



# Walkthrough of supporting ontologies

## *MSG-211 Technical Course, Session 2.5*

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FKIE

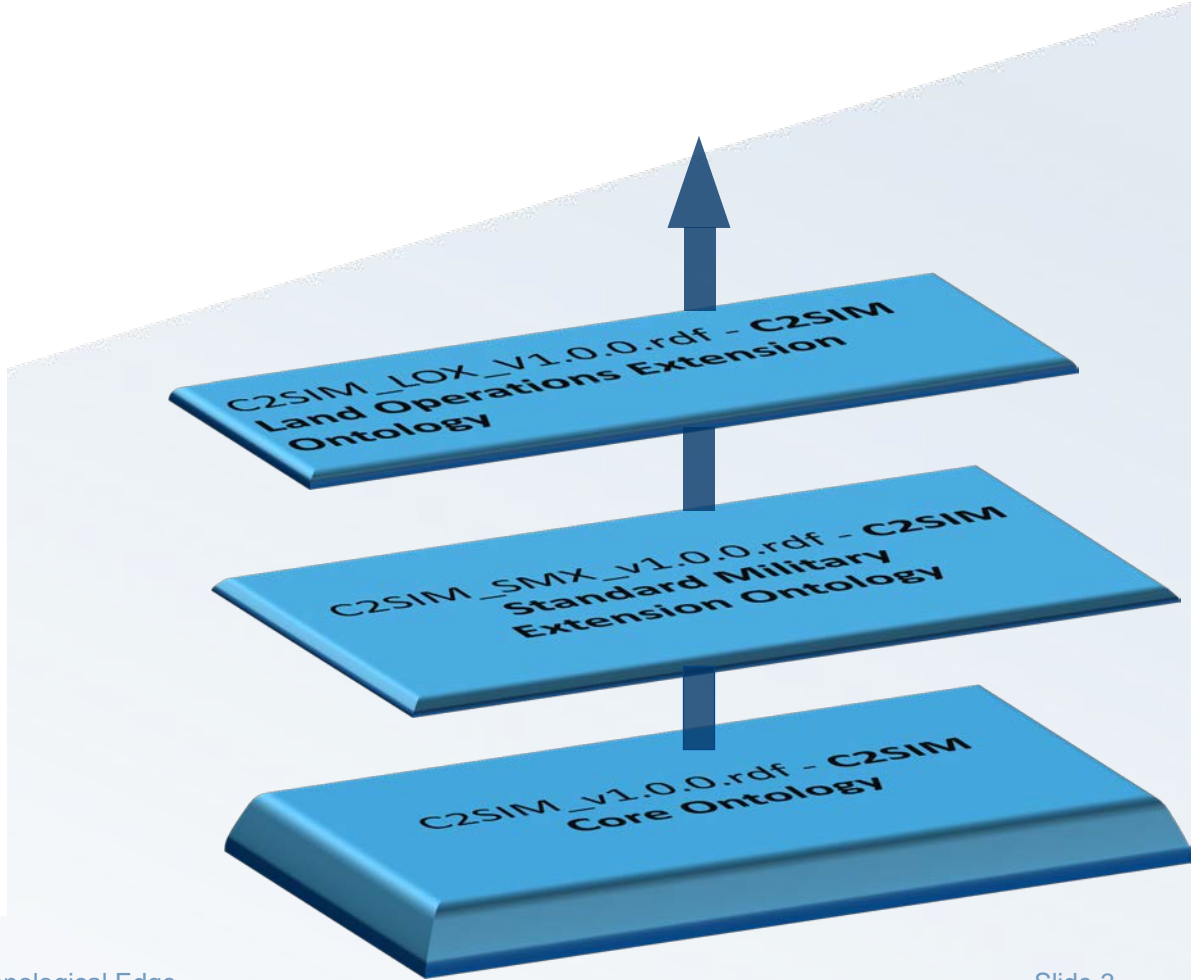
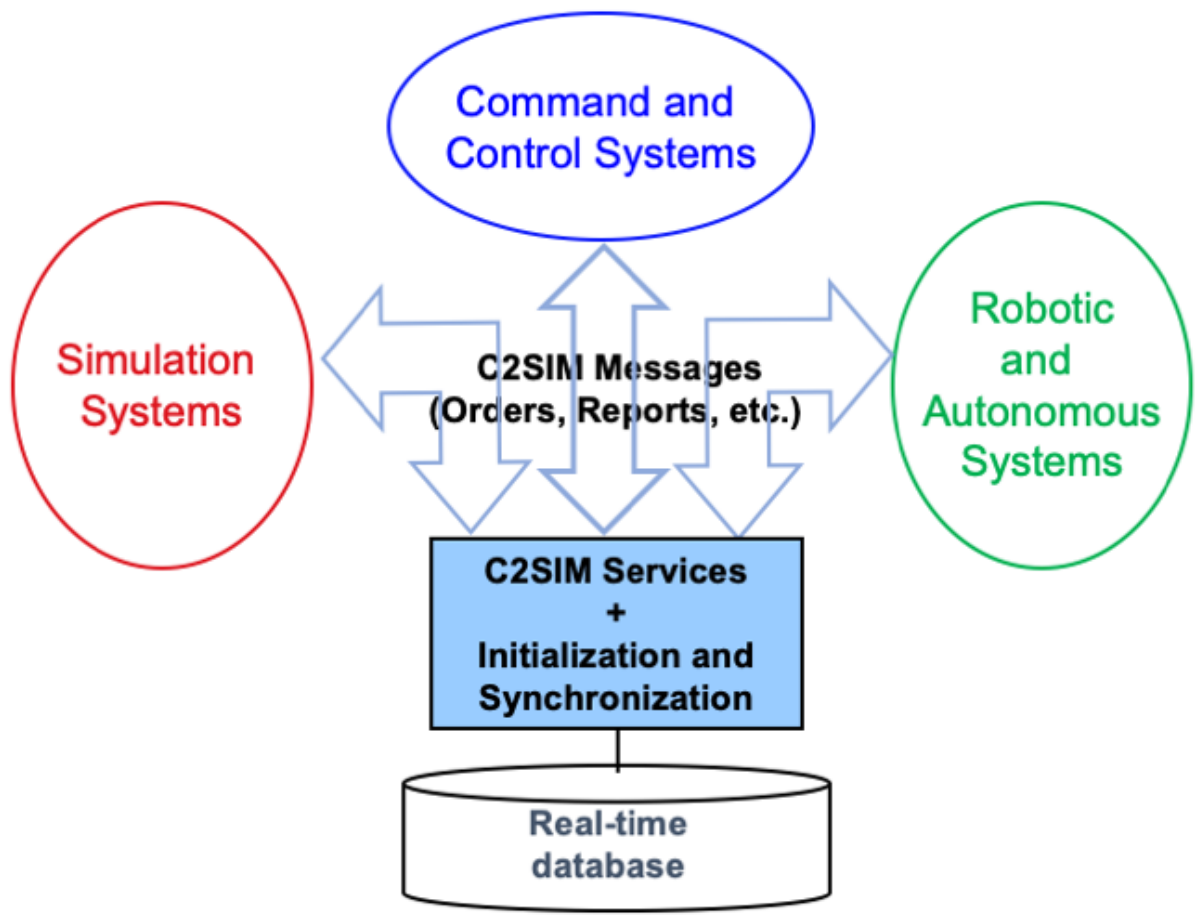
16 October 2023



# Outline

- C2SIM ontologies: Core Logical Data Model, SMX and LOX
  - Ontology Features: Taxonomy, Classes, Properties, Property Restrictions etc.
  - C2SIMContent, InitializationConcept, MessageConcept in different ontology layers
- C2SIM Extension Process using Protégé
  - Include extension into C2SIM structure
  - Model new information into ontology features
- Information Exchange with C2SIM
  - Ontology to Schema transformation
  - Schema to XML message

# C2SIM Information Exchange



# C2SIM Core LDM: Concept Structure

## InitializationConcept

InitializationDataFile   ScenarioSetting   SystemEntityList  
ObjectDefintions

## MessageConcept

C2SIMHeader   Message   MessageBody   MessageCode  
ReportContent   RequestContent

## C2SIMContent

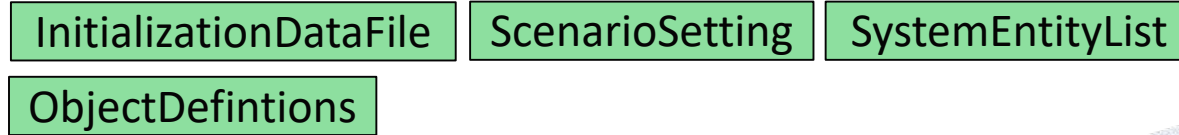
AbstractObject   Action   PhysicalConcept   Code  
Entity   EntityType   EntityDescriptor   EntityState  
Relationship   Resource

# Ontology Features in Protégé

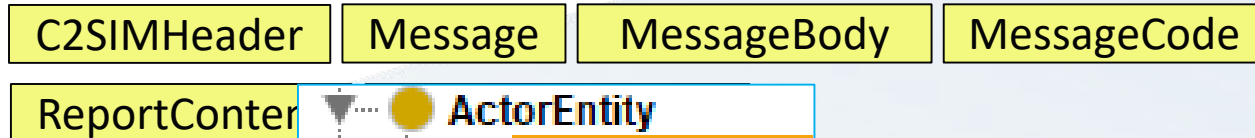
Annotation properties		Datatypes	Individuals
Classes	Object properties	Data properties	

# C2SIM Core LDM: C2SIMContent Entity

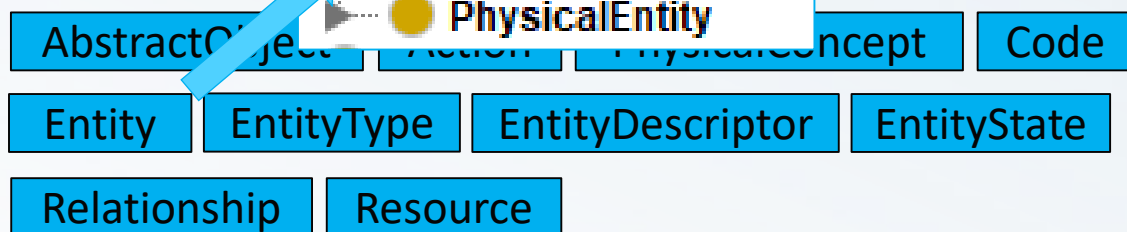
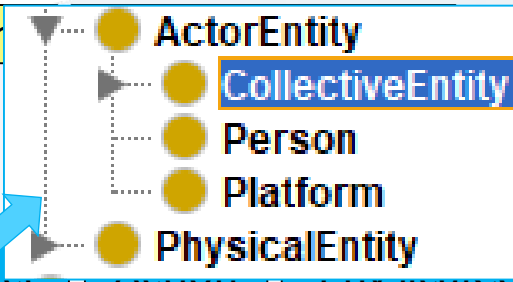
## InitializationConcept



## MessageConcept

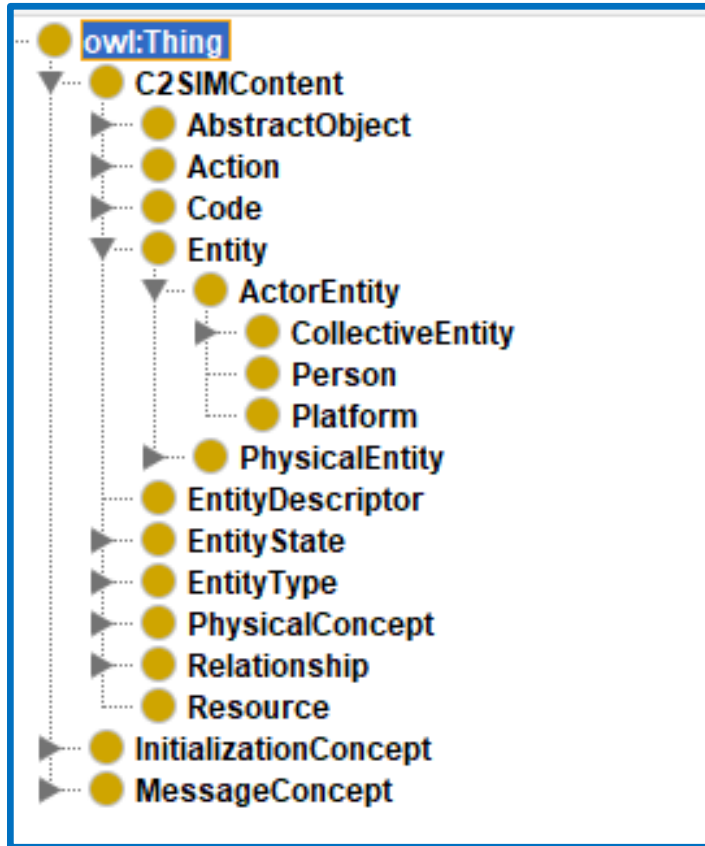


## C2SIMContent

- ActorEntity
- CollectiveEntity
- Person
- Platform
- PhysicalEntity

# Ontology Features in Protégé: Taxonomy

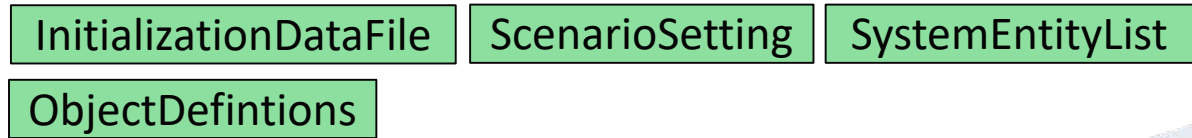


- **Hypernymy: Superordination of classes**
  - Superclass is defined by attributes
  - Transitive relation
  
- **Hyponymy: Subordination of classes**
  - „is a“ -relation
  - Subclass inherits attributes from superclass
  - Subclass specifies through additional attributes
  - Transitive relation

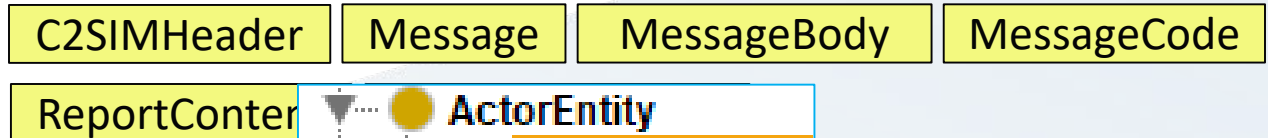


# C2SIM Core LDM: Classes and Attributes

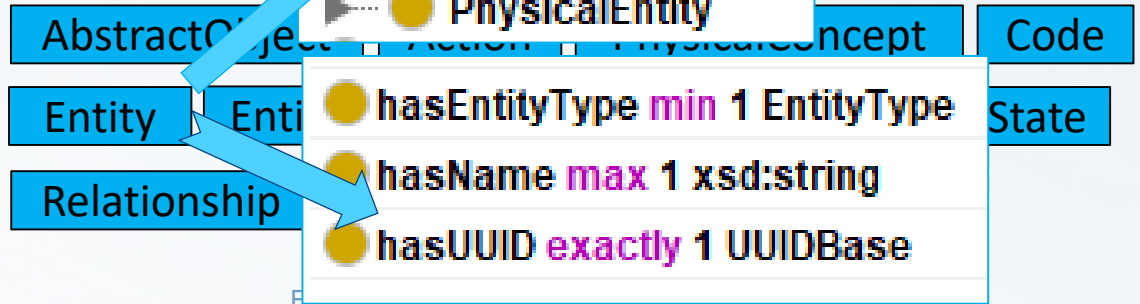
## InitializationConcept



## MessageConcept



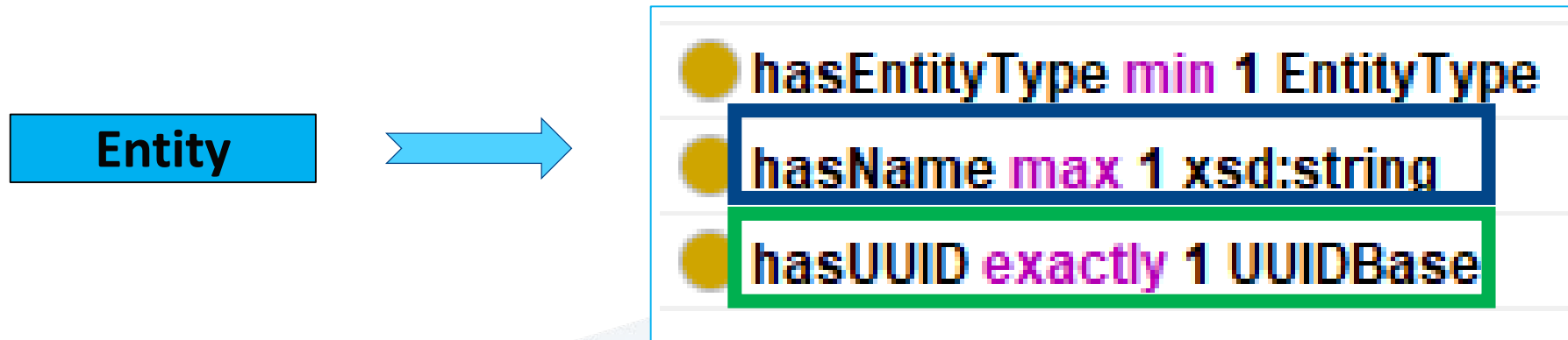
## C2SIMContent





# Ontology Features in Protégé: Datatype Property (Restriction)

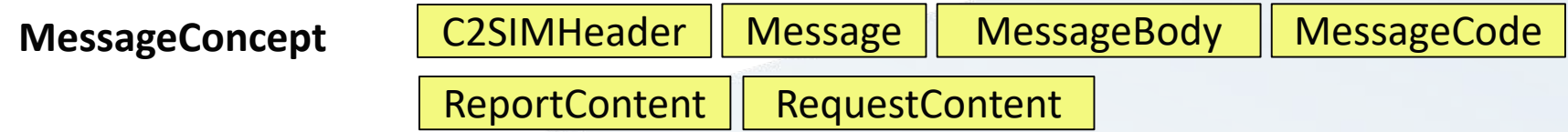
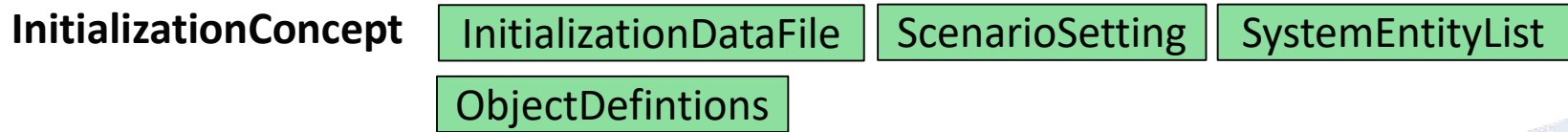
- Datatype properties assign a property to a value type: string, int, byte, etc.



