



A C2 Product-Centric Approach to Transform Current C4ISR Information Architectures

Command & Control Directorate

Communications Electronics Research, Development and Engineering Center (CERDEC)

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Formal C2 Issues

How to organize C2 information

- Data base-driven (e.g. object/relational IDEF data models...)
- Message Set-driven (e.g. bit/character-oriented fields, uses, and groups,...)
- Display Symbol-driven (e.g. MIL-STD 2525, FM 101-5-1, customized, ...)
- Application Algorithm-driven (e.g. HLA, Resource Allocation, Scheduling, Routing, ...)

How to best apply XML/UML Tools

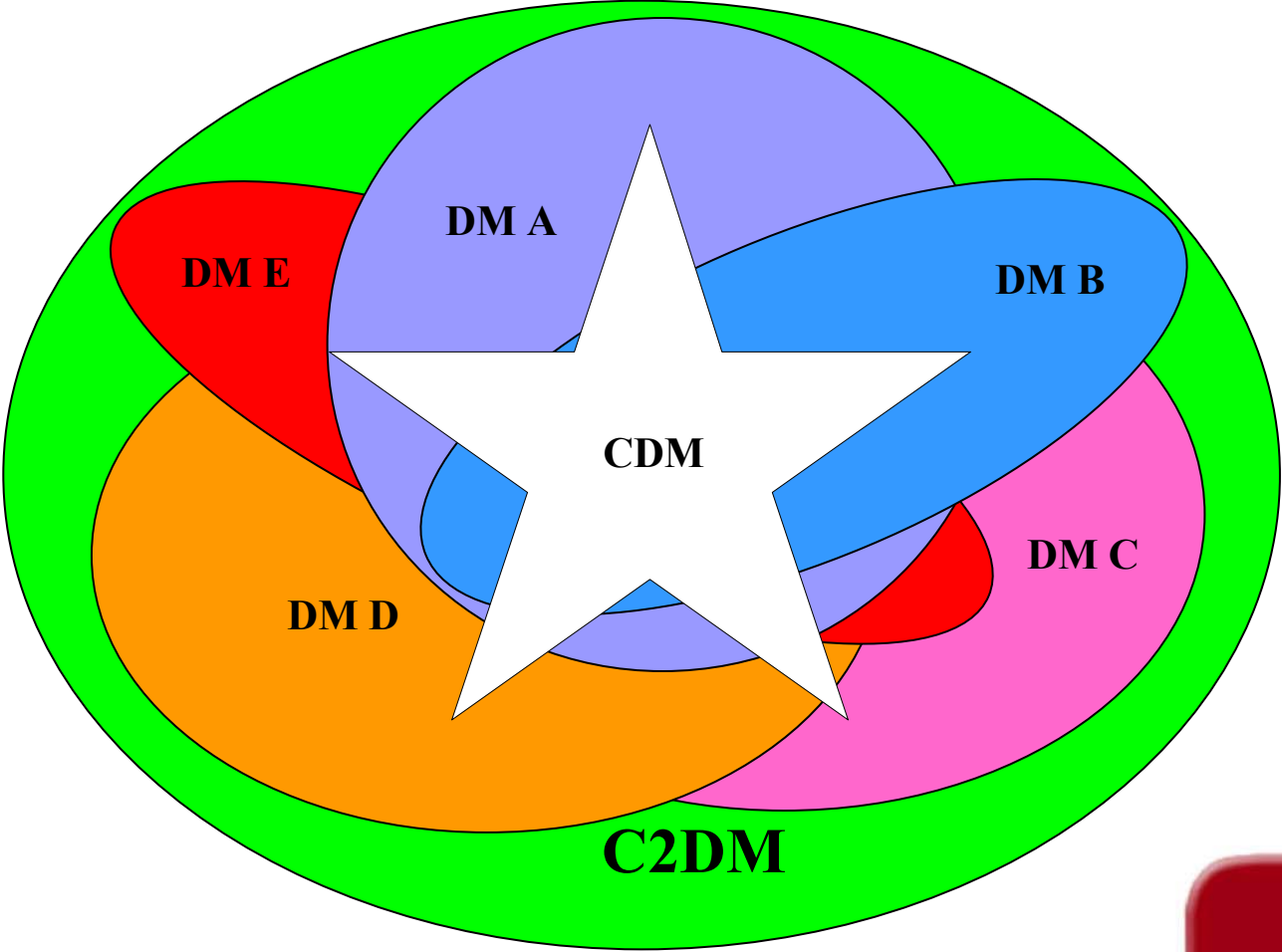
- XML Spy, XML Extensibility used for Validation, Namespaces, data Typing...
- Rational Rose, MS Visio, I-logix Rhapsody used for algorithm, applications design
 - to various C2 assets application information domains
 - Engagement Effects (Lethal / Non-Lethal)
 - ISR and Targeting Sensors (Active, Passive)
 - Transportation (Maneuver / Logistics)
 - Communications (IPC, RPC, LAN, WAN, Multi-User...)



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Overlapping Domain Models





Objective

- To facilitate C2 Architecture and Applications development in terms of a formal language for C2 based upon a C2RM
- To derive the rules for analyzing and parsing C2 Products from Natural Language to Machine Language for use by C2 Applications.
- To leverage commercial representation and modeling languages such as the Unified Modeling Language (UML) and Extensible Markup Language (XML) and associated tools.



C2Product Example:Operations Order (OPORD)



Five-Paragraph Meta-model based upon
FM 101-5, Staff Organization and Operations

- ◆ Header (POC, Time, Location Distribution, References...)
- ◆ **Situation**
 - ◆ The Enemy Forces (Where are they? How strong are they?...)
 - ◆ The Friendly Forces (Who are they? What kind of unit is it?...)
- ◆ **Mission**
 - ◆ A clear concise, statement of what the unit should achieve.
- ◆ **Execution**
 - ◆ What is the Concept of Operation?
 - ◆ What tasks to perform with what priority, rules and constraints?
- ◆ **Service Support**
 - ◆ Where and when is logistics available. Logistics priorities, How??
- ◆ **Command and Signal**
 - ◆ How communications and C2 will be maintained?
- ◆ Annexes



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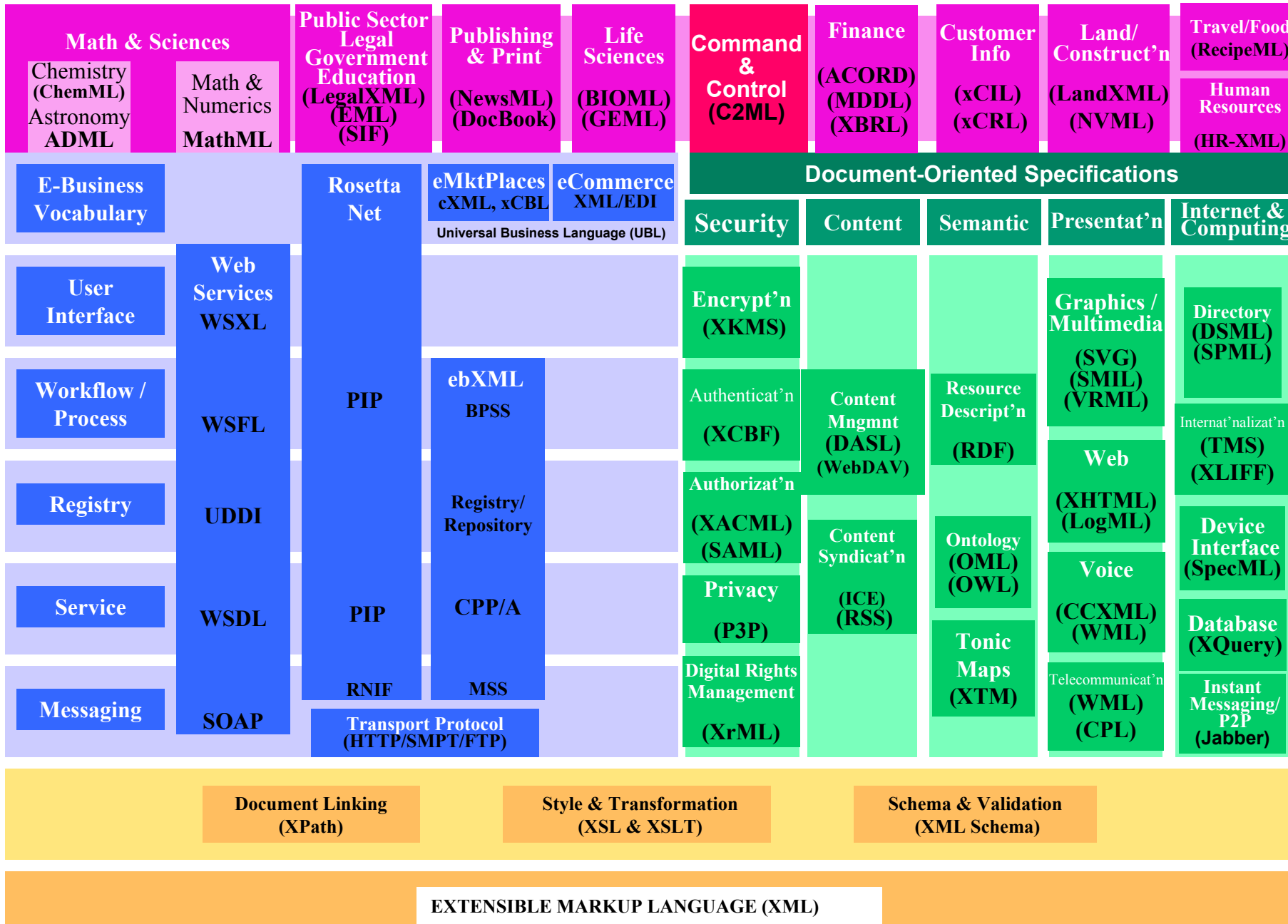
KEY XML SPECIFICATIONS AND STANDARDS

