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Systems Engineering & Formulation Division

Mission Ontology

Integrated Model-Centric Engineering



National Aeronautics and Space Administration

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1 Introduction

The Mission Ontology defines concepts and properties for describing missions in terms of their objectives, their constituent components, the functions those components perform, and the requirements that specify them.

2 Imported Ontologies

- <http://imce.jpl.nasa.gov/foundation/base/base>

3 Namespaces

Metrology <http://imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/Metrology#>

Metrology-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/Metrology#>

Metrology-metamodel <http://imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/Metrology-metamodel#>

Metrology-metamodel-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/Metrology-metamodel#>

PrimitiveTypes <http://imce.jpl.nasa.gov/www.omg.org/spec/PrimitiveTypes/20110701/PrimitiveTypes#>

PrimitiveTypes-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/PrimitiveTypes/20110701/PrimitiveTypes#>

PrimitiveTypes-metamodel <http://imce.jpl.nasa.gov/www.omg.org/spec/PrimitiveTypes/20110701/PrimitiveTypes-metamodel#>

PrimitiveTypes-metamodel-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/PrimitiveTypes/20110701/PrimitiveTypes-metamodel#>

QUDV <http://imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/QUDV#>

QUDV-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/QUDV#>

QUDV-metamodel <http://imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/QUDV-metamodel#>

QUDV-metamodel-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/QUDV-metamodel#>

StandardProfileL2 <http://imce.jpl.nasa.gov/www.omg.org/spec/UML/20110701/StandardProfileL2#>

StandardProfileL2-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/UML/20110701/StandardProfileL2#>

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SysML <http://imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/SysML#>

SysML-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/www.omg.org/spec/SysML/20140311/SysML#>

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UML <http://imce.jpl.nasa.gov/www.omg.org/spec/UML/20110701/UML#>

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analysis <http://imce.jpl.nasa.gov/foundation/analysis/analysis#>

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base <http://imce.jpl.nasa.gov/foundation/base/base#>

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behavior-view-backbone <http://imce.jpl.nasa.gov/backbone/imce.jpl.nasa.gov/foundation/behavior/behavior-view#>

data-view <http://www.w3.org/2003/g/data-view#>

data-view-backbone <http://imce.jpl.nasa.gov/backbone/www.w3.org/2003/g/data-view#>

dc <http://purl.org/dc/elements/1.1/>

dc-backbone <http://imce.jpl.nasa.gov/backbone/purl.org/dc/elements/1.1#>

mars-2020 <http://imce.jpl.nasa.gov/application/mars-2020/mars-2020#>

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owl2-mof2 <http://imce.jpl.nasa.gov/foundation/owl2-mof2/owl2-mof2#>

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xsd <http://www.w3.org/2001/XMLSchema#>

xsd-backbone <http://imce.jpl.nasa.gov/backbone/www.w3.org/2001/XMLSchema#>

4 Abstract Class Definitions

4.1 Item

An *Item* is a discrete unit of material or information exchanged between two *Functions*.

Asserted Superclasses: base:ContainedElement, base:Container, base:IdentifiedElement, mission-backbone:Entity, TraversingElement

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Aspect, mission-backbone:Thing

Asserted Subclasses: MaterialItem, Message

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasContainmentIndex [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: isReceivedBy [0..*] InterchangePoint

isSentBy [0..1] InterchangePoint

Inferred Object Properties: base:contains [0..*] Item

base:isContainedIn [0..1] Item

participatesIn [0..*] Interchange

traverses [0..*] Junction

The class definition diagram for Item is shown in Figure 1.

4.2 PerformingElement

A *PerformingElement* is an object that *performs* one or more *Functions*.

Asserted Superclasses: mission-backbone:Aspect

Inferred Superclasses: mission-backbone:Thing

Asserted Subclasses: Component, Mission

Asserted Object Properties: performs [0..*] Function

The class definition diagram for PerformingElement is shown in Figure 2.

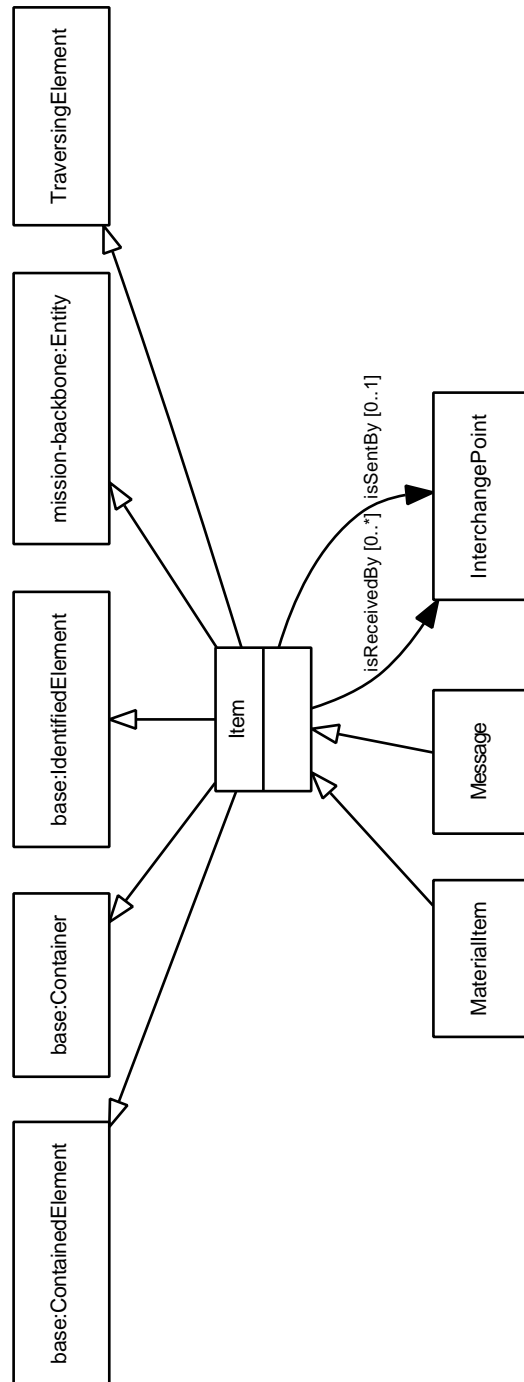


Figure 1: Class definition diagram for Item.

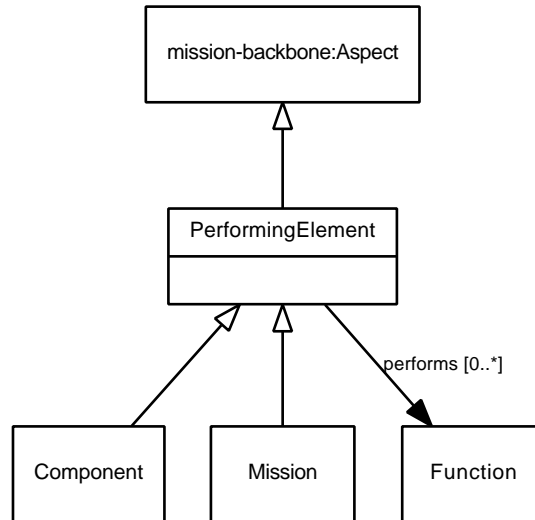


Figure 2: Class definition diagram for PerformingElement.

4.3 PresentingElement

A *PresentingElement* presents zero or more *Interfaces* that define its connections to the outside world.

Asserted Superclasses: mission-backbone:Aspect

Inferred Superclasses: mission-backbone:Thing

Asserted Subclasses: Component, Interface, Mission

Asserted Object Properties: presents [0..*] Interface

The class definition diagram for PresentingElement is shown in Figure 3.

4.4 SpecifiedElement

Asserted Superclasses: mission-backbone:Aspect

Inferred Superclasses: mission-backbone:Thing

Asserted Subclasses: Component, Mission, Performs, Presents, TransfersIn, TransfersOut

Asserted Object Properties: isSpecifiedBy [0..*] Requirement

The class definition diagram for SpecifiedElement is shown in Figure 4.

4.5 TraversingElement

A *TraversingElement* is any model element that *traverses* an *Interface*.

Asserted Superclasses: mission-backbone:Aspect

Inferred Superclasses: mission-backbone:Thing

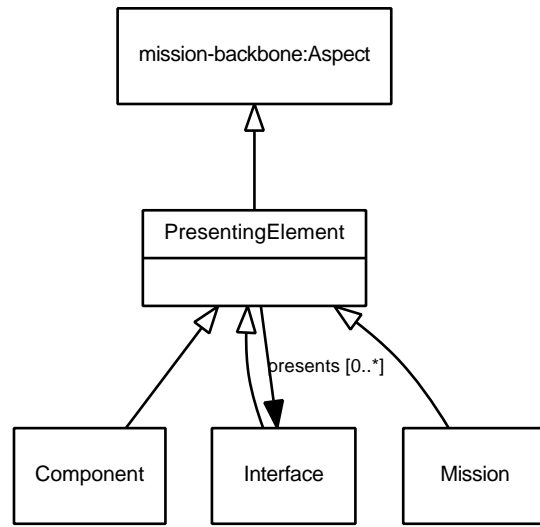


Figure 3: Class definition diagram for PresentingElement.

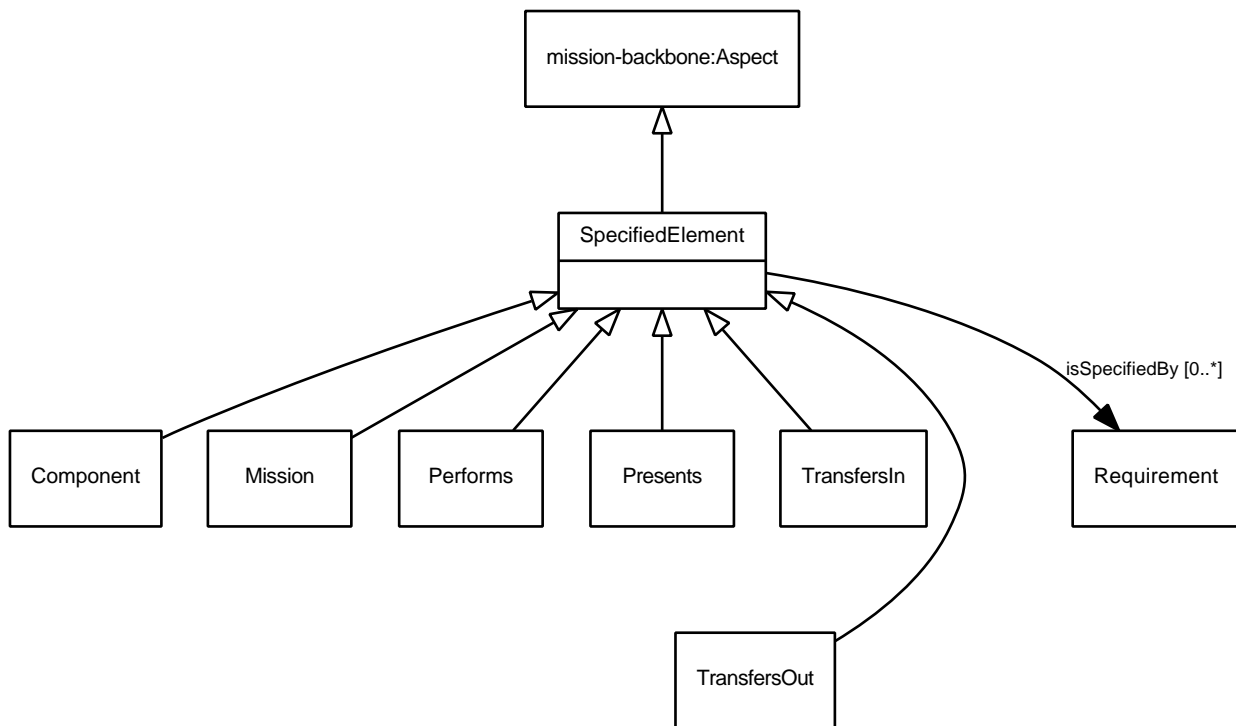


Figure 4: Class definition diagram for SpecifiedElement.

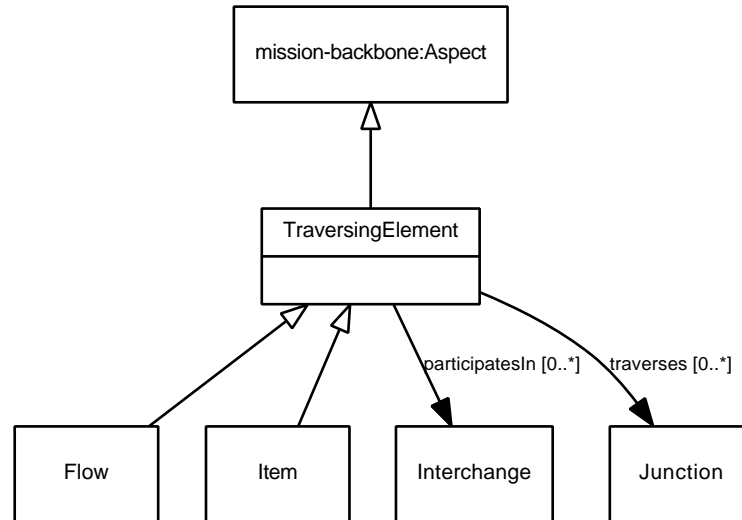


Figure 5: Class definition diagram for `TraversingElement`.

Asserted Subclasses: `Flow`, `Item`

Asserted Object Properties: `participatesIn [0..*]` `Interchange`

`traverses [0..*]` `Junction`

The class definition diagram for `TraversingElement` is shown in Figure 5.

5 Concrete Class Definitions

5.1 Component

A *Component* is a *PerformingElement* that is not a *Mission*. Example *Components* include launch vehicle, spacecraft, telecommunication subsystem, flight software, attitude control software, and mission operations team.

Asserted Superclasses: base:ContainedElement, base:Container, base:IdentifiedElement, mission-backbone:Entity, PerformingElement, PresentingElement, SpecifiedElement

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Aspect, mission-backbone:Thing

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasContainmentIndex [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: induces [0..*] Environment

isDeployedBy [0..*] Mission

isInfluencedBy [0..*] Environment

Inferred Object Properties: base:contains [0..*] Component

base:isContainedIn [0..1] Component

isSpecifiedBy [0..*] Requirement

performs [0..*] Function

presents [0..*] Interface

The class definition diagram for Component is shown in Figure 6. The class usage diagram for Component is shown in Figure 7.

5.2 Environment

An *Environment* corresponds to a set of conditions in which a *Component* must *perform* its *Functions*. Example environments include low earth orbit, trans-Jupiter cruise, and Martian north polar surface.

Asserted Superclasses: base:AggregatedElement, base:IdentifiedElement, mission-backbone:Entity

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Thing

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

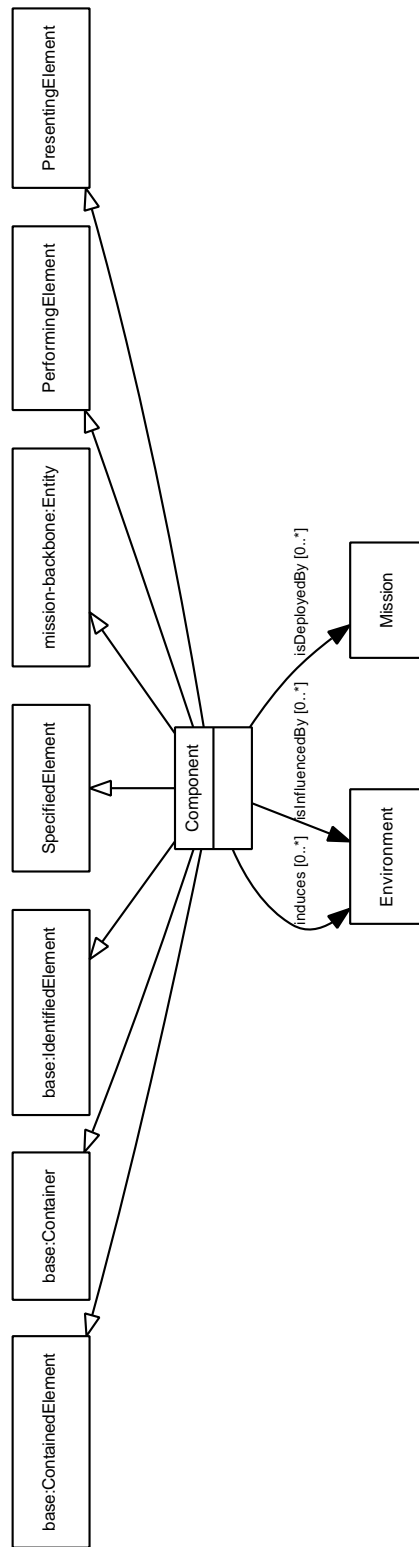


Figure 6: Class definition diagram for Component.

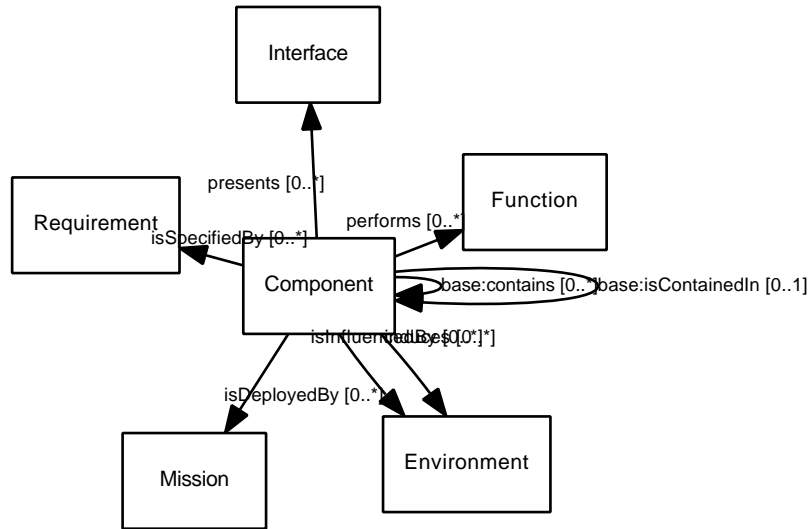


Figure 7: Class usage diagram for Component.

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: **influences** [0..*] Component

isInducedBy [0..*] Component

Inferred Object Properties: **base:aggregates** [0..*] Environment

base:isAggregatedIn [0..*] Environment

The class definition diagram for Environment is shown in Figure 8. The class usage diagram for Environment is shown in Figure 9.

5.3 Flow

A *Flow* represents a non-discrete transfer of matter or energy between *Functions*. Examples of *Flow* include electrical power, propellant, and heat.

