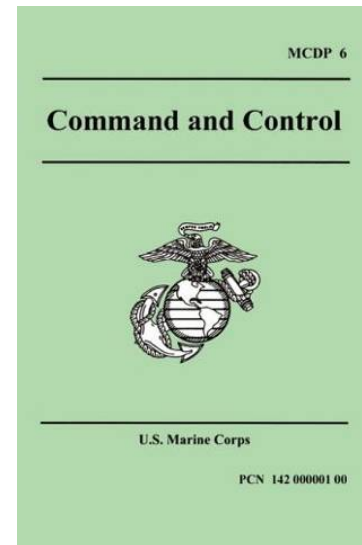
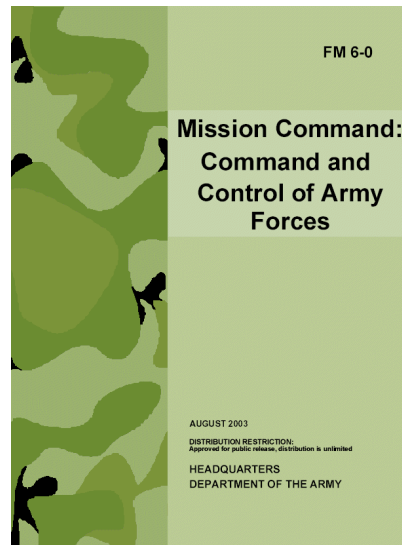


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C2 Core Ontology Doctrinal Sources...



- JP 5-0 Joint Operation Planning
- JP 1-02 DoD Dictionary of Military and Related Terms
- JP 3-13.1 Joint Doctrine for Command and Control
- JP 3-0 Joint Operations
- FM 3-0 Operations
- MCDP Command and Control



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High-Frequency Terminology



Low-Hanging Fruit

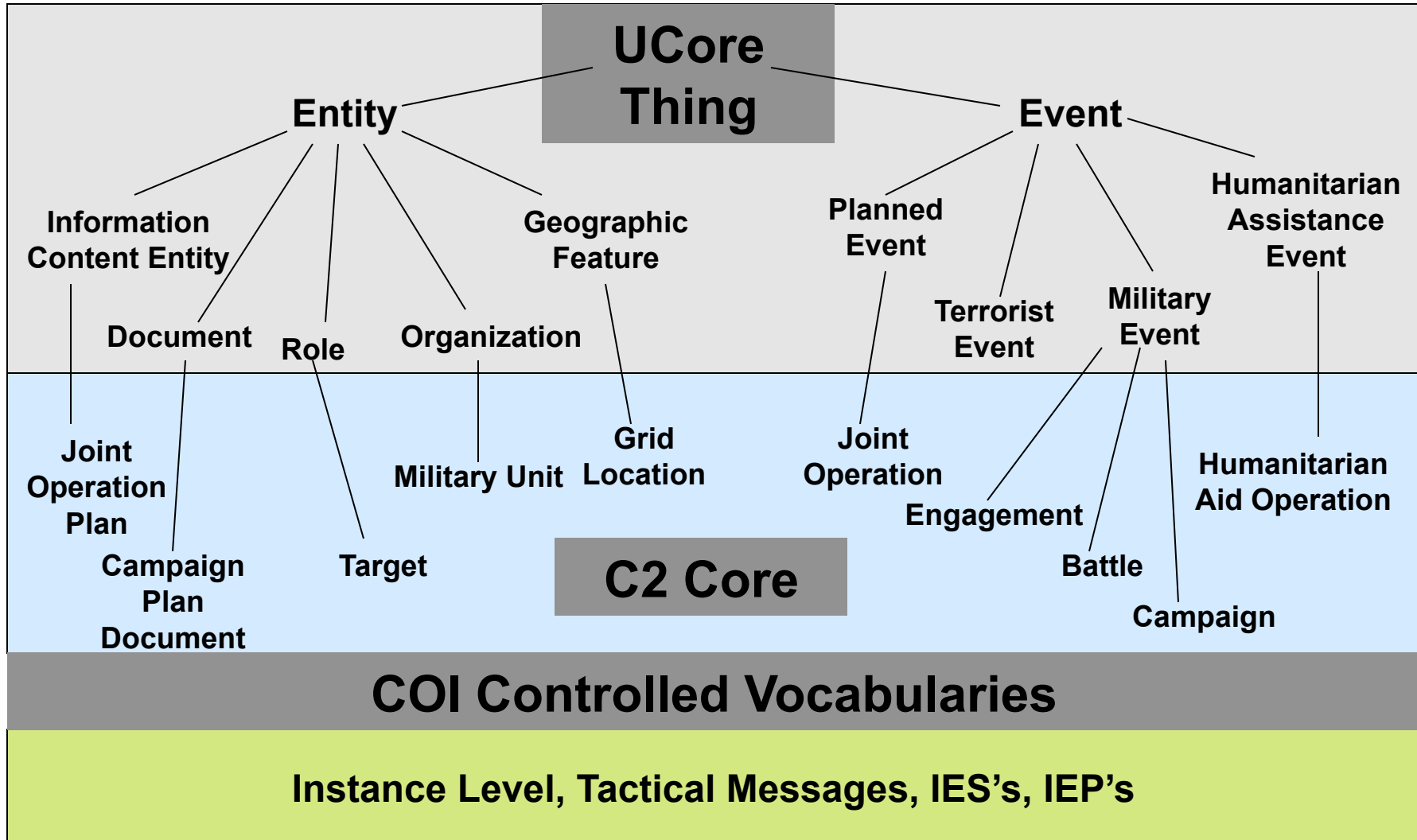
- Reliable data sources
- Good C2 models
- C2 field experience
- Using tested best practices

