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Information Engineering in Support of Multilateral Joint Operational Interoperability

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Presentation Layout

- Goal of the presentation.
- Some Necessary Definitions.
- Joint Interoperability with a Single Shared Ontology (C2IEDM Engineering).
- Joint Interoperability using Different Ontologies (Connecting C2IEDM with OTH-T-GOLD).
- Lessons Learned by the Author.



Goal of the Presentation

To propose a reflection on the conduct of activities leading to the construction of an *ontological basis*, a necessary prerequisite for systems-to-systems interoperability realisation.

This conduct of activities will be referred to as *information engineering* within the context of this presentation.



Goal of the Presentation

- Illustrate the Multilateral Interoperability Programme (MIP) Data Modelling Working Group (DMWG) work process: The construction of the *C2 Information Exchange Data Model (C2IEDM)*.
 - *Single Shared Ontology Construction*
- Illustrate a semantic mapping between the C2IEDM and the OTH-T-GOLD specification.
 - *Distinct Ontologies Interface Construction*



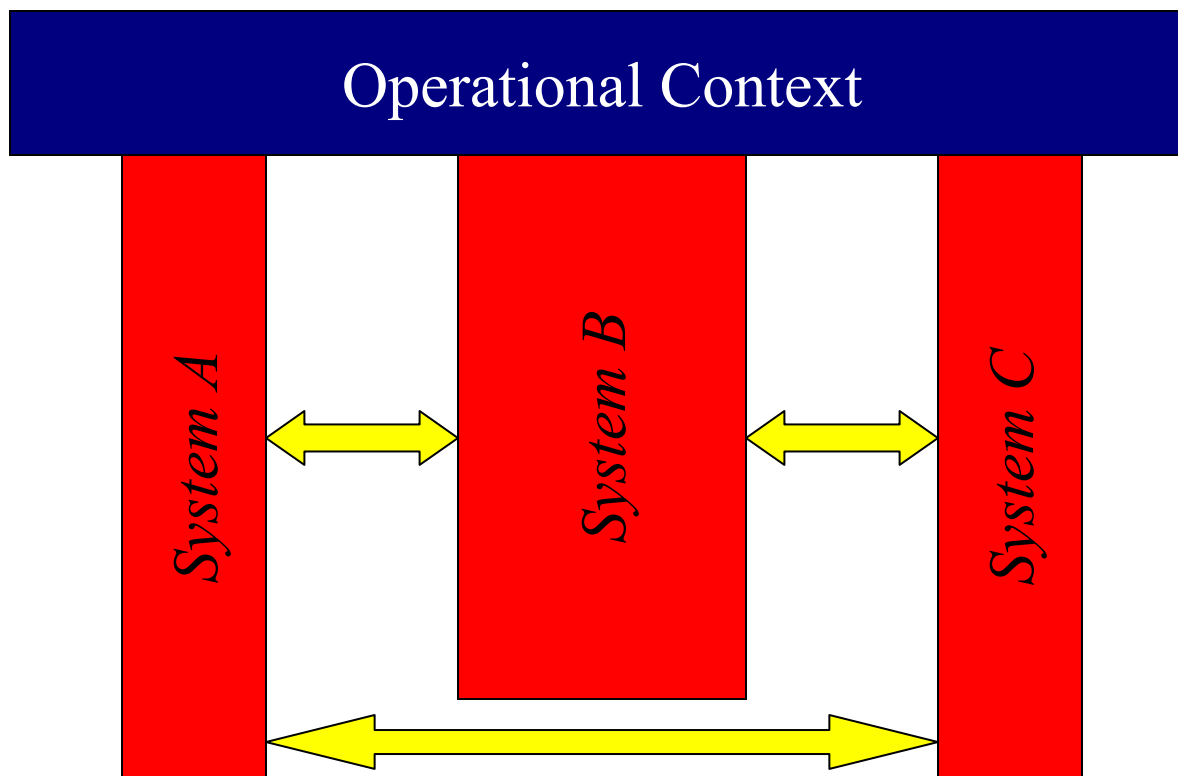
Working Definition of “Interoperability”

*« The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces, and to use the services so exchanged to enable them **to operate effectively together.** »*

Joint Pub 1-02



Working Definition of “Interoperability”