Asserted Superclasses: base:ContainedElement, base:Container, base:IdentifiedElement, mission-backbone:Entity, TraversingElement

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Aspect, mission-backbone:Thing

Inferred Datatype Properties: **base:hasAlternateName** [0..*] xsd:string

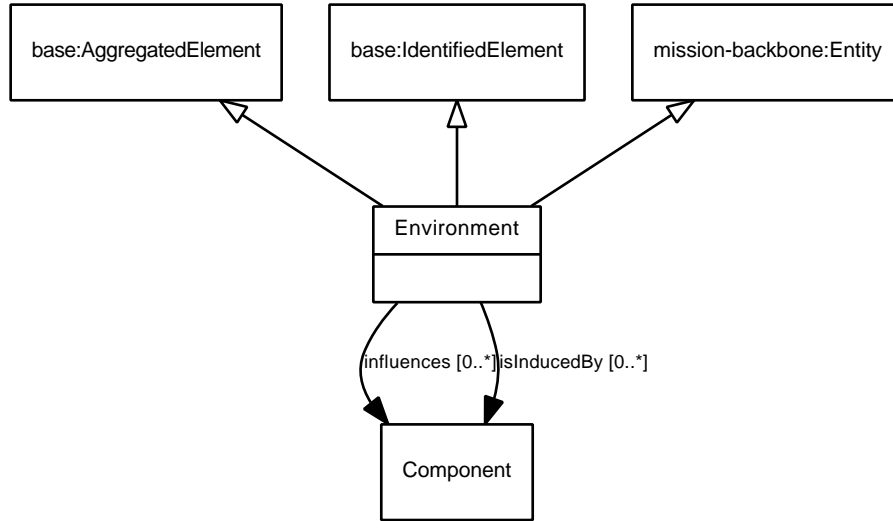


Figure 8: Class definition diagram for Environment.

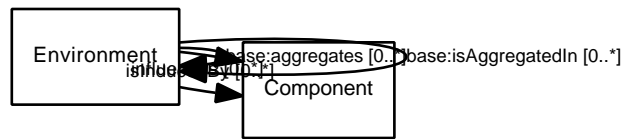


Figure 9: Class usage diagram for Environment.

base:hasCanonicalName [0..1] xsd:string
base:hasContainmentIndex [0..1] xsd:string
base:hasDescription [0..1] xsd:string
base:hasIdentifier [0..*] xsd:string
base:hasIndexEntry [0..*] xsd:string
base:hasShortName [0..1] xsd:string
base:hasSortKey [0..1] xsd:string
base:hasUuid [0..1] xsd:string

Asserted Object Properties: **isEmittedBy** [0..1] InterchangePoint
isIngestedBy [0..1] InterchangePoint

Inferred Object Properties: **base:contains** [0..*] Flow
base:isContainedIn [0..1] Flow
participatesIn [0..*] Interchange
traverses [0..*] Junction

The class definition diagram for Flow is shown in Figure 10. The class usage diagram for Flow is shown in Figure 11.

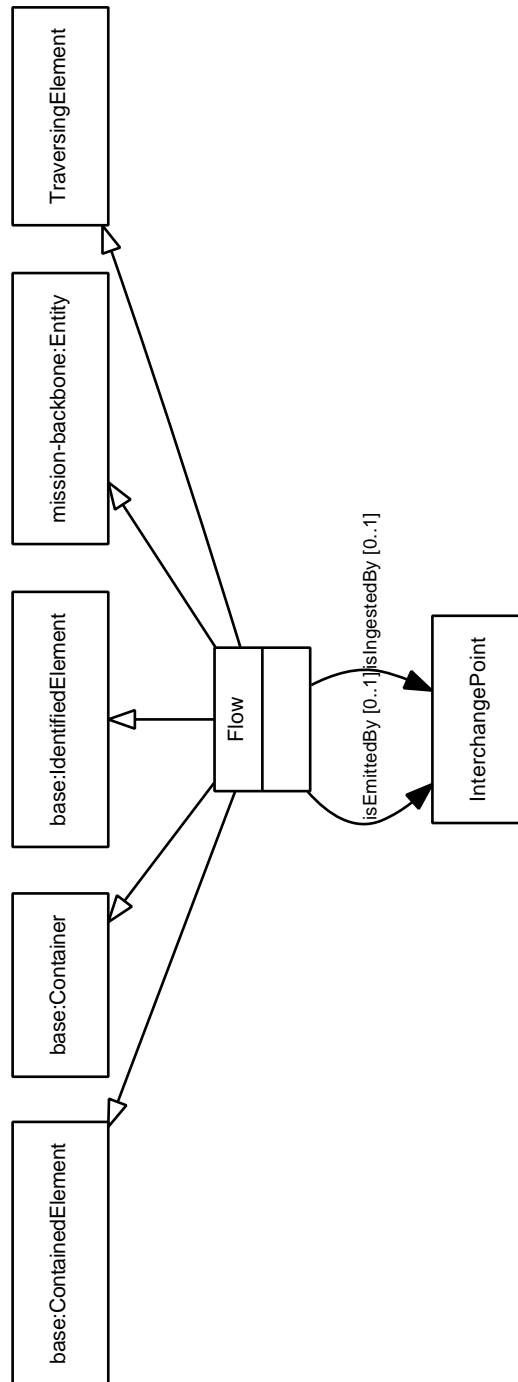


Figure 10: Class definition diagram for Flow.

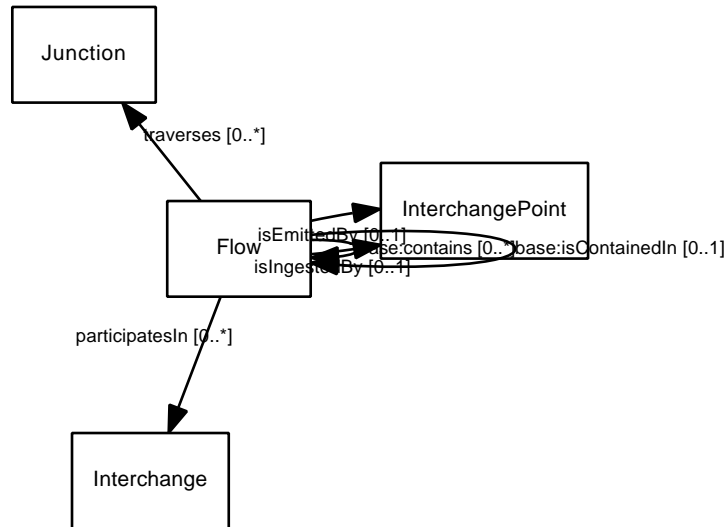


Figure 11: Class usage diagram for Flow.

5.4 Function

A *Function* is an operation or activity performed by a *Component* in the context of executing a *Mission*. Every *Function* is a *SpecifiedElement*, which implies that a *Requirement* can specify a *Function*. *Functions*, therefore, represent intended *Component* behavior. Example *Functions* include *search for life on Mars*, *insert into Martian orbit*, and *send instrument telemetry packet*.

Functions may emit or ingest *Flows* representing non-discrete exchanges of matter or energy. *Functions* may send or receive *Items* representing discrete exchanges of matter or information.

Asserted Superclasses: base:IdentifiedElement, mission-backbone:Entity

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Thing

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: interchangesThrough [0..*] InterchangePoint

invokes [0..*] Function

isInvokedBy [0..*] Function

isPerformedBy [0..1] PerformingElement

The class definition diagram for Function is shown in Figure 12. The class usage diagram for Function is shown in Figure 13.

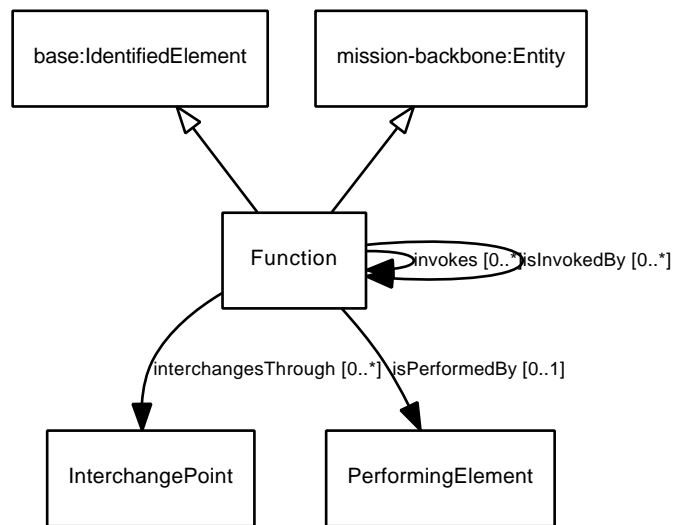


Figure 12: Class definition diagram for Function.

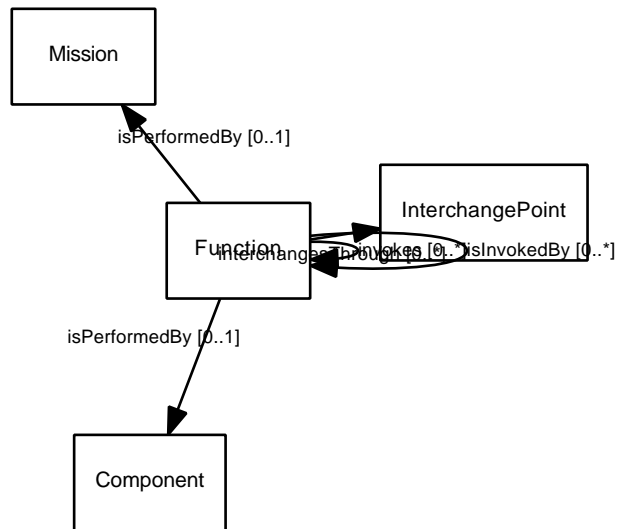


Figure 13: Class usage diagram for Function.

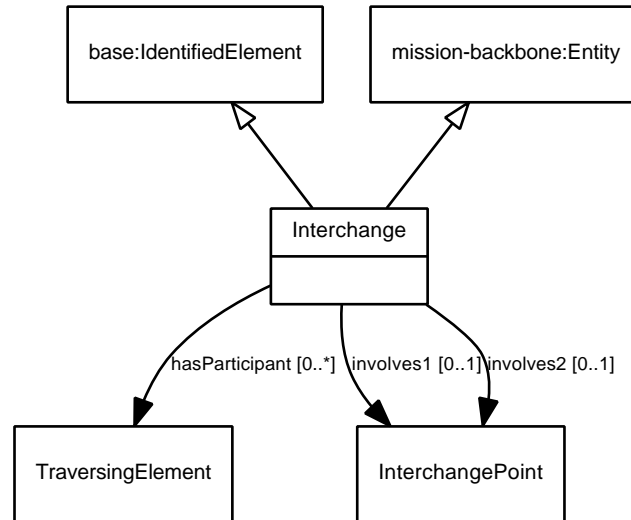


Figure 14: Class definition diagram for Interchange.

5.5 Interchange

An *Interchange* represents the intended joint behavior of a pair of *PerformingElements*. It indicates that a *Flow* or *Item* may be sent or emitted by one *PerformingElement* and received or ingested by another.

Asserted Superclasses: base:IdentifiedElement, mission-backbone:Entity

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Thing

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: hasParticipant [0..*] TraversingElement

involves1 [0..1] InterchangePoint

involves2 [0..1] InterchangePoint

The class definition diagram for Interchange is shown in Figure 14. The class usage diagram for Interchange is shown in Figure 15.

5.6 InterchangePoint

Asserted Superclasses: base:IdentifiedElement, mission-backbone:Entity

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Thing

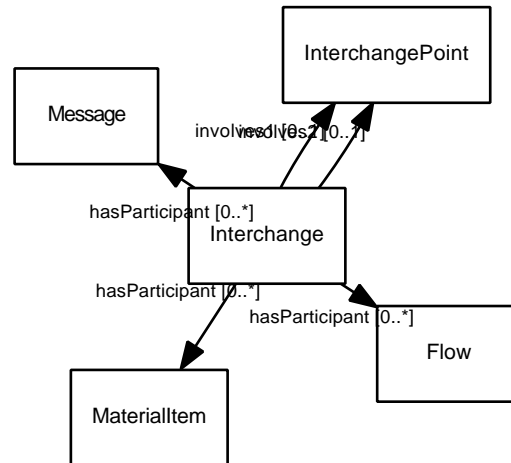


Figure 15: Class usage diagram for Interchange.

Inferred Datatype Properties: **base:hasAlternateName** [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: **emits** [0..*] Flow

ingests [0..*] Flow

isInterchangePointFor [0..1] Function

isInvolvedIn1 [0..*] Interchange

isInvolvedIn2 [0..*] Interchange

receives [0..*] Item

sends [0..*] Item

The class definition diagram for InterchangePoint is shown in Figure 16. The class usage diagram for InterchangePoint is shown in Figure 17.

5.7 Interface

An *Interface* represents a set of mechanical, electrical, signal, or other properties that describe some aspect of a *Component*'s connection to or interaction with another *Component*.

It is important to distinguish between a *Component*, which is a discrete thing, and an *Interface*, which is a collection of properties. In the formulation phase, for example, we might model the launch vehicle and the spacecraft as *Components*. The properties that describe how the spacecraft is designed to attach to the launch vehicle would be captured in one *Interface* (and associated with the spacecraft using the *presents* property).

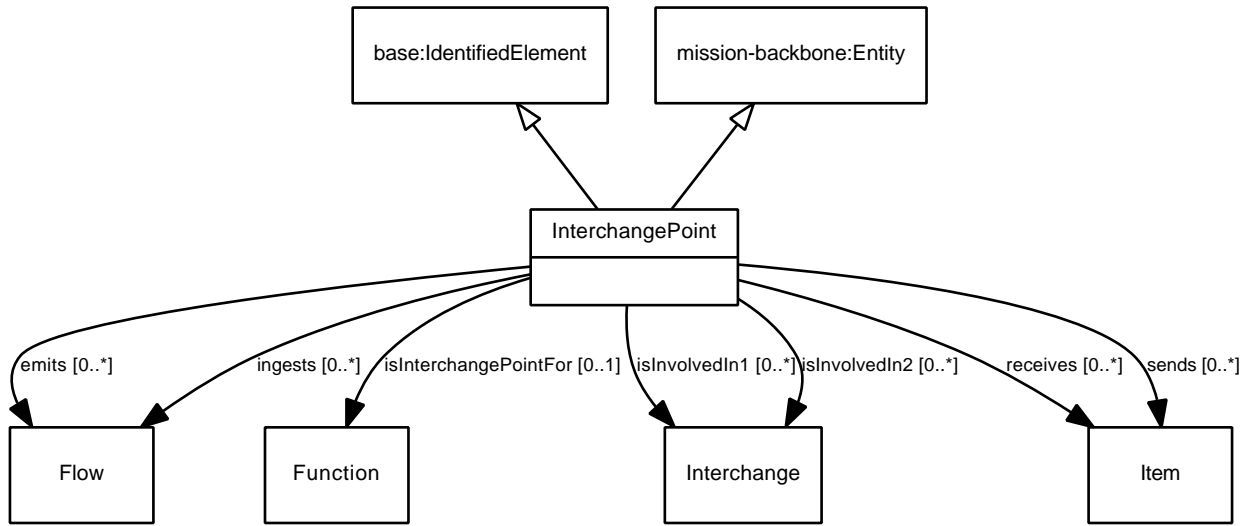


Figure 16: Class definition diagram for InterchangePoint.

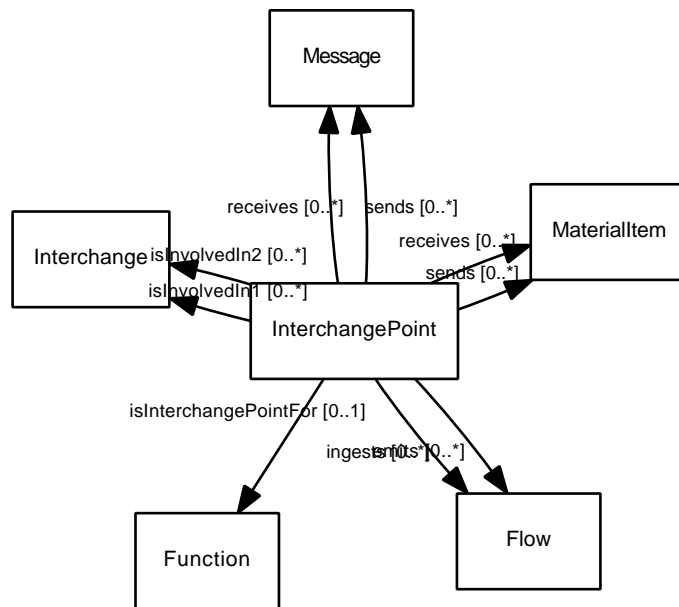


Figure 17: Class usage diagram for InterchangePoint.

The properties that describe how the launch vehicle is designed or configured to attach to the spacecraft would be captured in another *Interface*. The fact that two (or more) interfaces mate with each other is conveyed the existence of an *Junction* that *joins* the *Interfaces*.

This method of modeling interfaces allows us to capture the asymmetric aspect of producer/consumer relationships, as well as providing a convenient method for associating the sets of properties and characterize the interconnection of any pair of *Components* so that they can be analyzed for consistency.

Asserted Superclasses: base:IdentifiedElement, mission-backbone:Entity, PresentingElement

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Aspect, mission-backbone:Thing

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: isJoinedIn1 [0..1] Junction

isJoinedIn2 [0..1] Junction

isPresentedBy [0..1] PresentingElement

transfersIn [0..*] TraversingElement

transfersOut [0..*] TraversingElement

Inferred Object Properties: presents [0..*] Interface

The class definition diagram for Interface is shown in Figure 18. The class usage diagram for Interface is shown in Figure 19.

5.8 Junction

An *Junction* represents a set of mechanical, electrical, signal, or other properties that are common to a set of mutually connected *Interfaces*.

Asserted Superclasses: base:ContainedElement, base:Container, base:IdentifiedElement, mission-backbone:Entity

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Thing

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasContainmentIndex [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

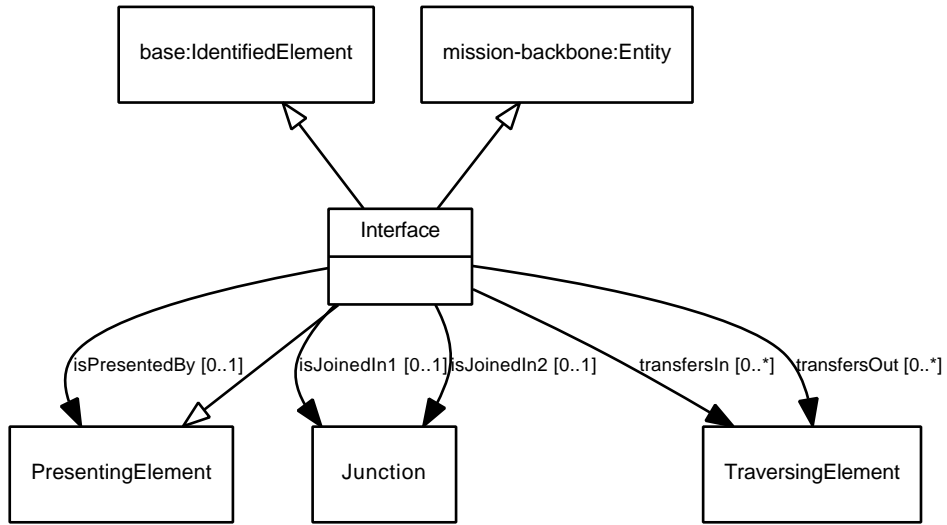


Figure 18: Class definition diagram for Interface.