- Definition of specific formats of a value with regular expressions: UUIDBase

```
Datatype Definitions +  
xsd:string[pattern "[0-9a-fA-F]{8}\-[0-9a-fA-F]{4}\-[0-9a-fA-F]{4}\-[0-9a-fA-F]{4}\-[0-9a-fA-F]{12}"]
```

# C2SIM Core LDM: Object Property (Restriction)



- hasEntityType **min 1** EntityType
- hasName **max 1** xsd:string
- hasUUID **exactly 1** UUIDBase

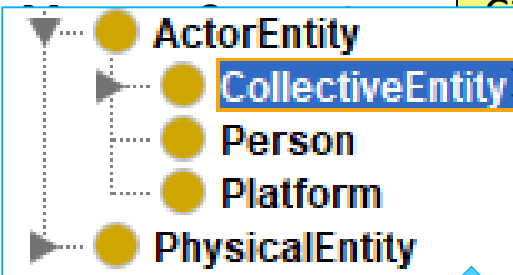
# C2SIM Core LDM: Taxonomy, Property Restrictions and Inheritance

InitializationConcept

InitializationDataFile ScenarioSetting SystemEntityList

ObjectDefinitions

- ActorEntity
- hasCurrentState **max 1** PhysicalState
- hasSubordinate **min 0** UUIDBase



General class axioms +

Class Of (Anonymous Ancestor)

- hasEntityDescriptor **exactly 1** EntityDescriptor
- hasCurrentTask **min 0** UUIDBase
- hasResource **min 0** Resource
- hasEntityType **min 1** EntityType
- hasUUID **exactly 1** UUIDBase
- hasName **max 1** xsd:string

Body MessageCode

C2SIMContent

AbstractConcept Concept Code

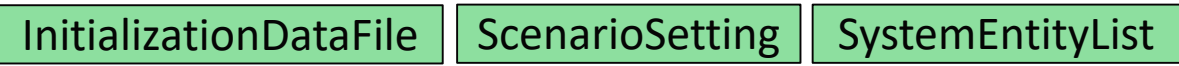
Entity EntityType EntityDescriptor EntityState

- hasEntityType **min 1** EntityType
- hasName **max 1** xsd:string
- hasUUID **exactly 1** UUIDBase

Relationship Resource

# C2SIM Core LDM: Property Restrictions and extended Inheritance

InitializationConcept



ObjectDefintions

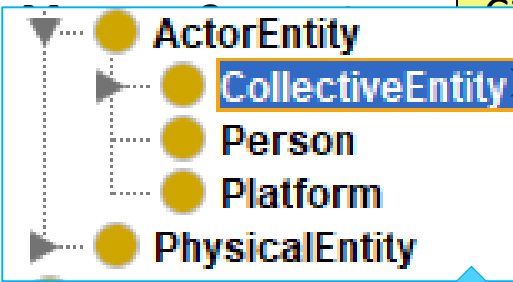
ActorEntity

- hasCurrentState **max 1** PhysicalState
- hasSubordinate **min 0** UUIDBase

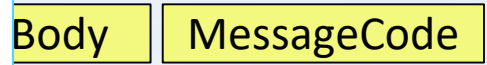
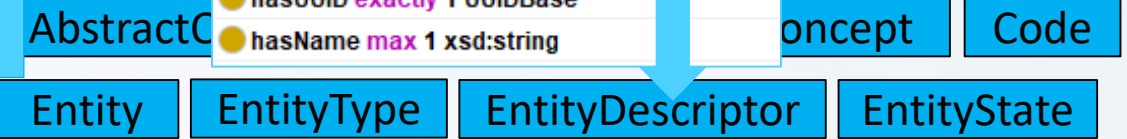
General class axioms +

Class Of (Anonymous Ancestor)

- hasEntityDescriptor **exactly 1** EntityDescriptor
- hasCurrentTask **min 0** UUIDBase
- hasResource **min 0** Resource
- hasEntityType **min 1** EntityType
- hasUUID **exactly 1** UUIDBase
- hasName **max 1** xsd:string



C2SIMContent



- hasAllegianceRelationship **min 0** AllegianceRelationship
- hasCommunicationsNetwork **min 0** UUIDBase
- hasSuperior **max 1** UUIDBase
- isAffiliatedWith **min 0** UUIDBase

# C2SIM Core LDM: Property Restrictions and extended Inheritance

InitializationConcept

InitializationDataFile ScenarioSetting SystemEntityList

ObjectDefintions

ActorEntity

- hasCurrentState **max 1** PhysicalState
- hasSubordinate **min 0** UUIDBase

General class axioms +

Class Of (Anonymous Ancestor)

- hasEntityDescriptor **exactly 1** EntityDescriptor
- hasCurrentTask **min 0** UUIDBase
- hasResource **min 0** Resource
- hasEntityType **min 1** EntityType
- hasUUID **exactly 1** UUIDBase
- hasName **max 1** xsd:string

- EntityState
- hasDirectionOfMovement **max 1** Orientation
- hasEntityHealthStatus **min 0** EntityHealthStatus
- hasLocation **min 1** Location
- hasOrientation **max 1** Orientation
- hasSpeed **max 1** xsd:float

General class axioms +

Class Of (Anonymous Ancestor)

- hasDateTime **max 1** TimelInstant

- ActorEntity
- CollectiveEntity
- Person
- Platform
- PhysicalEntity

C2SIMContent

AbstractConcept Concept Code

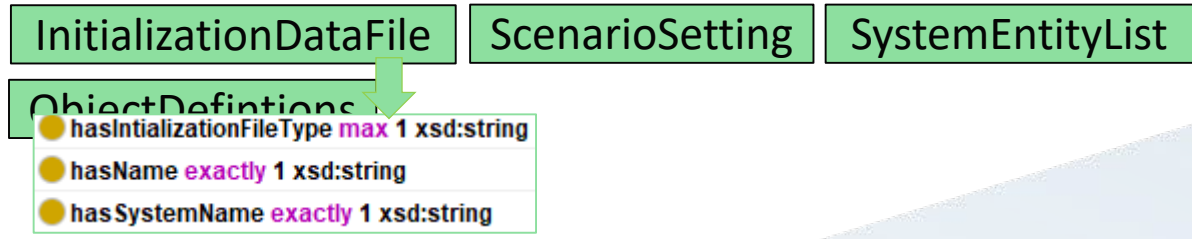
Entity EntityType EntityDescriptor EntityState

Relationship Resource

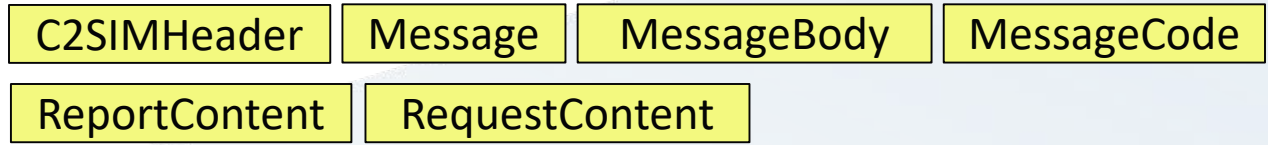
- Entity State
- PhysicalState

# C2SIM Core LDM: InitializationConcept InitializationDataFile

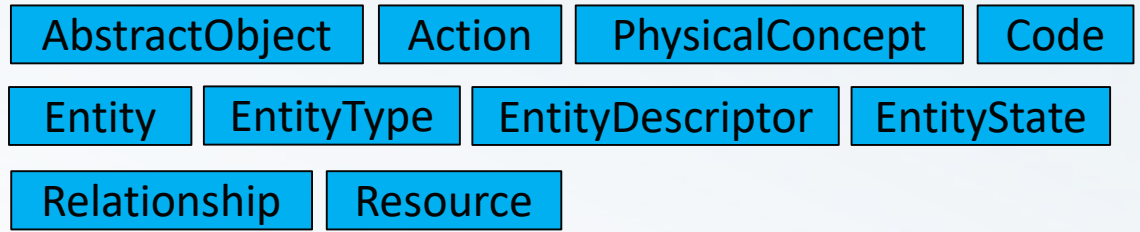
## InitializationConcept



## MessageConcept

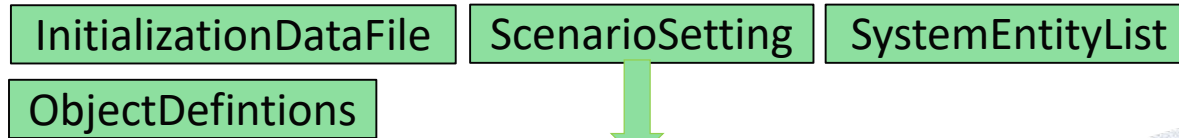


## C2SIMContent



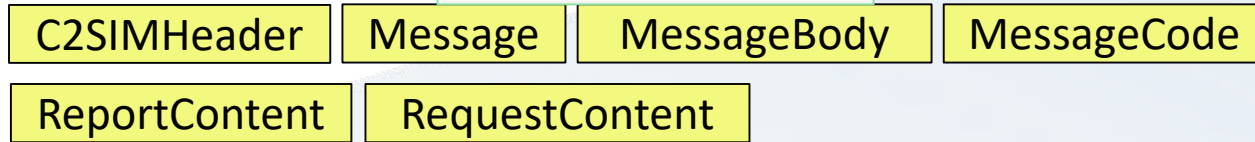
# C2SIM Core LDM: InitializationConcept ScenarioSetting

## InitializationConcept

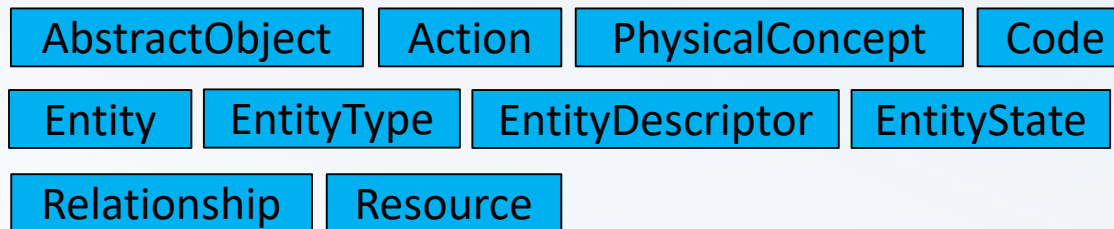


- hasDateTime **exactly 1** DateTime
- hasVersion **exactly 1** xsd:string
- InitializationConcept

## MessageConcept



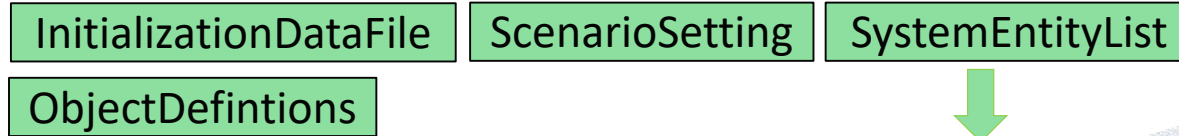
## C2SIMContent





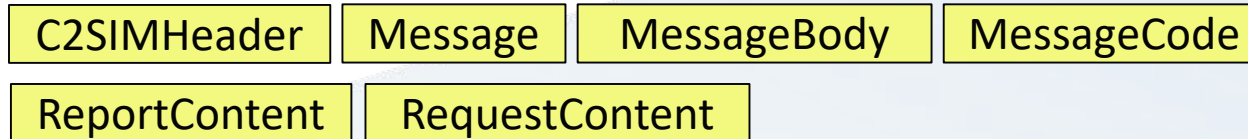
# C2SIM Core LDM: InitializationConcept SystemEntityList

## InitializationConcept

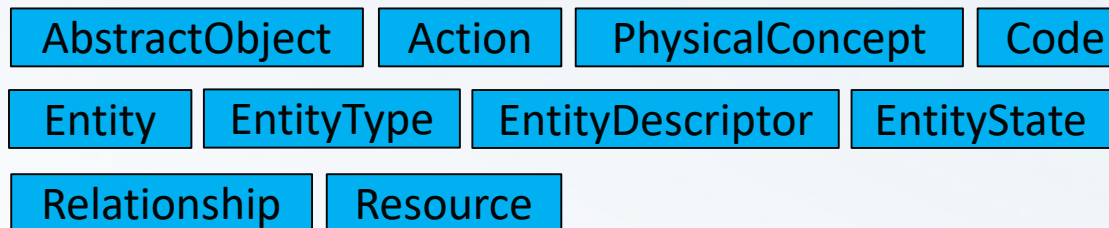


- hasActorReference **min 1** UUIDBase
- hasSystemName **exactly 1** xsd:string
- InitializationConcept

## MessageConcept

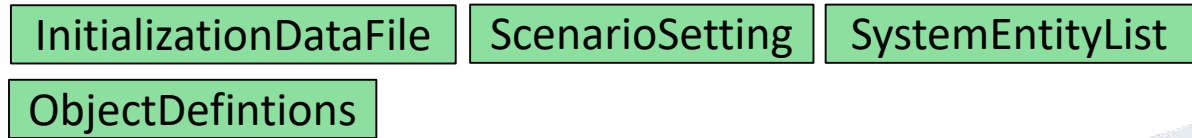


## C2SIMContent

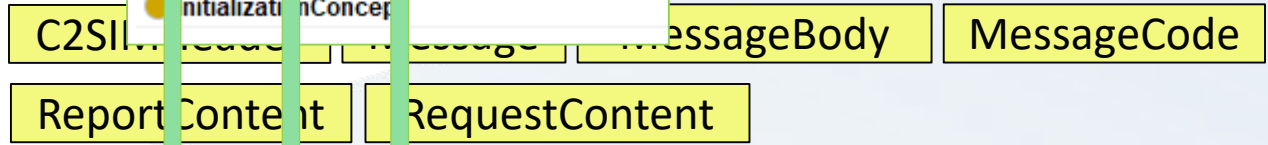


# C2SIM Core LDM: InitializationConcept ObjectDefinitions

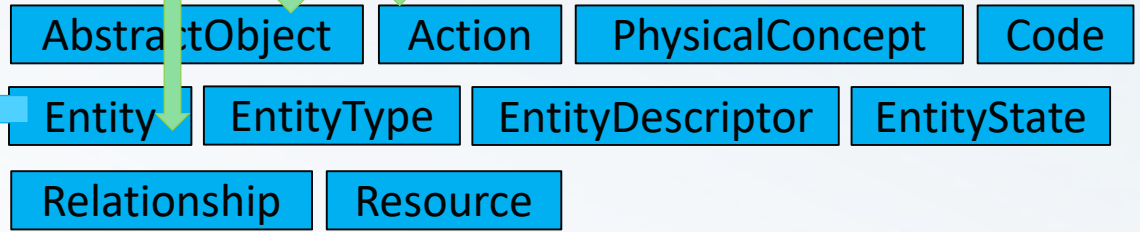
**InitializationConcept**



**MessageConcept**



**C2SIMContent**

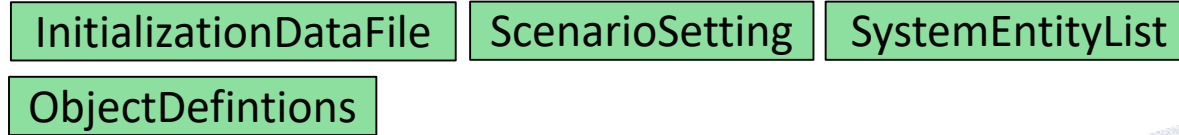


- hasAbstractObject min 0 AbstractObject
- hasAction min 0 Action
- hasEntity min 0 Entity
- initializationConcept

