



# ***GSAW Evening Session B The DoD/IC Ontology Working Group***

## ***Session Leads:***

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# Agenda

Subtitle – Gray, 20-point Arial

- 5:30 Welcome
- 5:45 What is an ontology?
  - Why would I care?
  - What's the problem?
- 6:15 The Basic Formal Ontology, Common Core Ontologies, and the ISO/IEEE
- 6:30 Break
- 6:45 Linked Data, the Semantic Web, and Object Based Production
  - What's the problem, reprise
- 7:00 The DoD/IC Ontology Working Group
- 7:15 The DoD/IC Ontology Foundry
- 7:30 Enhanced Object Based Production
- 8:00 Training opportunities
- 8:30 Adjourn

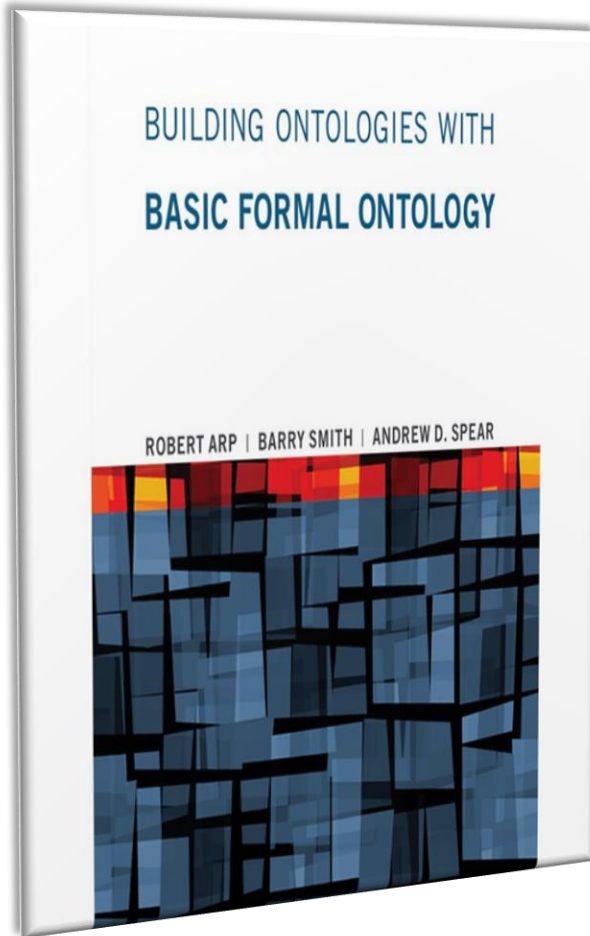
**Open discussion throughout**





# Background

The problem space – from the Introduction of Building Ontologies with Basic Formal Ontology (BFO)



Graphic source: [Building Ontologies with Basic Formal Ontology, MIT Press](#)

- We live in an age of information-driven science
  - Vast amounts of information are being produced daily
  - At the same time, vast amounts of text-based reporting and other data are increasingly being made available in forms that make them accessible to automated search and processing
- The sheer quantity of available information is becoming overwhelming
  - Effective use of new information requires some strategy for
    - Progressive integration with existing information
    - Making it readily available in formats understandable to both machines and to human beings
    - Ensuring accurate, unambiguous information meaning
- Machines are able to
  - Store massive amounts of information
  - Retrieve specific information in focused ways
  - Perform logical operations, to “reason” in a sense