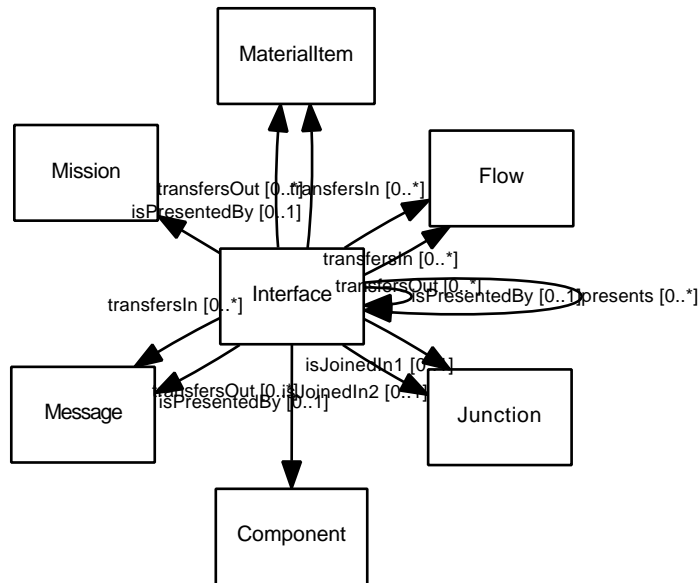


Figure 19: Class usage diagram for Interface.

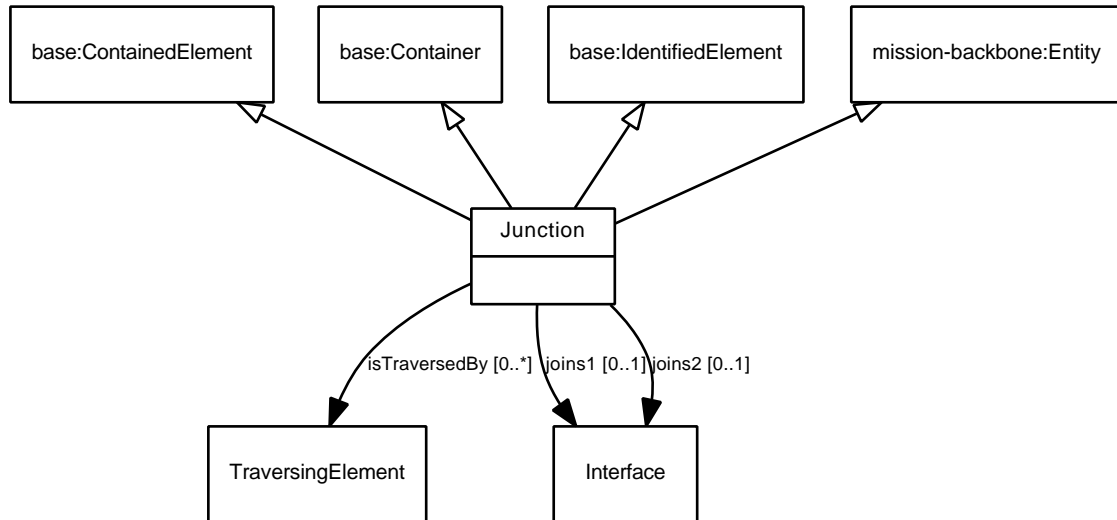


Figure 20: Class definition diagram for Junction.

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: **isTraversedBy** [0..*] TraversingElement

joins1 [0..1] Interface

joins2 [0..1] Interface

Inferred Object Properties: **base:contains** [0..*] Junction

base:isContainedIn [0..1] Junction

The class definition diagram for Junction is shown in Figure 20. The class usage diagram for Junction is shown in Figure 21.

5.9 *MaterialItem*

A *MaterialItem* is a discrete unit of material exchanged between two *Functions*. Example *MaterialItems* include rock hammer and soil sample.

Asserted Superclasses: Item

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, base:ContainedElement, base:Container, base:IdentifiedElement, mission-backbone:Aspect, mission-backbone:Entity, mission-backbone:Thing, TraversingElement

Inferred Datatype Properties: **base:hasAlternateName** [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasContainmentIndex [0..1] xsd:string

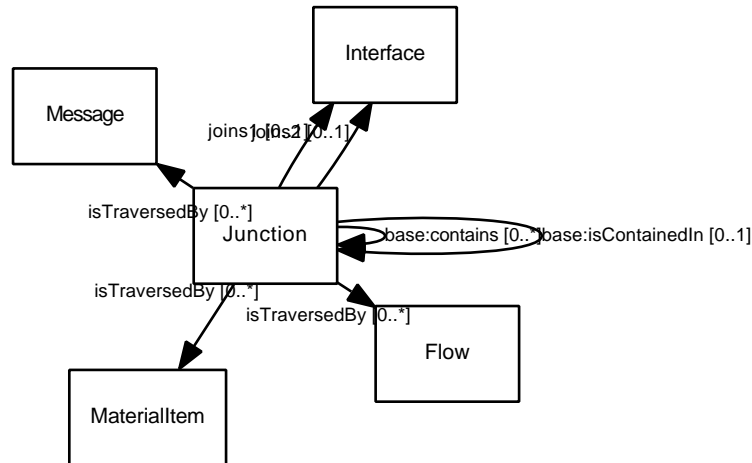


Figure 21: Class usage diagram for Junction.

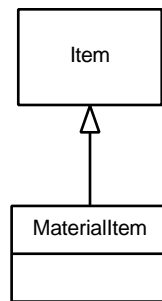


Figure 22: Class definition diagram for MaterialItem.

base:hasDescription [0..1] xsd:string
base:hasIdentifier [0..*] xsd:string
base:hasIndexEntry [0..*] xsd:string
base:hasShortName [0..1] xsd:string
base:hasSortKey [0..1] xsd:string
base:hasUuid [0..1] xsd:string

Inferred Object Properties: **base:contains** [0..*] Item

base:isContainedIn [0..1] Item
isReceivedBy [0..*] InterchangePoint
isSentBy [0..1] InterchangePoint
participatesIn [0..*] Interchange
traverses [0..*] Junction

The class definition diagram for MaterialItem is shown in Figure 22. The class usage diagram for MaterialItem is shown in Figure 23.

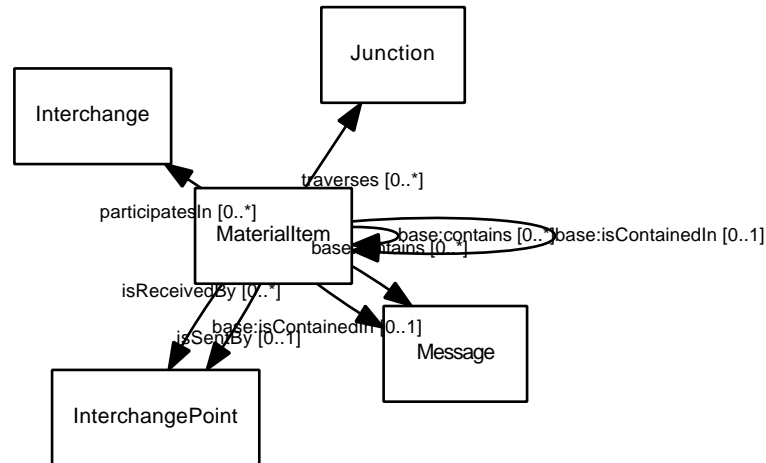


Figure 23: Class usage diagram for MaterialItem.

5.10 Message

A *Message* is a discrete unit of information exchanged between two *Functions*. Example *Messages* include command, command response, and file contents.

Asserted Superclasses: Item

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, base:ContainedElement, base:Container, base:IdentifiedElement, mission-backbone:Aspect, mission-backbone:Entity, mission-backbone:Thing, TraversingElement

Inferred Datatype Properties: **base:hasAlternateName** [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasContainmentIndex [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Inferred Object Properties: **base:contains** [0..*] Item

base:isContainedIn [0..1] Item

isReceivedBy [0..*] InterchangePoint

isSentBy [0..1] InterchangePoint

participatesIn [0..*] Interchange

traverses [0..*] Junction

The class definition diagram for Message is shown in Figure 24. The class usage diagram for Message is shown in Figure 25.

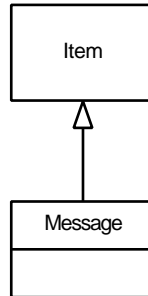


Figure 24: Class definition diagram for Message.

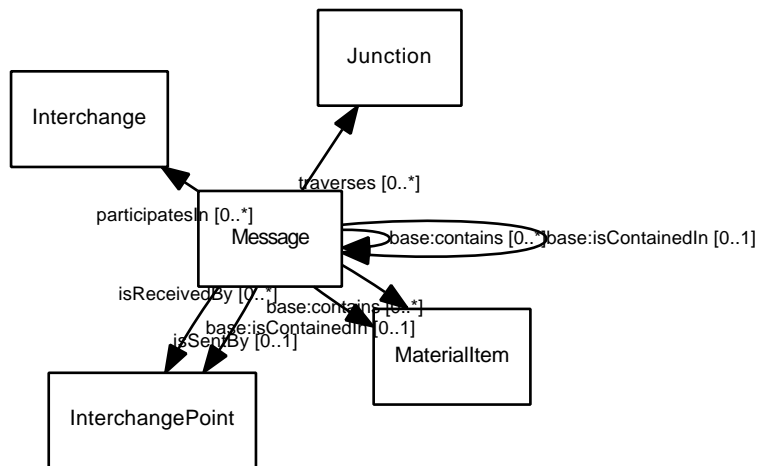


Figure 25: Class usage diagram for Message.

5.11 Mission

A *Mission* is a *PerformingElement* that *pursues Objectives*.

A *Mission* may contain *Components*, but the preferred relationship is that a *Mission* *deploys* its systems (which are *Components*). This convention allows for a *Mission* to be associated with shared or external *Components* that it does not strictly *contain*.

Asserted Superclasses: base:IdentifiedElement, mission-backbone:Entity, PerformingElement, PresentingElement, SpecifiedElement

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Aspect, mission-backbone:Thing

Inferred Datatype Properties: base:hasAlternateName [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: deploys [0..*] Component

pursues [0..*] Objective

Inferred Object Properties: isSpecifiedBy [0..*] Requirement

performs [0..*] Function

presents [0..*] Interface

The class definition diagram for *Mission* is shown in Figure 26. The class usage diagram for *Mission* is shown in Figure 27.

5.12 Objective

An *Objective* represents a specific interest that one or more stakeholders have in the successful execution of a mission. Example *Objectives* include characterize the extent of the European ocean and its relation to the deeper interior, characterize the European ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange, and determine global European surface compositions and chemistry, especially as related to habitability.

Objectives differ from *Requirements* in that they are not the result of negotiated agreement between customer and supplier, they need not be mutually consistent, and a *Mission* *pursues* but need not completely achieve all its *Objectives*. In a sense, the set of *Requirements* for a *Mission* represents the minimum acceptable achievement of *Objectives* for a given cost, schedule, and risk.

Asserted Superclasses: base:AggregatedElement, base:IdentifiedElement, mission-backbone:Entity

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Thing

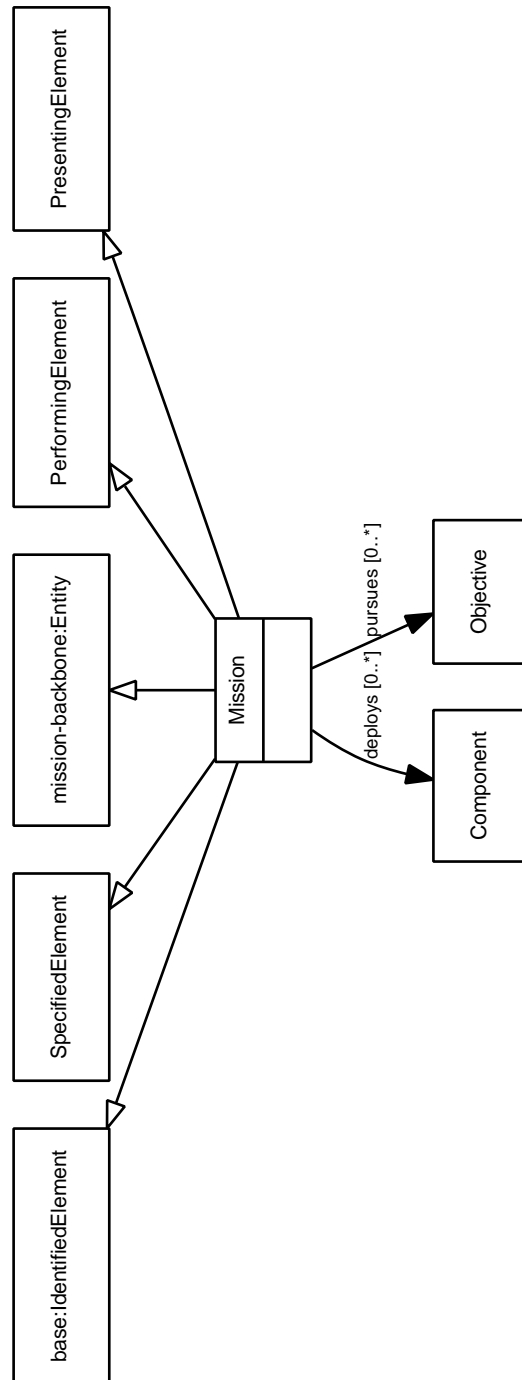


Figure 26: Class definition diagram for Mission.

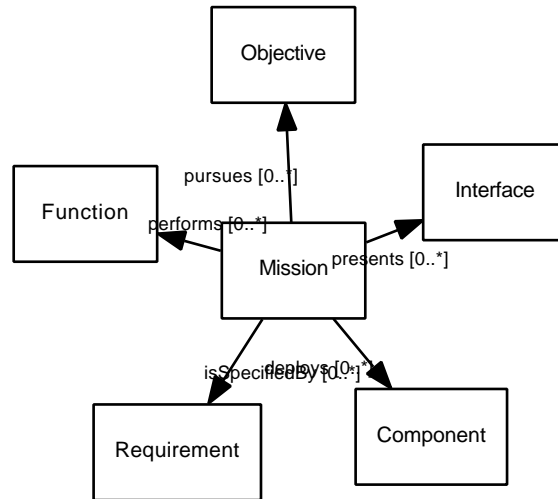


Figure 27: Class usage diagram for Mission.

Inferred Datatype Properties: **base:hasAlternateName** [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: **isPursuedBy** [0..*] Mission

Inferred Object Properties: **base:aggregates** [0..*] Objective

base:isAggregatedIn [0..*] Objective

The class definition diagram for Objective is shown in Figure 28. The class usage diagram for Objective is shown in Figure 29.

5.13 Requirement

A *Requirement* specifies an assertion about a *SpecifiedElement* (*Component*, *Function*, or *Interface*) that must be true for every acceptable realization of that element.

By definition, a *Requirement* that specifies a *Function* is a *functional requirement*. A *Requirement* that specifies an *Interface* is an *interface requirement*. A *Requirement* that specifies a *Component* is a *component requirement*.

Asserted Superclasses: base:IdentifiedElement, mission-backbone:Entity

Inferred Superclasses: base-backbone:Aspect, base-backbone:Thing, mission-backbone:Thing

Asserted Datatype Properties: **hasRationale** [0..1] xsd:string

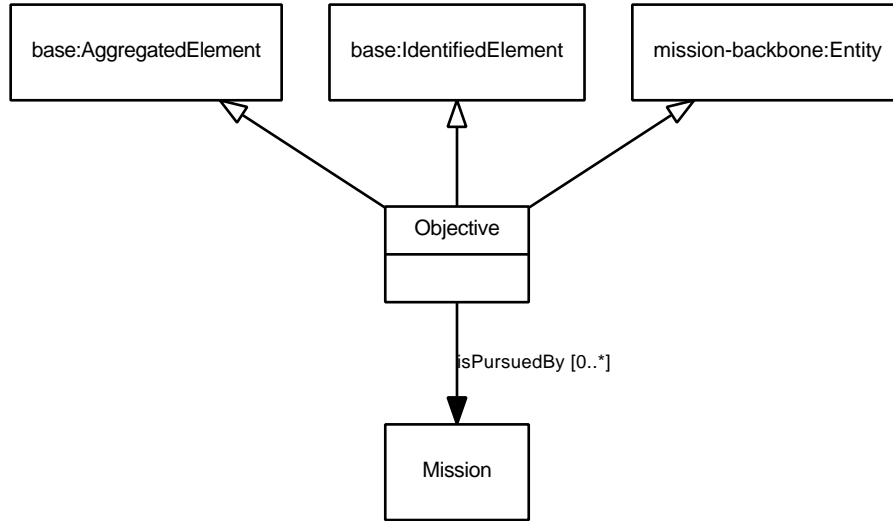


Figure 28: Class definition diagram for Objective.

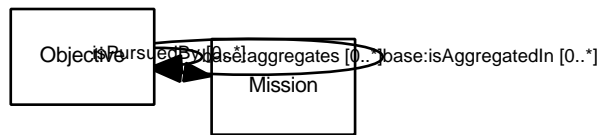


Figure 29: Class usage diagram for Objective.

Inferred Datatype Properties: **base:hasAlternateName** [0..*] xsd:string

base:hasCanonicalName [0..1] xsd:string

base:hasDescription [0..1] xsd:string

base:hasIdentifier [0..*] xsd:string

base:hasIndexEntry [0..*] xsd:string

base:hasShortName [0..1] xsd:string

base:hasSortKey [0..1] xsd:string

base:hasUuid [0..1] xsd:string

Asserted Object Properties: **isRefinedBy** [0..*] Requirement

refines [0..*] Requirement

specifies [0..1] SpecifiedElement

The class definition diagram for Requirement is shown in Figure 30. The class usage diagram for Requirement is shown in Figure 31.

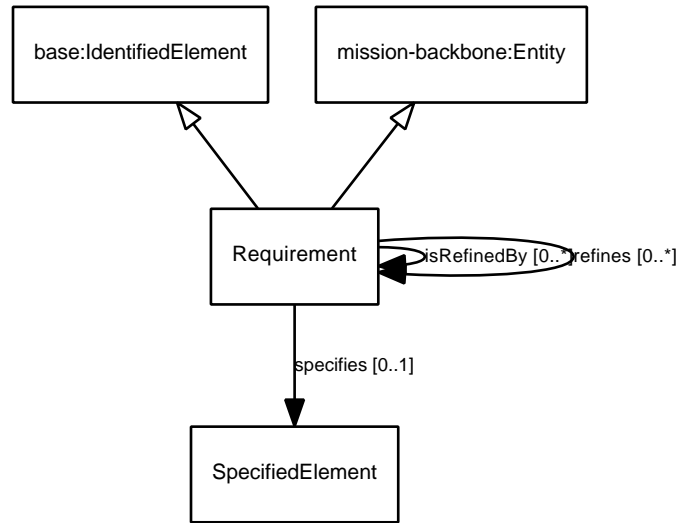


Figure 30: Class definition diagram for Requirement.