- ActorEntity
- CollectiveEntity
- Person
- Platform
- PhysicalEntity

# C2SIM Core LDM: MessageConcept Message, C2SIMHeader, MessageBody

## InitializationConcept



- hasC2SIMHeader **exactly 1** C2SIMHeader
- hasMessageBody **exactly 1** MessageBody
- MessageConcept

## MessageConcept

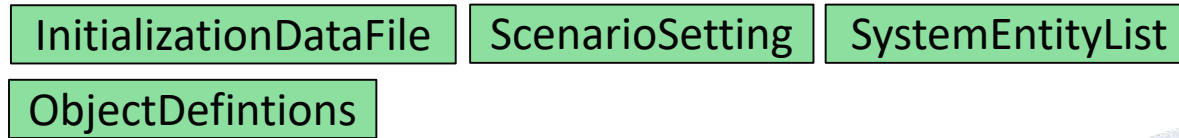


- hasCommunicativeActTypeCode **exactly 1** CommunicativeActTypeCode
- hasConversationID **exactly 1** UUIDBase
- hasMessageID **exactly 1** UUIDBase
- hasProtocol **value** "SISO-STD-C2SIM"
- hasProtocolVersion **value** "1.0.0"
- hasReplyToSystem **max 1** xsd:string
- hasSecurityClassificationCode **max 1** SecurityClassificationCode
- hasSendingTime **max 1** DateTime
- isFromSendingSystem **exactly 1** xsd:string
- isInReplyToMessageID **max 1** UUIDBase
- isToReceivingSystem **exactly 1** xsd:string
- MessageConcept

- RequestContent
- EntityD
- Source
- C2SIMInitializationBody
- DomainMessageBody
- AcknowledgementBody
- OrderBody
- ReportBody
- RequestBody
- ObjectInitializationBody
- SystemAcknowledgementBody
- SystemCommandBody

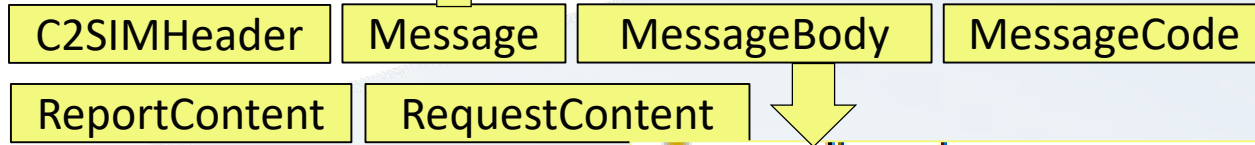
# C2SIM Core LDM: MessageConcept DomainMessageBody

## InitializationConcept



- hasC2SIMHeader **exactly 1** C2SIMHeader
- hasMessageBody **exactly 1** MessageBody
- MessageConcept

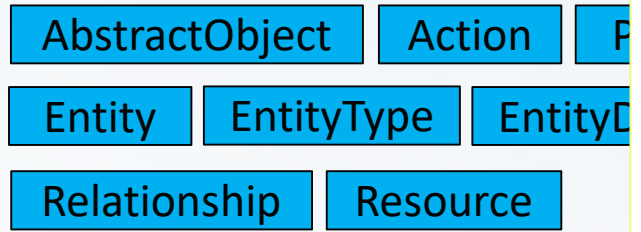
## MessageConcept



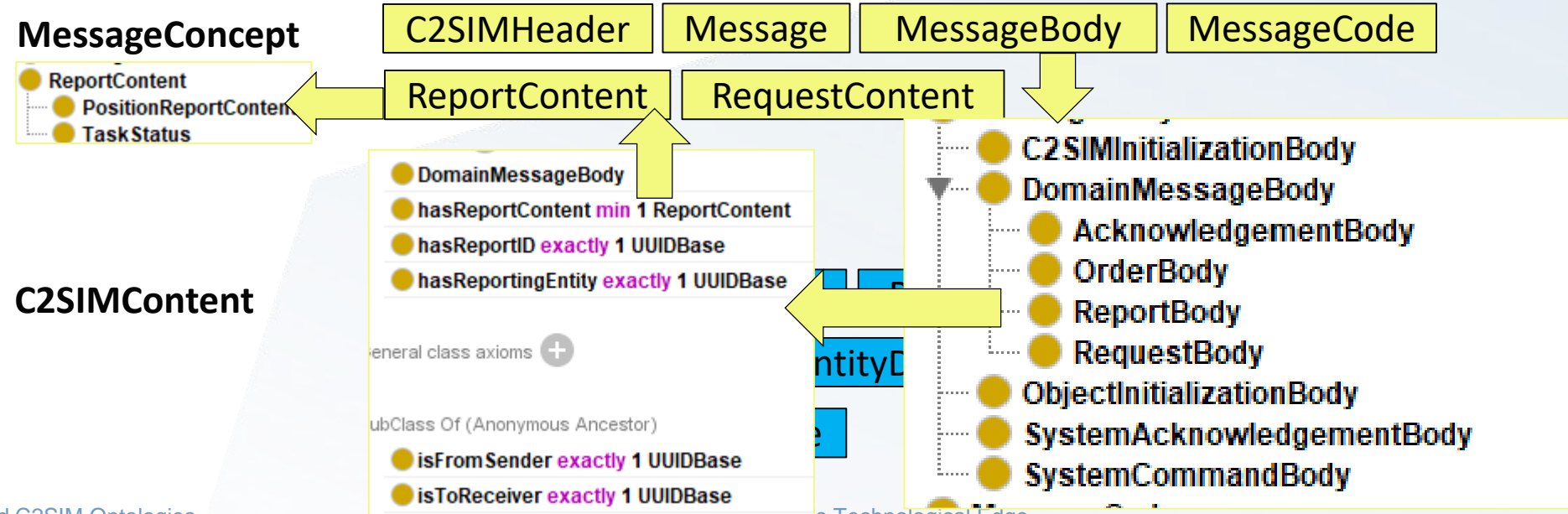
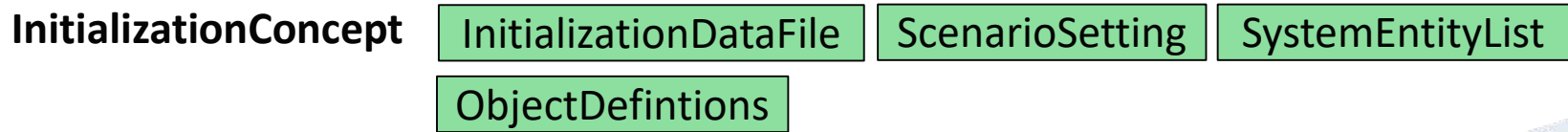
- isFromSender **exactly 1** UUIDBase
- isToReceiver **exactly 1** UUIDBase
- MessageBody

- C2SIMInitializationBody
- DomainMessageBody
- AcknowledgementBody
- OrderBody
- ReportBody
- RequestBody
- ObjectInitializationBody
- SystemAcknowledgementBody
- SystemCommandBody

## C2SIMContent

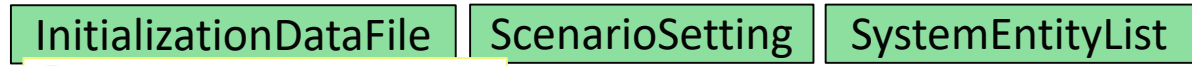


# C2SIM Core LDM: MessageConcept ReportBody



# C2SIM Core LDM: MessageConcept OrderBody

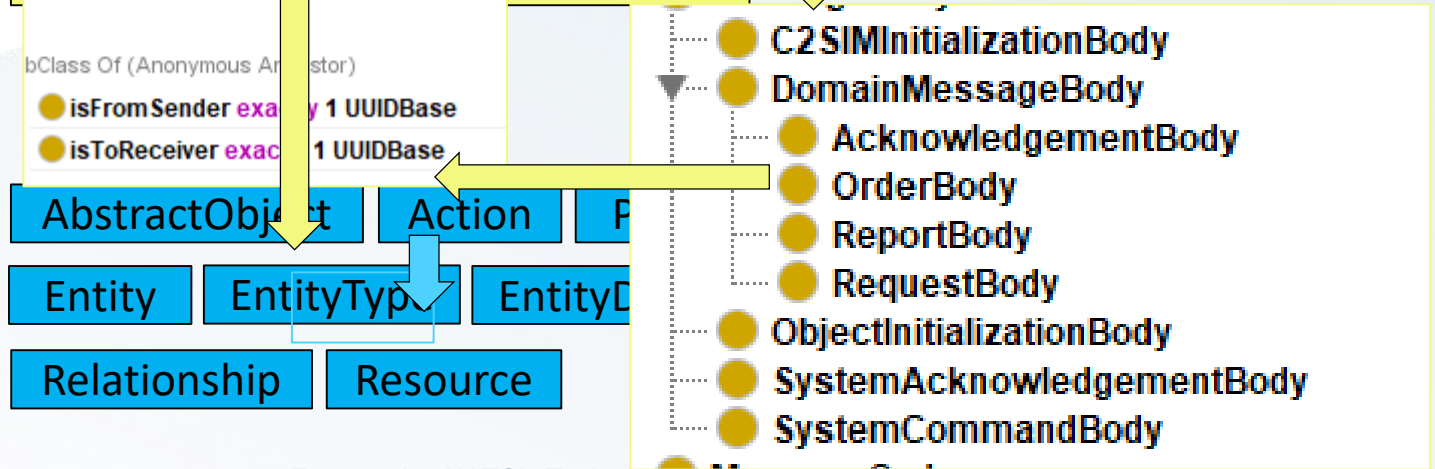
InitializationConcept



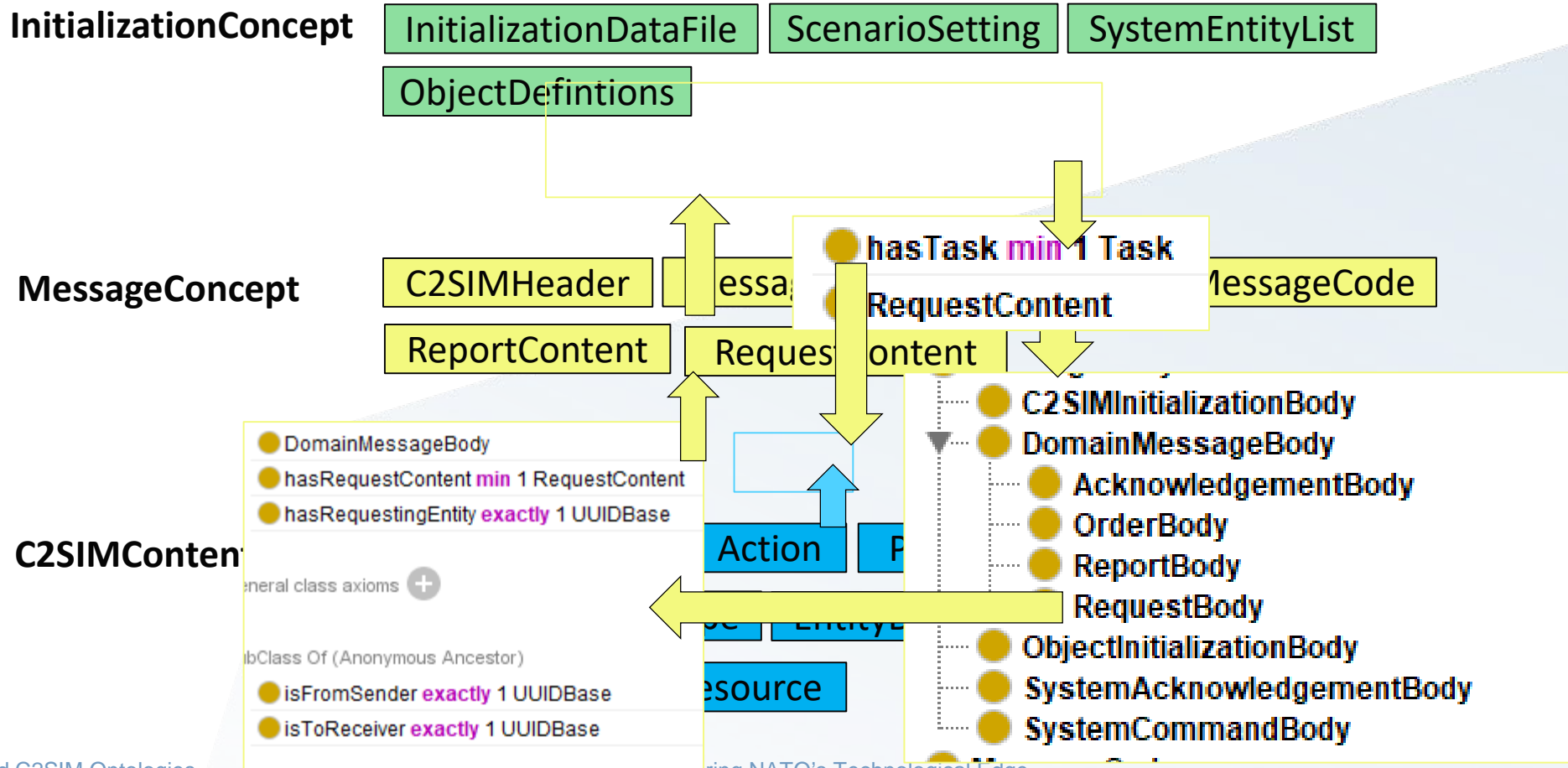
MessageConcept



C2SIMContent



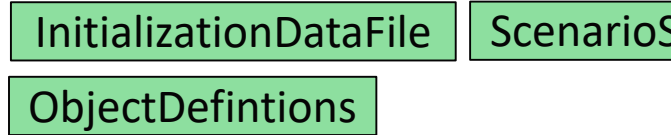
# C2SIM Core LDM: MessageConcept RequestBody



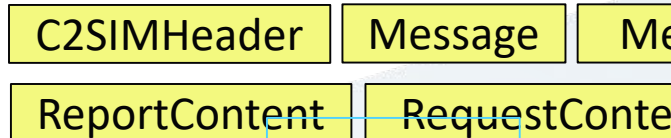


# C2SIM Core LDM: C2SIMContent Task

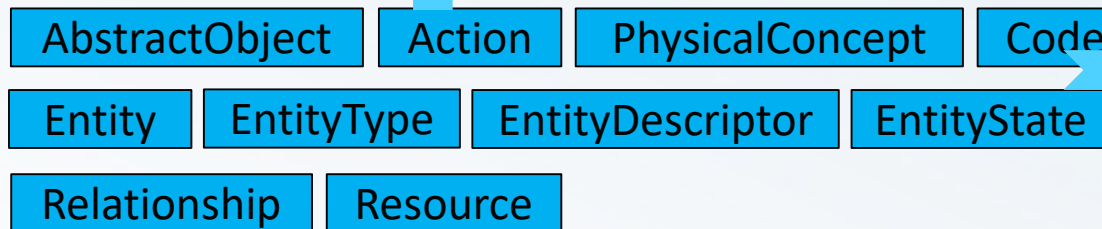
## InitializationConcept



## MessageConcept



## C2SIMContent



- Action
- hasAffectedEntity **min** 0 UUIDBase
- hasDesiredEffectCode **min** 0 DesiredEffectCode
- hasDuration **max** 1 Duration
- hasEndTime **max** 1 TimelInstant
- hasPerformingEntity **exactly** 1 UUIDBase
- hasStartTime **max** 1 TimelInstant
- hasTaskActionCode **exactly** 1 TaskActionCode

General class axioms +

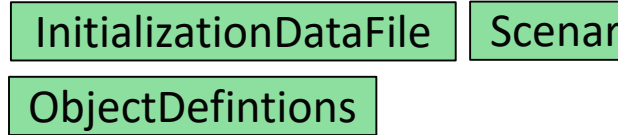
SubClass Of (Anonymous Ancestor)

- hasName **max** 1 xsd:string
- hasUUID **exactly** 1 UUIDBase
- hasMapGraphicID **min** 0 UUIDBase
- hasLocation **min** 0 Location
- hasActionTemporalRelationship **min** 0 Act Te