**A path forward must enable integration of old and new data in a manner that assures and preserves meaning**



***Break***

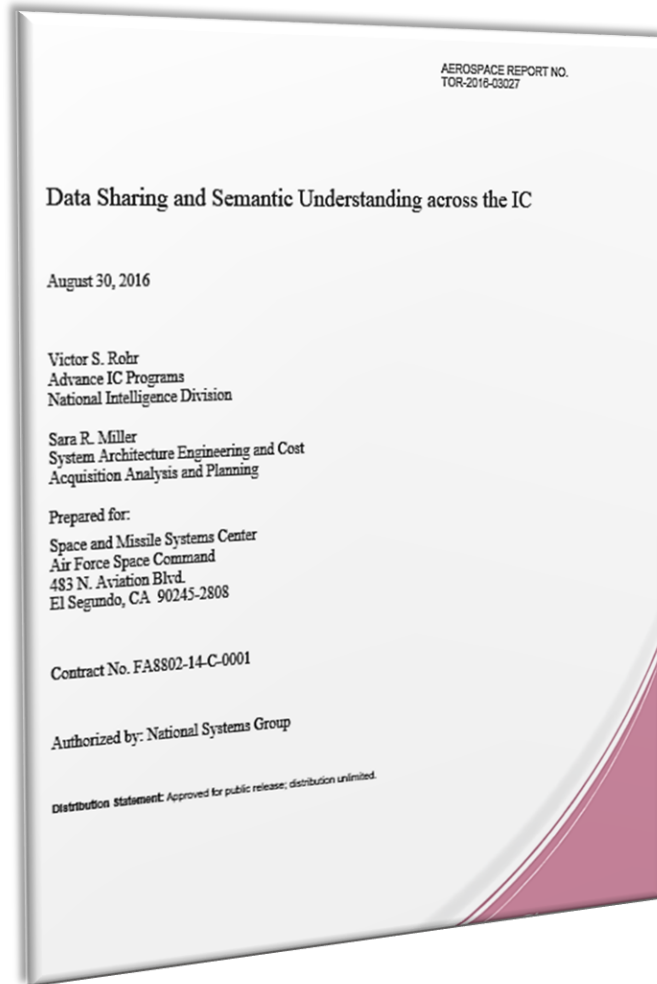
***Please return at 6:45***





# Current State of Semantic Consistency

As Described in Aerospace TOR-2016-03027: “Data Sharing and Semantic Understanding across the IC”



- Conflicting and Ambiguous Language
  - *The need for precision in term meaning*
- Ambiguous / inconsistent information capture
  - *Multiple choices for one concept*
  - *More than one concept applicable to a term*
- Inaccurate and/or incomplete information capture
  - *Vocabulary must support complex information*
- Impediments to Data Interoperability
  - *Multiple & incompatible approaches to expressing the same information*
- Impediments to analytic workflow capture
  - *Retaining intelligence formation data for exploitation requires precise semantics*
- Lack of coordinated semantic data standards and governance
  - *A must, along with best practices*

# Example of How Semantic Inconsistency Results in Poor Discovery of Info and Assets (analysis software, AI, ML can have similar problems)



There should be more results related to fighter jets. Why am I finding so few? All I get is an article about water jets!! This search is not working !!!



> fighter jet  
...A large Jet of water shot up from the sewer

Keyword search only returns results with words that **EXACTLY** match keywords.

Keyword search does not understand context – if “fighter” accompanies “jet” we are looking for aircraft not water related content

User typed this into the keyword search: **fighter jet**

A large Jet of water shot up from the sewer....

User got this irrelevant result

## Content Repository

(documents, data , models, etc )

Does not look for synonyms for keywords

Seven Lockheed attack aircraft took off from the AFB yesterday....

Does not understand categories – that F-22 is a type of jet and therefore relevant

A Lockheed Martin F-22 Raptor was decommissioned last week ...