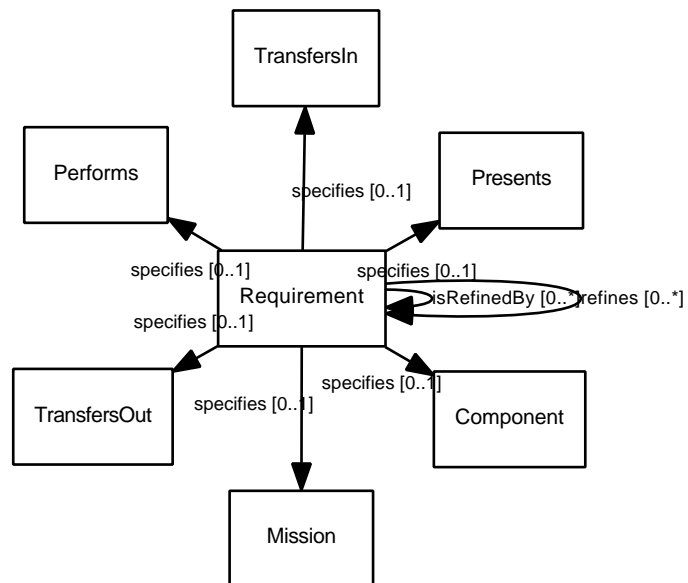


Figure 31: Class usage diagram for Requirement.

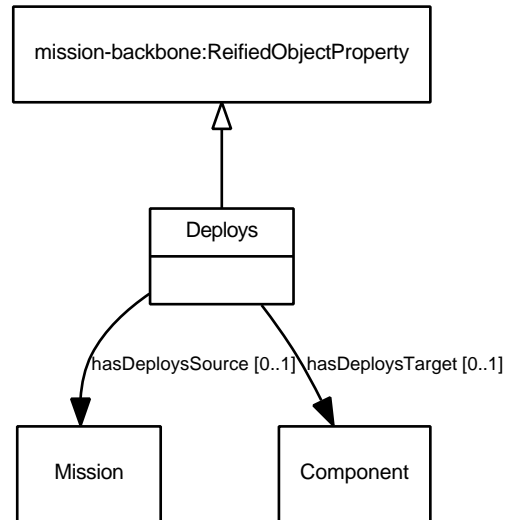


Figure 32: Class definition diagram for Deploys.

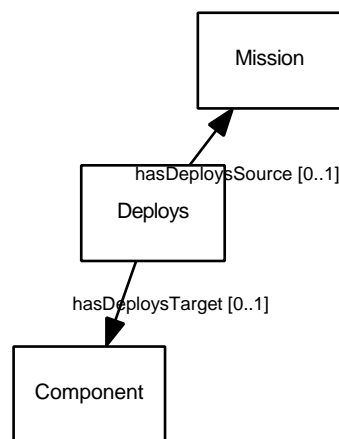


Figure 33: Class usage diagram for Deploys.

6 Object Property Reification Class Definitions

6.1 Deploys

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasDeploysSource** [0..1] Mission

hasDeploysTarget [0..1] Component

Reified Object Properties: deploys

The class definition diagram for Deploys is shown in Figure 32. The class usage diagram for Deploys is shown in Figure 33.

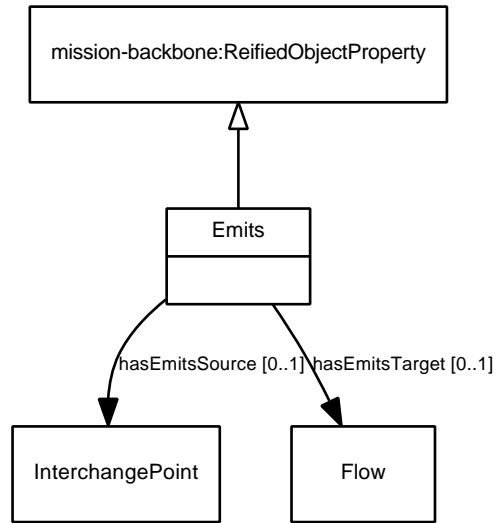


Figure 34: Class definition diagram for Emits.

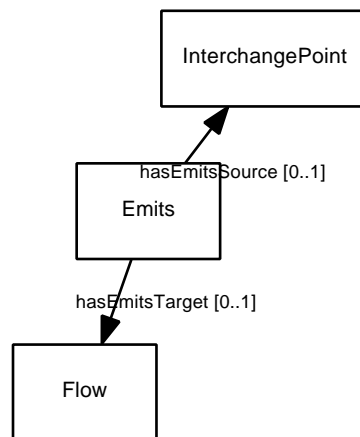


Figure 35: Class usage diagram for Emits.

6.2 Emits

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: hasEmitsSource [0..1] InterchangePoint

hasEmitsTarget [0..1] Flow

Reified Object Properties: emits

The class definition diagram for Emits is shown in Figure 34. The class usage diagram for Emits is shown in Figure 35.

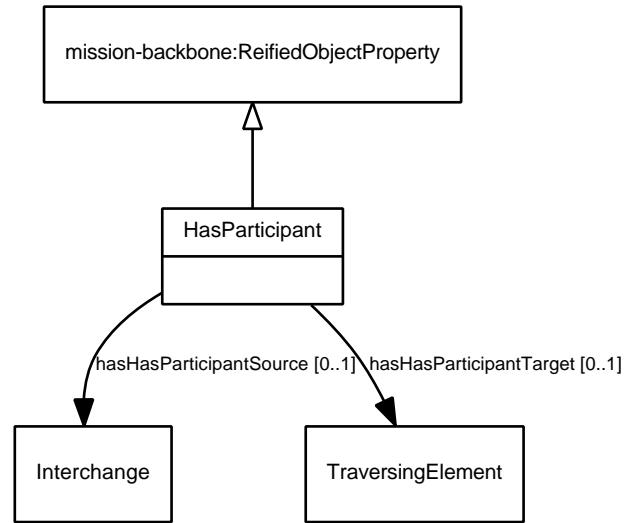


Figure 36: Class definition diagram for HasParticipant.

6.3 HasParticipant

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasHasParticipantSource** [0..1] Interchange
hasHasParticipantTarget [0..1] TraversingElement

Reified Object Properties: hasParticipant

The class definition diagram for HasParticipant is shown in Figure 36. The class usage diagram for HasParticipant is shown in Figure 37.

6.4 Induces

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasInducesSource** [0..1] Component
hasInducesTarget [0..1] Environment

Reified Object Properties: induces

The class definition diagram for Induces is shown in Figure 38. The class usage diagram for Induces is shown in Figure 39.

6.5 Influences

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

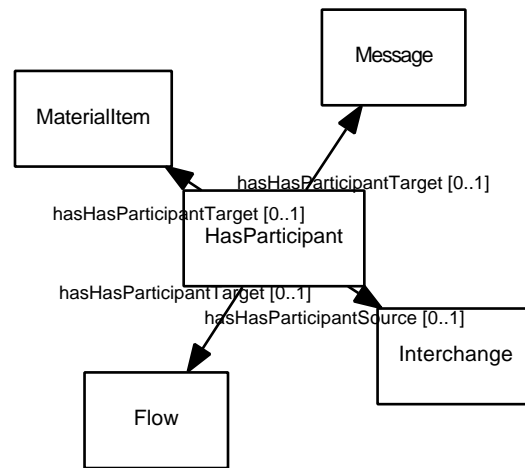


Figure 37: Class usage diagram for HasParticipant.

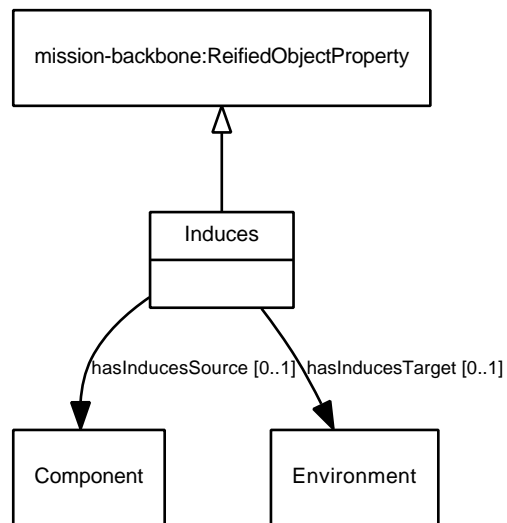


Figure 38: Class definition diagram for Induces.

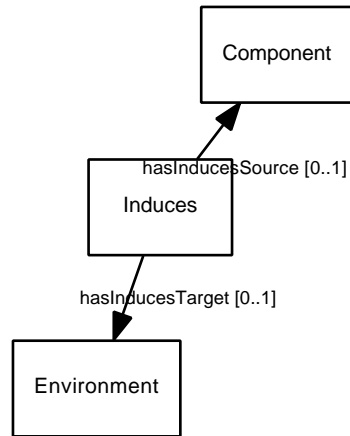


Figure 39: Class usage diagram for Induces.

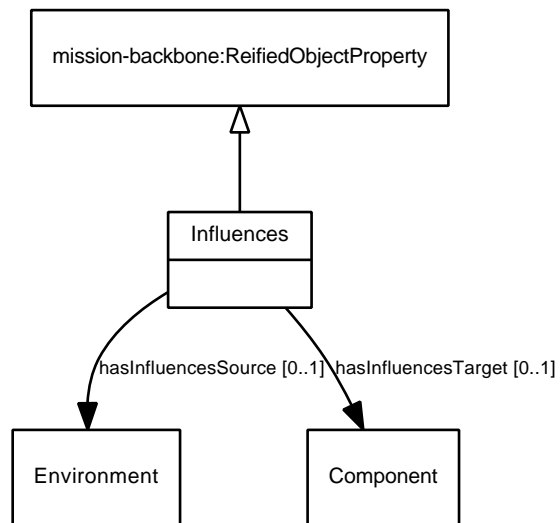


Figure 40: Class definition diagram for Influences.

Asserted Object Properties: **hasInfluencesSource** [0..1] Environment

hasInfluencesTarget [0..1] Component

Reified Object Properties: influences

The class definition diagram for Influences is shown in Figure 40. The class usage diagram for Influences is shown in Figure 41.

6.6 Ingests

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasIngestsSource** [0..1] InterchangePoint

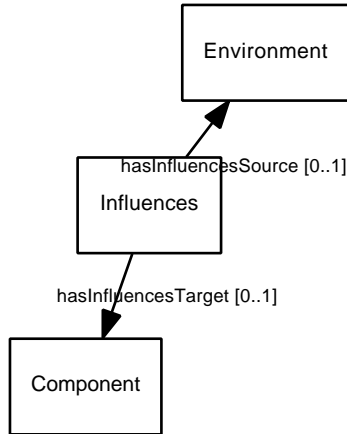


Figure 41: Class usage diagram for Influences.

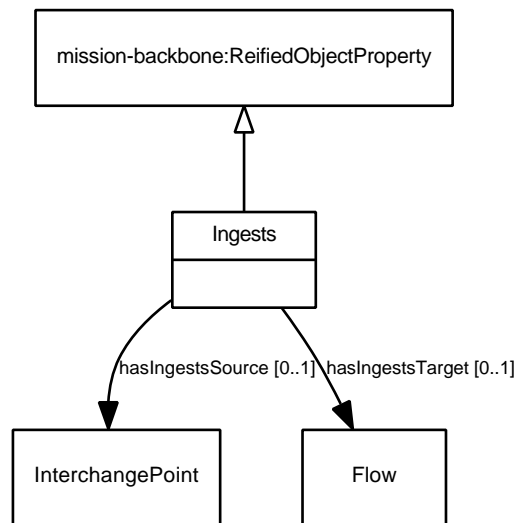


Figure 42: Class definition diagram for Ingests.

hasIngestsTarget [0..1] Flow

Reified Object Properties: ingests

The class definition diagram for Ingests is shown in Figure 42. The class usage diagram for Ingests is shown in Figure 43.

6.7 InterchangesThrough

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasInterchangesThroughSource** [0..1] Function

hasInterchangesThroughTarget [0..1] InterchangePoint

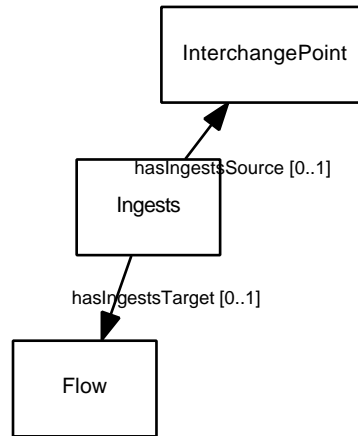


Figure 43: Class usage diagram for Ingests.

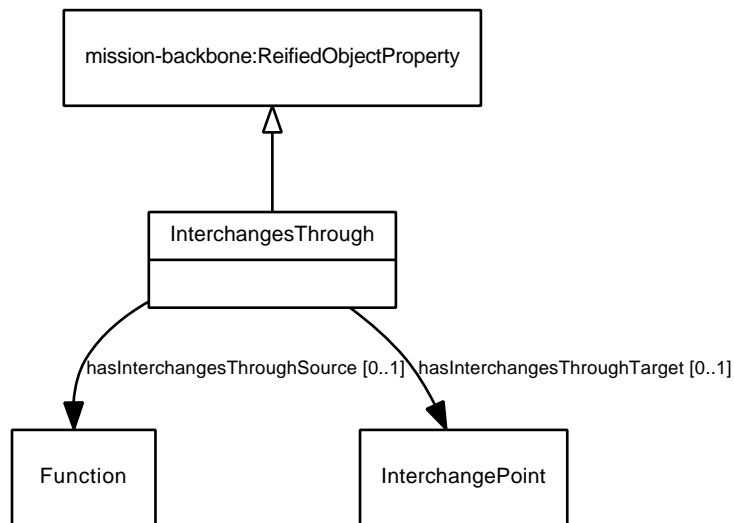


Figure 44: Class definition diagram for InterchangesThrough.

Reified Object Properties: interchangesThrough

The class definition diagram for InterchangesThrough is shown in Figure 44. The class usage diagram for InterchangesThrough is shown in Figure 45.

6.8 Invokes

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasInvokesSource** [0..1] Function

hasInvokesTarget [0..1] Function

Reified Object Properties: invokes

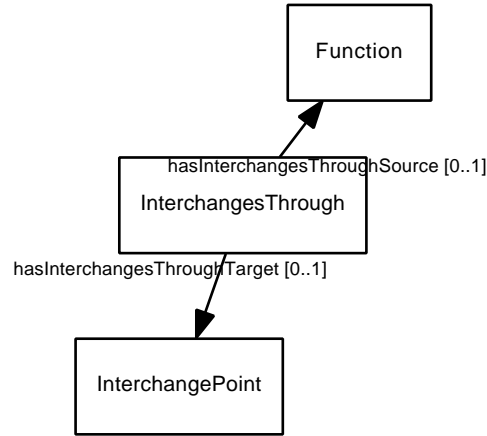


Figure 45: Class usage diagram for InterchangesThrough.

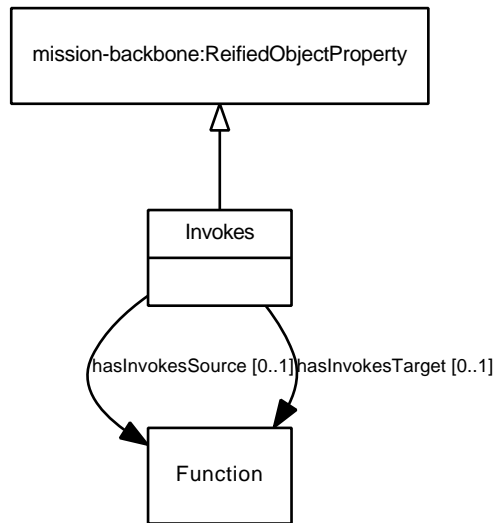


Figure 46: Class definition diagram for Invokes.

The class definition diagram for Invokes is shown in Figure 46. The class usage diagram for Invokes is shown in Figure 47.

6.9 Involves

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Subclasses: Involves1, Involves2

Asserted Object Properties: **hasInvolvesSource** [0..1] Interchange

hasInvolvesTarget [0..1] InterchangePoint

Reified Object Properties: involves

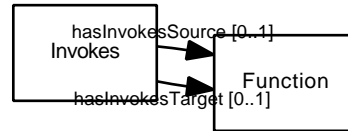


Figure 47: Class usage diagram for Involves.

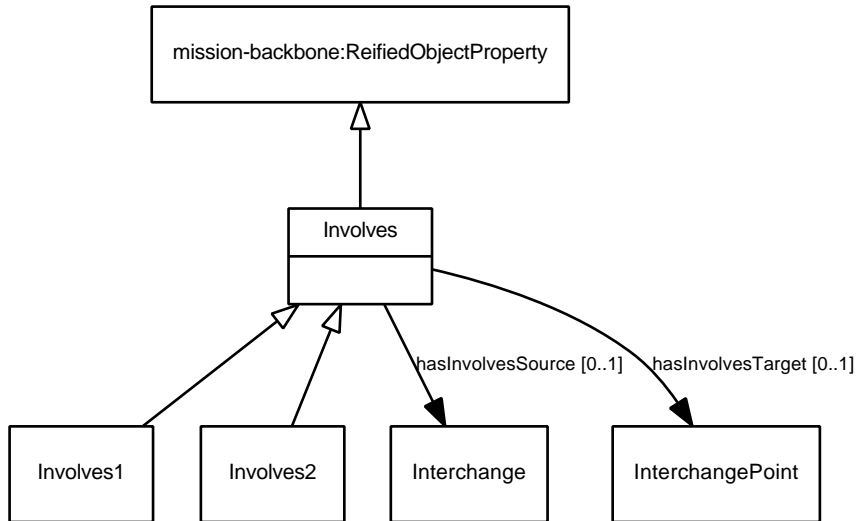


Figure 48: Class definition diagram for Involves.

The class definition diagram for Involves is shown in Figure 48.

6.10 Involves1

Asserted Superclasses: Involves

Inferred Superclasses: mission-backbone:ReifiedObjectProperty, mission-backbone:Thing

Asserted Object Properties: **hasInvolves1Source** [0..1] Interchange

hasInvolves1Target [0..1] InterchangePoint

Inferred Object Properties: **hasInvolvesSource** [0..1] Interchange

hasInvolvesTarget [0..1] InterchangePoint

Reified Object Properties: involves1

The class definition diagram for Involves1 is shown in Figure 49. The class usage diagram for Involves1 is shown in Figure 50.