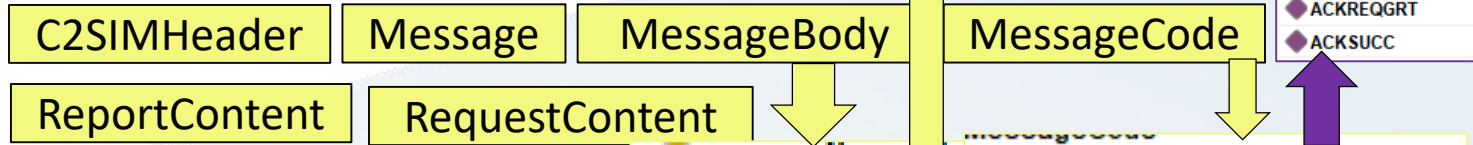
- AssistOtherUnit
- HoldInPlace
- MoveToLocation
- Observe
- OrientToLocation
- ReportPosition
- UseCapability

# C2SIM Core LDM: MessageConcept AcknowledgementBody

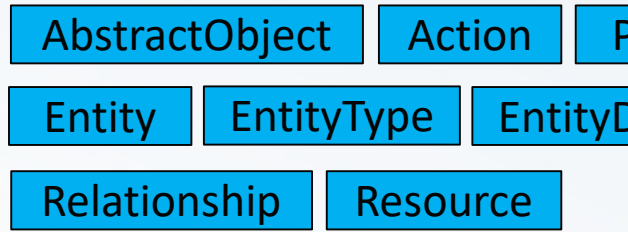
## InitializationConcept



## MessageConcept



## C2SIMContent



DomainMessageBody

- hasAcknowledgeTypeCode exactly 1 AcknowledgeTypeCode

General class axioms +

SubClass Of (Anonymous Ancestor)

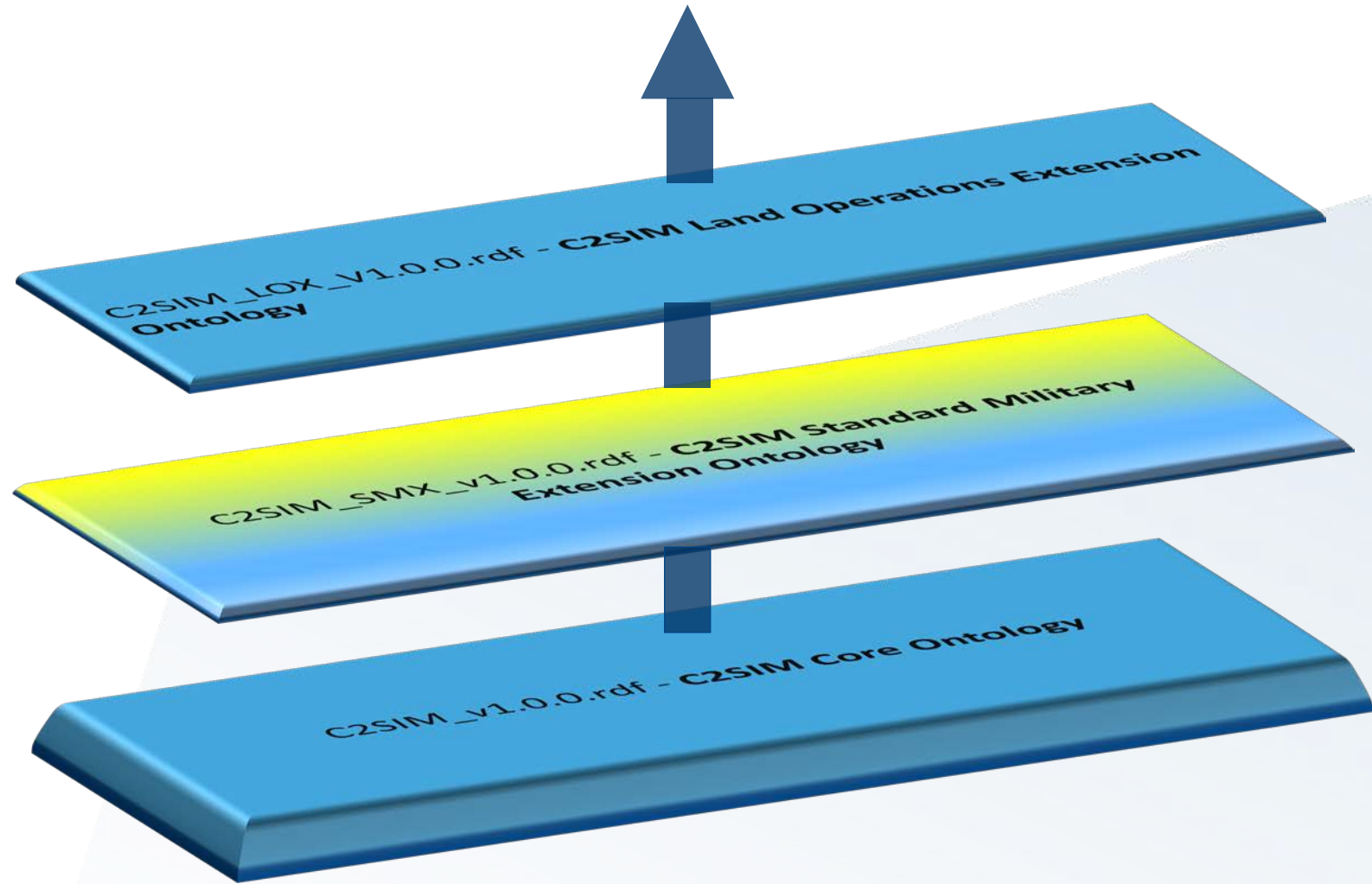
- isFromSender exactly 1 UUIDBase
- isToReceiver exactly 1 UUIDBase

- ACKFAIL
- ACKNOTEXEC
- ACKNOTRECGNZ
- ACKNOTUNDSTD
- ACKRCVD
- ACKREQDEN
- ACKREQGRT
- ACKSUCC

- C2SIMIn...
- Domain...
- Acknow...
- OrderBody
- ReportBody
- RequestBody
- ObjectInitializationBody
- SystemAcknowledgementBody
- SystemCommandBody
- MessageCode

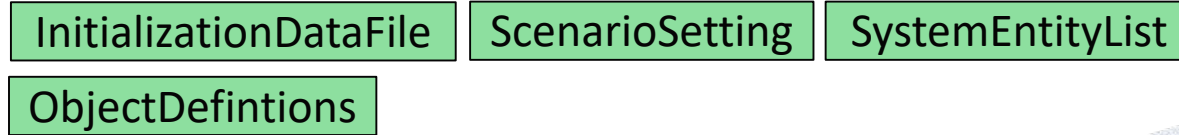
- AcknowledgeTypeCode
- CommunicativeActTypeCode
- SystemCommandTypeCode
- TaskStatusCode

# C2SIM Standard Military Extension

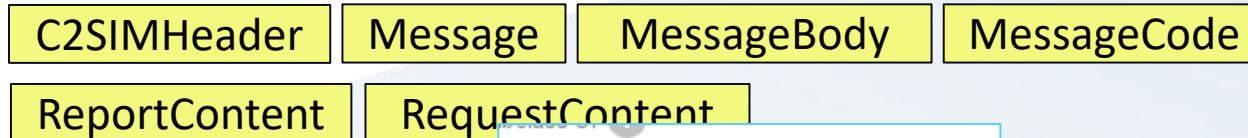


# C2SIM SMX: C2SIMContent Observation

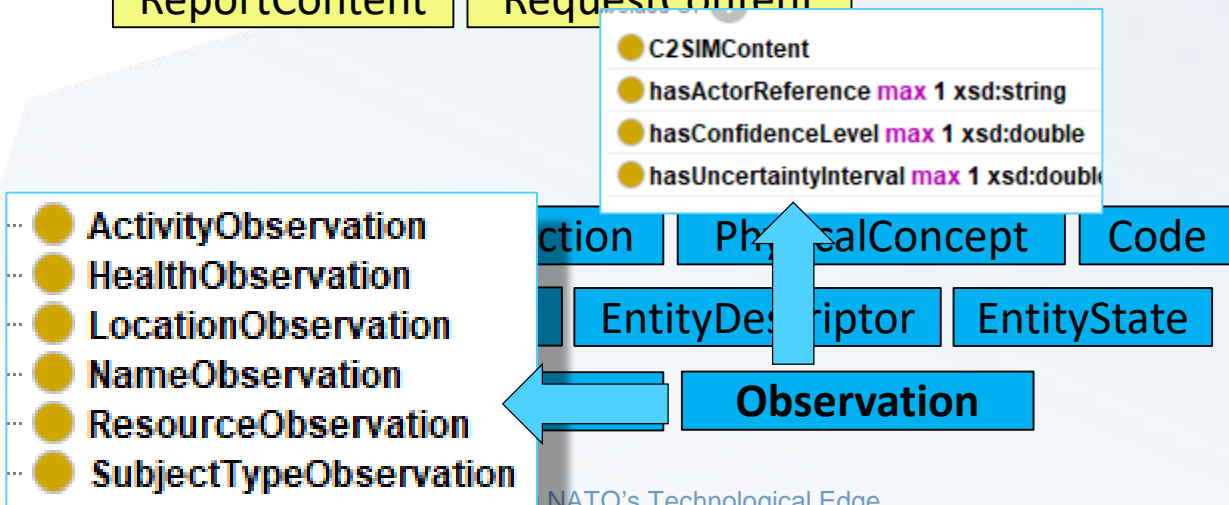
## InitializationConcept



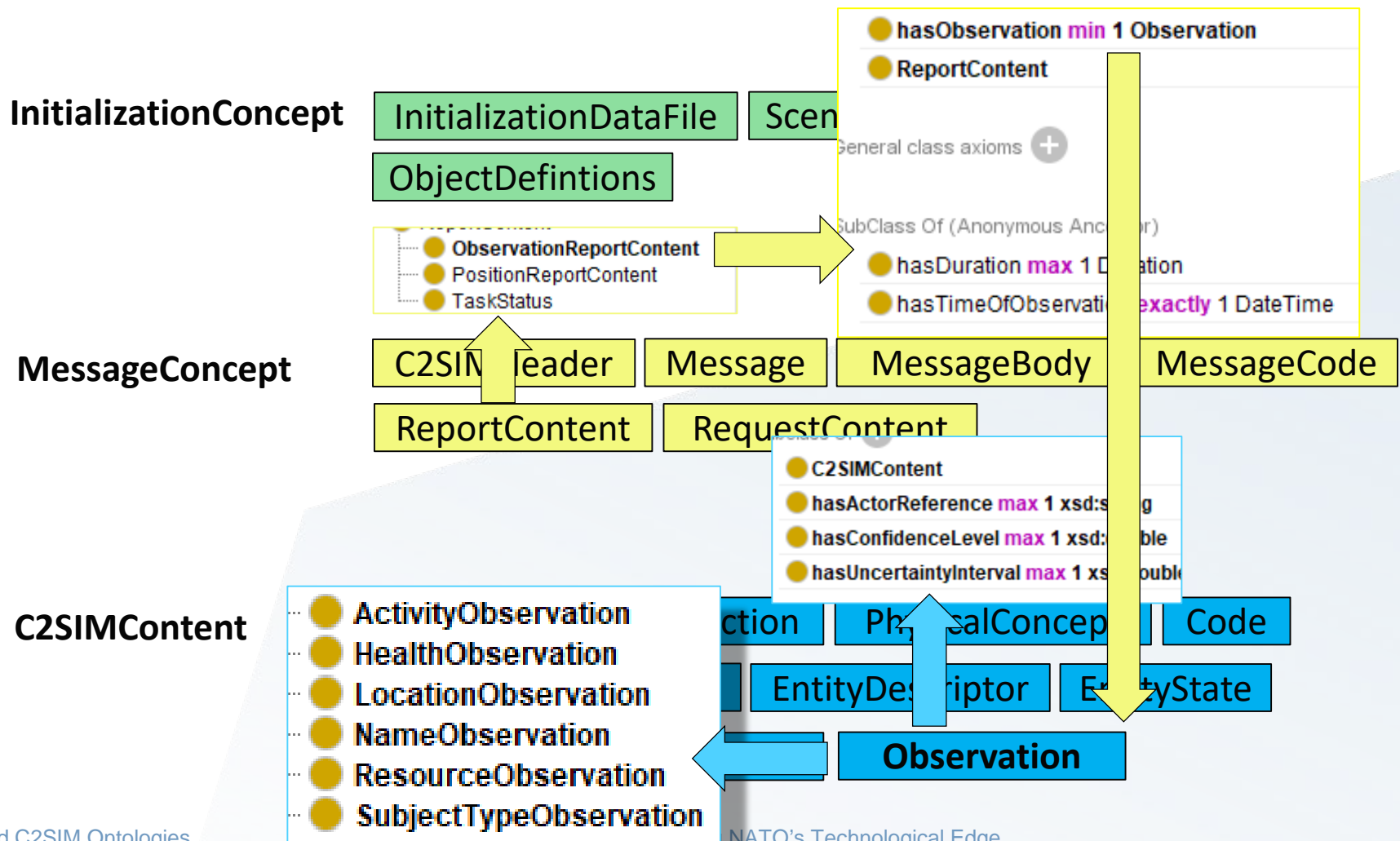
## MessageConcept



## C2SIMContent

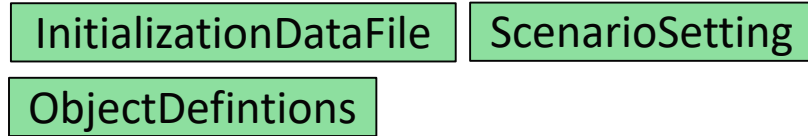


# C2SIM SMX: MessageConcept ReportContent and Observation



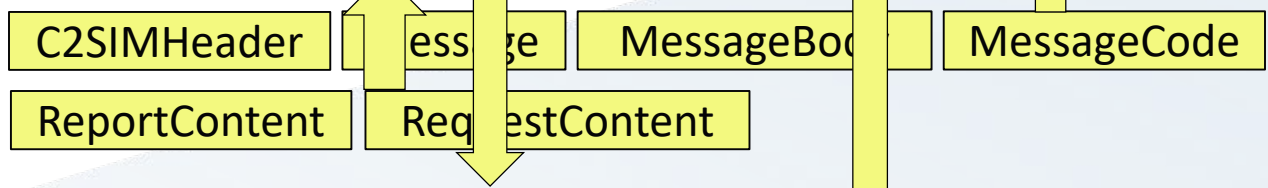
# C2SIM SMX: MessageConcept RequestContent and MIPRequestCategoryCode

## InitializationConcept



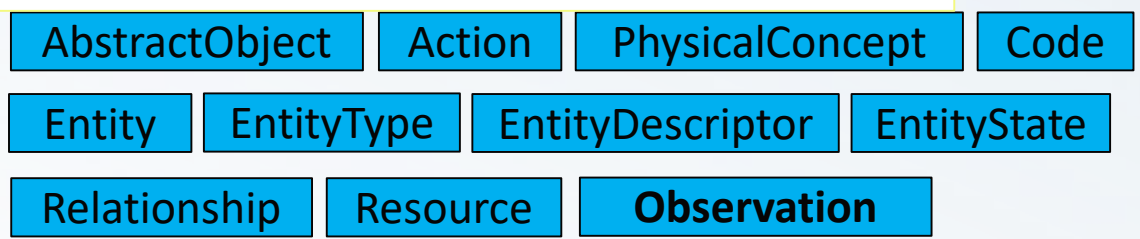
- AcknowledgeTypeCode
- CommunicativeActTypeCode
- MIPRequestCategoryCode
- SystemCommandTypeCode
- TaskStatusCode

## MessageConcept



- hasMIPRequestCategoryCode **exactly 1** MIPRequestCategoryCode
- RequestContent