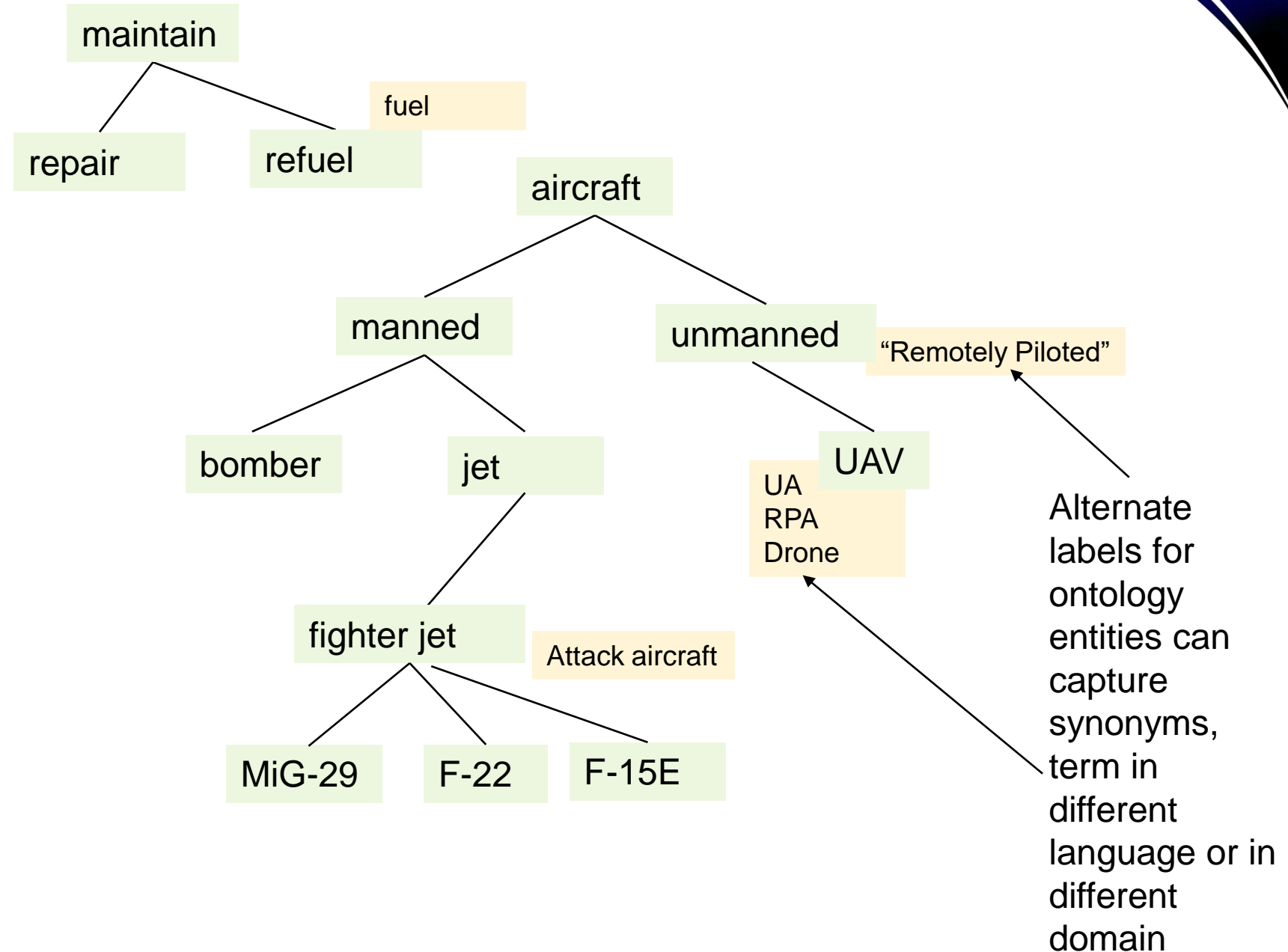
User did not get these relevant results



# Enhanced Search Via Ontologies

A search engine integrated with an ontology could:

- Walk down a hierarchy to find extra keywords to submit via the query. If user typed “fighter jet” the search engine could also search on “MiG-29”, “F-22”, and “F-15E”, “Fighter plane” to get more relevant results
- Identify synonyms to add to the keywords in the search query. If user typed “UAV” the search engine could also search on “UA”, “RPA”, and “Drone” to get more relevant results.