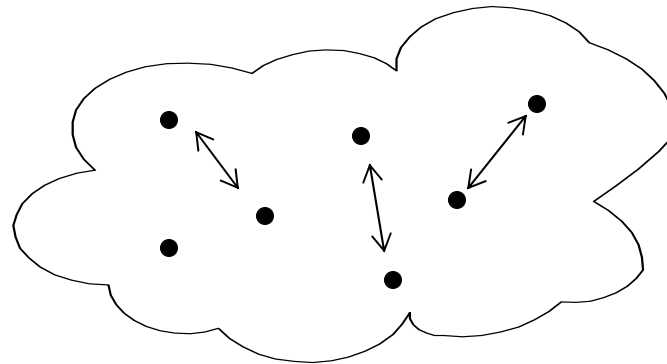


The operational context is the driving force for systems interoperability.



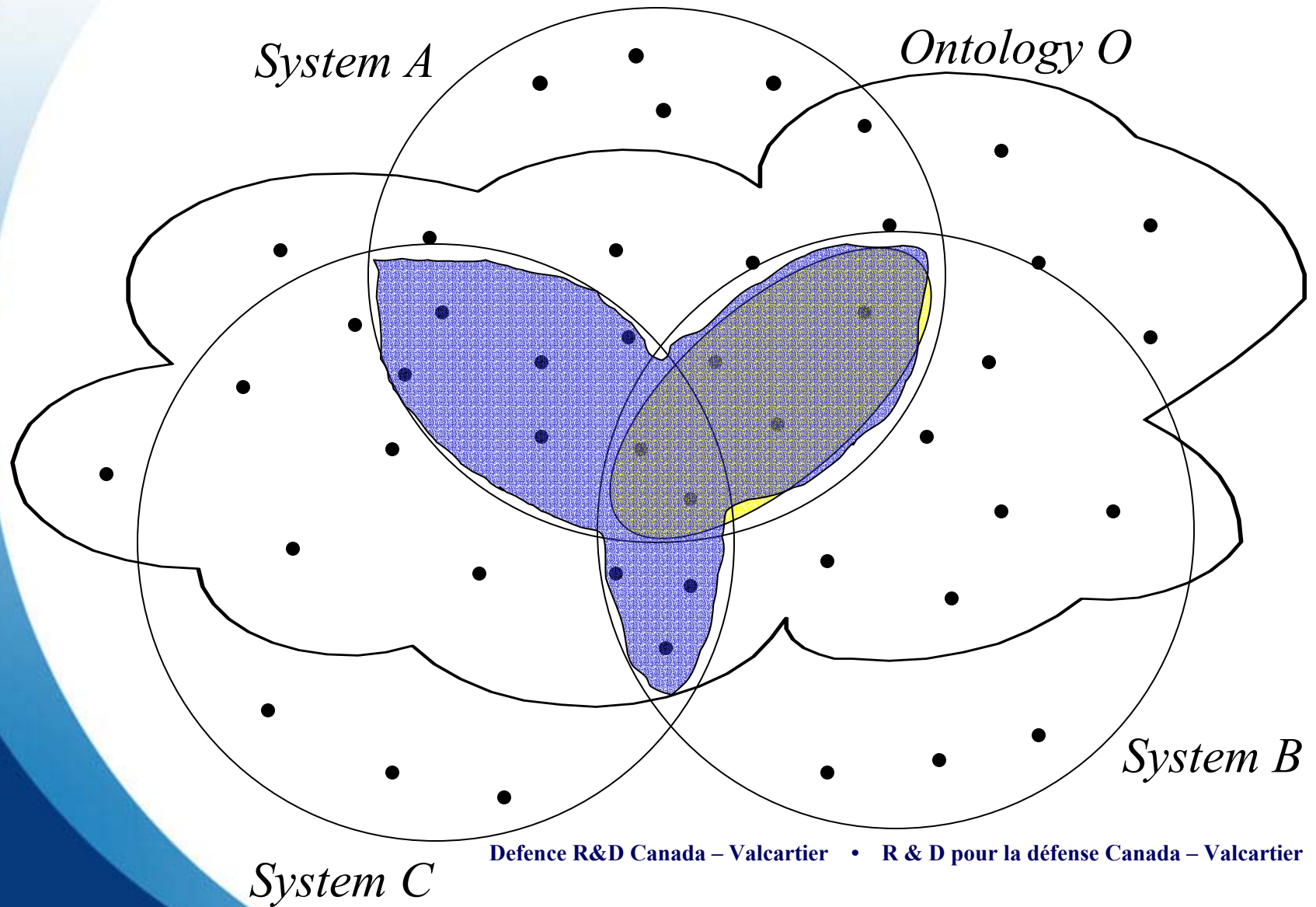
Working Definition of “Ontology”