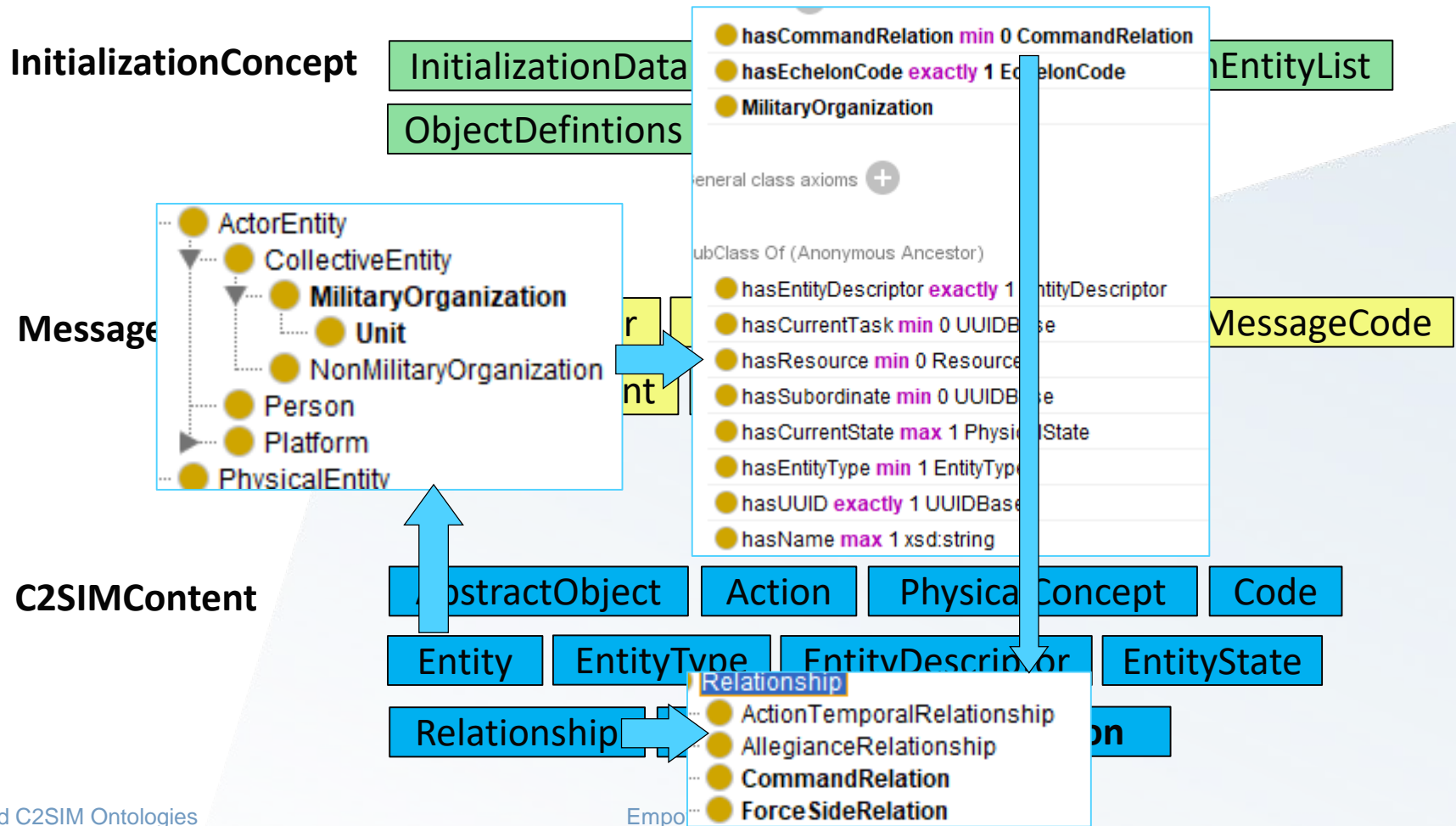
## C2SIMContent



- instances
- ◆ ACTION
  - ◆ ASSOC
  - ◆ CAPAB
  - ◆ HOLDNG
  - ◆ HOSTIL
  - ◆ LOCATN
  - ◆ PRESNC
  - ◆ STATUS
  - ◆ TYPE

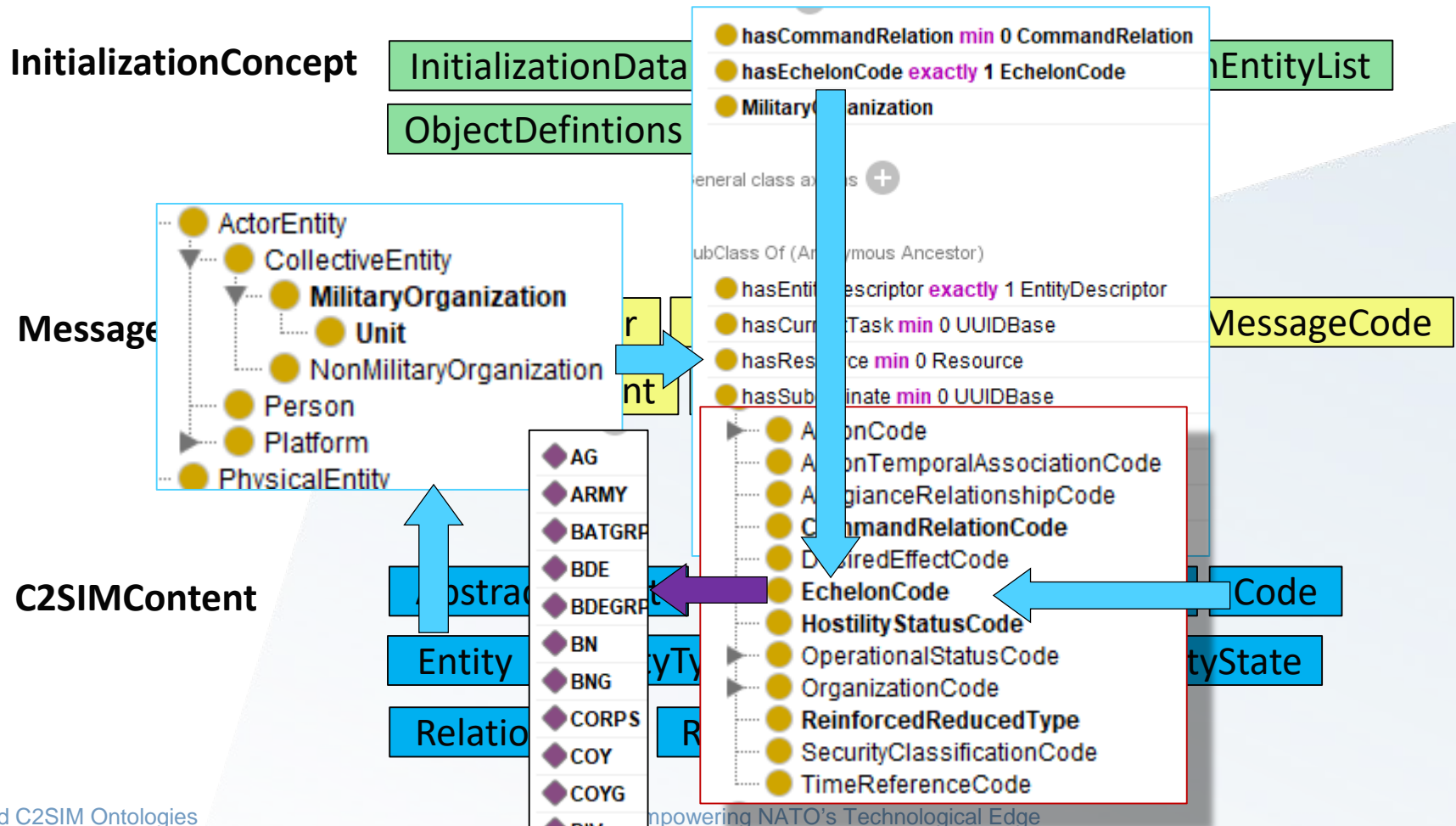


# C2SIM SMX: C2SIMContent Entity and CommandRelation



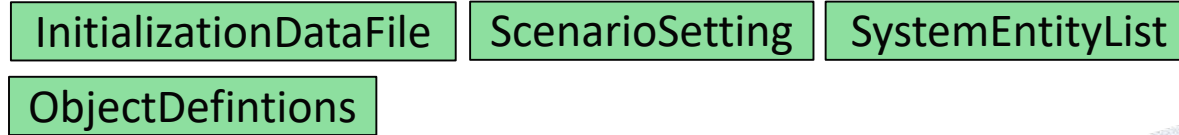


# C2SIM SMX: C2SIMContent Entity and EchelonCode

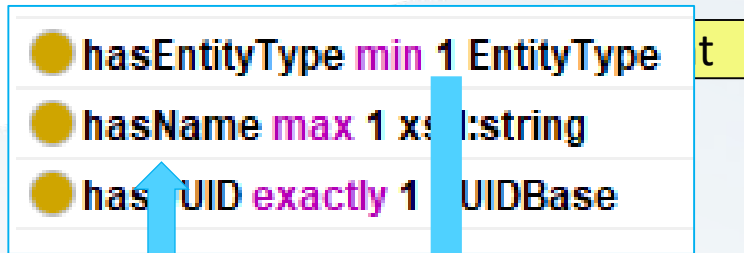


# C2SIM SMX: C2SIMContent Entity and EntityType

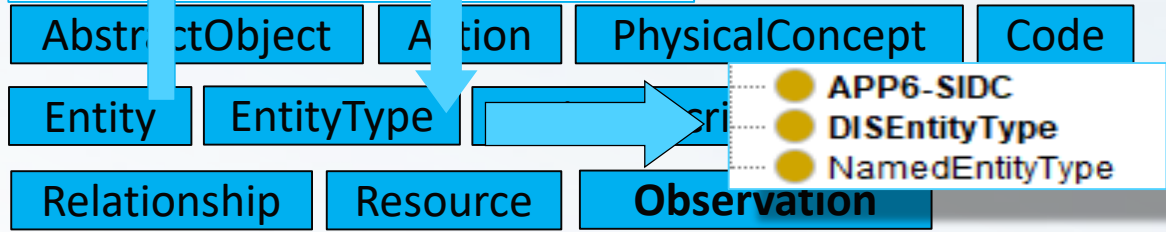
## InitializationConcept



## MessageConcept

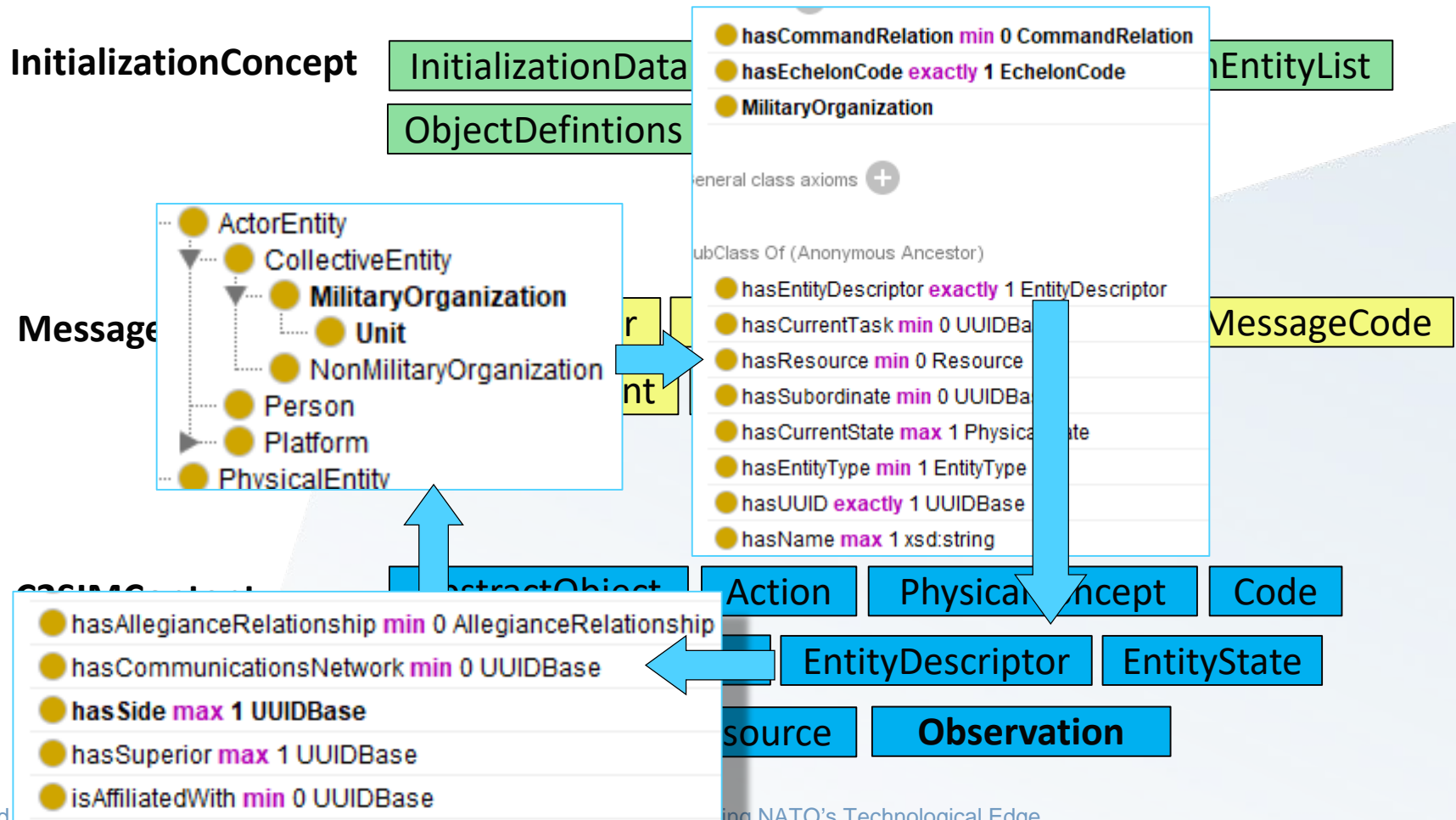


## C2SIMContent



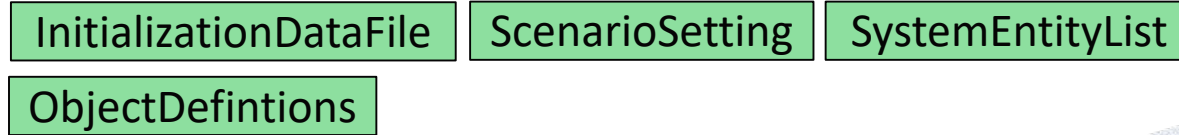
- APP6-SIDC
- DISEntityType
- NamedEntityType