# DoD/IC Ontology Working Group (DIOWG)

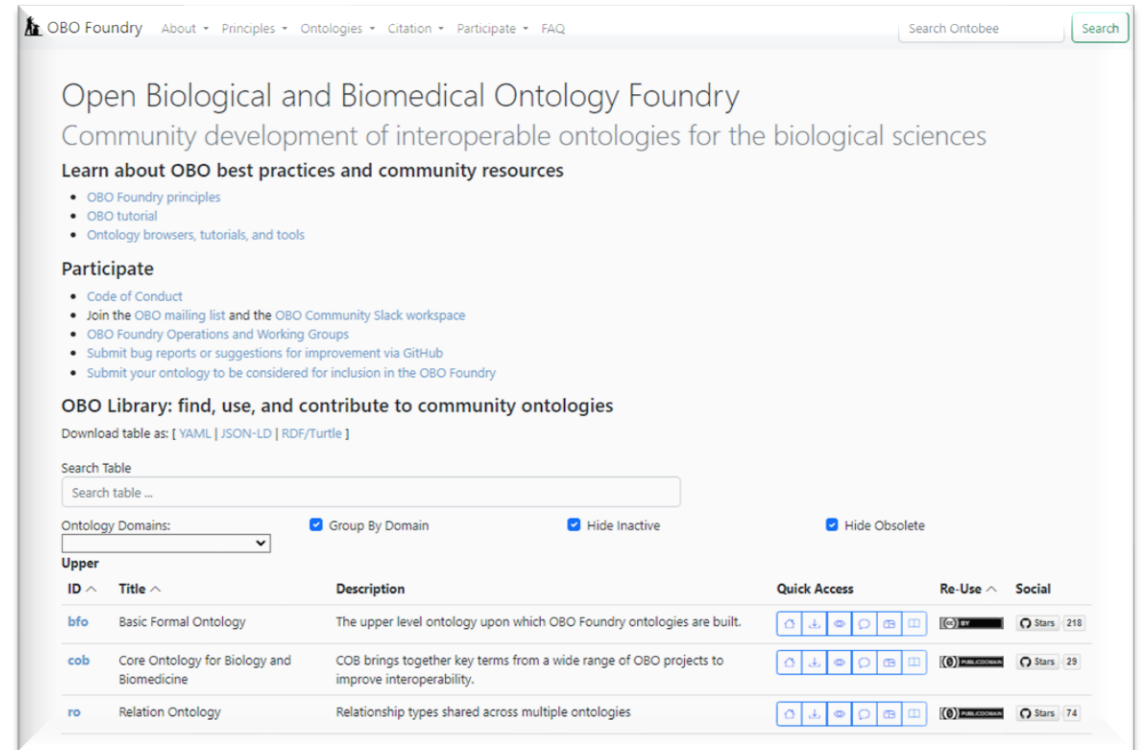
And the DoD/IC Ontology Foundry



# Why the DIOWG?

## Community Coordination Toward Semantic Consistency

- Leveraging the historical success of the Open Biological and Biomedical Ontology (OBO) Foundry, the DIOWG seeks to:
  - *Develop DoD-IC Ontology Foundry guidance*
  - *Promote ontology reuse*
  - *Foster enterprise-wide ontology development collaboration and coordination*
  - *Provide a forum for focused topic sub-working groups, such as:*
    - Policy & Guidance
    - Defense Intelligence Core and Common Core Ontology Reconciliation
    - IRI Naming and Resolution
    - Cyber Ontology Development
    - Basic Formal Ontology (BFO) 2020
  - *Entice broadest possible participation*
- The DIOWG provides recommendations. It does not seek to dictate compliance
- DIOWG participants include internationally recognized US Ontology experts



The screenshot shows the OBO Foundry website. The main heading is "Open Biological and Biomedical Ontology Foundry" with the subtitle "Community development of interoperable ontologies for the biological sciences". Below this, there are sections for "Learn about OBO best practices and community resources" and "Participate". The "OBO Library: find, use, and contribute to community ontologies" section features a search table with filters for "Group By Domain", "Hide Inactive", and "Hide Obsolete". The table lists three ontologies: bfo (Basic Formal Ontology), cob (Core Ontology for Biology and Biomedicine), and ro (Relation Ontology).

ID	Title	Description	Quick Access	Re-Use	Social
bfo	Basic Formal Ontology	The upper level ontology upon which OBO Foundry ontologies are built.	[Icons]	[Icons]	Stars 218
cob	Core Ontology for Biology and Biomedicine	COB brings together key terms from a wide range of OBO projects to improve interoperability.	[Icons]	[Icons]	Stars 29
ro	Relation Ontology	Relationship types shared across multiple ontologies	[Icons]	[Icons]	Stars 74