6.11 Involves2

Asserted Superclasses: Involves

Inferred Superclasses: mission-backbone:ReifiedObjectProperty, mission-backbone:Thing

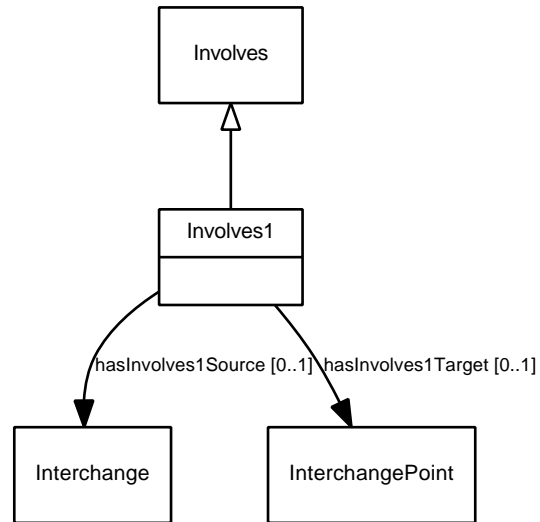


Figure 49: Class definition diagram for Involves1.

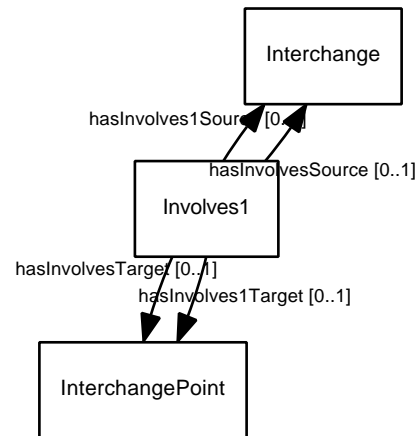


Figure 50: Class usage diagram for Involves1.

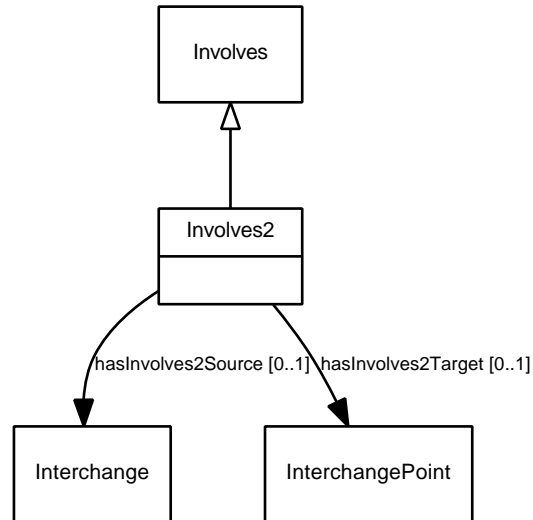


Figure 51: Class definition diagram for Involves2.

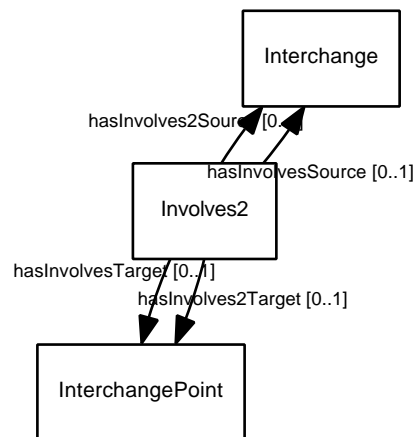


Figure 52: Class usage diagram for Involves2.

Asserted Object Properties: **hasInvolves2Source** [0..1] Interchange

hasInvolves2Target [0..1] InterchangePoint

Inferred Object Properties: **hasInvolvesSource** [0..1] Interchange

hasInvolvesTarget [0..1] InterchangePoint

Reified Object Properties: **involves2**

The class definition diagram for Involves2 is shown in Figure 51. The class usage diagram for Involves2 is shown in Figure 52.

6.12 Joins

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

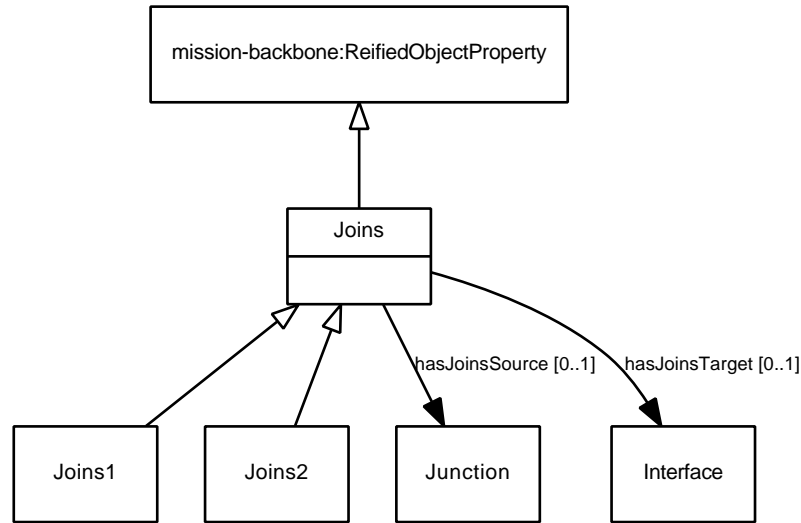


Figure 53: Class definition diagram for Joins.

Inferred Superclasses: mission-backbone:Thing

Asserted Subclasses: Joins1, Joins2

Asserted Object Properties: hasJoinsSource [0..1] Junction

hasJoinsTarget [0..1] Interface

Reified Object Properties: joins

The class definition diagram for Joins is shown in Figure 53.

6.13 Joins1

Asserted Superclasses: Joins

Inferred Superclasses: mission-backbone:ReifiedObjectProperty, mission-backbone:Thing

Asserted Object Properties: hasJoins1Source [0..1] Junction

hasJoins1Target [0..1] Interface

Inferred Object Properties: hasJoinsSource [0..1] Junction

hasJoinsTarget [0..1] Interface

Reified Object Properties: joins1

The class definition diagram for Joins1 is shown in Figure 54. The class usage diagram for Joins1 is shown in Figure 55.

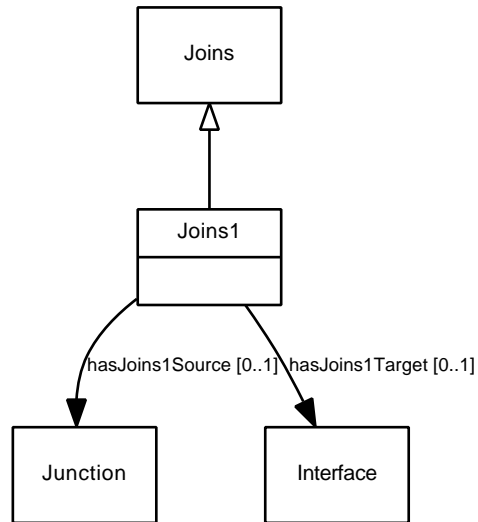


Figure 54: Class definition diagram for Joins1.

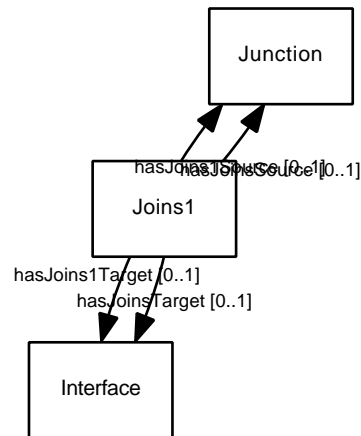


Figure 55: Class usage diagram for Joins1.

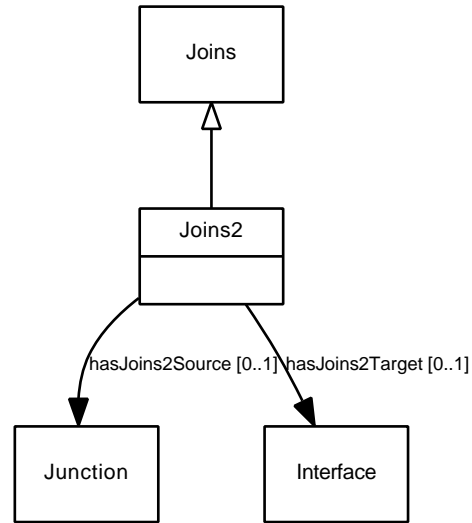


Figure 56: Class definition diagram for Joins2.

6.14 Joins2

Asserted Superclasses: Joins

Inferred Superclasses: mission-backbone:ReifiedObjectProperty, mission-backbone:Thing

Asserted Object Properties: **hasJoins2Source** [0..1] Junction

hasJoins2Target [0..1] Interface

Inferred Object Properties: **hasJoinsSource** [0..1] Junction

hasJoinsTarget [0..1] Interface

Reified Object Properties: joins2

The class definition diagram for Joins2 is shown in Figure 56. The class usage diagram for Joins2 is shown in Figure 57.

6.15 Performs

Asserted Superclasses: mission-backbone:ReifiedObjectProperty, SpecifiedElement

Inferred Superclasses: mission-backbone:Aspect, mission-backbone:Thing

Asserted Object Properties: **hasPerformsSource** [0..1] PerformingElement

hasPerformsTarget [0..1] Function

Inferred Object Properties: **isSpecifiedBy** [0..*] Requirement

Reified Object Properties: performs

The class definition diagram for Performs is shown in Figure 58. The class usage diagram for Performs is shown in Figure 59.

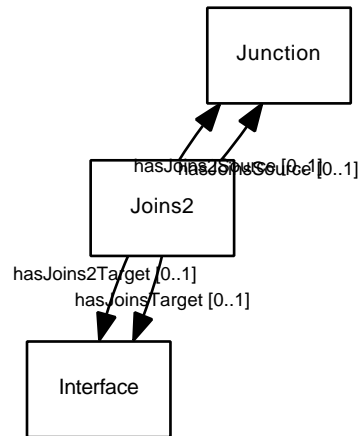


Figure 57: Class usage diagram for Joins2.

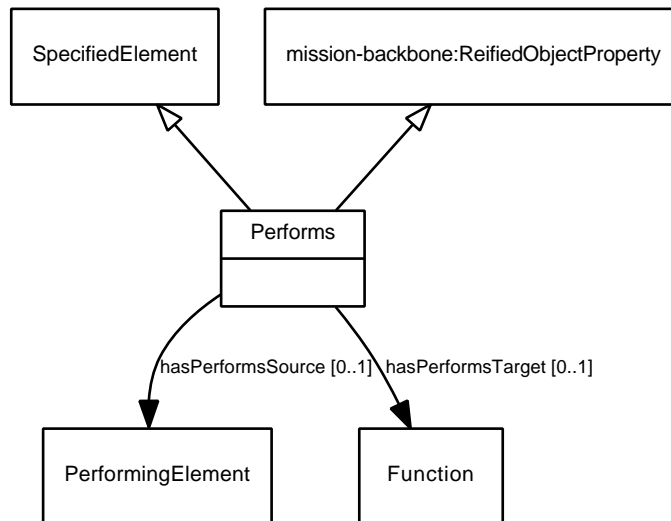


Figure 58: Class definition diagram for Performs.

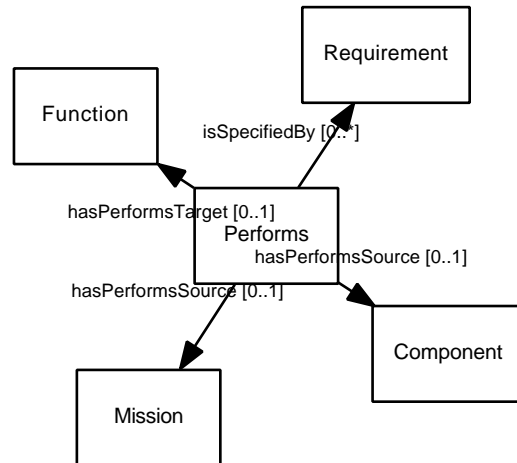


Figure 59: Class usage diagram for Performs.

6.16 Presents

Asserted Superclasses: mission-backbone:ReifiedObjectProperty, SpecifiedElement

Inferred Superclasses: mission-backbone:Aspect, mission-backbone:Thing

Asserted Object Properties: **hasPresentsSource** [0..1] PresentingElement

hasPresentsTarget [0..1] Interface

Inferred Object Properties: **isSpecifiedBy** [0..*] Requirement

Reified Object Properties: presents

The class definition diagram for Presents is shown in Figure 60. The class usage diagram for Presents is shown in Figure 61.

6.17 Pursues

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasPursuesSource** [0..1] Mission

hasPursuesTarget [0..1] Objective

Reified Object Properties: pursues

The class definition diagram for Pursues is shown in Figure 62. The class usage diagram for Pursues is shown in Figure 63.

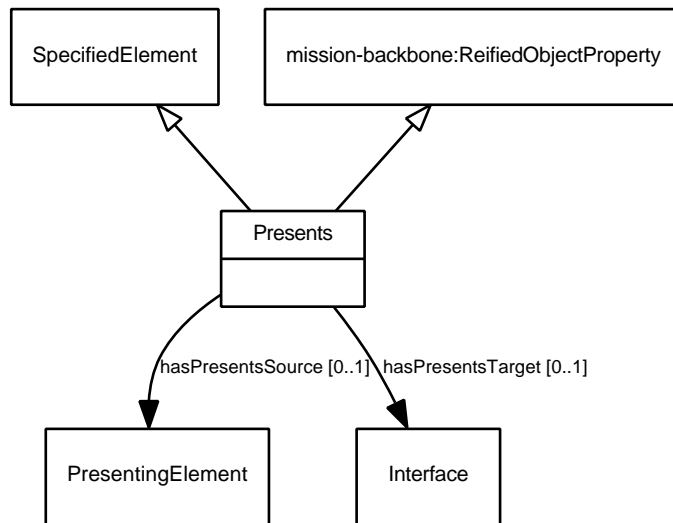


Figure 60: Class definition diagram for Presents.

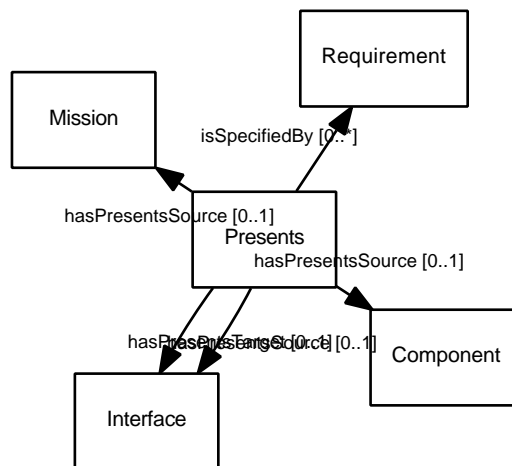


Figure 61: Class usage diagram for Presents.

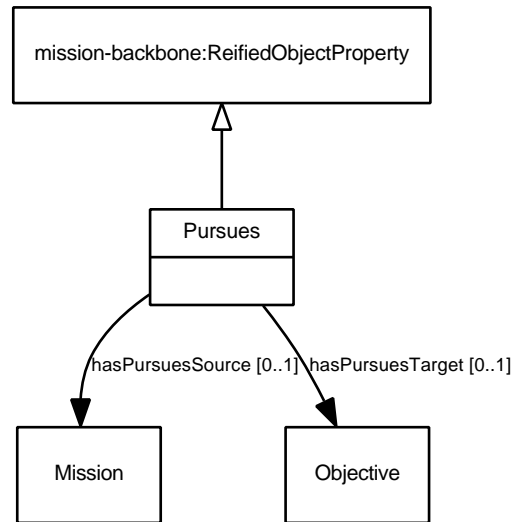


Figure 62: Class definition diagram for Pursues.

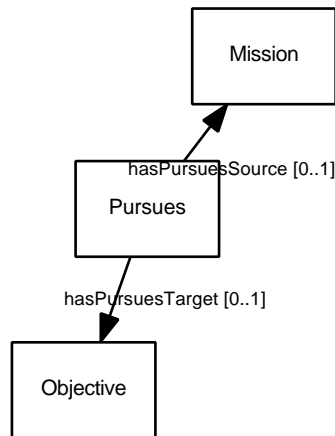


Figure 63: Class usage diagram for Pursues.

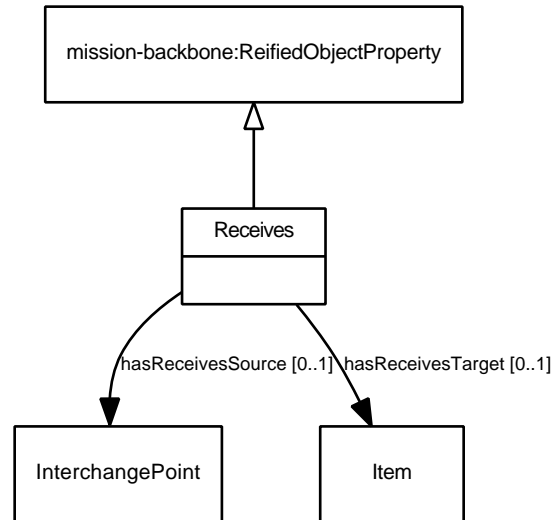


Figure 64: Class definition diagram for Receives.

6.18 Receives

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasReceivesSource** [0..1] InterchangePoint

hasReceivesTarget [0..1] Item

Reified Object Properties: receives

The class definition diagram for Receives is shown in Figure 64. The class usage diagram for Receives is shown in Figure 65.

6.19 Refines

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasRefinesSource** [0..1] Requirement

hasRefinesTarget [0..1] Requirement

Reified Object Properties: refines

The class definition diagram for Refines is shown in Figure 66. The class usage diagram for Refines is shown in Figure 67.

6.19.1 Comments

6.20 Sends

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

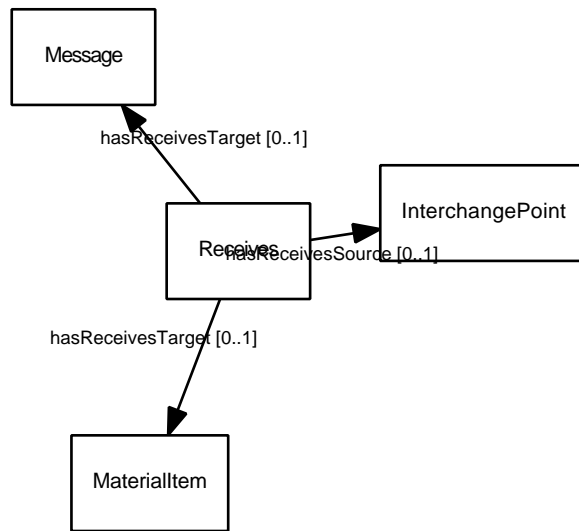


Figure 65: Class usage diagram for Receives.