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Taxonomy

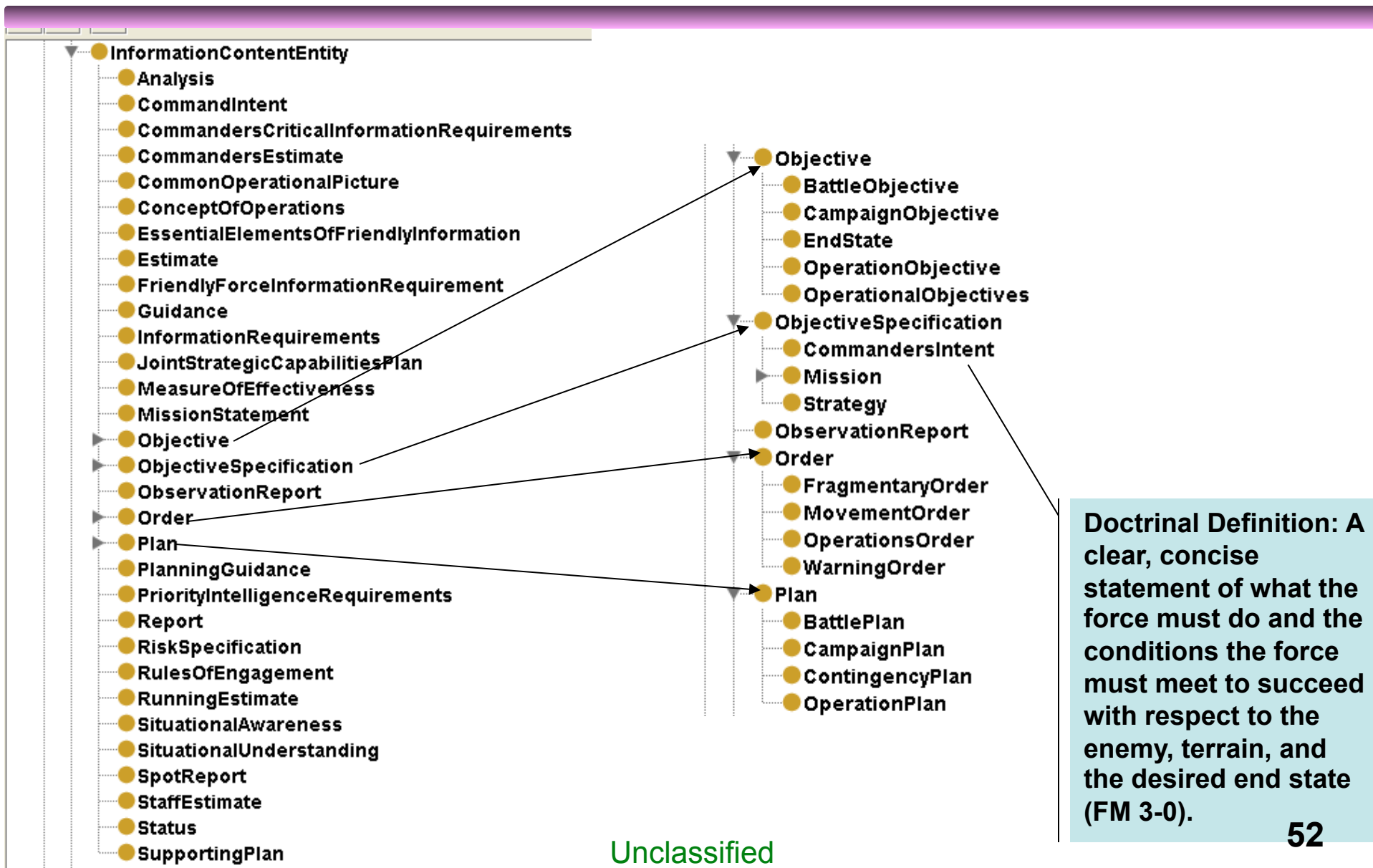


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C2 Information Content Entities