Graphic source: <https://obofoundry.org/>

**Governance and best practices to promote ontology collaboration, reuse, and endurance**



# History

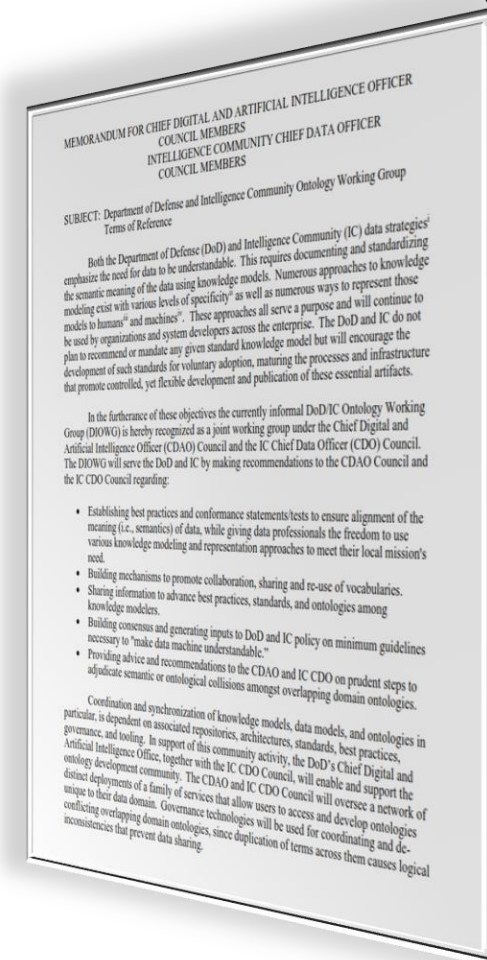
- 2016 – IC OWG Charter signed, effective for 5 years
  - Integrate semantic worldview in a machine-understandable way
  - Promote ontology collaboration
  - Drive toward common, standardized, reusable ontologies where appropriate and practicable
  - 2015 - 2016:
    - Recognized the value and proven success of a top-level ontology approach
    - Drafted recommendation stating the community would benefit from a top-level ontology approach
    - Planned to explore adoption of BFO as top-level ontology for the community
- 2019 – DoD-IC OWG
  - Formed naturally out of a recognition of need
    - Initially 5 individuals who met in May 2019; Distribution list now exceeds 250
  - Cites historical success of top-level ontology approach, BFO in particular, and recommends technical path forward:
    1. Renew and update as appropriate the IC-OWG charter, expanded to include DoD
    2. Re-establish the OWG under this new charter with dedicated and supporting resources
    3. Establish a DoD and IC ontology repository to serve as a standard for information system semantics
    4. **Establish rules and best practices for developing ontologies and submitting them to the repository**
    5. Establish processes for the continual review and vetting of discrepancies and issues
    6. Establish artifacts to foster understanding of ontologies, best practices, and other required topics

# The DIOWG Terms of Reference

April 2023

- Signed by the IC Chief Data Officer (CDO) and the DoD Chief Digital and Artificial Intelligence Officer (CDAO)
  - Formally recognizes the DIOWG as a joint working group under the DoD CDAO and the IC CDO Council
- The DIOWG will serve the DoD and the IC by:
  - Establishing guardrails, voluntary best practices, and conformance tests to ensure alignment of the meaning (i.e. semantics) of data, while giving data professionals the freedom to use various knowledge modeling and representation approaches to meet their local mission's need
  - Building mechanisms to promote collaboration, sharing and re-use of vocabularies
  - Sharing information to advance best practices, standards, and ontologies among knowledge modelers
  - Building consensus and generating inputs to DoD and IC on minimum guidelines necessary to "make data machine understandable"
  - Providing advice and recommendation to the DoD CDAO and the IC CDO on prudent steps to adjudicate semantic or ontological collisions amongst overlapping domain ontologies
- The DoD CDAO and IC CDO Council will oversee a network of distinct deployments of a family of services that allow users to access and develop ontologies for their data domains

***“Our national security imperatives demand that we avoid increasing different knowledge models and compounding the semantic fragmentation of our data assets”***



Text and graphic source: Department of Defense and Intelligence Community Ontology Working Group Terms of Reference, April 2023

Slide source: DoD-IC Ontology Working Group (DIOWG) Overview, OTR: [2023-00727](#)



# The DoD-IC Ontology Foundry

JHU/APL-Developed AGENT Tool



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AGENT DOCUMENTATION CROSS REFERENCES ONTOLOGY DASHBOARD REPORT CARD TOOLS DEVELOPER

Search Foundry Ontology Terms

## DoD-IC Ontology Foundry

Coordinating Ontologies for the DoD and IC

[Start Searching Foundry Ontology Terms](#)