An ontology, as a conceptualisation of a domain, explicitly captures the semantics of the entities in that domain. It comprises the definition of concepts, their properties, attributes, relations, as well as constraints and axioms that constrain the meaning of the concepts.



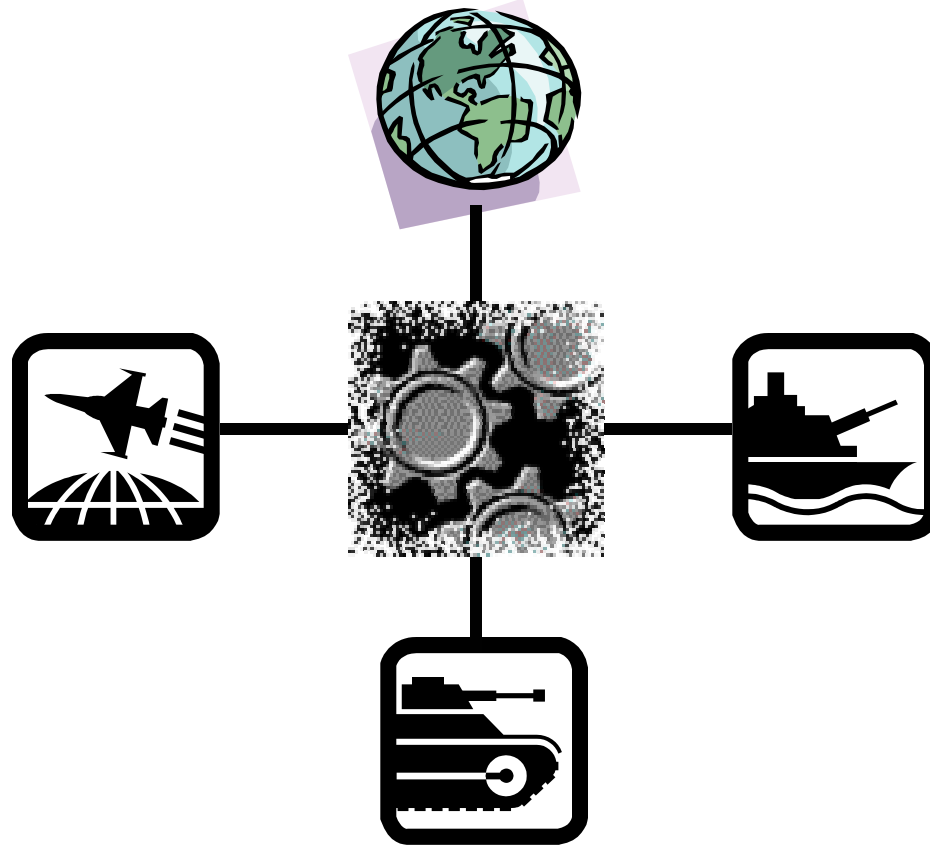


Semantic-level Interoperability





Joint Interoperability with a Single Shared Ontology (C2IEDM)





Information Engineering Process

- Examine the operational environment from an information engineering perspective.
- Create an operational working group that will comprise experts from each domain.
- Gather Information Requirements (IRs) and Information Exchange Requirements (IERs).
- Break IRs and IERs into Information Content Elements (ICEs).
- Ensure a shared understanding of the ICEs.
- Establish the C2IEDM data model against ICEs.