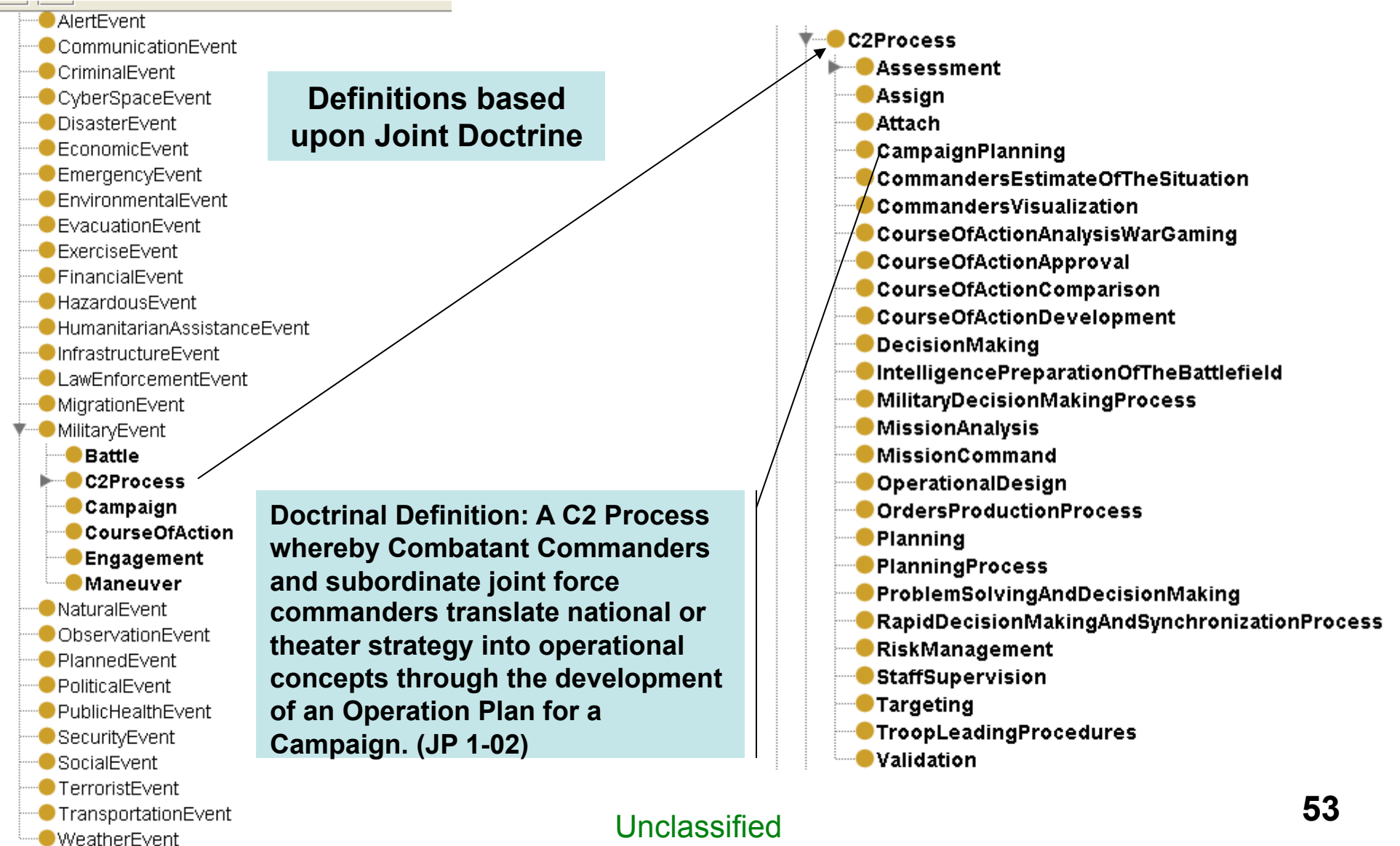


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C2 Core Events



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Example



- Net-Enabled Command Capability (NECC) Controlled Vocabulary Includes:
 - Geographic Locations
 - Information Entities
 - Plans
 - Operations
 - Information Requirements
 - Planning Processes
 - Observation and Analysis
 - Force Structures

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Extending UCore 2.0



- C2 Core Taxonomy
 - A tool for organizing controlled vocabularies
 - Using categories that extend from UCore 2.0
 - Acts as a mid-layer ontology
 - Connects UCore 2.0 with COI controlled vocabularies
 - Using doctrinally sound terminology

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Geospatial Location



NECC
Terms

Asserted class hierarchy: GeospatialLocation



- Thing
 - Entity
 - Agent
 - Artifact
 - Consumable
 - InformationContentEntity
 - Materiel
 - Property
 - Target
 - Cargo
 - CollectionOfThings
 - CyberAgent
 - Document
 - Environment
 - Equipment
 - Facility
 - FinancialInstrument
 - GeographicFeature
 - AreaOfInfluence
