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This OMG document replaces the first Beta ~~1~~2 document (ptc/1~~6~~7-07-03). It is an OMG Beta Specification and is currently in the finalization phase. ~~Comments on the content of this document are welcome, and should be directed to *issues@omg.org* by May 15, 2017.~~

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Table of Contents

1 Scope....1
1.1 General....1
1.2 Structured Arguments....1
1.3 Evidence....1
1.4 History, Motivation, and Rationale....2
2 Conformance....3
2.1 Introduction....3
2.2 Argumentation compliance point....3
2.3 Artifact model compliance point....3
2.4 Assurance Case compliance point....4
3 References....5
3.1 Normative References....5
3.2 Non-normative References....5
4 Terms and Definitions....5
5 Symbols....6
6 Additional Information....6
6.1 Changes to Adopted OMG Specifications [optional]....6
6.2 Acknowledgements....6
6.3 How to Proceed....6
7 Background and Rationale....7
7.1 The Need for Assurance Cases....7
7.2 Structured Arguments....7
7.3 Arguments as asserted positions....7
7.4 Structured Arguments in SACM....8
7.5 Precise statements related to evidence....9
Part I – Common Elements....10
8 Structured Assurance Case Base Classes....12
8.1 General....12
8.2 SACMElement (abstract)....12
8.3 ModelElement (abstract)....12
8.4 UtilityElement (abstract)....13
8.5 ImplementationConstraint....13
8.6 Description....13
8.7 Note....14
8.8 TaggedValue....14
9 Structured Assurance Case Packages....15
9.1 General....15
9.2 ArtifactElement (abstract)....15
9.3 AssuranceCasePackage....15
9.4 AssuranceCasePackageInterface....16
9.5 AssuranceCasePackageCitation....16
9.6 ArgumentPackage....17
9.7 TerminologyPackage....17
9.8 ArtifactPackage....17
10 Structured Assurance Case Terminology Classes....19
10.1 General....19
10.2 TerminologyElement (abstract)....19
10.3 TerminologyPackage....20
10.4 TerminologyPackageCitation....20
10.5 TerminologyAsset (abstract)....20
10.6 Category....21
10.7 ExpressionElement (abstract)....21
10.8 Expression....21
10.9 Term....22

10.10 TerminologyAssetCitation....22
Part II – Argumentation Metamodel....23
11 SACM Argumentation Metamodel....25
11.1 General....25
11.2 Argumentation Class Diagram....25
11.2.1 ArgumentationElement class (abstract)....26
11.2.2 ArgumentPackage Class....26
11.2.3 ArgumentPackageCitation Class....26
11.2.4 ArgumentPackageBinding Class....27
11.2.5 ArgumentPackageInterface Class....27
11.2.6 ArgumentAsset Class (abstract)....28
11.2.7 Assertion Class (abstract)....28
11.2.8 ArtifactElementCitation Class....29
11.2.9 ArgumentAssetCitation Class....29
11.2.10 Claim Class....29
11.2.11 ArgumentReasoning Class....30
11.2.12 AssertedRelationship Class (abstract)....30
11.2.13 AssertedInference Class....30
11.2.14 AssertedEvidence Class....31
11.2.15 AssertedChallenge Class....31
11.2.16 AssertedCounterEvidence Class....31
11.2.17 AssertedContext Class....32
Part III – Artifact Metamodel....33
12 Artifact Classes....35
12.1 General....35
12.2 ArtifactPackageCitation....36
12.3 ArtifactPackageBinding....36
12.4 ArtifactPackageInterface....36
12.5 ArtifactAsset class (abstract)....37
12.5.1 ArtifactAssetCitation class....37
12.5.2 Artifact class....38
12.5.3 ArtifactProperty class....38
12.5.4 ArtifactEvent class....38
12.5.5 Resource class....39
12.5.6 Activity class....39
12.5.7 Technique class....39
12.5.8 Participant class....40
12.5.9 ArtifactAssetRelationship class....40
12.5.10 ArtifactRelationship class....40
12.5.11 ActivityRelationship class....40
12.5.12 ArtifactActivityRelationship class....41
12.5.13 ArtifactTechniqueRelationship class....41
12.5.14 ParticipantRoleRelationship class....41
12.5.15 ArtifactResourceRelationship class....42
Annex A – Mappings from existing industrial notations for assurance cases 43
Annex B – Examples of Assurance Cases in SACM 2.0 XMI 45

Preface

OMG

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1 Scope

1.1 General

This specification defines a metamodel for representing structured assurance cases. An Assurance Case is a set of auditable claims, arguments, and evidence created to support the claim that a defined system/service will satisfy the particular requirements. An Assurance Case is a document that facilitates information exchange between various system stakeholder such as suppliers and acquirers, and between the operator and regulator, where the knowledge related to the safety and security of the system is communicated in a clear and defendable way. Each assurance case should communicate the scope of the system, the operational context, the claims, the safety and/or security arguments, along with the corresponding evidence.

Systems Assurance is the process of building clear, comprehensive, and defensible arguments regarding the safety and security properties of systems. The vital element of Systems Assurance is that it makes clear and well-defined claims about the safety and security of systems. Certain claims are supported through reasoning. Reasoning is expressed by explicit annotated links between claims, where one or more claims (called sub-claims) when combined provide inferential support to a larger claim. Certain associations (recorded as assertions) between claims and subclaims can require supporting arguments of their own (e.g., justification of an asserted inference). Claims are propositions which are expressed by statements in some natural language. The degree of precision in formulation of the claims may contribute to the comprehensiveness of an assurance case. The context is important to communicate the scope of the claim, and to clarify the language used by the claim by providing necessary definition and explanations. Context involves assumptions made about the system and its environment. Explicit statement of the assumptions contributes to the comprehensiveness of the argument. Argumentation flow between claims is structured to facilitate communication of the entire assurance case.