Adapted from Zapthink

Community Vocabulary

Message-Oriented Specifications

Core XML Specifications



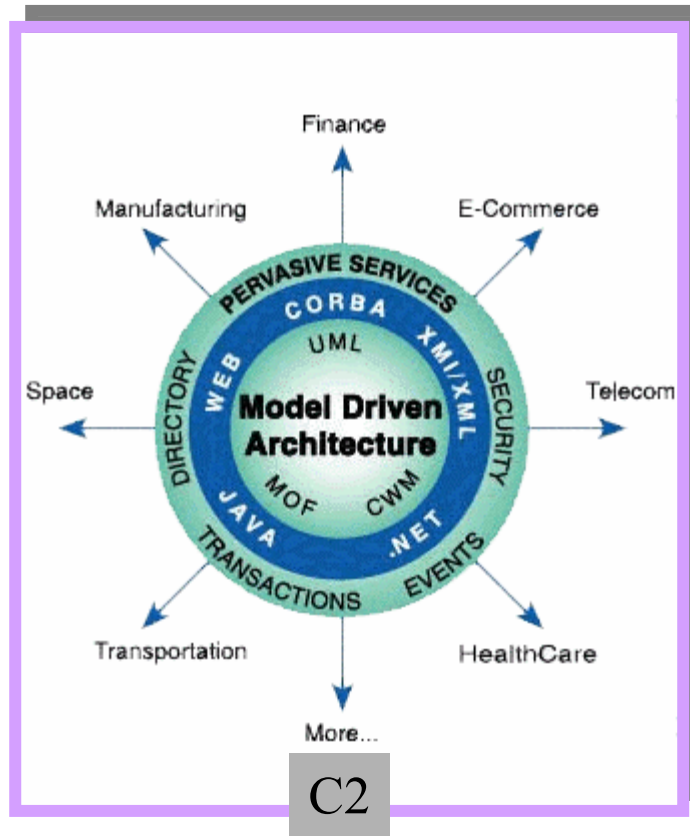
C2RM Relationship to C2RA, UML and XML



C2RM



C2XML



C2RA



C2UML

C2XML

+

C2UML

=

C2ML



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Formalizing C2 Products

W6H Elements and Templates

- C2 Conflict
- C2 Presentation
- C2 Operation
- C2 Procedure
- C2 Network
- C2 Link
- C2 Asset

- Peace
- War
- Campaign
- Battle
- Combat
- Engagement
- Armament

- Presentation
- Session
- Transport
- Network
- Link
- Physical

- Communications
- Identifications
- Transportations
- Inflictions

Environment /Interaction Media

Natural Language

Sentences

OPORDER

Statements

W6H Element Parser

W6H Instances

Control Language

W6H relationships

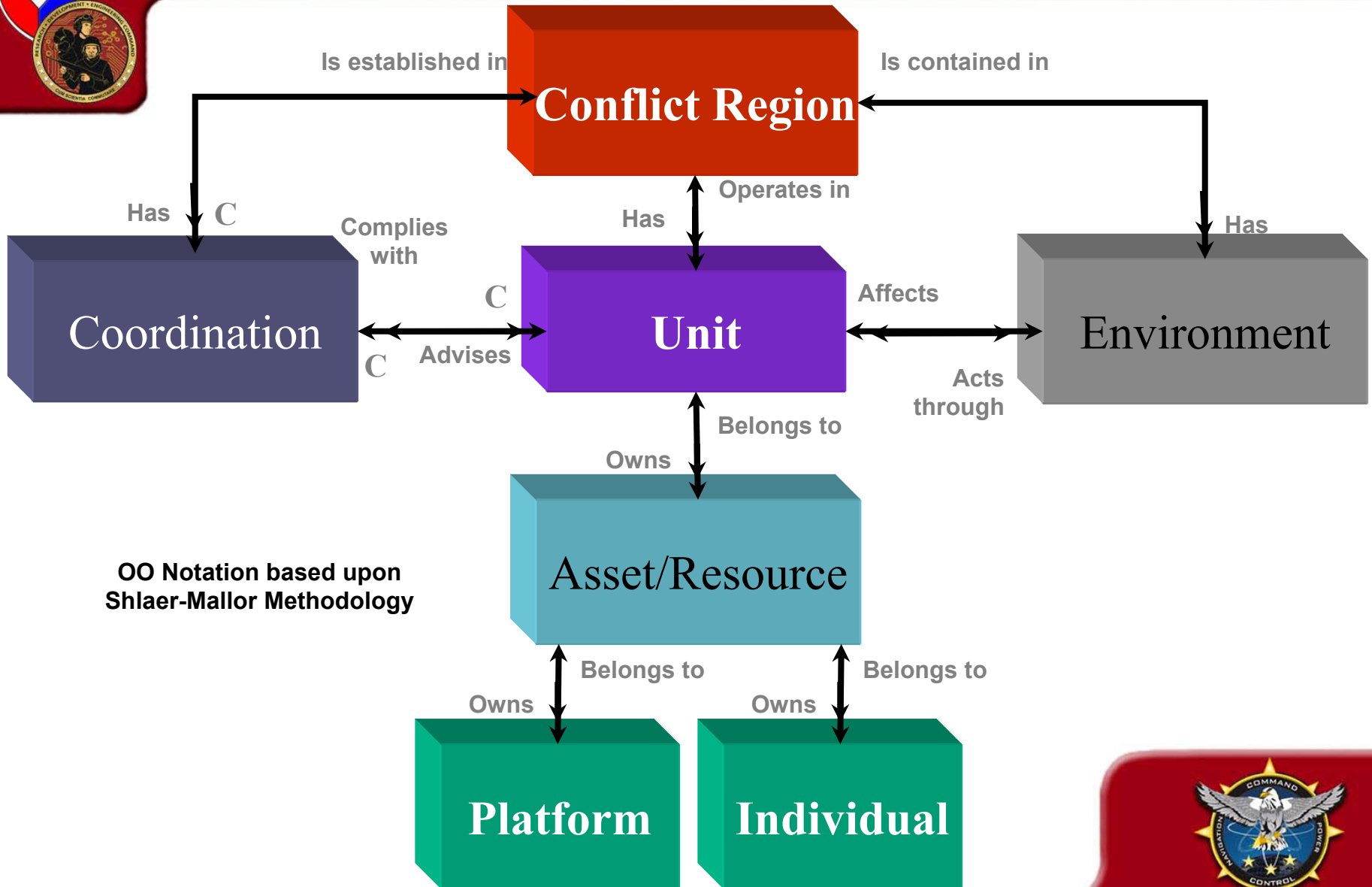
C2(X)ML

XML Instances



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OO Conflict Region Information Model