 - AreaOfInterest
 - AreaOfOperations
 - AreaOfResponsibility
 - ControlFeature
 - GeospatialLocation**
 - Sector
 - Sector
 - GroupOfOrganizations
 - GroupOfPersons

C2 Core
Taxonomy
"Entities"

Definition: A
geospatial region
where an entity or
event is located.

- Air Force Equipment Locations
- Air Force Unit Locations
- Army Equipment Locations
- Navy Equipment Locations
- Navy Unit Locations
- SOF Equipment Locations
- SOF Unit Locations
- USMC Equipment Locations
- USMC Unit Locations
- Army Unit Locations

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Information Entities

Asserted class hierarchy: InformationContentEntity



- Entity
 - Agent
 - Artifact
 - Consumable
 - InformationContentEntity**
 - Materiel
 - Property
 - Target
 - Cargo
 - CollectionOfThings
 - CyberAgent
 - Document
 - Environment
 - Equipment
 - Facility
 - FinancialInstrument
 - GeographicFeature
 - GroupOfOrganizations
 - GroupOfPersons
 - InformationSource
 - Infrastructure
 - LivingThing
 - Organization
 - PoliticalEntity
 - Sensor
 - Vehicle
 - Event

Definition: An entity which consists of information and which inheres in some information bearing entity.