# C2SIM SMX: C2SIMContent Entity and EntityDescriptor

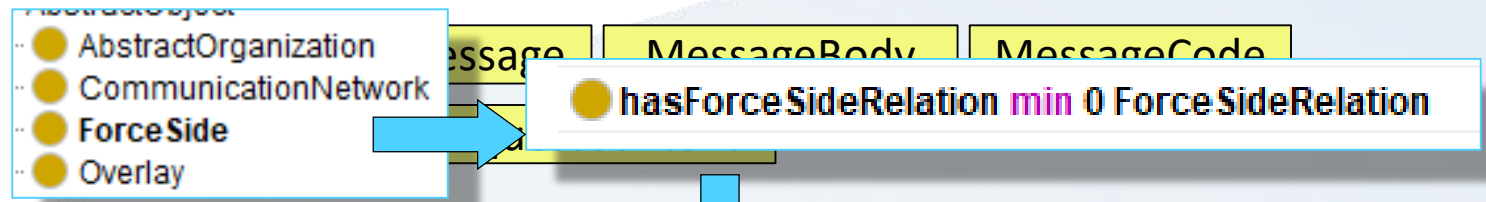


# C2SIM SMX: C2SIMContent AbstractObject and ForceSide

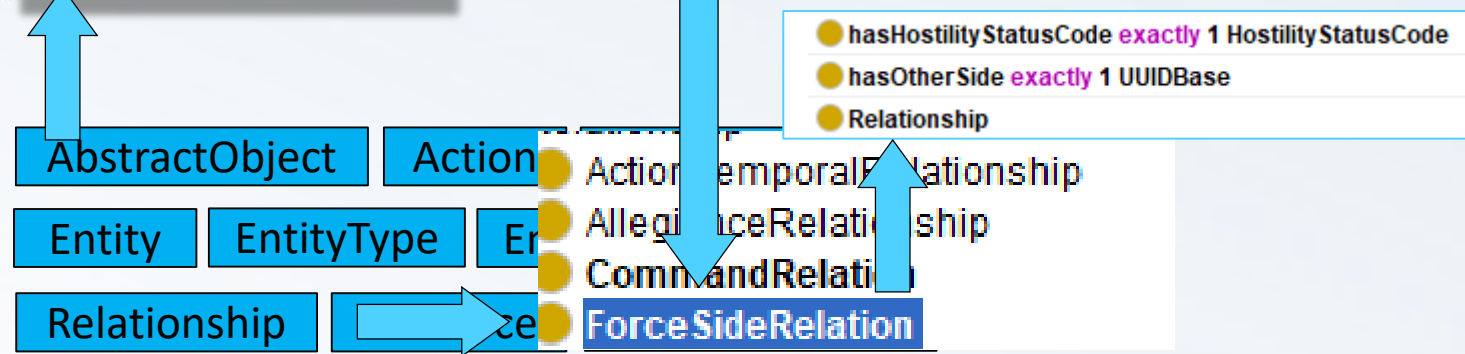
## InitializationConcept



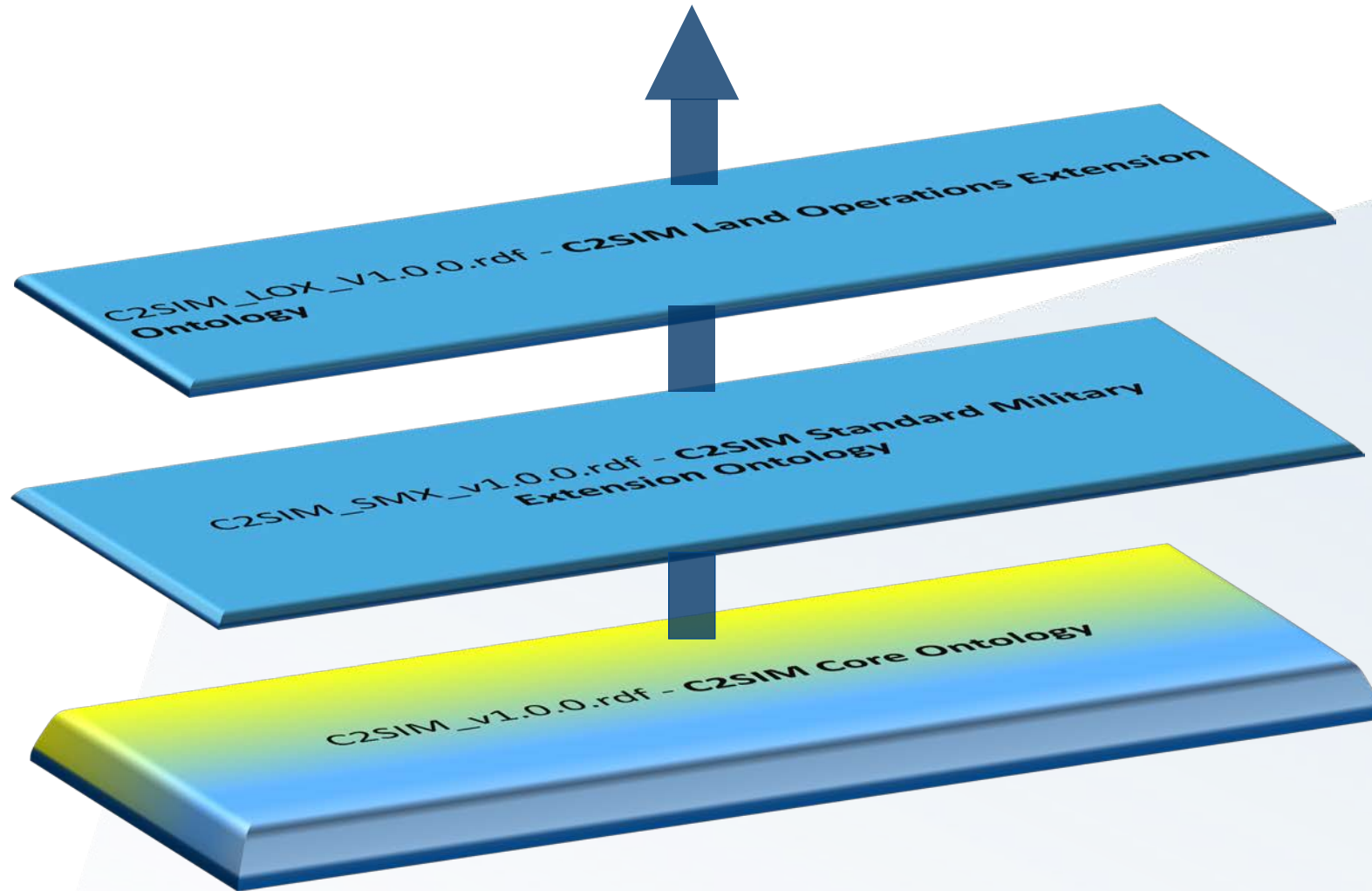
## MessageConcept



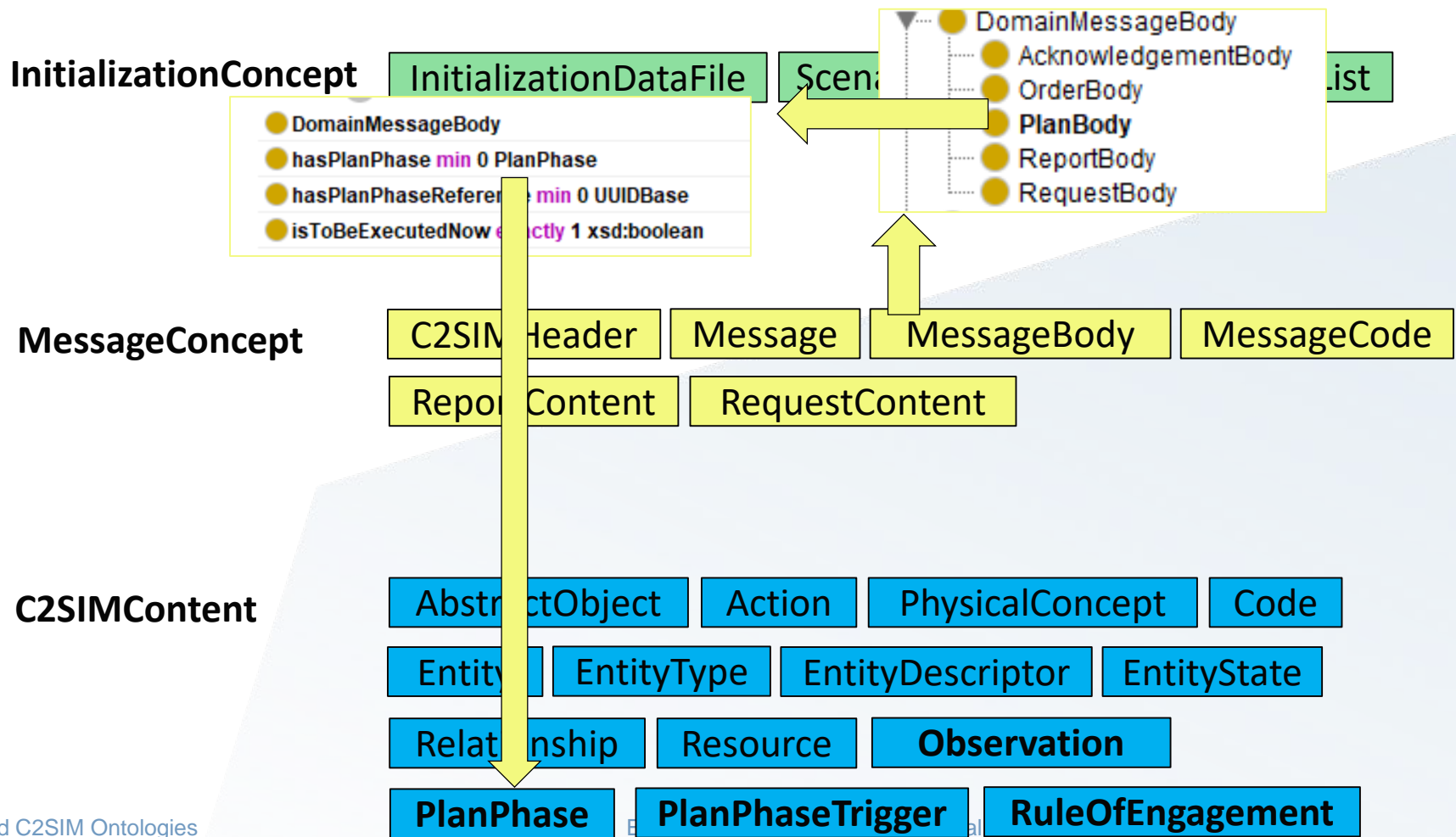
## C2SIMContent



# Land Operation Extension (LOX)



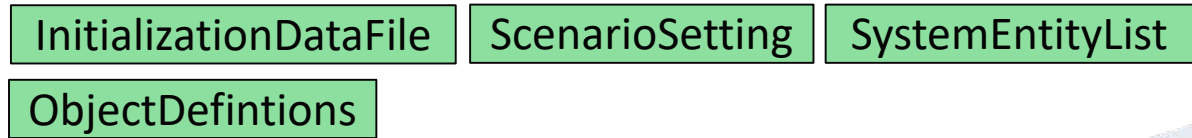
# C2SIM SMX: MessageBody PlanBody



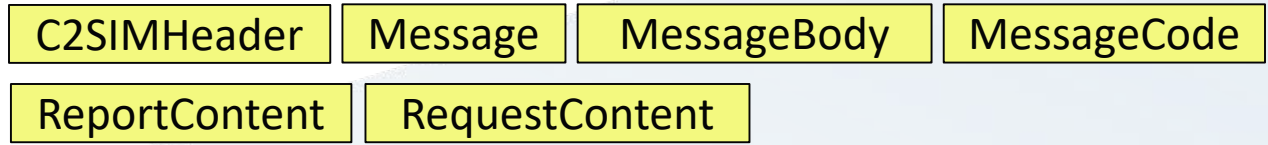


# C2SIM SMX: C2SIMContent PlanPhase and PlanPhaseTrigger

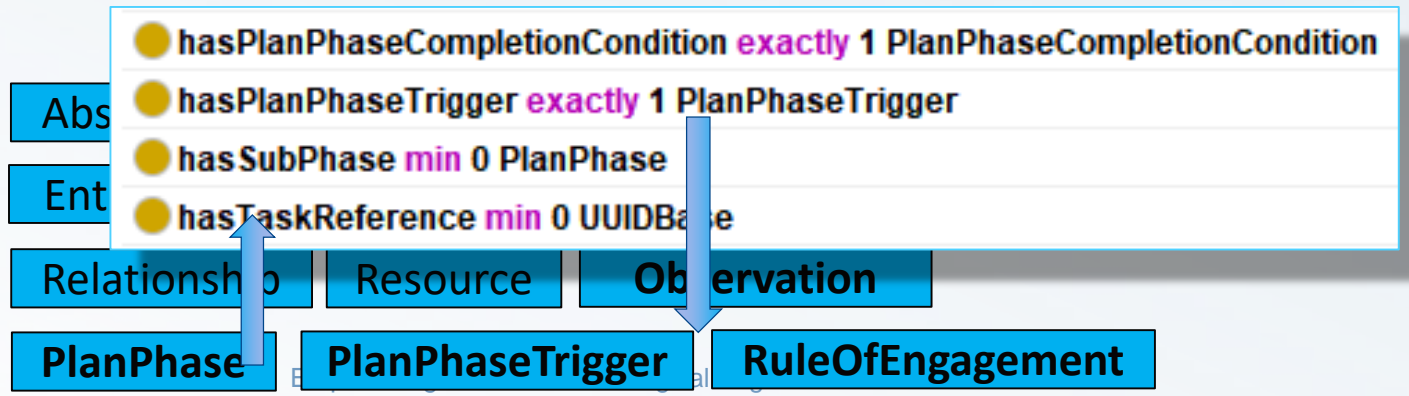
## InitializationConcept



## MessageConcept



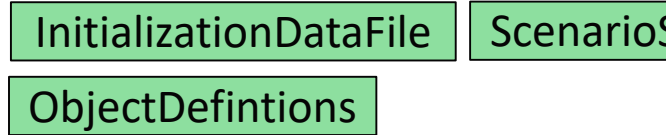
## C2SIMContent



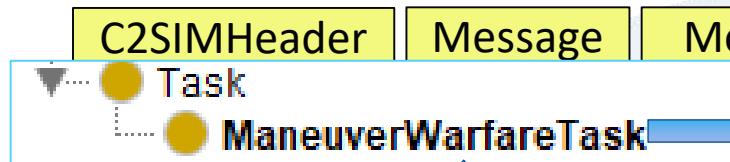


# C2SIM SMX: C2SIMContent Task and Maneuver Warfare Task

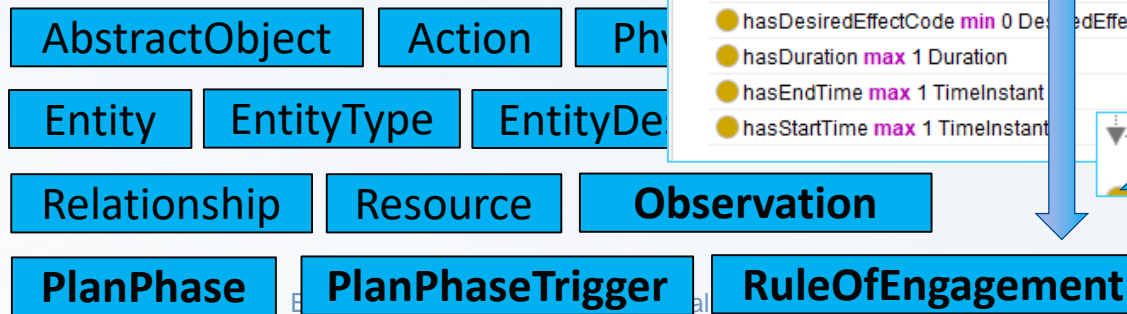
InitializationConcept



MessageConcept



C2SIMContent



SubClass Of +

- hasRuleOfEngagement min 0 RuleOfEngagement
- hasTaskFunctionalRelation min 0 taskFunctionalRelation
- Task

General class axioms +

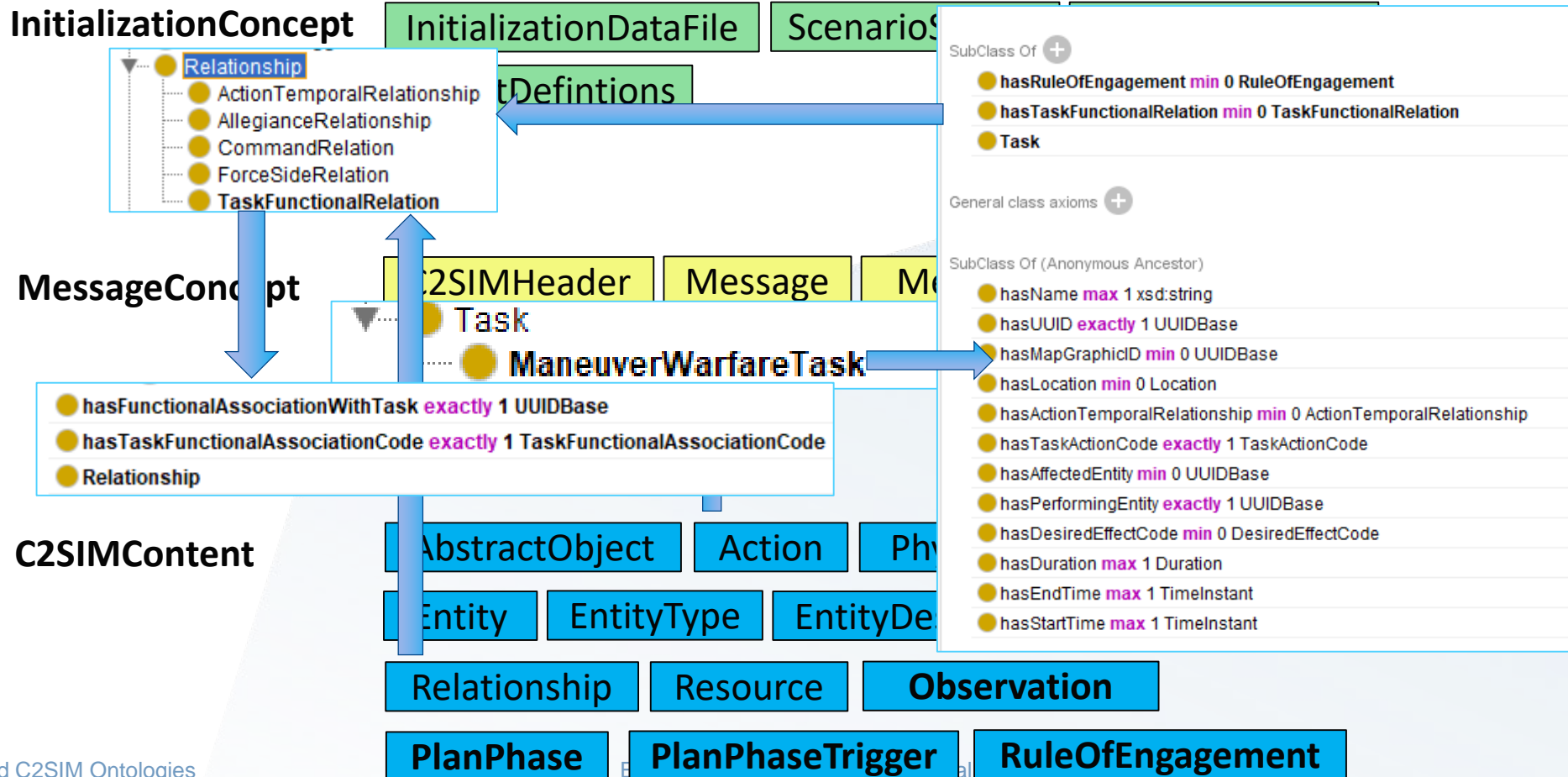
SubClass Of (Anonymous Ancestor)

- hasName max 1 xsd:string
- hasUUID exactly 1 UUIDBase
- hasMapGraphicID min 0 UUIDBase
- hasLocation min 0 Location
- hasActionTemporalRelationship min 0 ActionTemporalRelationship
- hasTaskActionCode exactly 1 TaskActionCode
- hasAffectedEntity min 0 UUIDBase
- hasPerformingEntity exactly 1 UUIDBase
- hasDesiredEffectCode min 0 DesiredEffectCode
- hasDuration max 1 Duration
- hasEndTime max 1 TimeInstant
- hasStartTime max 1 TimeInstant