OO Notation based upon Shlaer-Mallor Methodology

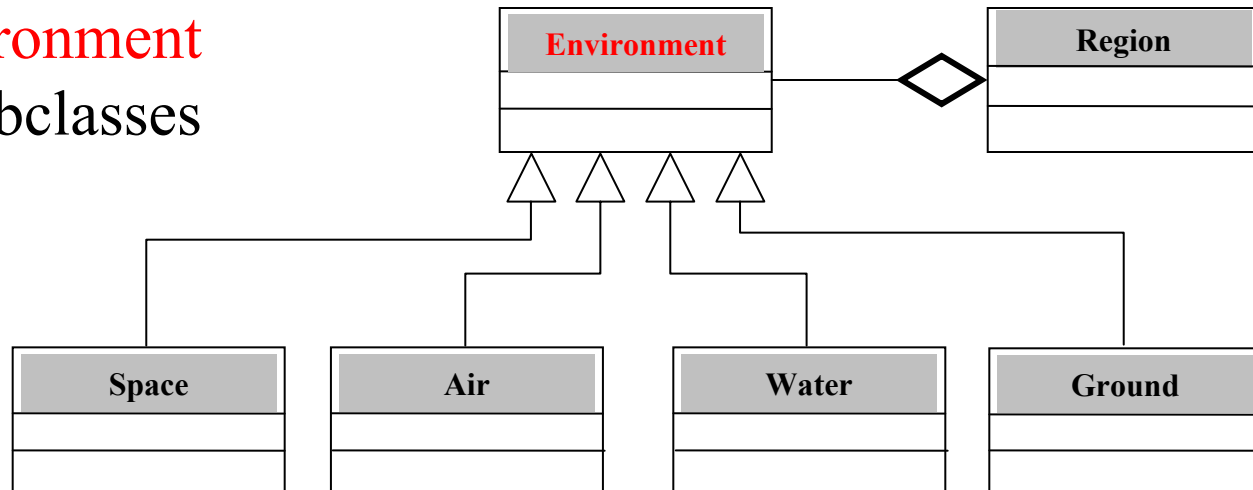


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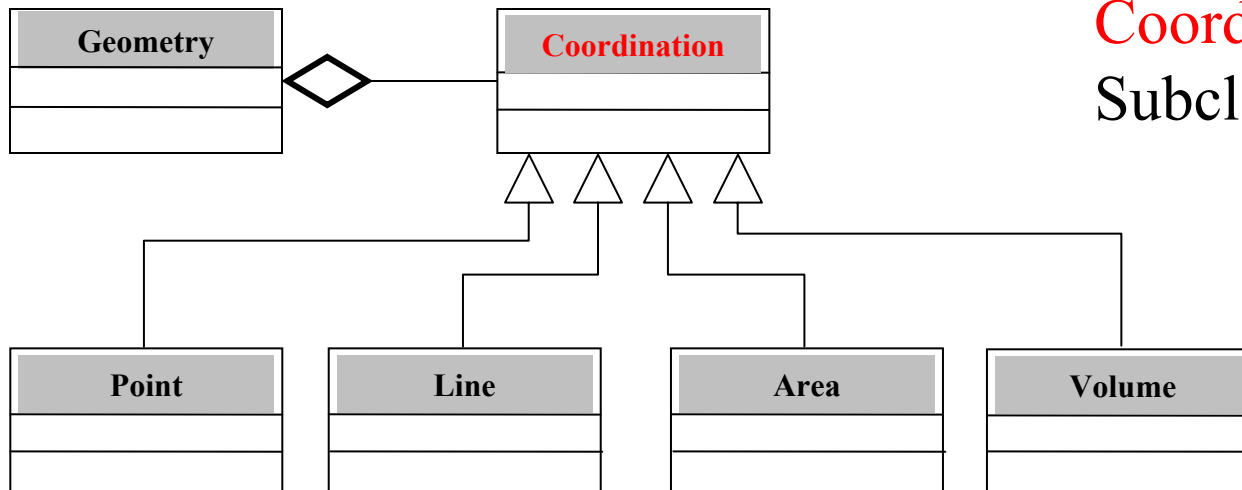