- Air Force Unit Mobilization History
- Air Force Unit Readiness History
- Air_Sea Port Information
- Passenger Movement Information
- Army Unit Mobilization History
- USMC Unit OPS Tempo History

NECC Terms

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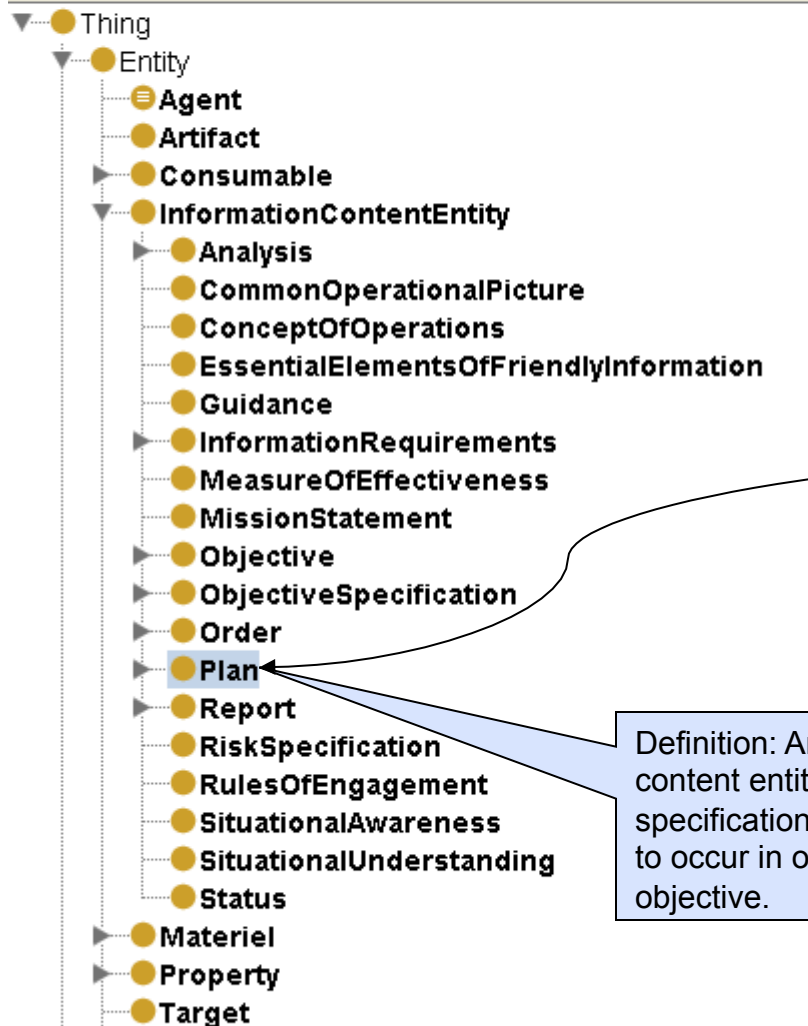
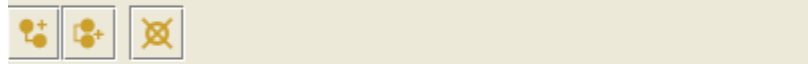
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Plans



NECC
Terms

Asserted class hierarchy: Plan



Definition: An information content entity that is a specification of events that are to occur in order to obtain some objective.

- Army Fires Plan
- Army Maneuver Plan
- Naval Fires Plan
- OPLAN
- USMC Fires Plan
- USMC Maneuver Plan
- Air Force Unit Planned Future Activities

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Information Requirements



Asserted class hierarchy: InformationRequirements



- Thing
 - Entity
 - Agent
 - Artifact
 - Consumable
 - InformationContentEntity
 - Analysis
 - CommonOperationalPicture
 - ConceptOfOperations
 - EssentialElementsOfFriendlyInformation
 - Guidance
 - InformationRequirements**
 - MeasureOfEffectiveness
 - MissionStatement
 - Objective
 - ObjectiveSpecification
 - Order
 - Plan
 - Report
 - RiskSpecification
 - RulesOfEngagement
 - SituationalAwareness
 - SituationalUnderstanding
 - Status
 - Materiel
 - Property
 - Target

- Army Combat Support Requirements
- USMC Combat Support Requirements
- USMC Unit Sustainment Requirements