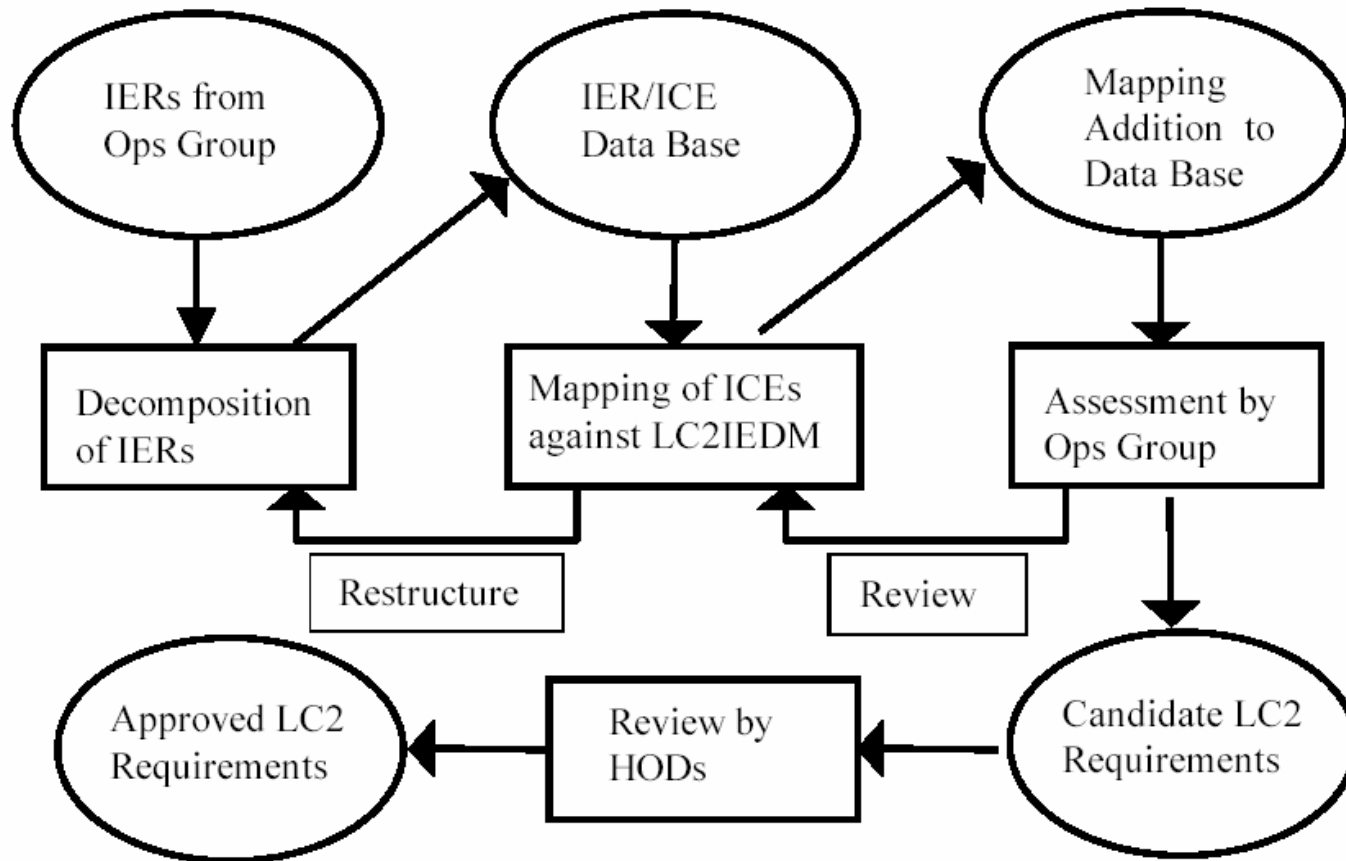


Figure 1. IER Evaluation Process



IERs Sources

NATO

- 135 STANAGS
inc. 5620 and 5621
- AD 80-50
- AAFCE 80-50
- CENTAG SOP
- NORTHAG SOP
- ATP-35
- ATP-40
- ATP-45
- ADatP - 3
- AIntP - 3
- APP-9
- APP-6 & 6A
- SD & IC

National

- SOP's from Nations
- US Message Text Formats
- Message Formats
- Message Standards
- National Doctrine
- MCCRT
- AIMS/IME
- BICES
- ADAMS
- ACCS
- DIGEST
- MIDB

Functional Models



Requirements for the C2IEDM

- Article V (or MIP) IERs.
- Crisis Response Operations (CROs) IERs.
- Combined Joint Task Force (CJTF) IERs.