The Other “Which” Subclasses

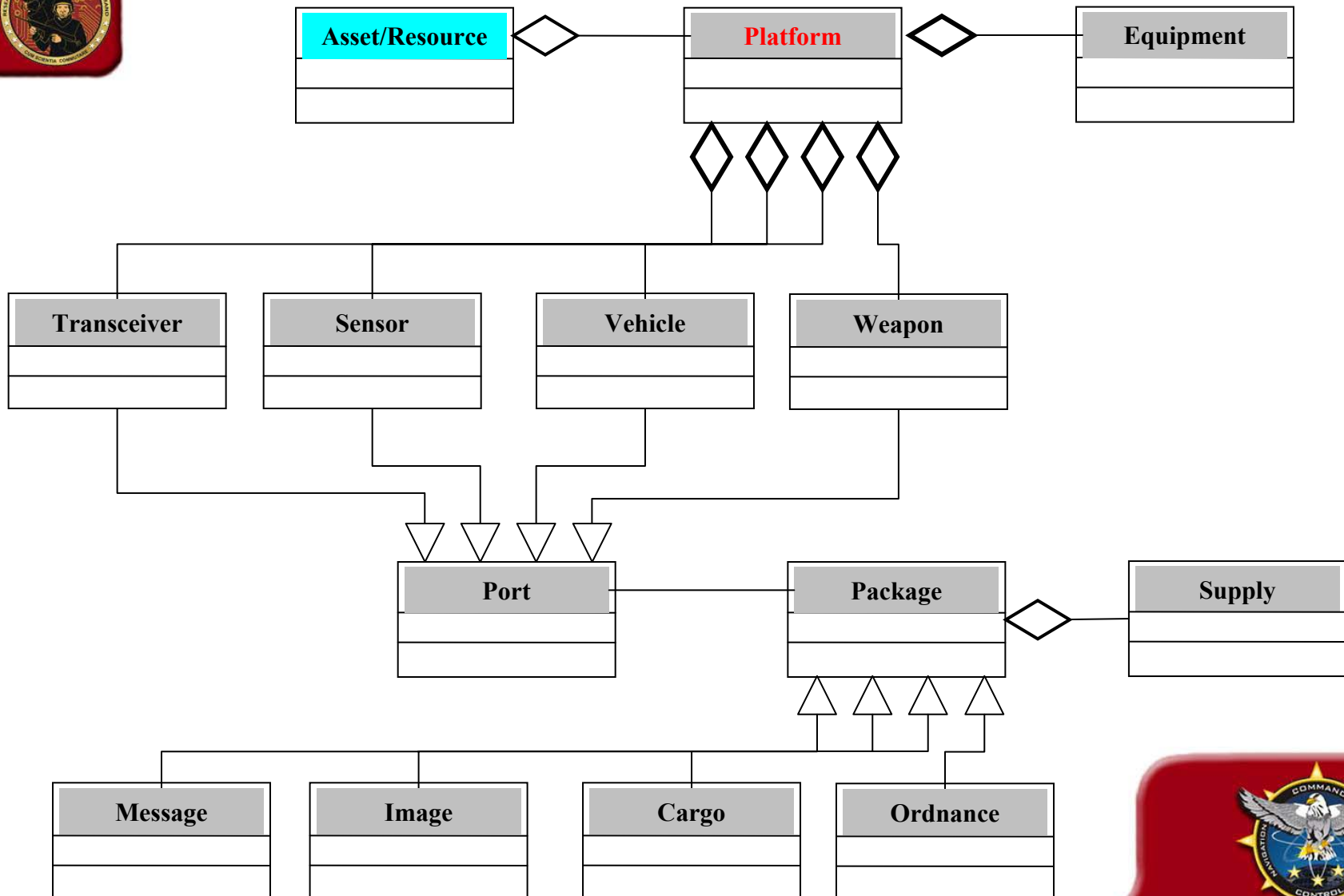
Environment Subclasses



Coordination Subclasses



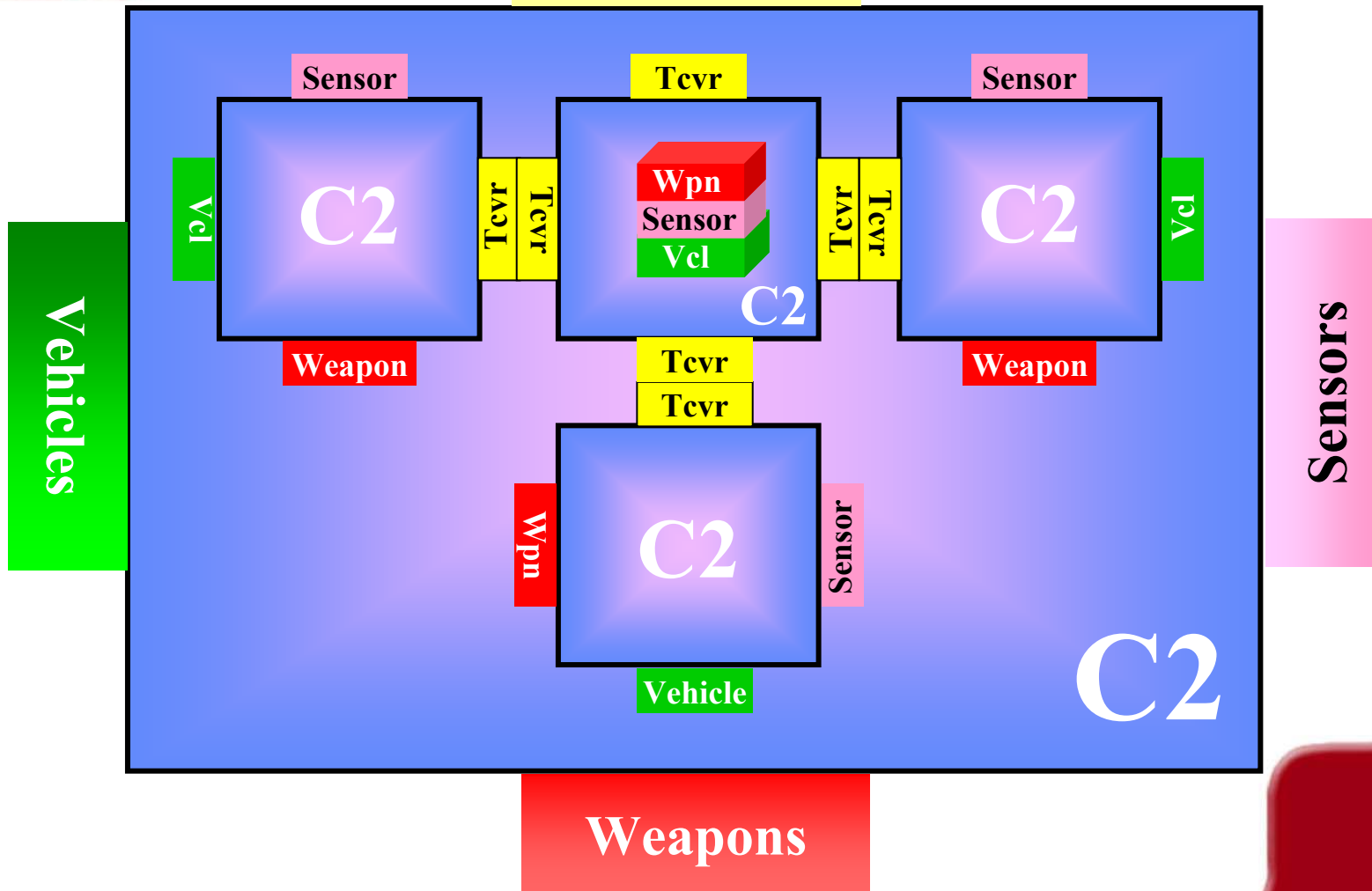
The "Which" Platform Subclasses



Nested/Aggregated C2RM Entities

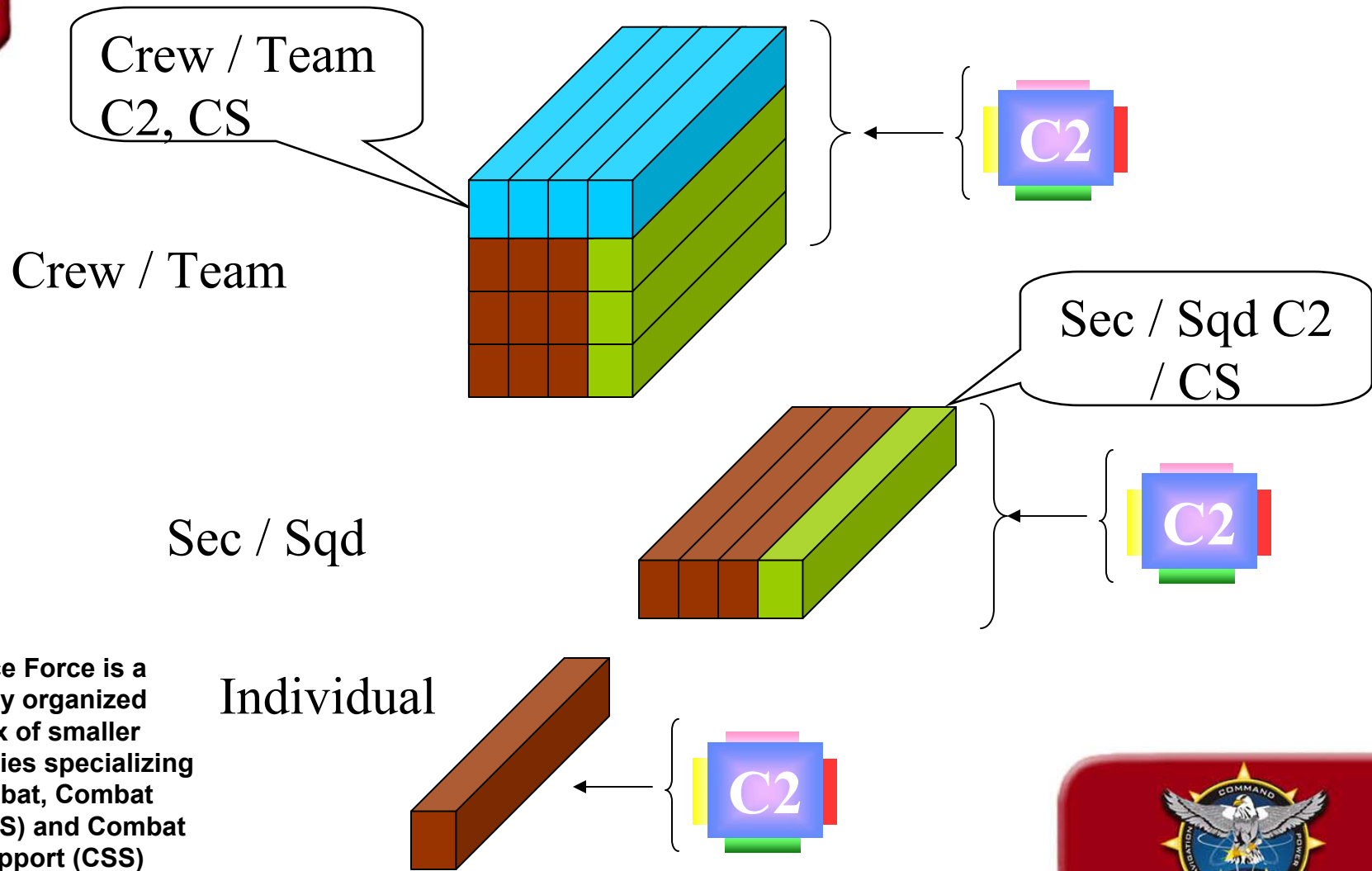


Tranceivers





Building a Reference Force

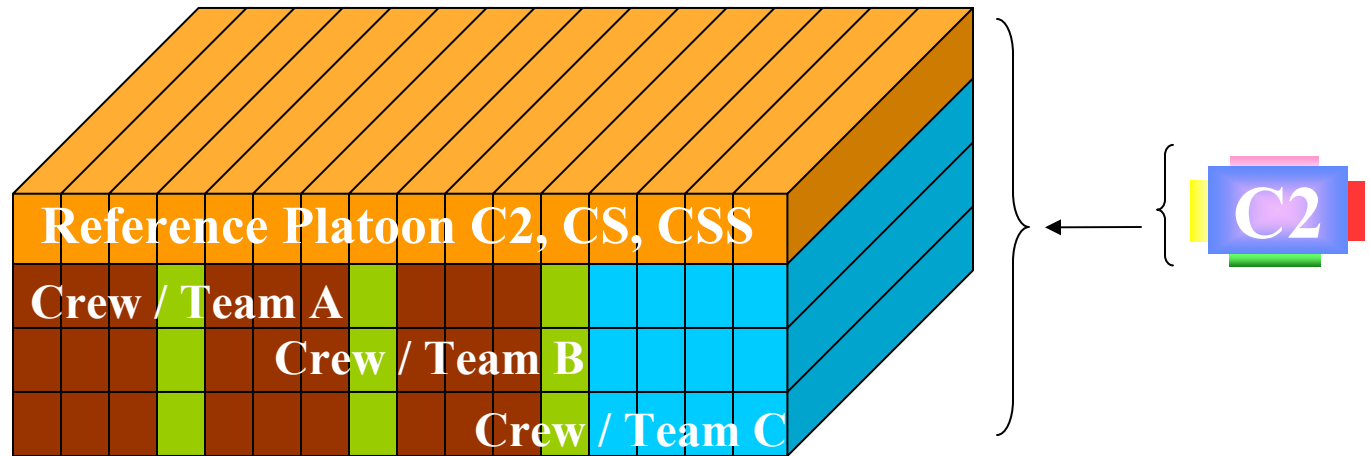


A Reference Force is a C2RM entity organized using a mix of smaller C2RM entities specializing in C2, Combat, Combat Support (CS) and Combat Service Support (CSS) Roles