Definition: All of the information elements that the commander and staff require to successfully conduct operations; that is, all elements necessary to address the factors of METT-TC (FM 6-0)

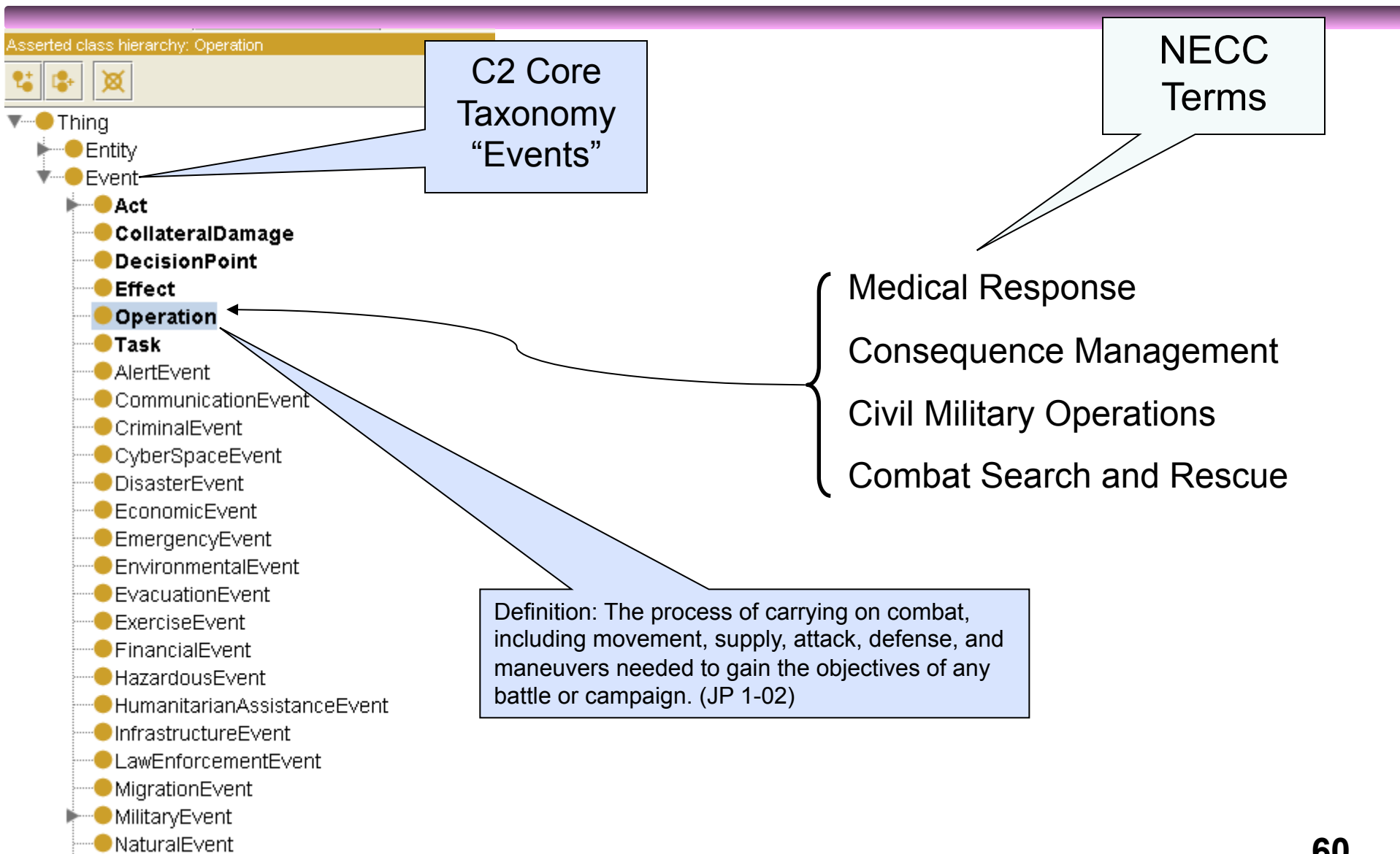
NECC Terms

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Operations