Minimum Exchange Requirements

- First Hostile Act
- Intelligence Report
- Intelligence Request
- Intelligence Summary
- Land Intelligence Report
- Enemy Situation Report
- Presence
- Own Land Force Situation Report
- Rule of Engagement Request
- Rule of Engagement Implementation
- Commander's Assessment
- NBC Chemical Downwind Report
- NBC Effective Downwind Report
- NBC 1 and 3
- Operational Plan/Order
- Fragmentary Order
- Logistic Situation Report Land Forces
- Logistic Assessrep Report



Minimum Exchange Requirements

- Casualty Evacuation Request
- Personnel Report
- Medical Assessment Report
- Medical Situation Report
- Non-Nuclear Fire Planning
- Fire Mission Report and Command
- Artillery Fire Unit and Status
- Barrier Report
- Obstacle Report
- Reserved Demolition Order
- Scatterable Minefield Warning / Request / Report
- Weapons Control Order
- Air Defense Report
- Airspace Control Order
- Air Attack Warning
- Air Request
- Helicopter Site Landing Report
- Helicopter Request
- Joint Air Attack Team Mission Order
- Civil/Military Operation Order



Minimum Exchange Requirements

- Meaconing, Intrusion, Jamming, Interference Warning Report
- EW Request/Tasking Message
- CCIS Status Report
- Communications Situation Report
- Radio Frequency Request



CROs Exchange Requirements

- Arrest Report
- Border Crossing
- Camps
- Civil Military Operations
- Confiscated Equipment
- EOD Incident
- Holdings Parties
- Host Nation Support
- Incident Report
- Mass Graves
- Meteorology
- Personnel Identification
- PSYOPS
- Displaced Persons
- Refugees



CJTF Exchange Requirements

Air and Sea Picture Domain

- Control Measures
- Fire Support
- Ground Picture
- Unit and Facility

Joint Intelligence Domain

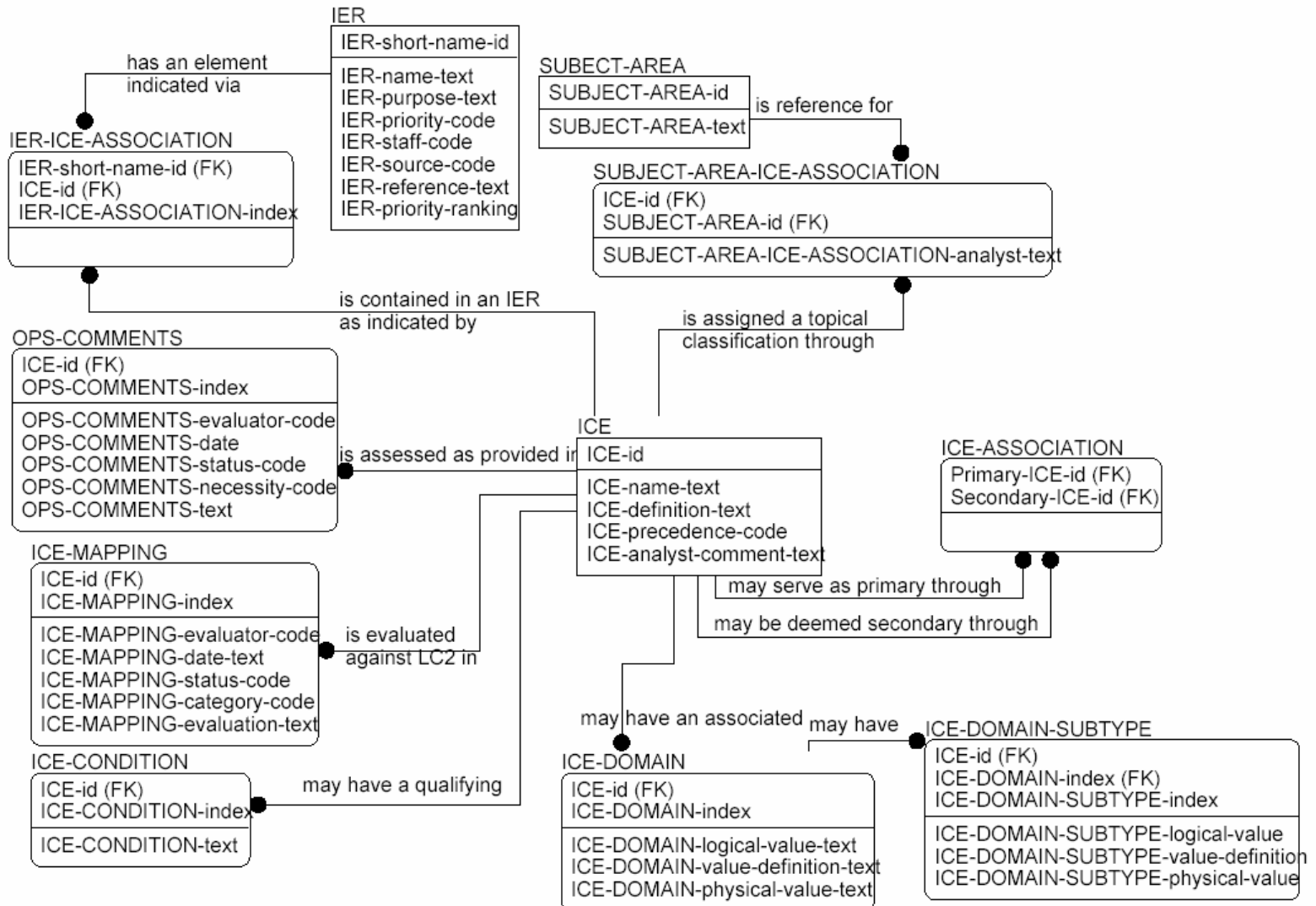
- Air/Marine Intelligence
- Human Intelligence
- Joint Electronic Warfare
- Collection Management
- Targeting