Prefix	Name	Description	Version	
act	Aircraft Ontology	The scope of this ontology is entities, including processes, that are specific to the domain of aircraft.	1.0.0.7286	
ActorInstance	Actor Instance	Knowledge graph for describing real world instances of persons, organizations, agents, or actors in the CBRNE-SF ontologies.	4.1.0.7286	
agent	Agent Ontology	This is an ontology that covers the domain of agents that are capable of performing intentional actions. This includes both individual persons as well as organizations, and it excludes mere groups of people and software agents.	1.0.0.7286	
AgentOntology	Agent Ontology	No description found.	Version 1.2	
agentProvinst		No description found.		
AllCoreOntology	All Core Ontology	No description found.	Version 1.2	
anm	Animal Ontology	The scope of this ontology is entities, including processes, that are specific to animals.	1.0.0.7286	
apc	Armored Personnel Carrier Ontology	The scope of this ontology is entities, including processes, that are specific to armored personnel carriers.	1.0.0.7286	
art	Artifact Ontology	The scope of this ontology is the representation of entities, including processes, that are related to artifacts in general. More specific domain ontologies may be needed for specific types of artifacts.	1.0.0.7286	
ArtifactOntology	Artifact Ontology	No description found.	Version 1.2 - APL Modified 1.0	

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Graphic source: Chief Digital and AI Office Overview Briefing, used with permission

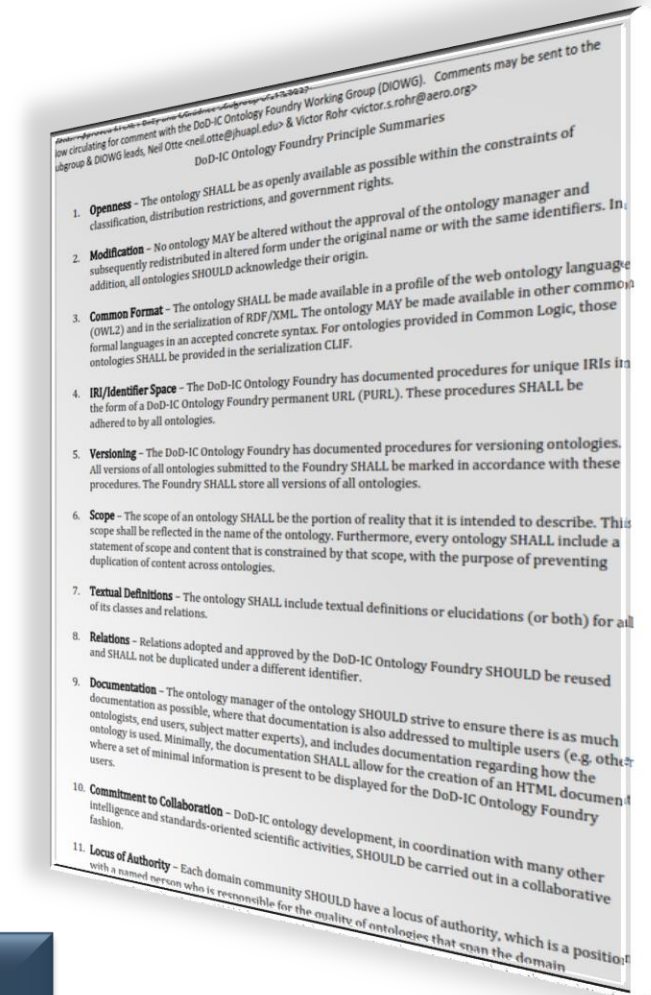
***An ontology foundry, maintained by a collective of ontology developers, is a repository of interoperable ontologies that are designed for long-term use, sufficiently comprehensive to support wide applicability, precise in meaning, and interoperable through adherence to a set of shared principles***

Slide source: DoD-IC Ontology Working Group (DIOWG) Overview, OTR: [2023-00727](#)

# Sample DIOWG Product

## Ontology Principle Summary Statements

- Produced by the DIOWG Policy & Guidance subgroup
  - Principles for ontology development
  - OBO Foundry principles used as a starting point
  - Each principle has a summary statement, purpose statement, requirements, recommendations, and examples
- Principles informed by success of the OBO Foundry
  - OBO Foundry: <https://obofoundry.org/>
  - OBO Foundry experts are helping with the development of these principles
- The full document includes per principle:
  - Purpose
  - Recommendations
  - Requirements
  - Examples



*Other sample products: Governance recommendation, BFO-2020 evaluation, domain-level ontology work*







***Thank you***