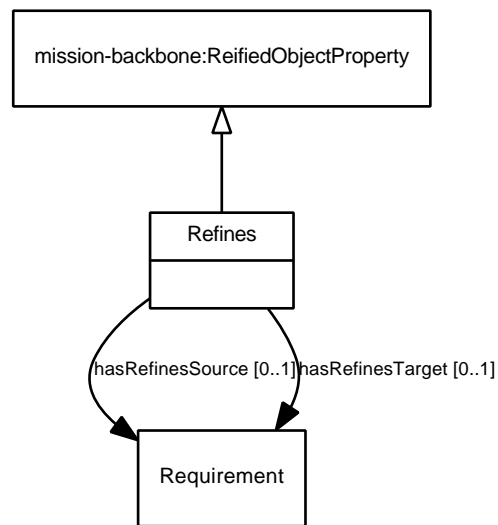


Figure 66: Class definition diagram for Refines.

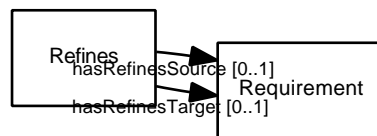


Figure 67: Class usage diagram for Refines.

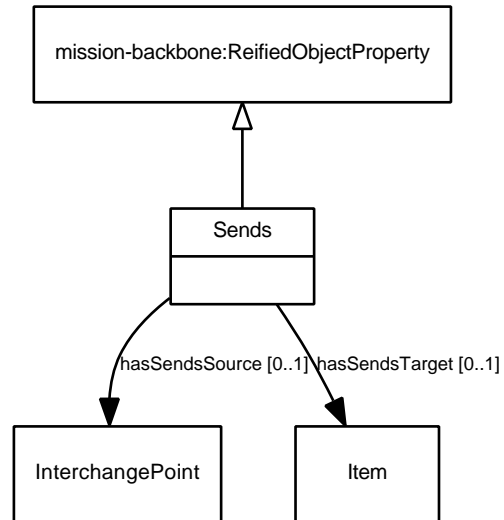


Figure 68: Class definition diagram for Sends.

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasSendsSource** [0..1] InterchangePoint
hasSendsTarget [0..1] Item

Reified Object Properties: sends

The class definition diagram for Sends is shown in Figure 68. The class usage diagram for Sends is shown in Figure 69.

6.21 Specifies

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasSpecifiesSource** [0..1] Requirement
hasSpecifiesTarget [0..1] SpecifiedElement

Reified Object Properties: specifies

The class definition diagram for Specifies is shown in Figure 70. The class usage diagram for Specifies is shown in Figure 71.

6.22 Transfers

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Subclasses: TransfersIn, TransfersOut

Asserted Object Properties: **hasTransfersSource** [0..1] Interface

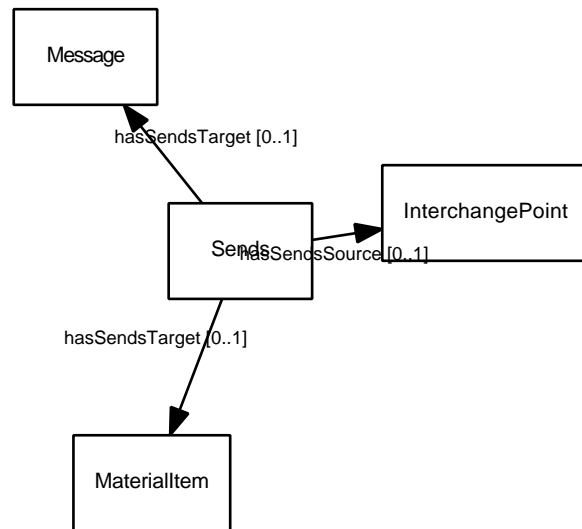


Figure 69: Class usage diagram for Sends.

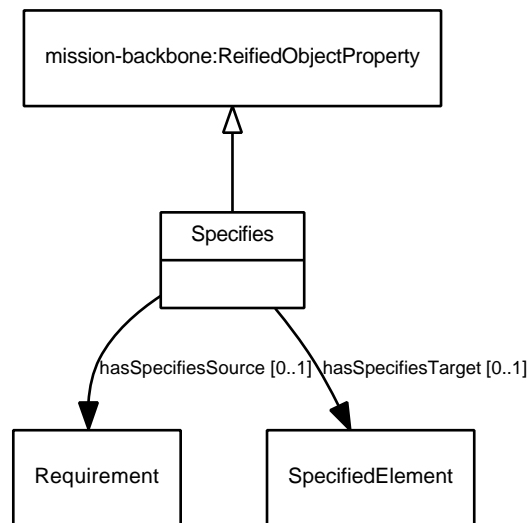


Figure 70: Class definition diagram for Specifies.

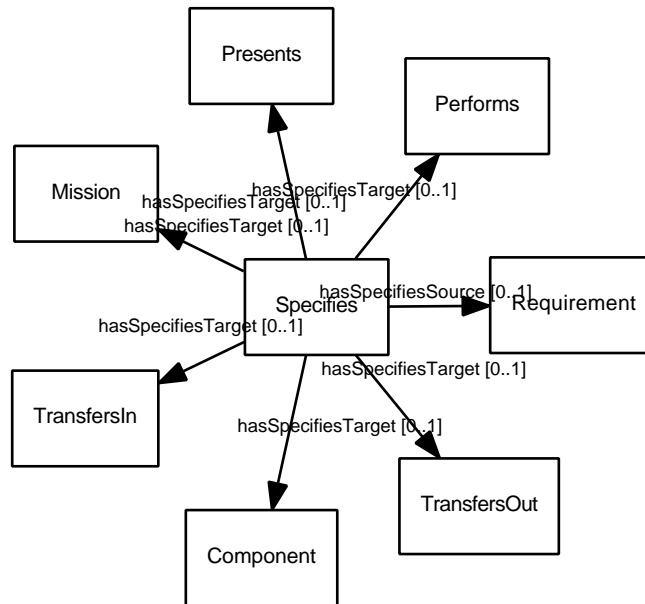


Figure 71: Class usage diagram for Specifies.

hasTransfersTarget [0..1] TraversingElement

Reified Object Properties: transfers

The class definition diagram for Transfers is shown in Figure 72.

6.23 TransfersIn

Asserted Superclasses: SpecifiedElement, Transfers

Inferred Superclasses: mission-backbone:Aspect, mission-backbone:ReifiedObjectProperty, mission-backbone:Thing

Asserted Object Properties: **hasTransfersInSource** [0..1] Interface

hasTransfersInTarget [0..1] TraversingElement

Inferred Object Properties: **hasTransfersSource** [0..1] Interface

hasTransfersTarget [0..1] TraversingElement

isSpecifiedBy [0..*] Requirement

Reified Object Properties: transfersIn

The class definition diagram for TransfersIn is shown in Figure 73. The class usage diagram for TransfersIn is shown in Figure 74.

6.24 TransfersOut

Asserted Superclasses: SpecifiedElement, Transfers

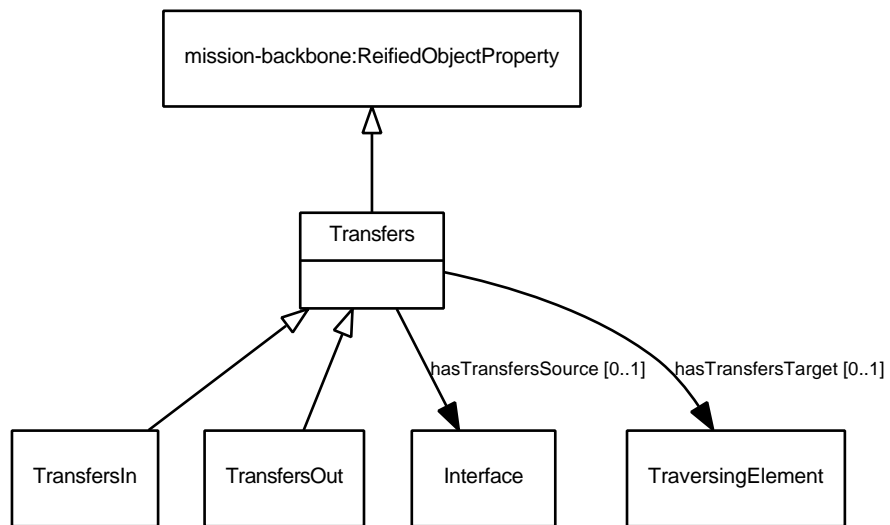


Figure 72: Class definition diagram for Transfers.

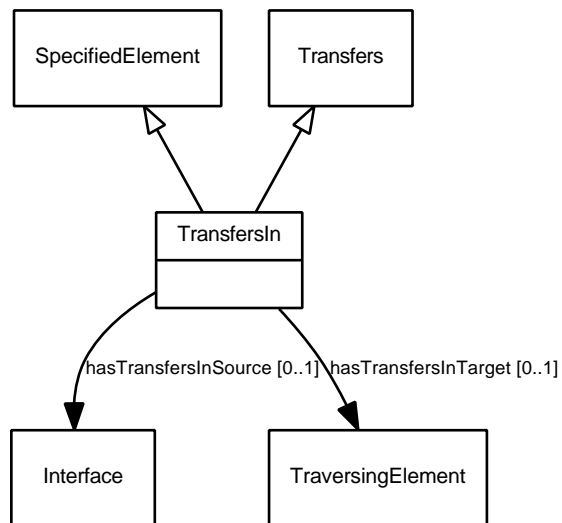


Figure 73: Class definition diagram for TransfersIn.

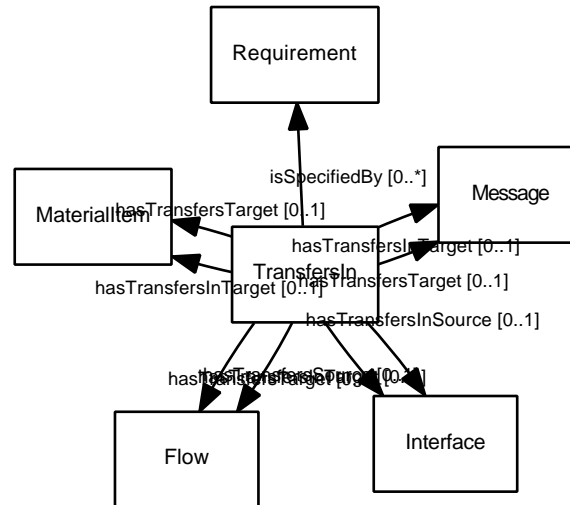


Figure 74: Class usage diagram for TransfersIn.

Inferred Superclasses: mission-backbone:Aspect, mission-backbone:ReifiedObjectProperty, mission-backbone:Thing

Asserted Object Properties: **hasTransfersOutSource** [0..1] Interface
hasTransfersOutTarget [0..1] TraversingElement

Inferred Object Properties: **hasTransfersSource** [0..1] Interface
hasTransfersTarget [0..1] TraversingElement
isSpecifiedBy [0..*] Requirement

Reified Object Properties: transfersOut

The class definition diagram for TransfersOut is shown in Figure 75. The class usage diagram for TransfersOut is shown in Figure 76.

6.25 Traverses

Asserted Superclasses: mission-backbone:ReifiedObjectProperty

Inferred Superclasses: mission-backbone:Thing

Asserted Object Properties: **hasIsTraversedBySource** [0..1] Junction
hasIsTraversedByTarget [0..1] TraversingElement

Reified Object Properties: isTraversedBy

The class definition diagram for Traverses is shown in Figure 77. The class usage diagram for Traverses is shown in Figure 78.

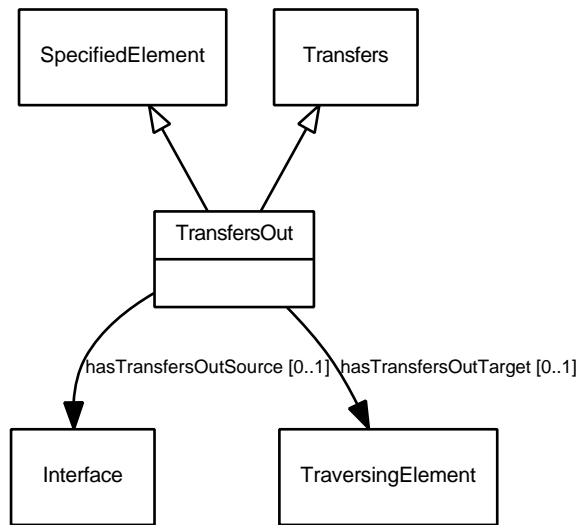


Figure 75: Class definition diagram for TransfersOut.

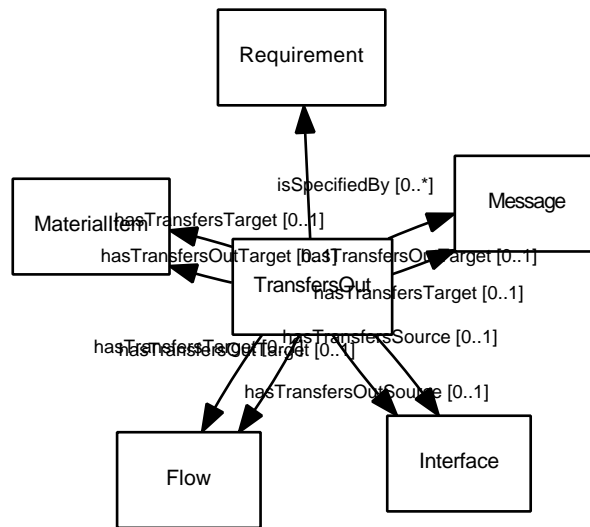


Figure 76: Class usage diagram for TransfersOut.

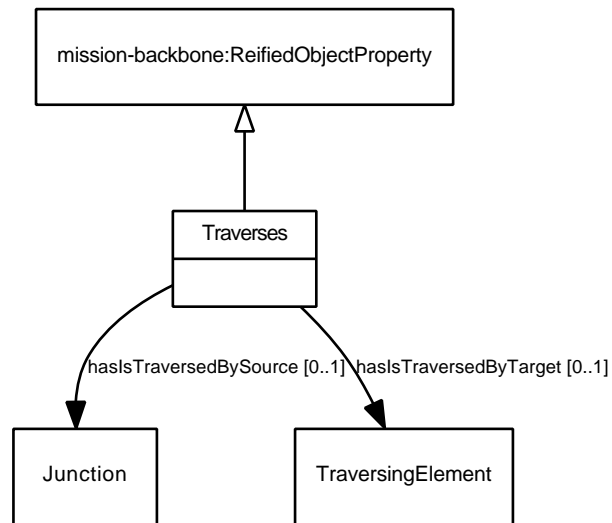


Figure 77: Class definition diagram for Traverses.

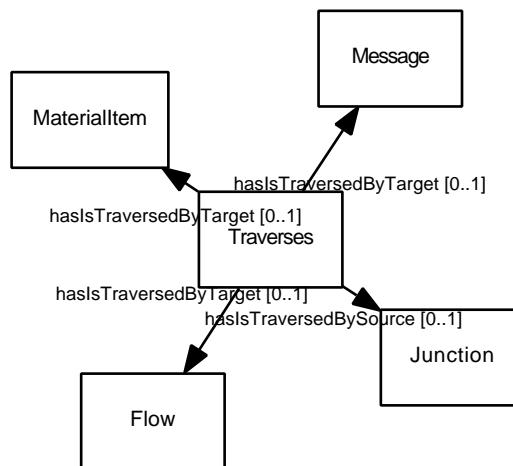


Figure 78: Class usage diagram for Traverses.

7 Concrete Datatype Property Definitions

7.1 hasRationale

A *rationale* explains why a *Requirement* exists and why it *specifies* what it does.

Asserted Superproperties: base-backbone:topDataProperty, mission-backbone:topDataProperty

Domain: Requirement

Range: [0..1] xsd:string

Derived: false

8 Abstract Object Property Definitions

8.1 involves

An *Interaction* i involves a pair of *Functions* $\{f_1\}$ and $\{f_2\}$ if and only if $\{f_1\}$ emits a *Flow* or sends an *Item* that $\{f_2\}$ ingests or receives,

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Range: [0..*] InterchangePoint

Inverse: isInvolvedIn

Derived: false

Reification Class: Involves

Reification Property Chain: hasInvolvesSource⁻¹ ◦ hasInvolvesTarget

8.2 isInvolvedIn

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Range: [0..*] Interchange

Inverse: involves

Derived: true

8.3 isJoinedIn

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Range: [0..1] Junction

Inverse: joins

Derived: true

8.4 joins

A *Junction* j joins a pair of *Interfaces* $\{i_1\}$ and $\{i_2\}$ if and only if the set $\{i_k\}$ share some type of connection and j represents properties common to all *Interfaces* in $\{i_k\}$ pertinent to that connection.

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Range: [0..*] Interface

Inverse: isJoinedIn

Derived: false

Reification Class: Joins

Reification Property Chain: hasJoinsSource⁻¹ ◦ hasJoinsTarget

8.5 transfers

An *Interface* i *transfers* a *TraversingElement* e if and only if i is the access point by which e enters or leaves a *Component* that *presents* i .

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Range: [0..*] TraversingElement

Derived: false

Reification Class: Transfers

Reification Property Chain: hasTransfersSource⁻¹ ◦ hasTransfersTarget

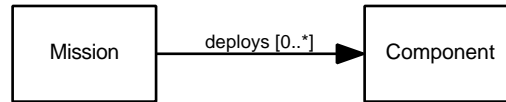


Figure 79: Property usage diagram for deploys.

9 Concrete Object Property Definitions

9.1 deploys

A *Mission* m *deploys* *Component* c if and only if m exploits or utilizes c in pursuit of *Objectives*. Note that a given *Mission* may not *own* all the *Components* it *deploys*; some *Components* (e.g., ground system assets) may be shared with multiple missions.

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Mission

Range: [0..*] Component

Inverse: isDeployedBy

Derived: false

Reification Class: Deploys

Reification Property Chain: hasDeploysSource⁻¹ ◦ hasDeploysTarget

The property usage diagram for deploys is shown in Figure 79.

9.2 emits

A *Function* F *emits* a *Flow* f if and only if F is the source of f .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: InterchangePoint

Range: [0..*] Flow

Inverse: isEmittedBy

Derived: false

Reification Class: Emits

Reification Property Chain: hasEmitsSource⁻¹ ◦ hasEmitsTarget

The property usage diagram for emits is shown in Figure 80.



Figure 80: Property usage diagram for emits.

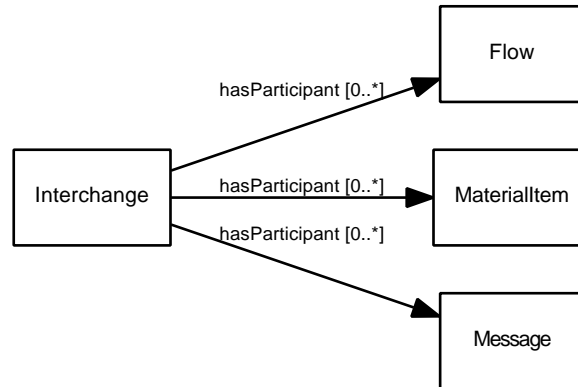


Figure 81: Property usage diagram for hasParticipant.