Logistics Domain

- Force Maintenance
- Force Movement
- Medical Support
- Logistic and Combat Service Support



Linking ICEs with IERs





Classifying ICEs into Subject Areas

- Organisation
- Location
- Rules of Engagement
- Materiel
- Control Features
- Holdings
- Status of Items
- NBC defensive
- Activity
- Capability
- Objects
- Candidate Target
- Facility/Installation
- Person
- Geographic Feature
- Medical
- Weather
- Communications



Pros and Cons of a Single Shared Ontology

Pros

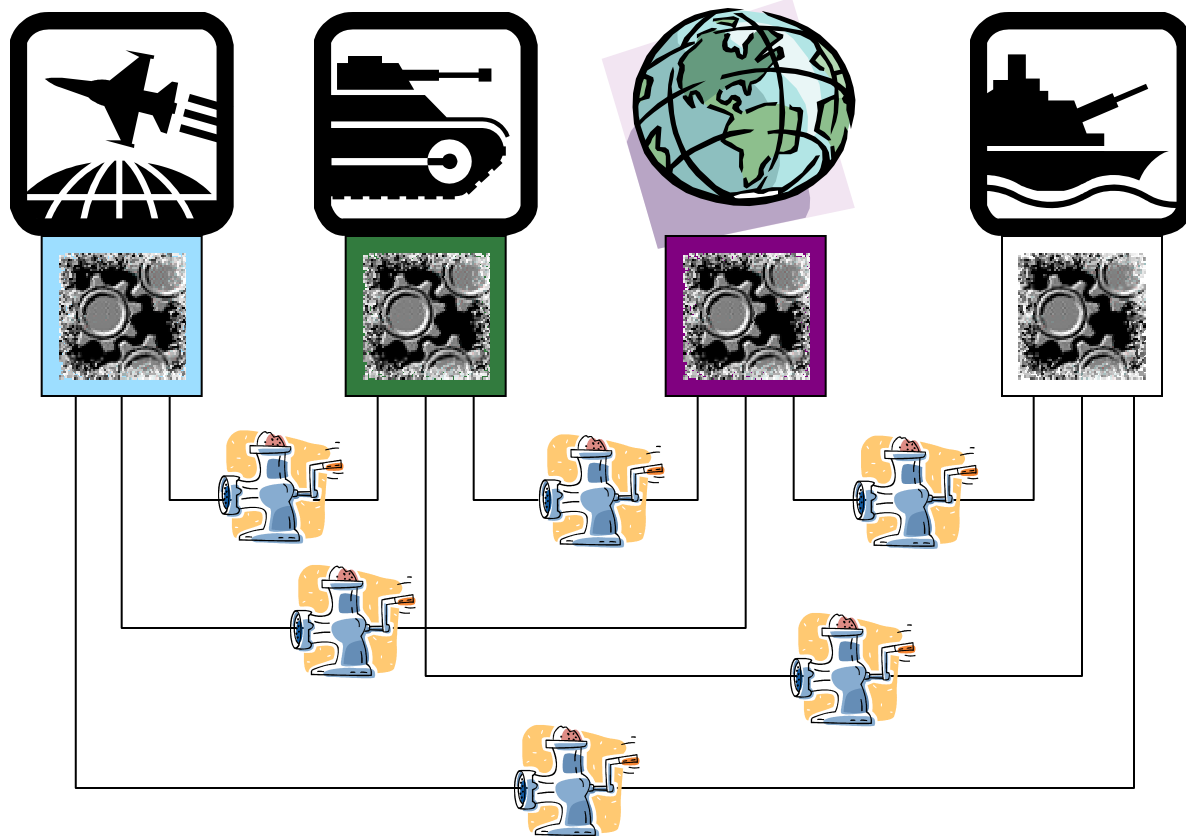
- Only 1 interface to write to achieve interoperability with the community.
- 100% shared understanding.
- Increased maintainability.