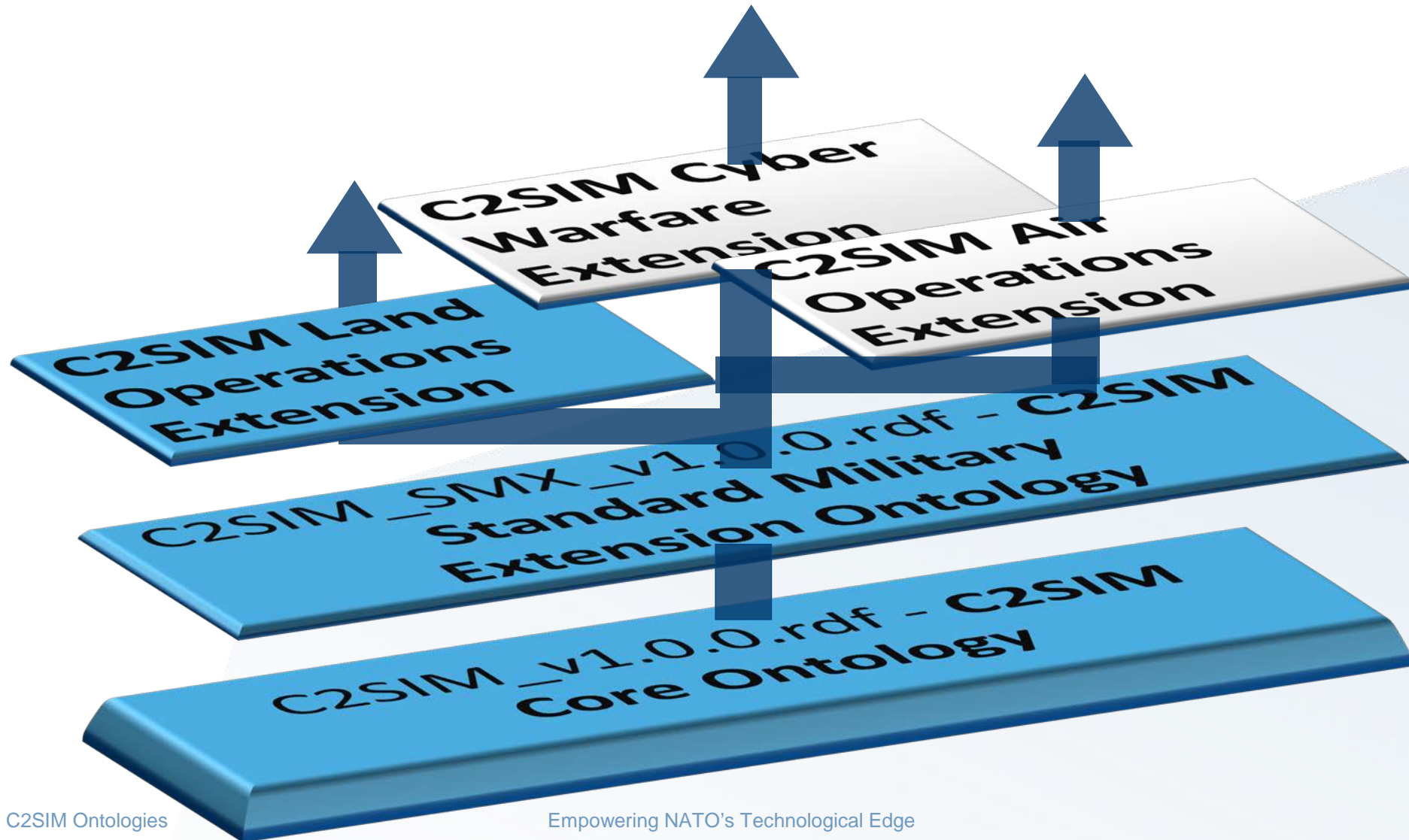
▼ ● RuleOfEngagement

● MipWeaponUseROE

# C2SIM SMX: C2SIMContent Task and ManeuverWarfareTask



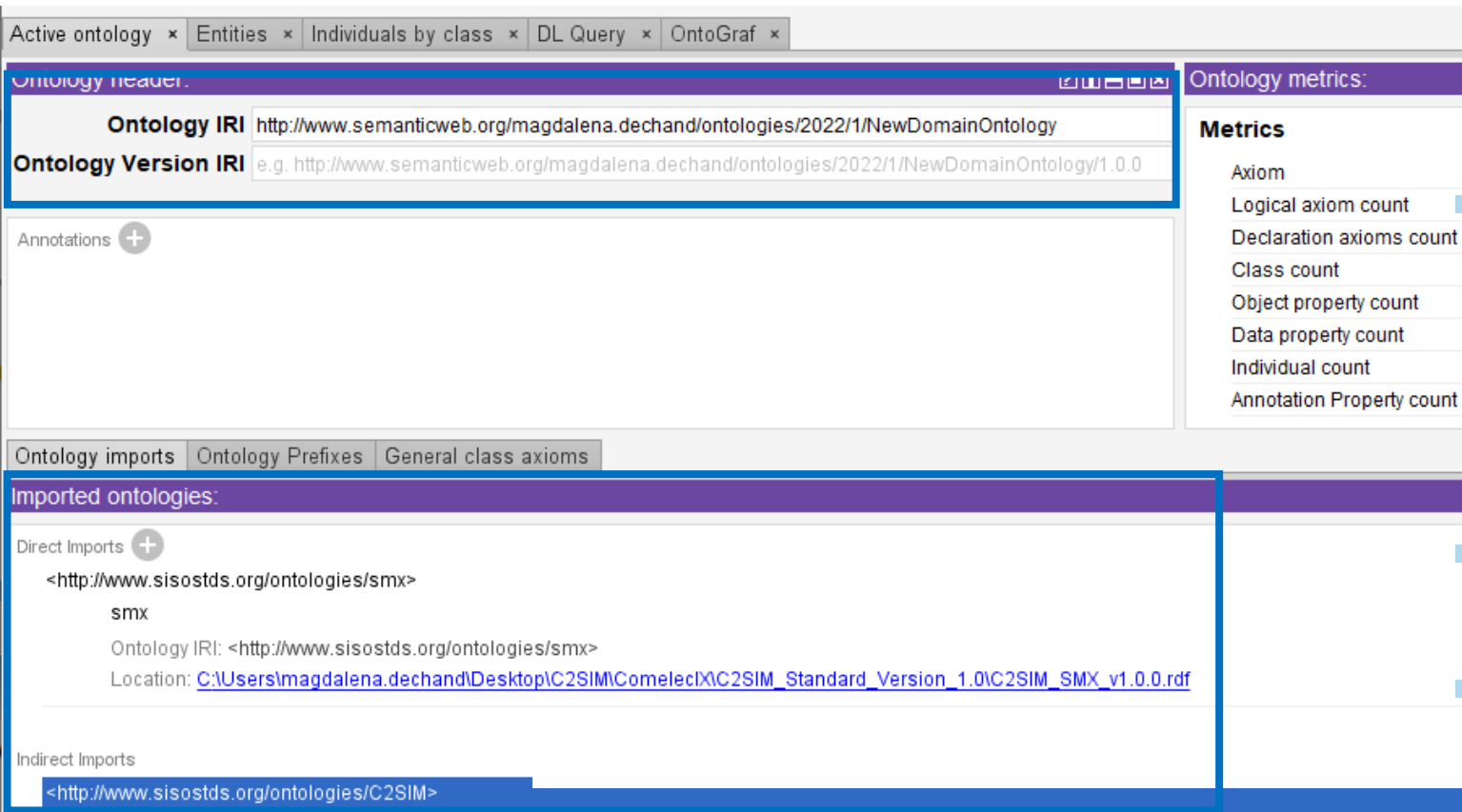
# C2SIM Extension Process



# C2SIM Extension Process Support

- Scenario driven vs. incorporating different standards to C2SIM
- Enable information exchange for initialization or for tasking and reporting
- Add or change concepts and properties to existing C2SIM ontologies
  - Problem Reports
  - Change Requests
- Create new domain extension
  - Join working group
  - Submit your extension to community

# C2SIM Structure NameSpace and Imports



Active ontology x Entities x Individuals by class x DL Query x OntoGraf x

**Ontology header:**

**Ontology IRI** `http://www.semanticweb.org/magdalena.dechand/ontologies/2022/1/NewDomainOntology`

**Ontology Version IRI** e.g. `http://www.semanticweb.org/magdalena.dechand/ontologies/2022/1/NewDomainOntology/1.0.0`

Annotations +

**Ontology metrics:**

**Metrics**

- Axiom
- Logical axiom count
- Declaration axioms count
- Class count
- Object property count
- Data property count
- Individual count
- Annotation Property count

Ontology imports | Ontology Prefixes | General class axioms

**Imported ontologies:**

Direct Imports +

- <<http://www.sisostds.org/ontologies/smx>>
  - smx
  - Ontology IRI: <<http://www.sisostds.org/ontologies/smx>>
  - Location: [C:\Users\magdalena.dechand\Desktop\C2SIM\Comelect\C2SIM\\_Standard\\_Version\\_1.0\C2SIM\\_SMX\\_v1.0.0.rdf](C:\Users\magdalena.dechand\Desktop\C2SIM\Comelect\C2SIM_Standard_Version_1.0\C2SIM_SMX_v1.0.0.rdf)

Indirect Imports

- <<http://www.sisostds.org/ontologies/C2SIM>>

- NameSpace ensures that all newly modelled information will be stored in the extension layer
- Import of ontology layers
- SMX automatically imports Core

# C2SIM Extension Ontology Features

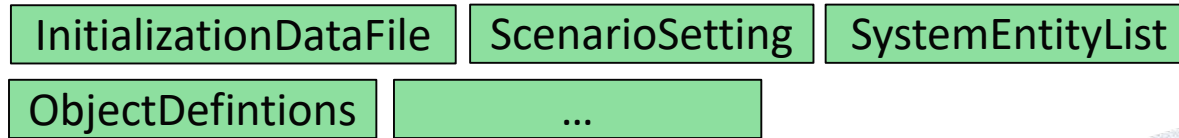
- Add new concepts
  - Subclasses
    - Inherits property restrictions of superclass
    - Specify adding property restrictions
  - Create new individuals/instances as member of a class
- Add property restrictions to already existing classes
- Add data properties to use as restrictions
- Add new datatypes to use for datatype properties
- Add object properties to use as restrictions



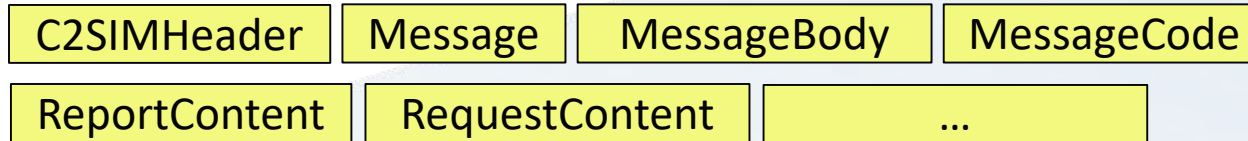
# C2SIM Extension Process

## Add Classes

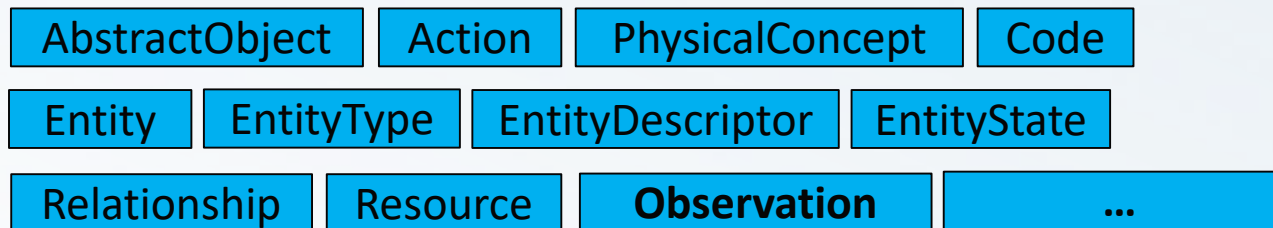
### InitializationConcept



### MessageConcept



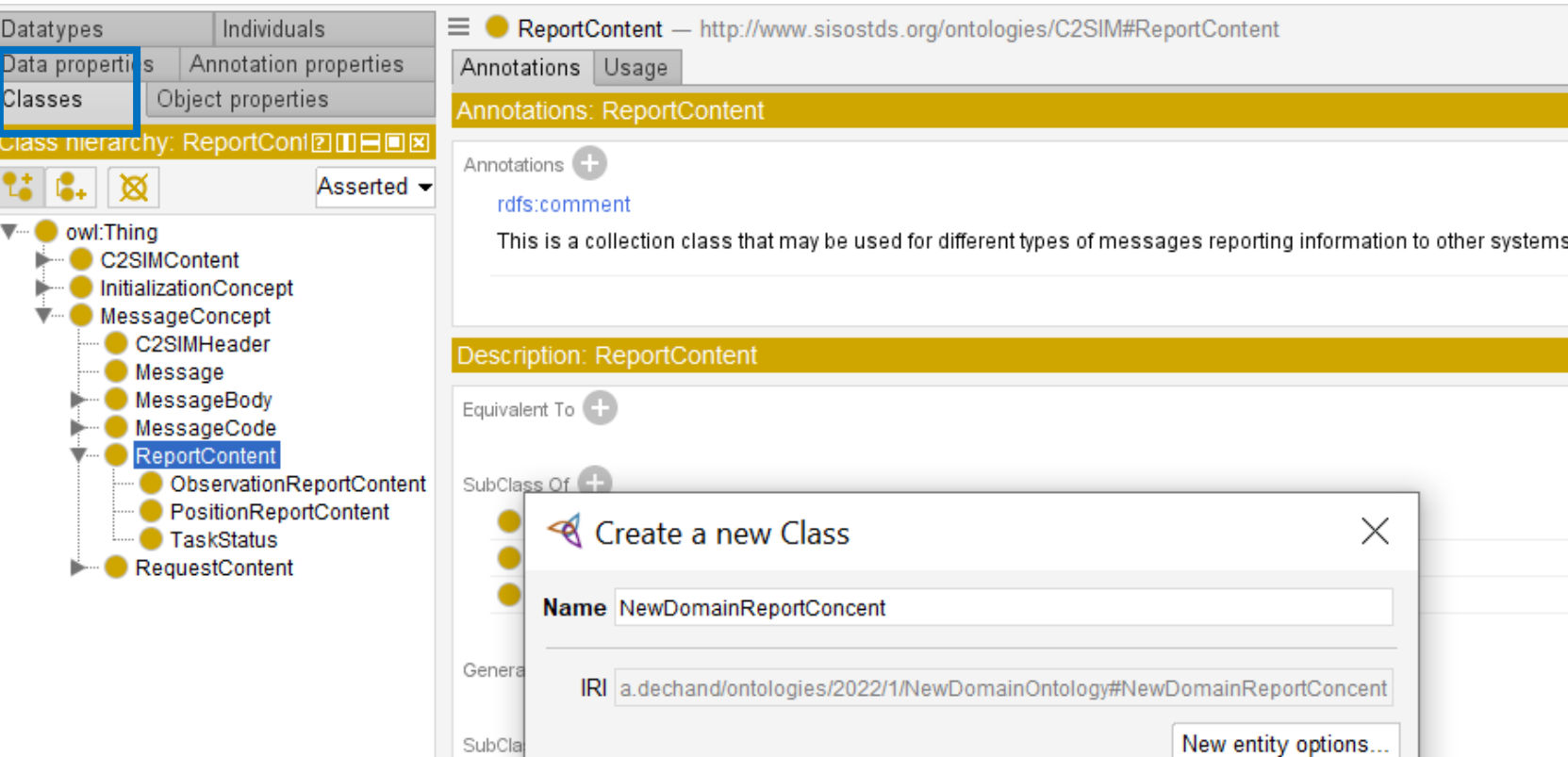
### C2SIMContent





# C2SIM Extension Process

## Add Classes in Protégé



The screenshot shows the Protégé interface for editing an ontology. On the left, the 'Class hierarchy' pane shows a tree structure starting with 'owl:Thing', followed by 'C2SIMContent', 'InitializationConcept', 'MessageConcept', and 'ReportContent'. 'ReportContent' is highlighted in blue. Below it are subclasses: 'ObservationReportContent', 'PositionReportContent', 'TaskStatus', and 'RequestContent'. The main area shows the 'ReportContent' class with its IRI, annotations (including an rdfs:comment), and a description: 'This is a collection class that may be used for different types of messages reporting information to other systems.' A 'Create a new Class' dialog box is open, showing the 'Name' field with 'NewDomainReportConcent' and the 'IRI' field with 'a.dechand/ontologies/2022/1/NewDomainOntology#NewDomainReportConcent'.