A Reference Force Platoon

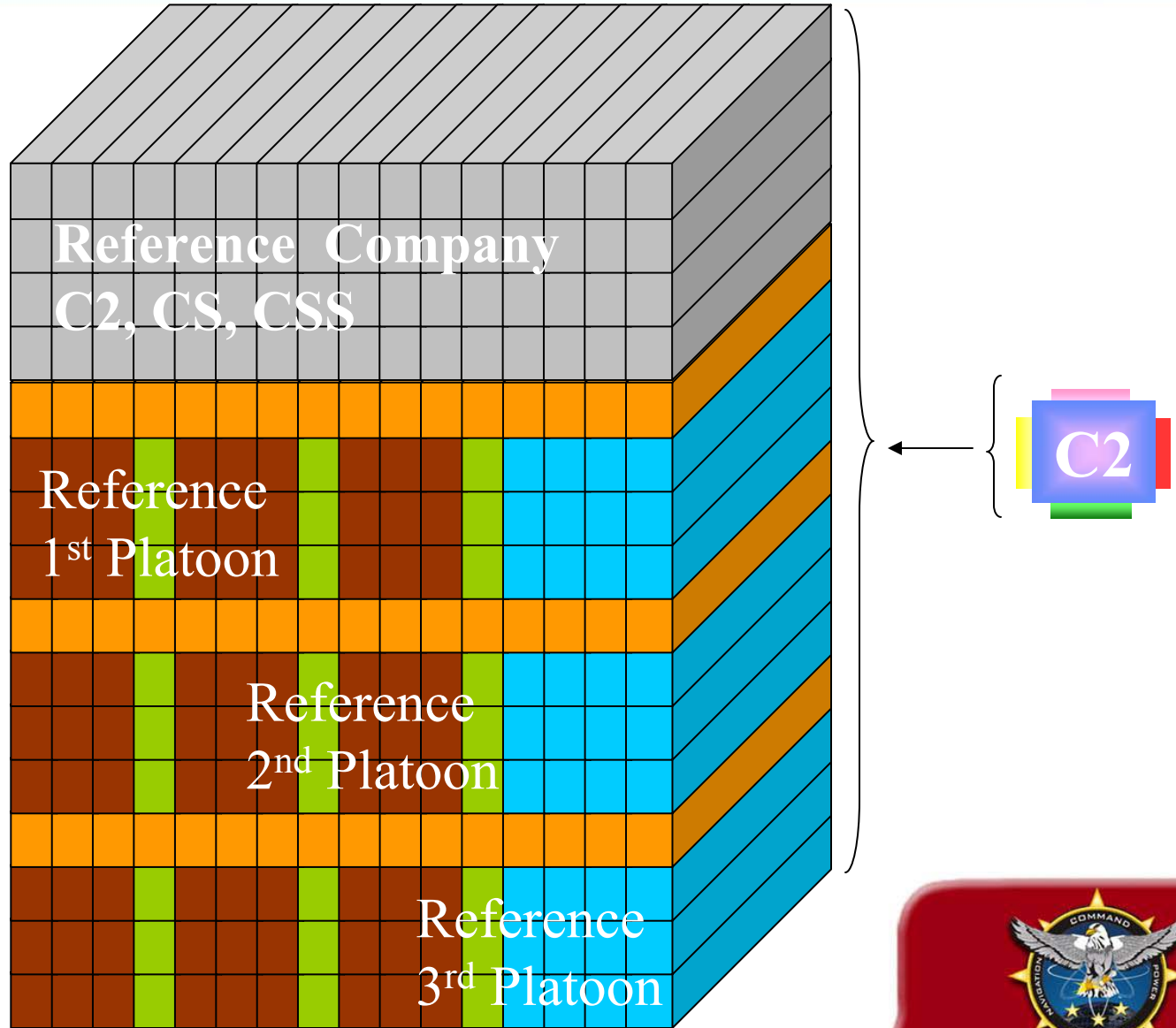


A Reference Force is a C2RM entity organized using a mix of smaller C2RM entities specializing in C2, Combat, Combat Support (CS) and Combat Service Support (CSS) Roles