9.3 hasParticipant

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Interchange

Range: [0..*] TraversingElement

Inverse: participatesIn

Derived: false

Reification Class: HasParticipant

Reification Property Chain: hasHasParticipantSource⁻¹ ◦ hasHasParticipantTarget

The property usage diagram for hasParticipant is shown in Figure 81.

9.4 induces

A *Component c* induces an *Environment e* if and only if *c* generates or contributes to the conditions described in *e*.

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Component

Range: [0..*] Environment

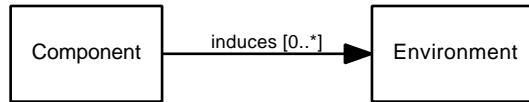


Figure 82: Property usage diagram for induces.

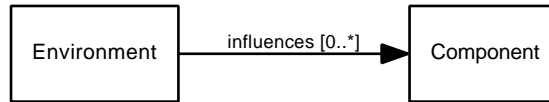


Figure 83: Property usage diagram for influences.

Inverse: isInducedBy

Derived: false

Reification Class: Induces

Reification Property Chain: hasInducesSource⁻¹ ◦ hasInducesTarget

The property usage diagram for induces is shown in Figure 82.

9.5 influences

An *Environment* e *influences* a *Component* c if and only if c is subject to the conditions that define e .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Environment

Range: [0..*] Component

Inverse: isInfluencedBy

Derived: false

Reification Class: Influences

Reification Property Chain: hasInfluencesSource⁻¹ ◦ hasInfluencesTarget

The property usage diagram for influences is shown in Figure 83.

9.6 ingests

An *Function* F *ingests* a *Flow* f if and only if F consumes or is otherwise the recipient of f .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: InterchangePoint

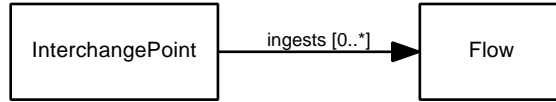


Figure 84: Property usage diagram for ingests.

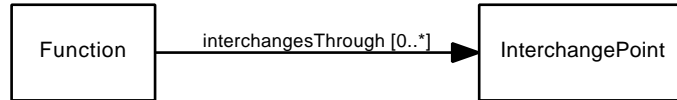


Figure 85: Property usage diagram for interchangesThrough.

Range: [0..*] Flow

Inverse: isIngestedBy

Derived: false

Reification Class: Ingests

Reification Property Chain: hasIngestsSource⁻¹ ◦ hasIngestsTarget

The property usage diagram for ingests is shown in Figure 84.

9.7 interchangesThrough

A *PerformingElement* p *interchangesThrough* an *InterchangePoint* i if and only if p has as a consequence of execution an interchange of matter or information with some other *PerformingElement* via i . Exactly one *PerformingElement* *interchangesThrough* each *InterchangePoint*.

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Function

Range: [0..*] InterchangePoint

Inverse: isInterchangePointFor

Derived: false

Reification Class: InterchangesThrough

Reification Property Chain: hasInterchangesThroughSource⁻¹ ◦ hasInterchangesThroughTarget

The property usage diagram for interchangesThrough is shown in Figure 85.

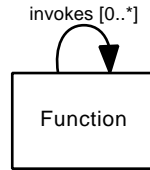


Figure 86: Property usage diagram for invokes.

9.8 invokes

A *Function* f_1 *invokes* a *Function* f_2 if and only if execution of f_1 may directly cause execution of f_2 .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Function

Range: [0..*] Function

Inverse: isInvokedBy

Derived: false

Reification Class: Invokes

Reification Property Chain: hasInvokesSource⁻¹ ◦ hasInvokesTarget

The property usage diagram for invokes is shown in Figure 86.

9.9 involves1

Asserted Superproperties: involves

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: Interchange

Range: [0..1] InterchangePoint

Inverse: isInvolvedIn1

Derived: false

Reification Class: Involves1

Reification Property Chain: hasInvolves1Source⁻¹ ◦ hasInvolves1Target

The property usage diagram for involves1 is shown in Figure 87.

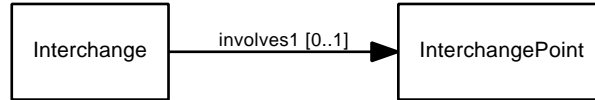


Figure 87: Property usage diagram for involves1.

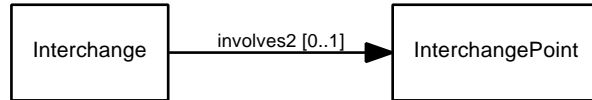


Figure 88: Property usage diagram for involves2.

9.10 involves2

Asserted Superproperties: involves

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: Interchange

Range: [0..1] InterchangePoint

Inverse: isInvolvedIn2

Derived: false

Reification Class: Involves2

Reification Property Chain: hasInvolves2Source⁻¹ ◦ hasInvolves2Target

The property usage diagram for involves2 is shown in Figure 88.

9.11 isDeployedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Component

Range: [0..*] Mission

Inverse: deploys

Derived: true

The property usage diagram for isDeployedBy is shown in Figure 89.

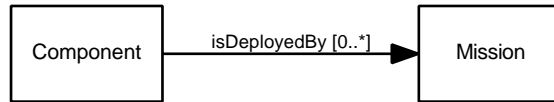


Figure 89: Property usage diagram for isDeployedBy.

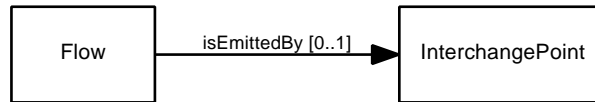


Figure 90: Property usage diagram for isEmittedBy.

9.12 isEmittedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Flow

Range: [0..1] InterchangePoint

Inverse: emits

Derived: true

The property usage diagram for isEmittedBy is shown in Figure 90.

9.13 isInducedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Environment

Range: [0..*] Component

Inverse: induces

Derived: true

The property usage diagram for isInducedBy is shown in Figure 91.

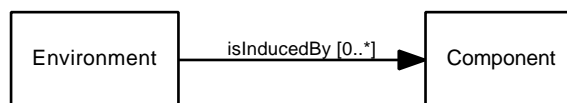


Figure 91: Property usage diagram for isInducedBy.

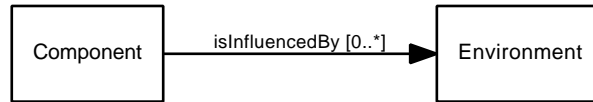


Figure 92: Property usage diagram for isInfluencedBy.

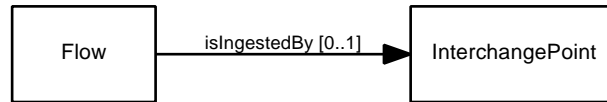


Figure 93: Property usage diagram for isIngestedBy.

9.14 isInfluencedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Component

Range: [0..*] Environment

Inverse: influences

Derived: true

The property usage diagram for isInfluencedBy is shown in Figure 92.

9.15 isIngestedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Flow

Range: [0..1] InterchangePoint

Inverse: ingests

Derived: true

The property usage diagram for isIngestedBy is shown in Figure 93.

9.16 isInterchangePointFor

See *interchangesThrough*.

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: InterchangePoint

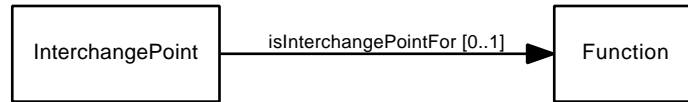


Figure 94: Property usage diagram for isInterchangePointFor.

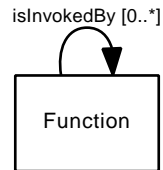


Figure 95: Property usage diagram for isInvokedBy.

Range: [0..1] Function

Inverse: interchangesThrough

Derived: true

The property usage diagram for isInterchangePointFor is shown in Figure 94.

9.17 *isInvokedBy*

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Function

Range: [0..*] Function

Inverse: invokes

Derived: true

The property usage diagram for isInvokedBy is shown in Figure 95.

9.18 *isInvolvedIn1*

Asserted Superproperties: isInvolvedIn

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: InterchangePoint

Range: [0..*] Interchange

Inverse: involves1

Derived: true

The property usage diagram for isInvolvedIn1 is shown in Figure 96.

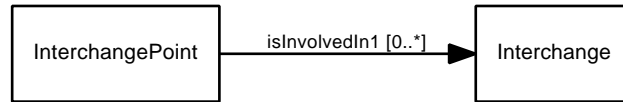


Figure 96: Property usage diagram for isInvolvedIn1.

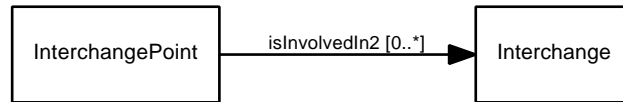


Figure 97: Property usage diagram for isInvolvedIn2.

9.19 isInvolvedIn2

Asserted Superproperties: isInvolvedIn

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: InterchangePoint

Range: [0..*] Interchange

Inverse: involves2

Derived: true

The property usage diagram for isInvolvedIn2 is shown in Figure 97.

9.20 isJoinedIn1

Asserted Superproperties: isJoinedIn

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: Interface

Range: [0..1] Junction

Inverse: joins1

Derived: true

The property usage diagram for isJoinedIn1 is shown in Figure 98.

9.21 isJoinedIn2

Asserted Superproperties: isJoinedIn

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

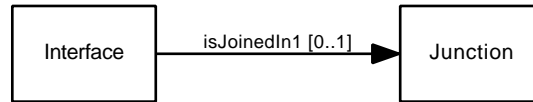


Figure 98: Property usage diagram for isJoinedIn1.

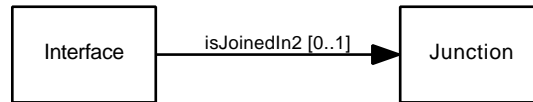


Figure 99: Property usage diagram for isJoinedIn2.

Domain: Interface

Range: [0..1] Junction

Inverse: joins2

Derived: true

The property usage diagram for isJoinedIn2 is shown in Figure 99.

9.22 isPerformedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Function

Range: [0..1] PerformingElement

Inverse: performs

Derived: true

The property usage diagram for isPerformedBy is shown in Figure 100.

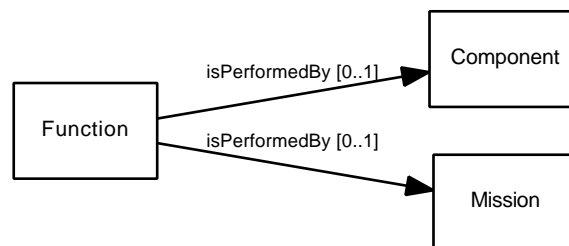


Figure 100: Property usage diagram for isPerformedBy.

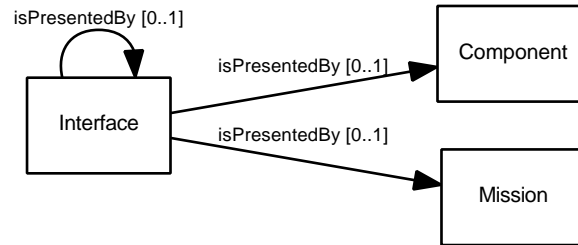


Figure 101: Property usage diagram for isPresentedBy.

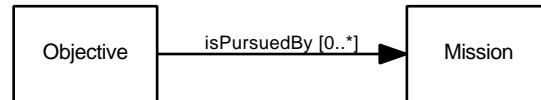


Figure 102: Property usage diagram for isPursuedBy.

9.23 isPresentedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Interface

Range: [0..1] PresentingElement

Inverse: presents

Derived: true

The property usage diagram for isPresentedBy is shown in Figure 101.

9.24 isPursuedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

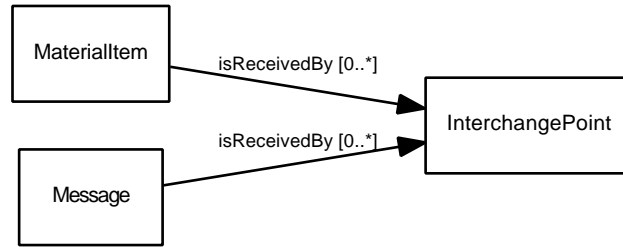
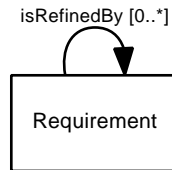
Domain: Objective

Range: [0..*] Mission

Inverse: pursues

Derived: true

The property usage diagram for isPursuedBy is shown in Figure 102.

Figure 103: Property usage diagram for *isReceivedBy*.Figure 104: Property usage diagram for *isRefinedBy*.

9.25 *isReceivedBy*

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Item

Range: [0..*] InterchangePoint

Inverse: receives

Derived: true

The property usage diagram for *isReceivedBy* is shown in Figure 103.

9.26 *isRefinedBy*

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Requirement

Range: [0..*] Requirement

Inverse: refines

Derived: true

The property usage diagram for *isRefinedBy* is shown in Figure 104.

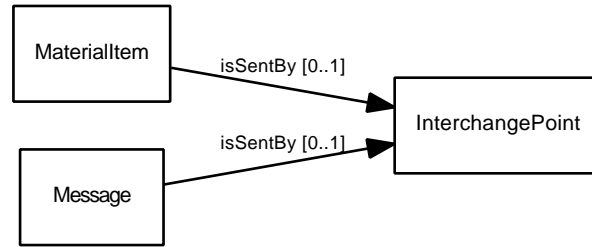


Figure 105: Property usage diagram for isSentBy.

9.27 isSentBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Item

Range: [0..1] InterchangePoint

Inverse: sends

Derived: true

The property usage diagram for isSentBy is shown in Figure 105.

9.28 isSpecifiedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: SpecifiedElement

Range: [0..*] Requirement

Inverse: specifies

Derived: true

The property usage diagram for isSpecifiedBy is shown in Figure 106.

9.29 isTraversedBy

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Junction

Range: [0..*] TraversingElement

Inverse: traverses

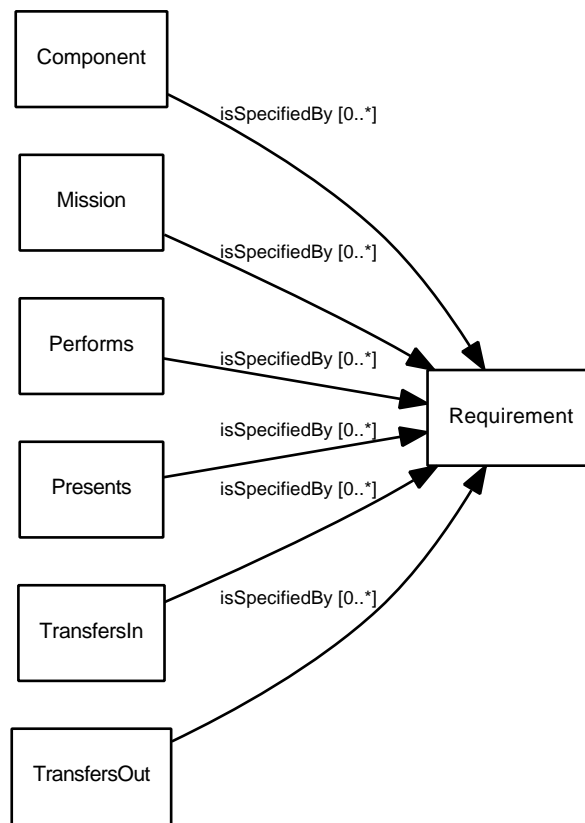


Figure 106: Property usage diagram for isSpecifiedBy.

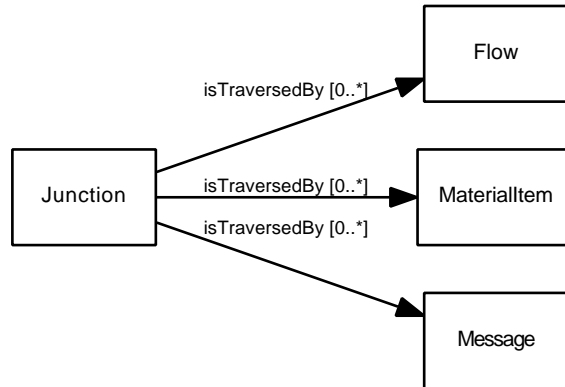


Figure 107: Property usage diagram for isTraversedBy.

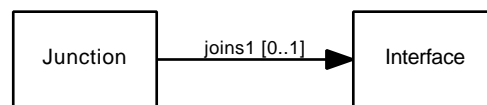


Figure 108: Property usage diagram for joins1.

Derived: false**Reification Class:** Traverses**Reification Property Chain:** hasIsTraversedBySource⁻¹ ◦ hasIsTraversedByTarget

The property usage diagram for isTraversedBy is shown in Figure 107.

9.30 joins1

Asserted Superproperties: joins**Inferred Superproperties:** mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty**Domain:** Junction**Range:** [0..1] Interface**Inverse:** isJoinedIn1**Derived:** false**Reification Class:** Joins1**Reification Property Chain:** hasJoins1Source⁻¹ ◦ hasJoins1Target

The property usage diagram for joins1 is shown in Figure 108.

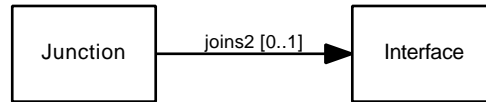


Figure 109: Property usage diagram for joins2.

9.31 joins2

Asserted Superproperties: joins

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: Junction

Range: [0..1] Interface

Inverse: isJoinedIn2

Derived: false

Reification Class: Joins2

Reification Property Chain: hasJoins2Source⁻¹ ◦ hasJoins2Target

The property usage diagram for joins2 is shown in Figure 109.

9.32 participatesIn

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: TraversingElement

Range: [0..*] Interchange

Inverse: hasParticipant

Derived: true

The property usage diagram for participatesIn is shown in Figure 110.

9.33 performs

A *Component c* performs a *Function f* if and only if *c* has the sole responsibility for execution of *f*.

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: PerformingElement

Range: [0..*] Function

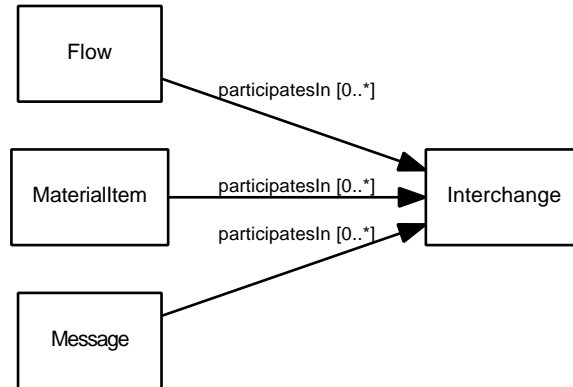


Figure 110: Property usage diagram for participatesIn.