Cons

- You have to spend energy to have everybody agreeing upon a concept.
- Legacy systems can hardly adapt.



Joint Interoperability using Different Ontologies





Designing the Meat Grinder

- Conduct a Semantics Translation Analysis.
- Identify the Systems Entry Points.
- Develop the grinder that will speak both languages.



Semantics Translation Analysis

- Examine the operational context under which the bilateral information exchange will take place.
- Identify Information Requirements (IRs) and Information Exchange Requirements (IERs).
- Break them into ICEs and verify if their semantics are captured in both ontologies.
- Make the connection between the data elements.



Practical Example

- LC2IEDM \leftrightarrow OTH-T-GOLD (GCCS)
 - Operational Context: Land/Navy Joint Operations.
 - IERs: Pushing Land Units Positions and Pulling Maritime Tracks.
 - No bi-directional pulling/pushing (assymetrical exchange).



ICEs Semantics Existence in both Models

OTH-T GOLD CTC Set Fields and LC2IEDM/ODB Attributes Correspondence

POS/JPOS Field	LC2IEDM 5.3	ODB	Comment
1- DATE-TIME GROUP 2- MONTH	reporting-data-absolute-timing-effective-date	reporting-data-absolute-timing-effective-date	
3- LATITUDE OF CENTER	absolute-point-latitude-coordinate	absolute-point-latitude-coordinate	
4- LONGITUDE OF CENTER	absolute-point-longitude-coordinate	absolute-point-longitude-coordinate	
5- SENSOR CODE	reporting-data-source-type-code	reporting-data-source-type-code	Proposition to skip this field because there is too much semantic disparity between OTH-T GOLD and the LC2IEDM.
7- LENGTH OF SEMI-MAJOR AXIS	object-item-location-accuracy-quantity	organisation-point-accuracy-quantity	
9- COURSE	object-item-location-bearing-angle	organisation-point-bearing-angle	
10- SPEED	object-item-location-speed-rate	organisation-point-speed-rate	



Mapping Data Elements

OTH-T GOLD Rev B and C Entry List 59		LC2IEDM 5.3	
Country	Code	Country	Code
Exercise NATO Force	OT	Not otherwise specified	NOS
Exercise Neutral Country	ZC	Not otherwise specified	NOS
Exercise Neutral Force	ZZ	Not otherwise specified	NOS
German Democratic Republic	GC	Not otherwise specified	NOS
Germany	GM	Germany, Federal Republic of	GE
Germany, Berlin	BZ	Not otherwise specified	NOS
Germany, Federal Republic of	GE	Germany, Federal Republic of	GE
Ghana	GH	Ghana	GH
Gibraltar	GI	Gibraltar	GI



Pros and Cons of Designing a Meat Grinder between 2 Ontologies

Pros

- Low-cost solution.
- Usually easier to implement.
- Information Analysis is usually simpler.
- Offer a possible interoperability solution for legacy systems.

Cons

- Semantics disparities between ontologies (almost always).
- Symmetrical exchange is almost always a big no-no.



Lessons Learned and Conclusion

- Ontology translations always suffer semantic loss. However, this is acceptable if and only if the operational context is supported.
- OTH-T-GOLD is not an ontology.
- The human is part of the ontology.

Questions???

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