A Reference Force Company

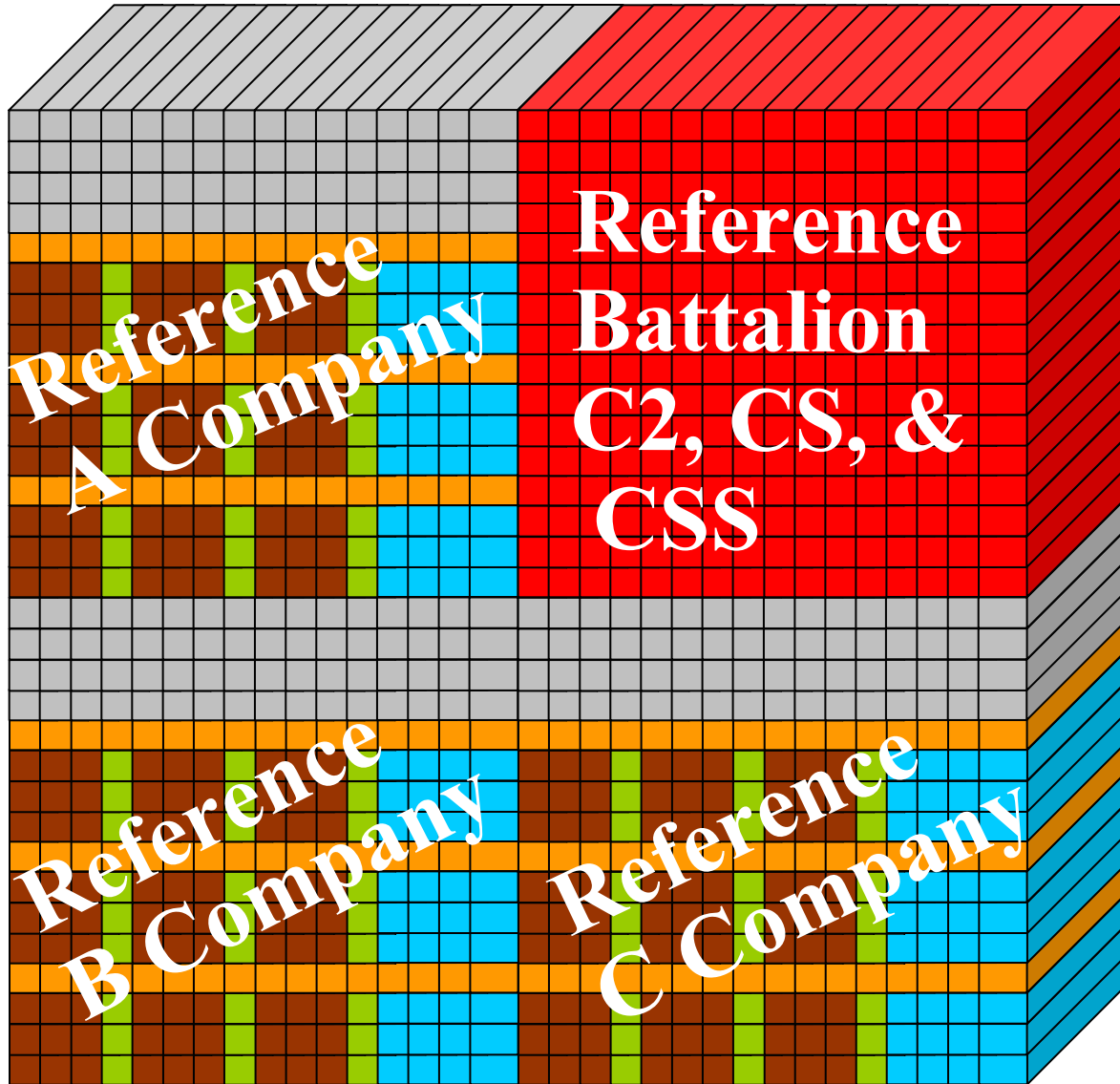


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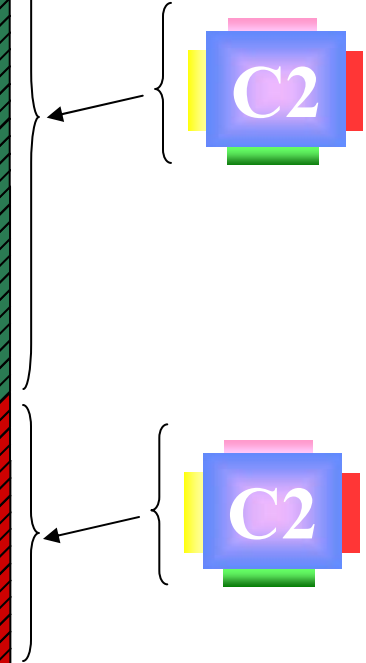
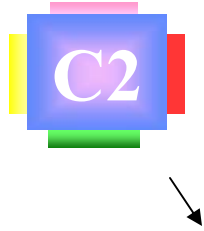
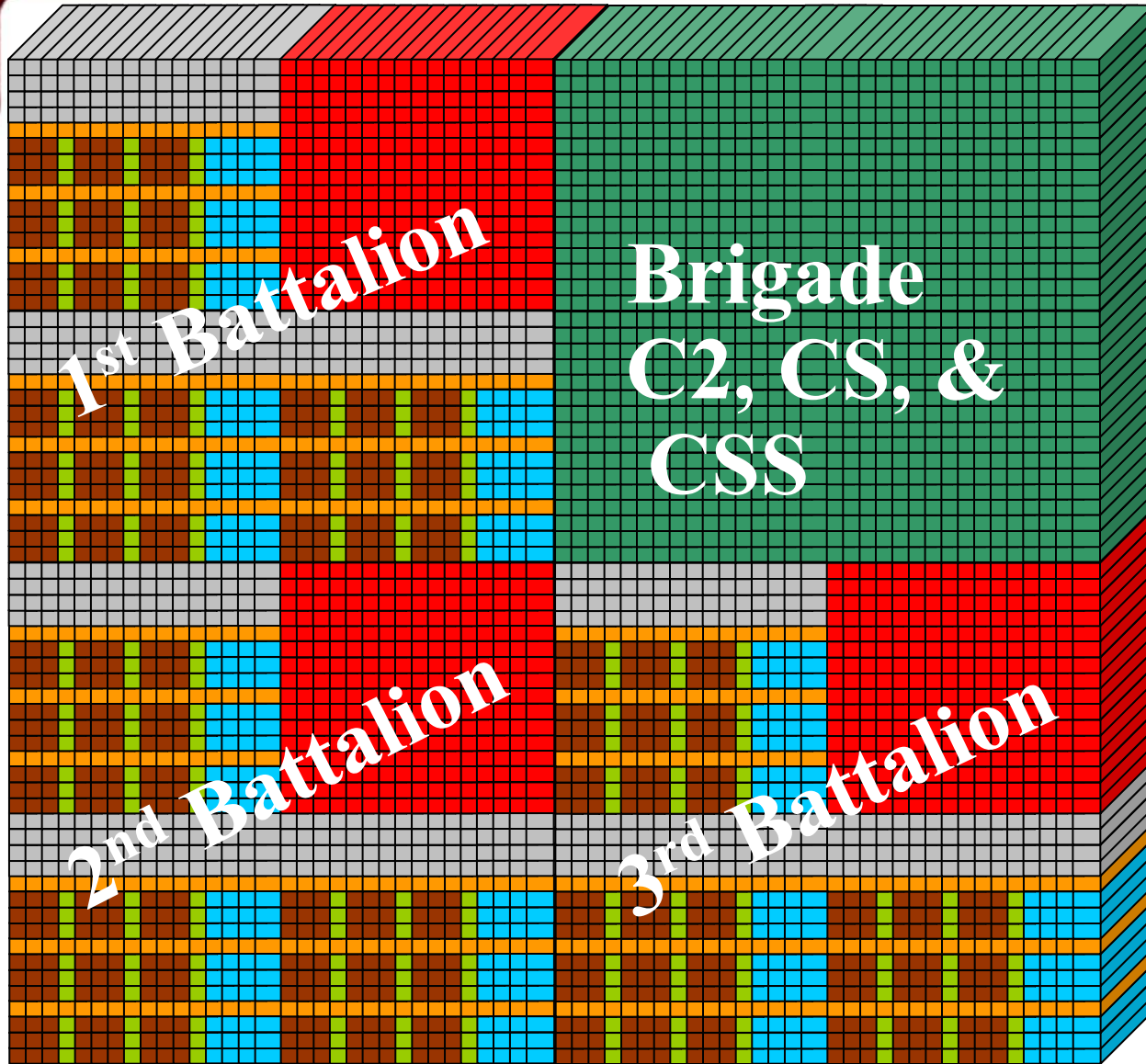
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A Reference Force Battalion