- Choose class Level to add subclass
- Choose name for subclass
- Create subclass

# C2SIM Extension Process

## Add Instances

The screenshot shows the Protégé ontology editor interface. On the left is a class hierarchy tree with 'TaskActionCode' selected. The main workspace displays the 'TaskActionCode' class page, including its description, equivalent classes, and subclasses. A 'TaskActionCode' dialog box is open, showing a list of predefined instances such as 'ABK\_HAZ', 'ABORGN', 'ABW', 'Accept', 'ACKFAIL', 'ACKNOTEXEC', 'ACKNOTRECGNZ', 'ACKNOTUNDSTD', and 'ACKRCVD'. A blue box highlights the 'Add' (+) button in this dialog. In the foreground, a 'Create a new Named individual' dialog box is open, with the name 'Attack' entered in the 'Name' field and the IRI 'nticweb.org/magdalena.dechand/ontologies/2022/1/NewDomainOntology#Attack' in the 'IRI' field. The 'Instances' section in the main workspace is also highlighted with a blue box.

- Assign to a class
  - Use predefined list
- Create new Instance

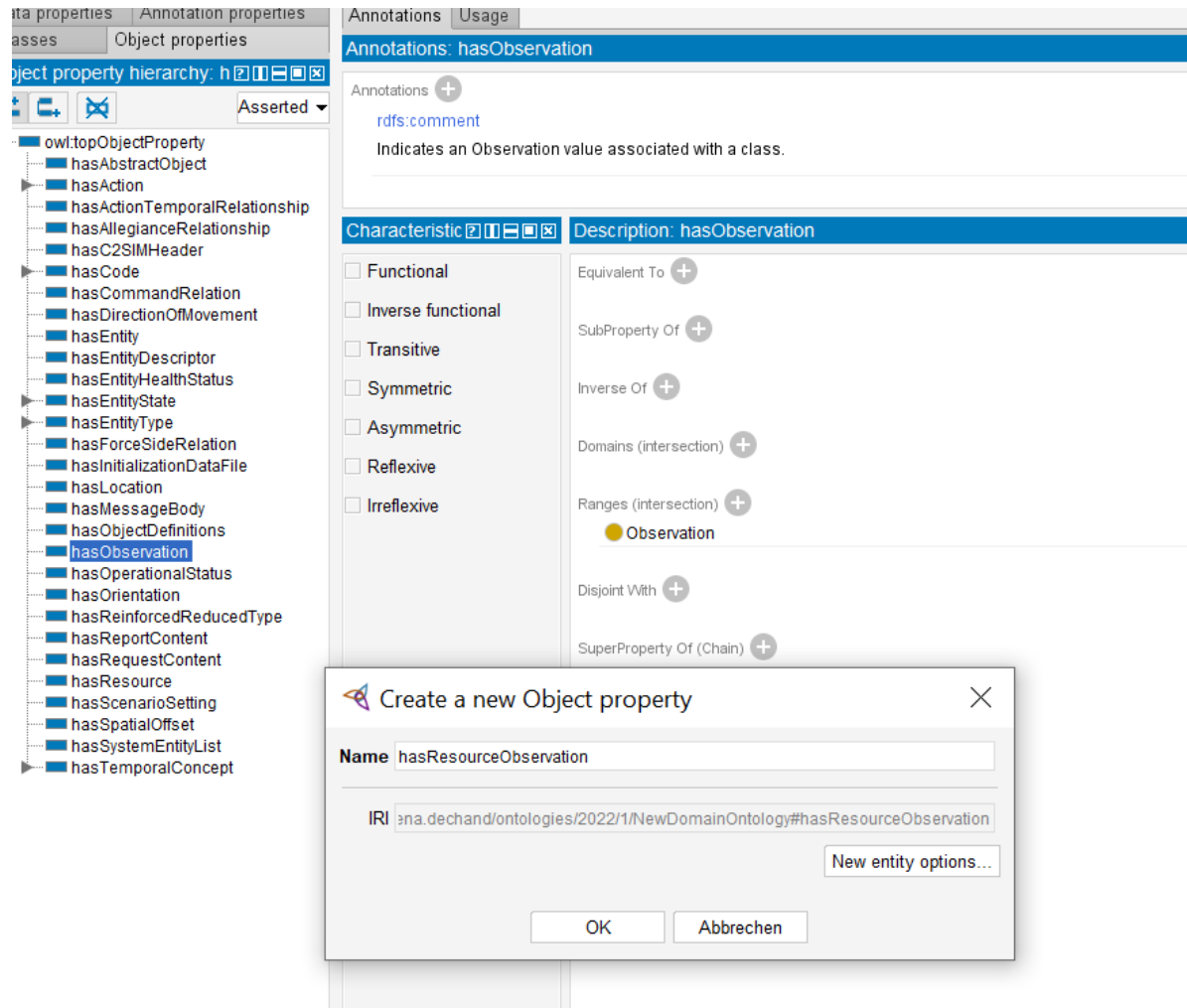
# C2SIM Extension Process

## Add Property Restriction

The screenshot illustrates the process of adding a property restriction in Protege. On the left, a class hierarchy tree shows 'ResourceObservation' selected under 'owl:Thing'. The main workspace displays the 'ResourceObservation' class with its description: 'Observations on resource availability, e.g. fuel, ammunition'. A dialog box titled 'ResourceObservation' is open, showing the 'Class expression editor' tab with the expression: `hasResource min 0 Resource`. A second dialog box, 'Object restriction creator', is also open, showing the 'Restricted property' list with 'hasResource' selected. The 'Restriction type' dropdown is set to 'Min (min cardinality)', and the 'Cardinality' is set to 1. The 'Restriction filler' list on the right includes 'Resource' as a selected option.

# C2SIM Extension Process

## Create Object Property



The screenshot displays a software interface for managing ontologies. On the left, a tree view shows a taxonomy of object properties, including 'hasObservation'. The main window shows the configuration for 'hasObservation', including its description and various characteristics like 'Functional', 'Inverse functional', etc. A dialog box titled 'Create a new Object property' is open, showing the name 'hasResourceObservation' and its IRI.

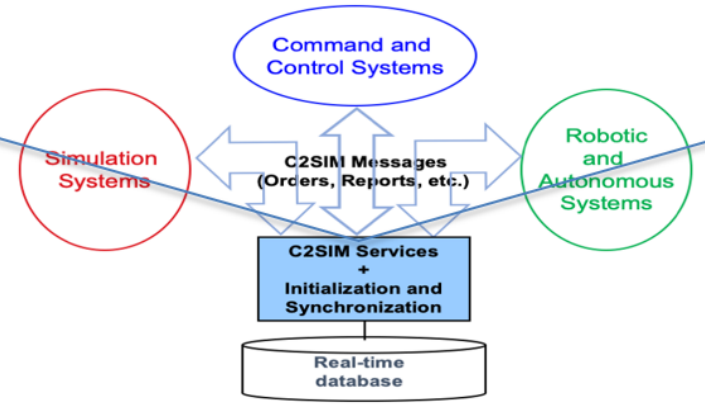
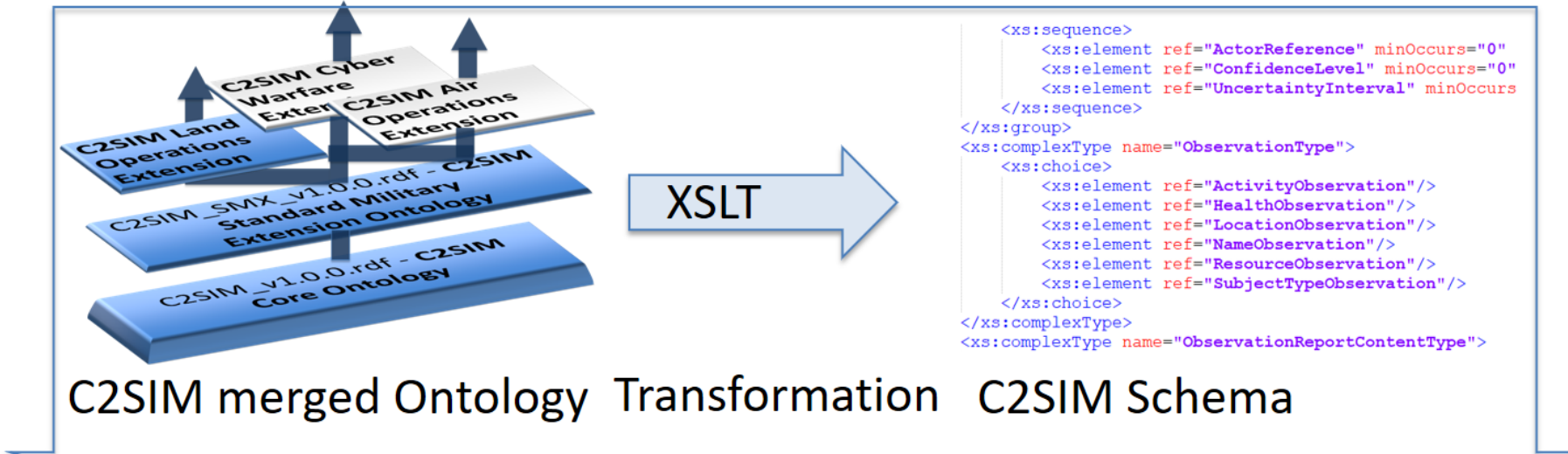
- Properties organized in taxonomy
- Characteristics not used in C2SIM
- Range needed for schema transformation

# C2SIM Extension Process

## Create Data Property and Datatype

The screenshot displays the Protege ontology editor interface. On the left, a tree view shows the hierarchy of data properties under 'owl:topDataProperty', with 'hasQuantity' selected. The main workspace shows the configuration for 'hasQuantity', including its description 'Instances of the class have data identifying a numeric value associated with the quantity for th...', its domain 'xsd:double', and its range 'xsd:double'. A list of available datatypes is shown, with 'UUIDBase' highlighted. Two 'Create a new Datatype' dialog boxes are overlaid on the screen, one in the foreground and one in the background, both showing fields for 'Name' and 'IRI'.

# C2SIM Transformation Process for Information Exchange



Blais et al., 2019



# C2SIM\_SMX\_LOX\_v1.0.0.xsd

## Schema

```

<xs:element name="NameObservation" type="NameObservationType"/>
<xs:group name="ObservationGroup">
  <xs:annotation>
    <xs:documentation>This is an observation of the state of something in the world; generally an actor, but possibly anything that is an actor.
    The subclasses defined here are sufficient to create a report with Size, Activity, Location, Unit Identification, Time, and Equipment, or some subset of these.
    </xs:documentation>
    <xs:documentation>http://www.sisostds.org/ontologies/smx#Observation</xs:documentation>
  </xs:annotation>
  <xs:sequence>
    <xs:element ref="ActorReference" minOccurs="0" maxOccurs="1"/>
    <xs:element ref="ConfidenceLevel" minOccurs="0" maxOccurs="1"/>
    <xs:element ref="UncertaintyInterval" minOccurs="0" maxOccurs="1"/>
  </xs:sequence>
</xs:group>
<xs:complexType name="ObservationType">
  <xs:choice>
    <xs:element ref="ActivityObservation"/>
    <xs:element ref="HealthObservation"/>
    <xs:element ref="LocationObservation"/>
    <xs:element ref="NameObservation"/>
    <xs:element ref="ResourceObservation"/>
    <xs:element ref="SubjectTypeObservation"/>
  </xs:choice>
</xs:complexType>
<xs:complexType name="ObservationReportContentType">
  <xs:annotation>
    <xs:documentation>This report contains an observation of some aspect of a subject--not necessarily including the location, health, or activity.
    Multiple observations all refer to the same observed actor.</xs:documentation>
    <xs:documentation>http://www.sisostds.org/ontologies/smx#ObservationReportContent</xs:documentation>
  </xs:annotation>
  <xs:sequence>
    <xs:group ref="ReportContentGroup"/>
    <xs:element ref="Observation" minOccurs="1" maxOccurs="unbounded"/>
  </xs:sequence>

```



# XML Messages according to C2SIM Schema

```

<MessageBody>
  <DomainMessageBody>
    <OrderBody>
      <FromSender>00000000-0001-0037-0000-000000000000</FromSender>
      <ToReceiver>00000000-0001-0342-0000-000000000000</ToReceiver>
      <IssuedTime>
        <IsoDateTime>2020-12-08T09:26:31Z</IsoDateTime>
      </IssuedTime>
      <OrderID>311dd7fc-73af-4d1a-8351-7bf012cb7f27</OrderID>
      <Task>
        <ManeuverWarfareTask>
          <Location>
            <GeodeticCoordinate>
              <Latitude>50.99114</Latitude>
              <Longitude>11.98973</Longitude>
            </GeodeticCoordinate>
          </Location>
          <Location>
            <GeodeticCoordinate>
              <Latitude>51.058514</Latitude>
              <Longitude>12.143538</Longitude>
            </GeodeticCoordinate>
          </Location>
          <UUID>6418304f-c239-4ed2-ab24-30127180befb</UUID>
          <PerformingEntity>00000000-0001-0342-0000-000000000000</Perfor
          <TaskActionCode>ATTACK</TaskActionCode>
        </ManeuverWarfareTask>
      </Task>
    </OrderBody>
  </DomainMessageBody>

```

**C2SIM- Core**

**LOX**

**C2SIM- Core**

```

<ReportContent>
  <ObservationReportContent>
    <TimeOfObservation>
      <DateTime>
        <IsoDateTime>2020-09-11T08:00:00Z</IsoDateTime>
      </DateTime>
    </TimeOfObservation>
    <Observation>
      <LocationObservation>
        <Location>
          <GeodeticCoordinate>
            <AltitudeAGL>0.0</AltitudeAGL>
            <Latitude>50.869267</Latitude>
            <Longitude>11.890426</Longitude>
          </GeodeticCoordinate>
        </Location>
      </LocationObservation>
    </Observation>
  </ObservationReportContent>

```

**C2SIM Core**

**SMX**

**SMX**

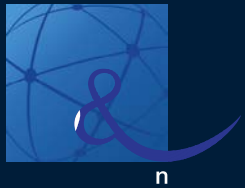
**C2SIM Core**

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- Biagini, M., Corona, F., Wolski, M., & Schade, U. (2017). Conceptual Scenario Supporting Extension of C2SIM to Autonomous Systems. *22nd ICCRTS*. Los Angeles, CA: CCRP.
- Blais, C., Gautreau, B., Schade, U., Sikorski, L., Wolski, M., & Singapogu, S. (2019). Transformation Process for Generating an Extensible Markup Language (XML) Schema from a Formal Ontology for Practical Application in C2SIM Implementations. *2019 Winter Simulation Innovation Workshop*. Orlando, FL: SISO.
- Blais, C., Reece, D., & Singapogu, S. (2019). From Information Description to Information Understanding: The Role of Ontology in Emerging SISO Standards. *2019 Winter Simulation Innovation Workshop*. Orlando, FL: SISOHeffner, K., &
- Blais, C., Dechand, M., Dembach, M. & Singapogu, S. (2021). The Use of Reasoning with the Command and Control System to Simulation System Interoperation (C2SIM) Standard. *2021 Virtual Simulation Innovation Workshop (SIW)*
- Dechand, M., Sikorski, L., Trautwein, I., Gautreau, B., Bouvier, E., & Khimeche, L. (2019). Development of an Air Operation eXtension with the (future) C2SIM standard. *NATO Modelling and Simulation Group Symposium*. Wien.
- Pullen, J. M., Corner, D., Blais, C., Reece, D., Ruth, J., & Singapogu, S. (2019). Command and Control System to Simulation System Interoperation: Development of the C2SIM Standard. *Winter Simulation Innovation Workshop*. Orlando, FL,: SISO
- Protégé Ontology Tool: <https://protege.stanford.edu/>
- C2SIM Products: <https://www.sisostds.org/Default.aspx?tabid=105&EntryId=51847>



NORTH ATLANTIC TREATY ORGANIZATION  
SCIENCE & TECHNOLOGY ORGANIZATION



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WEB [www.sto.nato.int](http://www.sto.nato.int)

The screenshot shows the NATO STO website homepage. At the top, there is a navigation bar with the NATO OTAN logo, the text "NORTH ATLANTIC TREATY ORGANIZATION SCIENCE AND TECHNOLOGY ORGANIZATION", and the S&T organization logo. To the right of the navigation bar are social media icons for YouTube, Facebook, LinkedIn, and Twitter, along with a "Sign In" link. Below the navigation bar are menu items: ORGANIZATION, NEWS, PROGRAMME, ACTIVITIES, PUBLICATIONS, and CONTACT. The main content area features a "NEWSROOM" section with a large featured article titled "2022 HIGHLIGHTS" from the "SCIENCE AND TECHNOLOGY ORGANIZATION". The article image shows a person's profile with digital data overlaid. To the right of the featured article are two smaller news items: "NATO STO hosts wargame on Space Deterrence ..." and "2023 COLLABORATIVE Programme of Work Report ...".