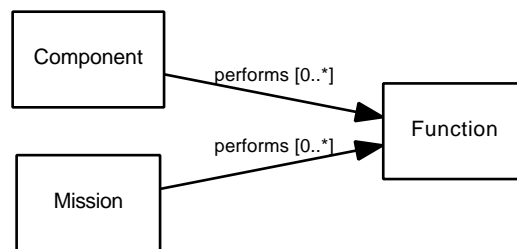


Figure 111: Property usage diagram for performs.

Inverse: isPerformedBy

Derived: false

Reification Class: Performs

Reification Property Chain: hasPerformsSource⁻¹ ◦ hasPerformsTarget

The property usage diagram for performs is shown in Figure 111.

9.34 presents

A *Component* *c* presents an *Interface* *i* if and only if *c* has a direct electrical, mechanical, or logical connection to the outside via *i*. Exactly one *Component* presents each *Interface*.

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: PresentingElement

Range: [0..*] Interface

Inverse: isPresentedBy

Derived: false

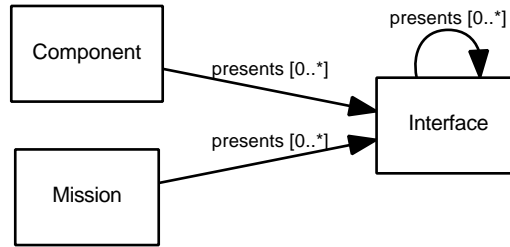


Figure 112: Property usage diagram for presents.

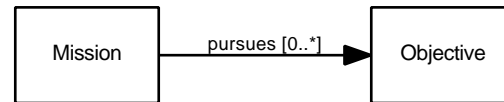


Figure 113: Property usage diagram for pursues.

Reification Class: Presents

Reification Property Chain: $\text{hasPresentsSource}^{-1} \circ \text{hasPresentsTarget}$

The property usage diagram for presents is shown in Figure 112.

9.35 *pursues*

A *Mission* m *pursues* an *Objective* o if and only if the successful execution of m results in at least partial achievement of o .

Asserted Superproperties: `mission-backbone:topReifiedObjectProperty`

Inferred Superproperties: `mission-backbone:topObjectProperty`

Domain: Mission

Range: $[0..*]$ Objective

Inverse: `isPursuedBy`

Derived: false

Reification Class: Pursues

Reification Property Chain: $\text{hasPursuesSource}^{-1} \circ \text{hasPursuesTarget}$

The property usage diagram for pursues is shown in Figure 113.

9.36 *receives*

A *Function* F *receives* an *Item* i if and only if F consumes i .

Asserted Superproperties: `mission-backbone:topReifiedObjectProperty`

Inferred Superproperties: `mission-backbone:topObjectProperty`

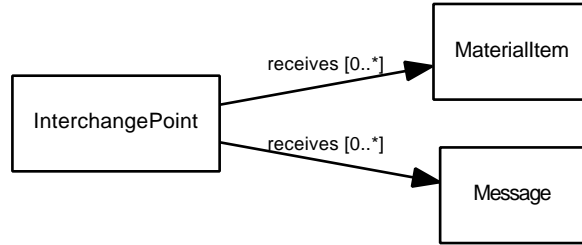


Figure 114: Property usage diagram for receives.

Domain: InterchangePoint

Range: [0..*] Item

Inverse: isReceivedBy

Derived: false

Reification Class: Receives

Reification Property Chain: hasReceivesSource⁻¹ ◦ hasReceivesTarget

The property usage diagram for receives is shown in Figure 114.

9.37 refines

A Requirement l refines a Requirement h if and only if satisfaction of l implies partial satisfaction of h .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Requirement

Range: [0..*] Requirement

Inverse: isRefinedBy

Derived: false

Reification Class: Refines

Reification Property Chain: hasRefinesSource⁻¹ ◦ hasRefinesTarget

The property usage diagram for refines is shown in Figure 115.

9.38 sends

A Function F sends an Item i if and only if F is the source for i .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

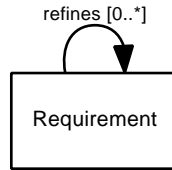


Figure 115: Property usage diagram for refines.

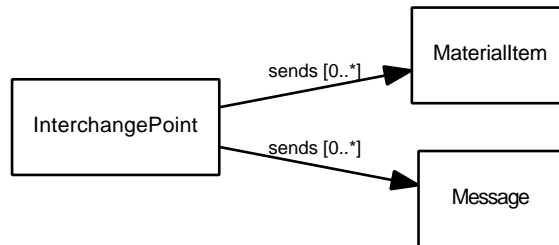


Figure 116: Property usage diagram for sends.

Domain: InterchangePoint

Range: [0..*] Item

Inverse: isSentBy

Derived: false

Reification Class: Sends

Reification Property Chain: hasSendsSource⁻¹ ◦ hasSendsTarget

The property usage diagram for sends is shown in Figure 116.

9.39 specifies

A *Requirement* r specifies a element e if and only if the properties of e are bound by r .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Requirement

Range: [0..1] SpecifiedElement

Inverse: isSpecifiedBy

Derived: false

Reification Class: Specifies

Reification Property Chain: hasSpecifiesSource⁻¹ ◦ hasSpecifiesTarget

The property usage diagram for specifies is shown in Figure 117.

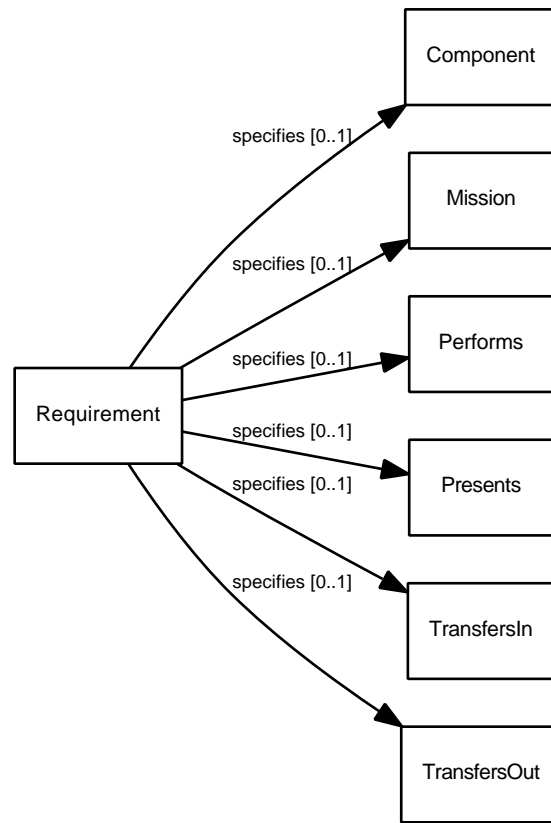


Figure 117: Property usage diagram for specifies.

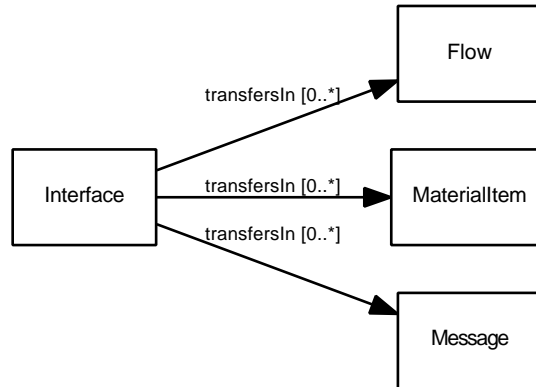


Figure 118: Property usage diagram for transfersIn.

9.40 transfersIn

An *Interface* i *transfersOut* a *TraversingElement* e if and only if i is the access point by which e leaves a *Component* that presents i .

Asserted Superproperties: transfers

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: Interface

Range: [0..*] TraversingElement

Derived: false

Reification Class: TransfersIn

Reification Property Chain: hasTransfersInSource⁻¹ ◦ hasTransfersInTarget

The property usage diagram for transfersIn is shown in Figure 118.

9.41 transfersOut

An *Interface* i *transfersOut* a *TraversingElement* e if and only if i is the access point by which e leaves a *Component* that presents i .

Asserted Superproperties: transfers

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectProperty

Domain: Interface

Range: [0..*] TraversingElement

Derived: false

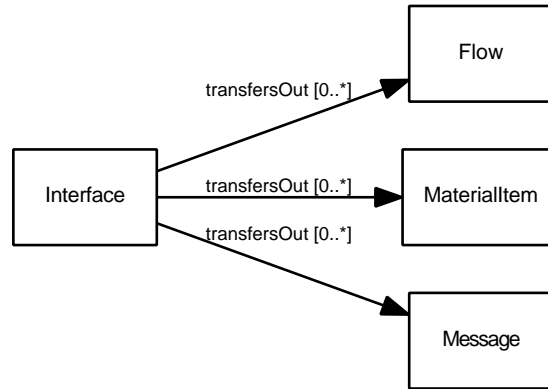


Figure 119: Property usage diagram for transfersOut.

Reification Class: TransfersOut

Reification Property Chain: hasTransfersOutSource⁻¹ ◦ hasTransfersOutTarget

The property usage diagram for transfersOut is shown in Figure 119.

9.42 traverses

A *TraversingElement* e traverses an *Junction* j if and only if j provides a medium or channel for the transfer of e .

Asserted Superproperties: mission-backbone:topReifiedObjectProperty

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: TraversingElement

Range: [0..*] Junction

Inverse: isTraversedBy

Derived: true

The property usage diagram for traverses is shown in Figure 120.

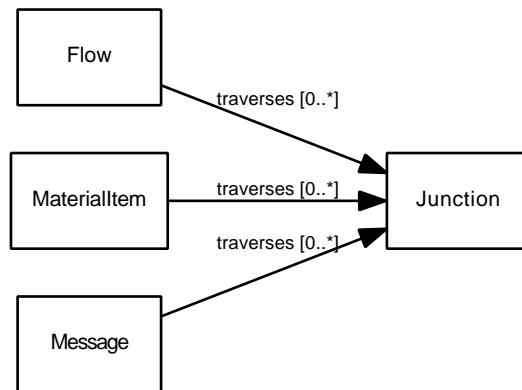


Figure 120: Property usage diagram for traverses.

10 Object Property Reification Source/Target Object Property Definitions

10.1 hasDeploysSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Deploys

Range: [0..1] Mission

Derived: false

10.2 hasDeploysTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Deploys

Range: [0..1] Component

Derived: false

10.3 hasEmitsSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Emits

Range: [0..1] InterchangePoint

Derived: false

10.4 hasEmitsTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Emits

Range: [0..1] Flow

Derived: false

10.5 hasHasParticipantSource**Asserted Superproperties:** mission-backbone:topReifiedObjectPropertySource**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** HasParticipant**Range:** [0..1] Interchange**Derived:** false**10.6 hasHasParticipantTarget****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertyTarget**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** HasParticipant**Range:** [0..1] TraversingElement**Derived:** false**10.7 hasInducesSource****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertySource**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Induces**Range:** [0..1] Component**Derived:** false**10.8 hasInducesTarget****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertyTarget**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Induces**Range:** [0..1] Environment**Derived:** false**10.9 hasInfluencesSource****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertySource**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Influences**Range:** [0..1] Environment**Derived:** false

10.10 hasInfluencesTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Influences

Range: [0..1] Component

Derived: false

10.11 hasIngestsSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Ingests

Range: [0..1] InterchangePoint

Derived: false

10.12 hasIngestsTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Ingests

Range: [0..1] Flow

Derived: false

10.13 hasInterchangesThroughSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: InterchangesThrough

Range: [0..1] Function

Derived: false

10.14 hasInterchangesThroughTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: InterchangesThrough

Range: [0..1] InterchangePoint

Derived: false

10.15 hasInvokesSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Invokes

Range: [0..1] Function

Derived: false

10.16 hasInvokesTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Invokes

Range: [0..1] Function

Derived: false

10.17 hasInvolves1Source

Asserted Superproperties: hasInvolvesSource

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertySource

Domain: Involves1

Range: [0..1] Interchange

Derived: false

10.18 hasInvolves1Target

Asserted Superproperties: hasInvolvesTarget

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertyTarget

Domain: Involves1

Range: [0..1] InterchangePoint

Derived: false

10.19 **hasInvolves2Source**

Asserted Superproperties: hasInvolvesSource

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertySource

Domain: Involves2

Range: [0..1] Interchange

Derived: false

10.20 **hasInvolves2Target**

Asserted Superproperties: hasInvolvesTarget

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertyTarget

Domain: Involves2

Range: [0..1] InterchangePoint

Derived: false

10.21 **hasInvolvesSource**

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Involves

Range: [0..1] Interchange

Derived: false

10.22 **hasInvolvesTarget**

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Involves

Range: [0..1] InterchangePoint

Derived: false

10.23 hasIsTraversedBySource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Traverses

Range: [0..1] Junction

Derived: false

10.24 hasIsTraversedByTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Traverses

Range: [0..1] TraversingElement

Derived: false

10.25 hasJoins1Source

Asserted Superproperties: hasJoinsSource

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertySource

Domain: Joins1

Range: [0..1] Junction

Derived: false

10.26 hasJoins1Target

Asserted Superproperties: hasJoinsTarget

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertyTarget

Domain: Joins1

Range: [0..1] Interface

Derived: false

10.27 hasJoins2Source

Asserted Superproperties: hasJoinsSource

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertySource

Domain: Joins2

Range: [0..1] Junction

Derived: false

10.28 hasJoins2Target

Asserted Superproperties: hasJoinsTarget

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertyTarget

Domain: Joins2

Range: [0..1] Interface

Derived: false

10.29 hasJoinsSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Joins

Range: [0..1] Junction

Derived: false

10.30 hasJoinsTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Joins

Range: [0..1] Interface

Derived: false

10.31 hasPerformsSource**Asserted Superproperties:** mission-backbone:topReifiedObjectPropertySource**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Performs**Range:** [0..1] PerformingElement**Derived:** false**10.32 hasPerformsTarget****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertyTarget**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Performs**Range:** [0..1] Function**Derived:** false**10.33 hasPresentsSource****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertySource**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Presents**Range:** [0..1] PresentingElement**Derived:** false**10.34 hasPresentsTarget****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertyTarget**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Presents**Range:** [0..1] Interface**Derived:** false**10.35 hasPursuesSource****Asserted Superproperties:** mission-backbone:topReifiedObjectPropertySource**Inferred Superproperties:** mission-backbone:topObjectProperty**Domain:** Pursues**Range:** [0..1] Mission**Derived:** false

10.36 hasPursuesTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Pursues

Range: [0..1] Objective

Derived: false

10.37 hasReceivesSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Receives

Range: [0..1] InterchangePoint

Derived: false

10.38 hasReceivesTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Receives

Range: [0..1] Item

Derived: false

10.39 hasRefinesSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Refines

Range: [0..1] Requirement

Derived: false

10.40 hasRefinesTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Refines

Range: [0..1] Requirement

Derived: false

10.41 hasSendsSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Sends

Range: [0..1] InterchangePoint

Derived: false

10.42 hasSendsTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Sends

Range: [0..1] Item

Derived: false

10.43 hasSpecifiesSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Specifies

Range: [0..1] Requirement

Derived: false

10.44 hasSpecifiesTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Specifies

Range: [0..1] SpecifiedElement

Derived: false

10.45 hasTransfersInSource

Asserted Superproperties: hasTransfersSource

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertySource

Domain: TransfersIn

Range: [0..1] Interface

Derived: false

10.46 hasTransfersInTarget

Asserted Superproperties: hasTransfersTarget

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertyTarget

Domain: TransfersIn

Range: [0..1] TraversingElement

Derived: false

10.47 hasTransfersOutSource

Asserted Superproperties: hasTransfersSource

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertySource

Domain: TransfersOut

Range: [0..1] Interface

Derived: false

10.48 hasTransfersOutTarget

Asserted Superproperties: hasTransfersTarget

Inferred Superproperties: mission-backbone:topObjectProperty,
mission-backbone:topReifiedObjectPropertyTarget

Domain: TransfersOut

Range: [0..1] TraversingElement

Derived: false

10.49 hasTransfersSource

Asserted Superproperties: mission-backbone:topReifiedObjectPropertySource

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Transfers

Range: [0..1] Interface

Derived: false

10.50 hasTransfersTarget

Asserted Superproperties: mission-backbone:topReifiedObjectPropertyTarget

Inferred Superproperties: mission-backbone:topObjectProperty

Domain: Transfers

Range: [0..1] TraversingElement

Derived: false

A UML/SysML Embedding

Table 1: Class UML/SysML Embedding

	SysML-metamodel:Class.Block	SysML-metamodel:Class.Block.InterfaceBlock	SysML-metamodel:Component.Block	SysML-metamodel:Component.Requirement	UML-metamodel:AssociationClass	UML-metamodel:Class	UML-metamodel:Component
Component			•				•
Environment			•				•
Flow	•					•	
Function			•				•
Interchange					•		
InterchangePoint			•				•
Interface	•	•				•	
Item	•					•	
Junction					•		
MaterialItem	•					•	
Message	•					•	
Mission			•				•
Objective			•				•
PerformingElement							
PresentingElement							
Requirement				•			•
SpecifiedElement							
TraversingElement							

Table 2: Class OWL2-MOF2 Embedding

	owl2-mof2:BinaryAssociationEndType	owl2-mof2:BinaryDependencyEndType	owl2-mof2:ObjectPropertyDependentRangeType	owl2-mof2:StructuralFlowPropertyType	owl2-mof2:StructuralFullPortEncapsulatedClassifierType
Component	•	•			•
Environment	•				
Flow	•	•		•	
Function			•		
Interchange			•		
InterchangePoint		•			
Interface		•			•
Item	•	•		•	
Junction	•				
MaterialItem	•	•		•	
Message	•	•		•	
Mission	•	•			•
Objective			•		
PerformingElement			•		
PresentingElement			•		
Requirement			•		
SpecifiedElement			•		
TraversingElement			•		

Table 3: Object Property Reification Class OWL2-MOF2 Embedding

	owl2-mof2-backbone:ReifiedObjectProperty	owl2-mof2:BinaryAssociation	owl2-mof2:BinaryAssociationBlockEnd	owl2-mof2:BinaryDependencyEndType	owl2-mof2:ObjectPropertyDependentRangeType	owl2-mof2:StructuralFlowPropertyRelationship
Deploys		•		•		
Emits				•		•
HasParticipant				•		•
Induces	•			•		
Influences	•			•		
Ingests				•		•
InterchangesThrough	•				•	
Invokes		•		•		
Involves	•			•		
Involves1			•	•		
Involves2			•	•		
Joins	•			•		
Joins1			•	•		
Joins2			•	•		
Performs		•		•		
Presents	•			•		
Pursues	•			•		
Receives				•		•
Refines	•			•		
Sends				•		•
Specifies	•			•		
Transfers	•			•		
TransfersIn				•		•
TransfersOut				•		•
Traverses				•		•

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