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A Reference Force Brigade





W6H Class Diagram

when



C2



C2



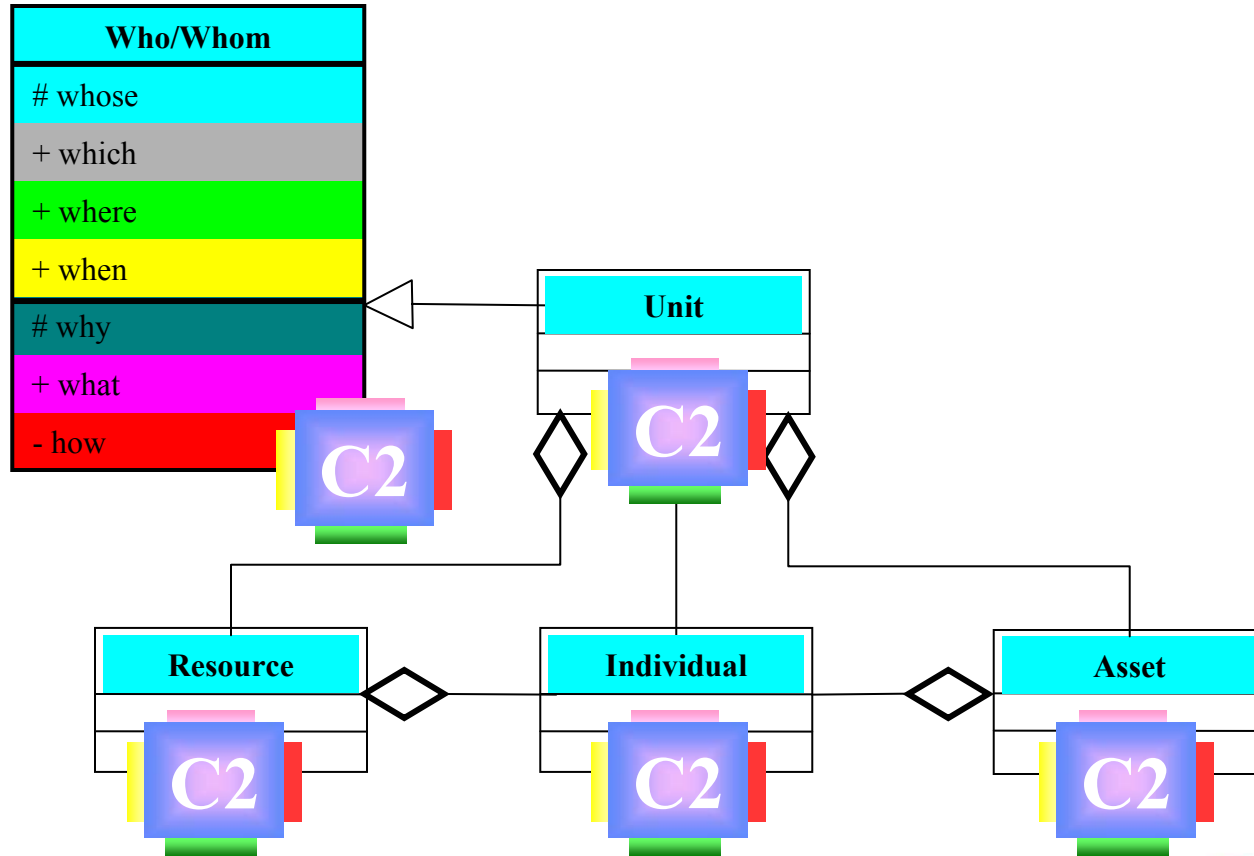
C2

where



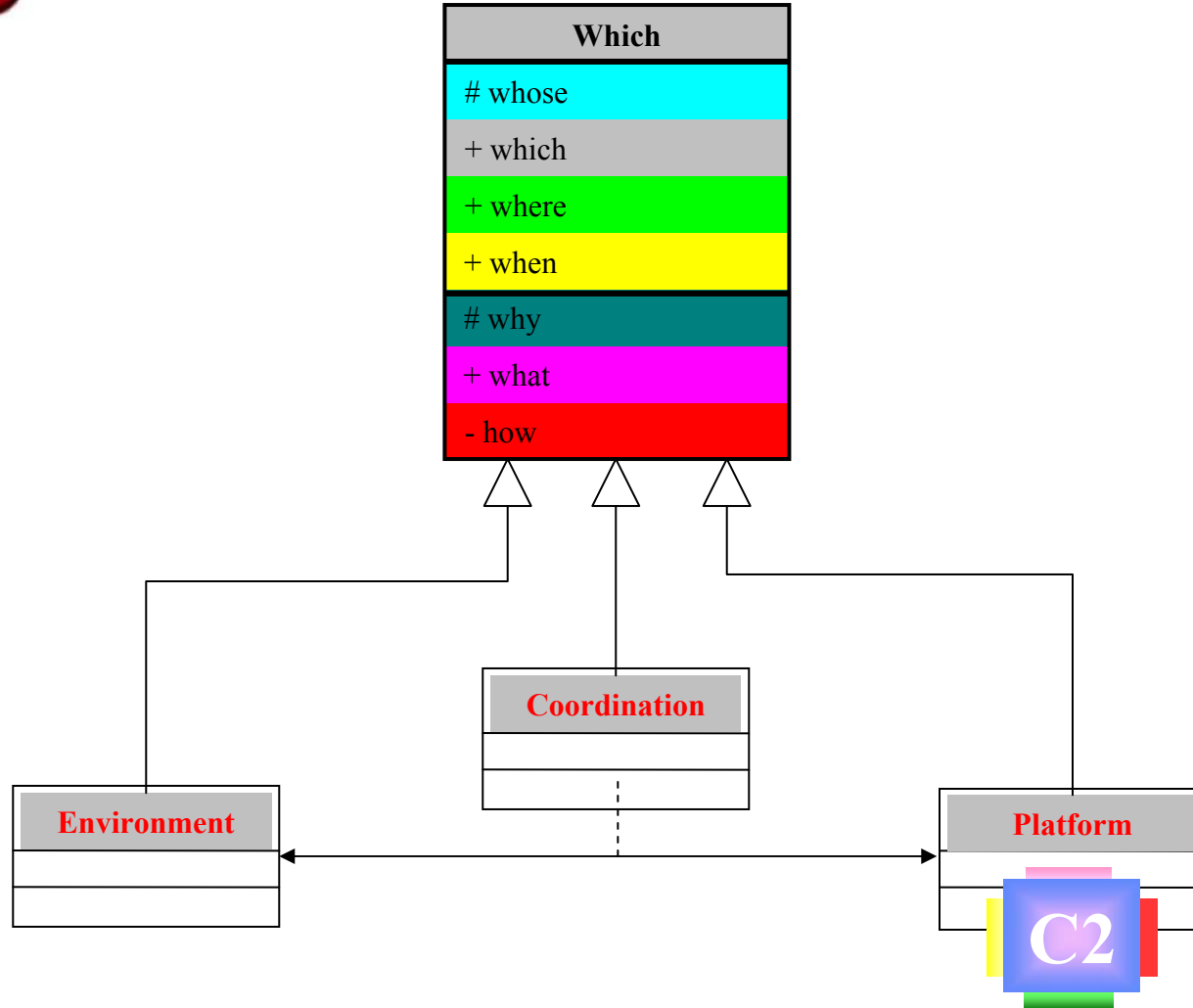


The “Who” / “Whom” Class





The “Which” Class



XML Schema for W6H Constructs



Main Construct

When

Who

Supplemental Constructs

Color Schema

When

Who

Which

What

Whom

Which

Where

How

Why

Where

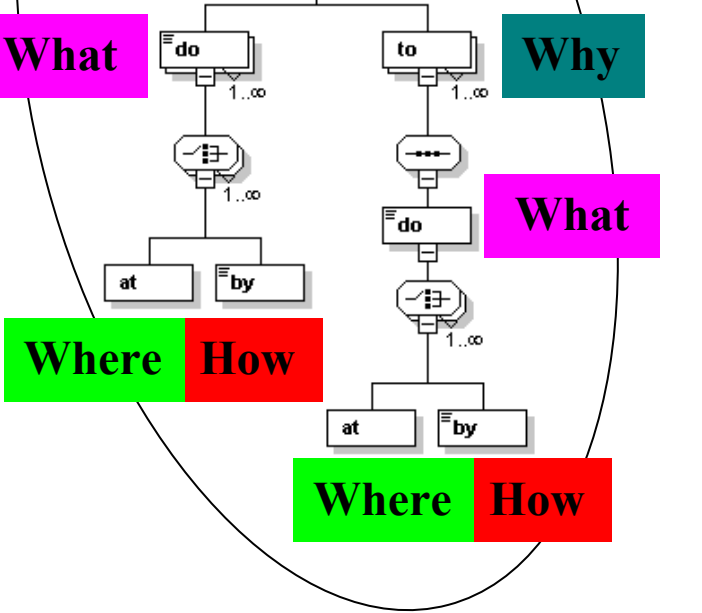
What

Why

When → on
 Who → unit
 Which → asset
 What → do
 Whom → unit
 Where → at
 How → by
 Why → to

Where How

Where How



Control Language for C2 Products



Control Language Definition

Control Language is made of simple sentences(associations) using 2 or more W6H Elements constructs. There are two types of constructs: Main and Supplemental

- * **Main Constructs** includes all W6H elements **at most one time**.

Who (does) **what** (action) (to) **whom** (with) **which**, **where**, **when**, **why** and **how**.

- * **Supplemental Constructs** are derived using UML-based Domain Object statements:

Which W6H element is **included** in which other W6H element?

Which W6H element is **extended** by which other W6H element?

Which W6H element is a **generalization/specialization** of which other W6H element?

Which W6H element is an **aggregate (shared/composite)** of which other W6H element?

Which W6H element is **equivalent** to which other W6H element?

Commander's Intent Example W6H Relationships

Who(1st Armored Brigade) **What**(destroy) **Whom** (enemy) **Which** (using minimum force)

Where (in objective area) **When** (on order)

Why (to ensure safe forward passage by 21st Infantry Division)

How (immediate, wedge formation,)



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C2ML Information Architecture

C2 Products contain W6H constructs of Data Elements characterized by the following properties:

- Attributes
- Sub elements
- Logical grouping
- Multiplicity
- Aggregation
- Nesting
- Hierarchical Enumerations





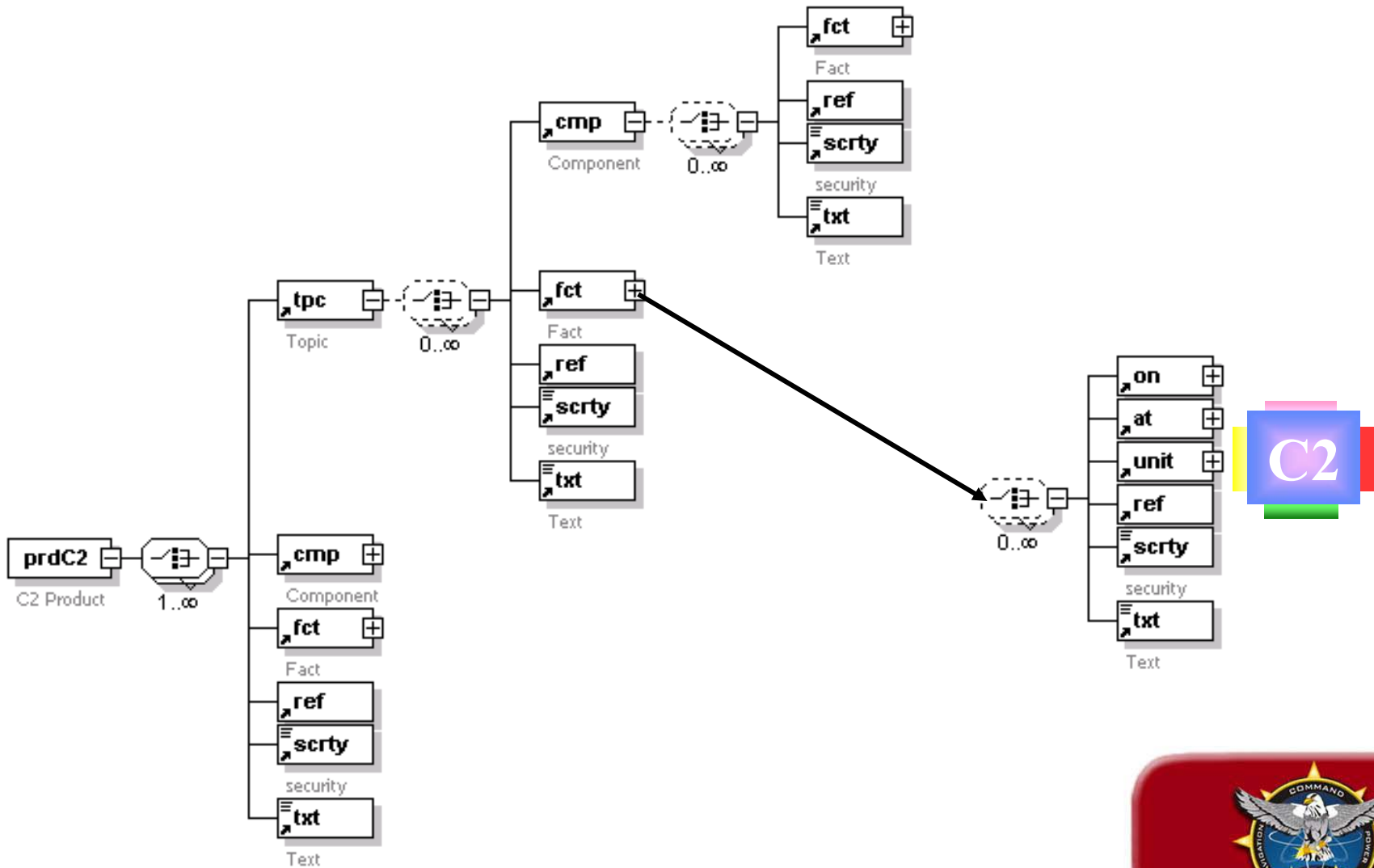
C2ML Dictionary

The C2ML dictionary is required to support the parsing of Control Language. It provides a structure that allows easy interpretation, verification and validation of tagged terms. It defines Data Elements with the following properties:

- Tagging rules
- Attributes
- Sub elements
- Logical grouping of tags thru nesting
- Hierarchical Enumerations
- Descriptive Definitions
- Explanations
- Specifications
- Examples
- References