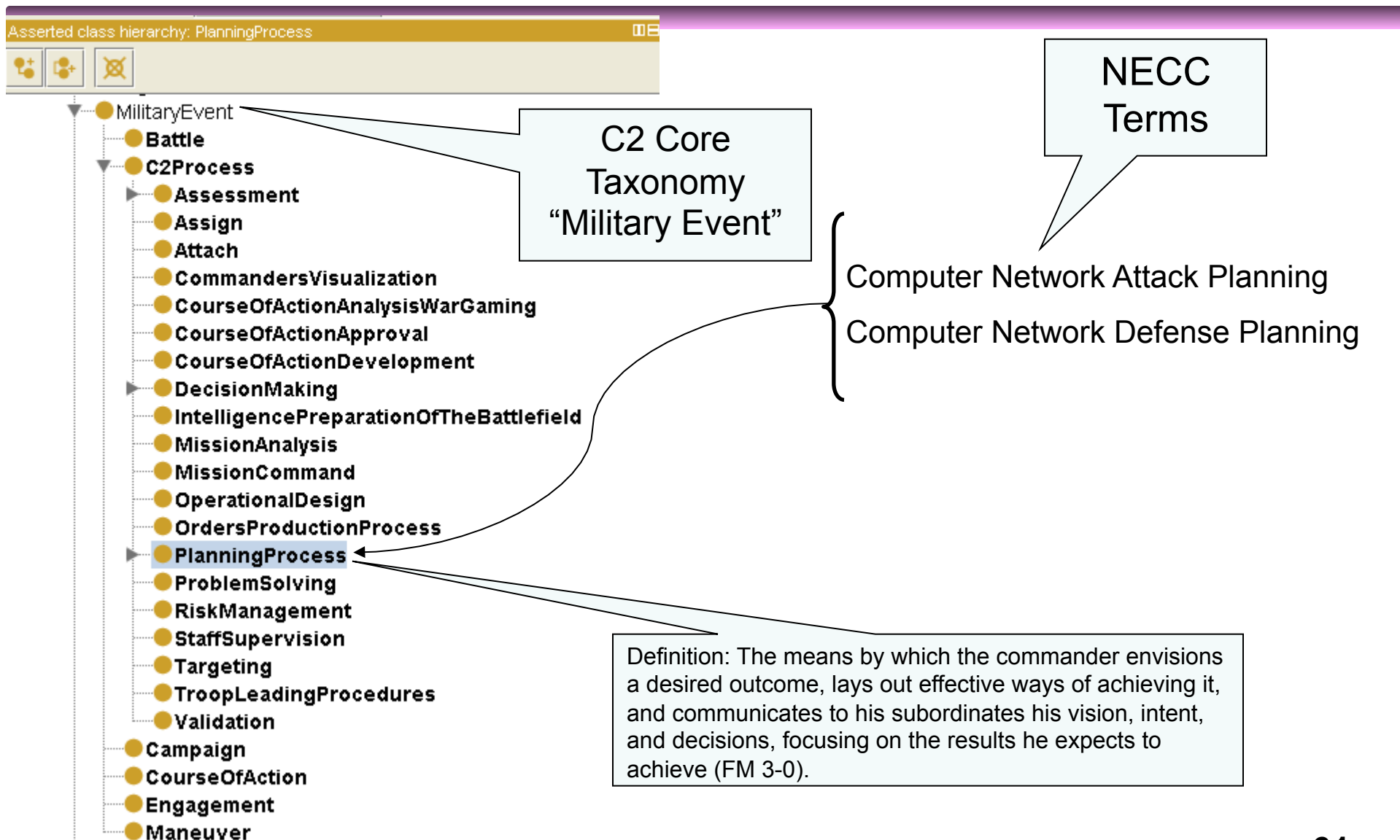
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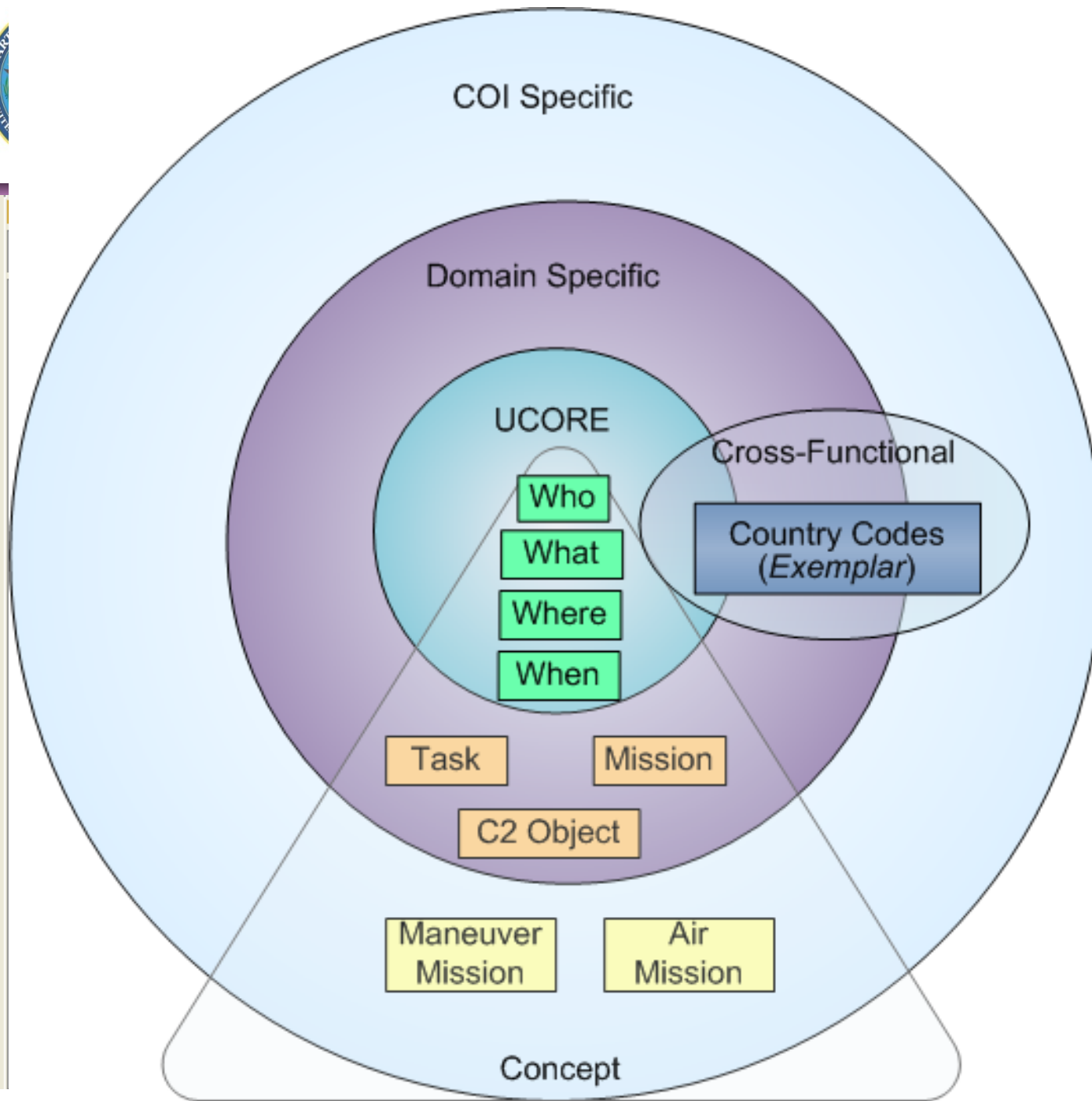
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Planning Processes



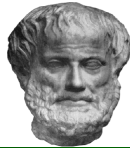
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How UCore SL helps

As in biology and medicine, so also in government, top-down modularity, combined with logical and ontological rigor, can contribute to the realization of the information sharing needs of the future

Common upper level helps consolidate common for methods ontology training, helps in creating useful metrics for ontology evaluation