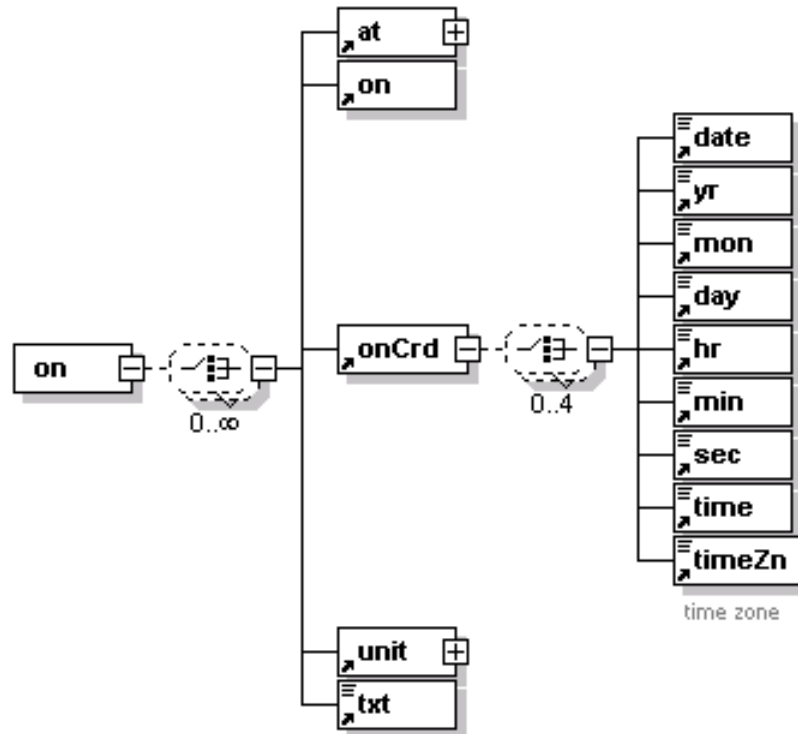


Generic C2 Product XML Schema



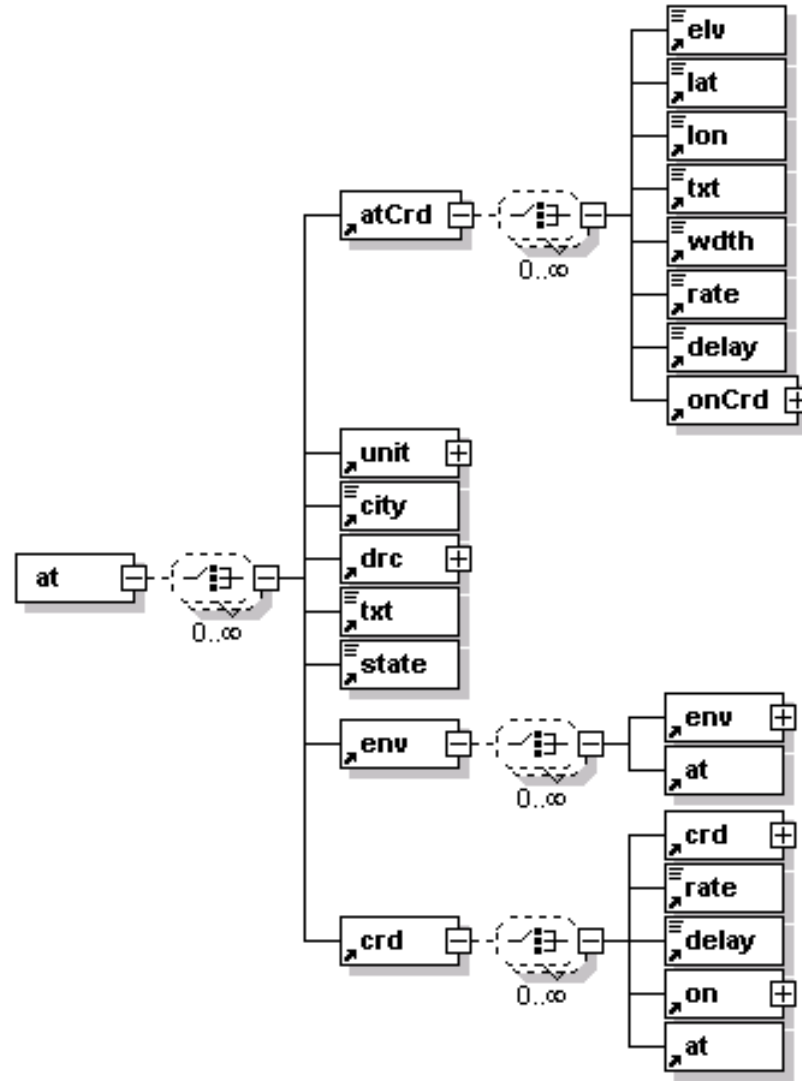
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On Time (When) XML Schema

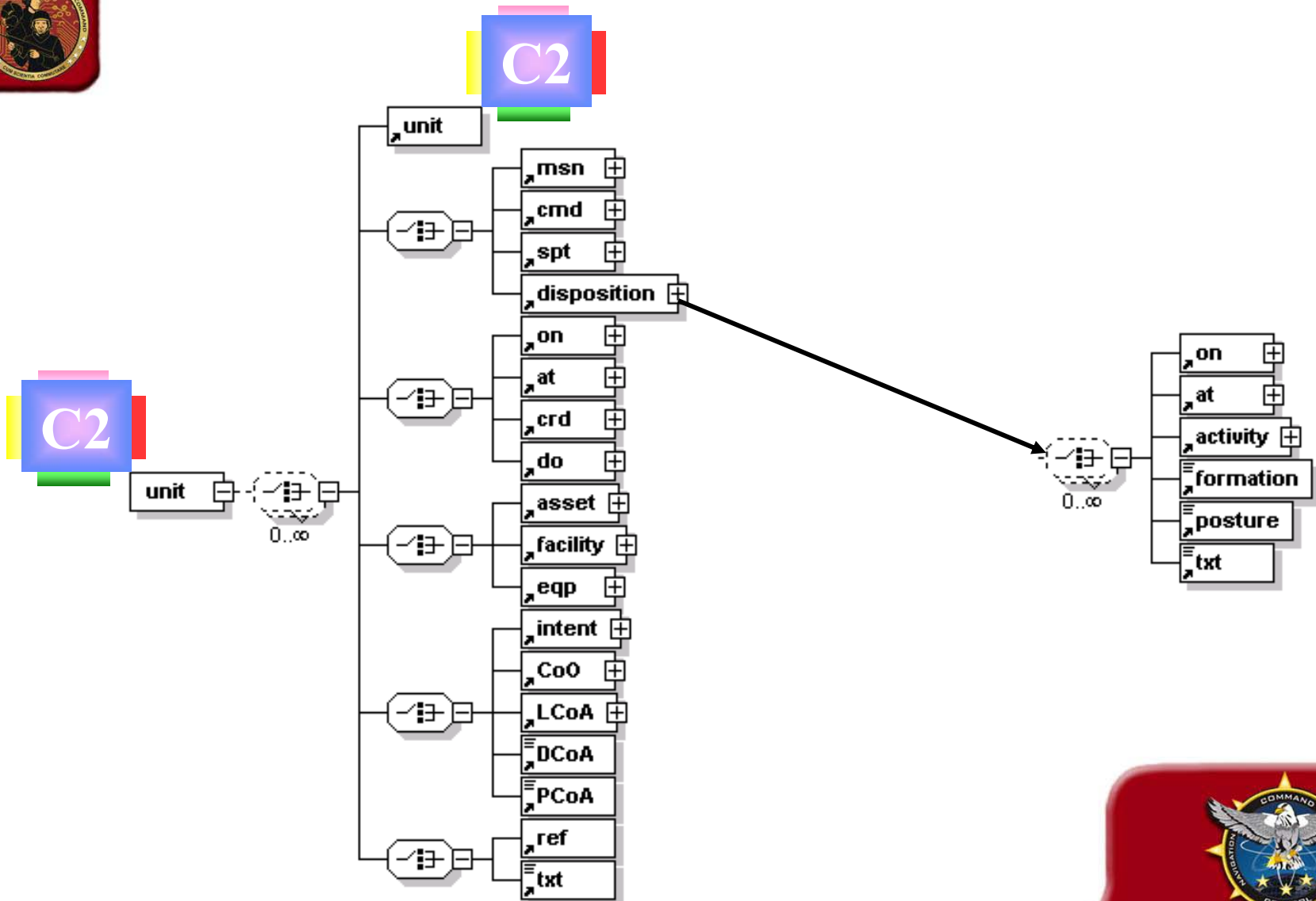




At Location (Where) XML Schema



Unit and Its Disposition XML Schema





Conclusions

- C2 information models need to be harmonized across the full spectrum of operations in a unified seamless ontology and schema in support of the general evolution of the current legacy force and the future force.

C2 information models need to be applied consistently to display of warfighting objects, environment objects and tactical graphics, to structured message standards, databases and repositories and to collaborative and interoperable decision-support applications.

- The C2 domain is inherently Object-Oriented and UML is a viable and robust meta-model for C2 architectures and applications from a syntactic view.
- The C2RM is needed as viable and robust meta-model for all C2 domain semantic views of UML models and applications and all C2 XML representations spanning ground, sea, amphibious, air and space operations as well as Joint, coalition, intra and inter service and for Home Land Security.
- C2 metadata registries will be more effectively utilized if they are designed to correspond to a robust coherent and well-organized C2 meta-model such as the C2RM.