1.2 Structured Arguments

Part of this specification defines a metamodel for representing structured arguments. A convincing argument that a system meets its assurance requirements is at the heart of an assurance case, which also may contain extensive references to evidence. The Argumentation Metamodel facilitates projects by allowing them to effectively and succinctly communicate in a structured way how their systems and services are meeting their assurance requirements. The scope of the Argumentation Metamodel is therefore to allow the interchange of structured arguments between diverse tools by different vendors. Each Argumentation Metamodel instance represents the argument that is being asserted by the stakeholder that is offering the argument for consideration.

This specification is designed to stand alone, or may be used in combination with the SACM Artifact Metamodel. The Artifact Metamodel is designed to represent aspects of evidence and properties about evidence in further detail. In the Argumentation Metamodel we have simplified support to model the relation of evidence to a structured argument. Standardization will ensure that end users are investing not just in individual tools but also rather in a coordinated strategy.

The metamodel for argumentation provides a common structure and interchange format that facilitates the exchange of system assurance arguments contained within individual tool models. The metamodel represents the core concepts for structured argumentation that underlie a number of existing argumentation notations.

1.3 Evidence

Part of this specification provides a metamodel for communicating the way in which evidence artifactartifacts are collected by various participants using techniques, resources and activities. This allows users to build a repository of evidence that communicates its provenance and how it was gathered. This Artifact Metamodel identifies the main elements that determine the evidence collection process: artifacts, participants, resources, activities and techniques. Artifacts may be exchanged as packages or combined into composites.

The SACM Artifact Metamodel defines a catalog of elements for constructing and interchanging packages of evidence that communicate how the evidence was collected.

In conjunction with the Argumentation Metamodel, certain claims may be expressed to be supported by evidence that is within the Artifact Metamodel, to permit the authors of the assurance claims to offer evidentiary support for their positions. Evidence is usually collected by applying systematic methods and procedures and is often collected by automated tools.

Evidence is information or objective artifacts, based on established fact or expert judgment, which is presented to show that the claim to which it relates is valid (i.e., true). Various and diverse things may be produced as evidence, such as documents, expert testimony, test results, measurement results, records related to process, product, and people, etc.

1.4 History, Motivation, and Rationale

The original Structured Assurance Case Metamodel version 1.0 was the composite of two efforts within the OMG's Systems Assurance Task Force. One effort, the Structured Assurance Evidence Metamodel (SAEM) was created through the OMG Request For Proposal (RFP) approach and the other, the Argumentation Metamodel (ARG) was created through the OMG Request For Comment (RFC) approach. Both were completed in the mid-2010 timeframe and then put into the same Finalization Task Force (FTF) due to the interconnectedness of their topics and concepts. The first version of SACM was eventually produced in the spring of 2012 consisting of a top-level container object joining SAEM and ARG without significantly altering the two original metamodels.

A Revision Task Force (RTF) was convened to drive further integration of the two original parts of SACM into one Metamodel and that effort formulated a set of goals to shape and guide the integration. Basically the stated goals were:

- Improve support for ISO/IEC 15026-2. In order to facilitate the use of structured assurance cases for producing and reviewing ISO/IEC 15026-2 conformant assurance cases, the structured assurance case metamodel needs to more fully support the constructs and entities in ISO/IEC 15026-2.

- Improve support for "Goal Structuring Notation." In order to facilitate the use of structured assurance cases by the existing community of practitioners across the world that are currently using Goal Structuring Notation (GSN) and the specific capabilities in GSN for working with assurance cases, the structured assurance case metamodel needs to more fully support the constructs and entities in GSN.

- Harmonization of Parts. In order to facilitate acceptance and successful use of SACM, the argumentation and evidence container metamodels need to be more consistently aligned and integrated. Areas of focus include elimination of overlap, making useful facilities now available on one side generalized to be useful on both sides, achieving uniform terminology and consistency, and using common concepts.

- Add initial support for Patterns/Templates. In order to make the use of assurance cases more practical and efficient for users including those that do not have in-depth experience within the assurance case domain (e.g., acquisition officials, systems integrators, auditors, regulators, and tool vendors), the structured assurance case metamodel needs to support the concept of assurance case patterns and templates. Patterns will provide support to enable reuse and the effective composition of assurance cases along with the underlying argumentation supporting goals. Templates will provide support for defining and describing constraining conventions that a community may require for assurance cases within a particular domain due to regulatory requirements or accepted practices in that domain/industry/community.

- Improve the modularity and simplicity of SACM

- Provide for future concepts such as structured expressions and other formalisms

The SACM 1.1 was subsequently worked to attempt to meet these goals and a draft metamodel was created during the summer OMG 2013 Berlin meeting. However the magnitude of the changes necessary to actually integrate the two original metamodels into one cohesive approach and achieve some of the other goals turned out to be too big of a change for a point release. The final SACM 1.1, released in July 2015, was scaled back to address some of the issues and it cleaned up some terminology and logical issues but it did not substantially alter the underlying metamodel.

During this same timeframe other efforts in the OMG (the Dependability Assurance Framework for Safety-Sensitive Consumer Devices (DAF)) and in The Open Group (the Dependability Assurance Framework (O-DA), as well as the work of the Food and Drug Administration (FDA) in the U.S. started making use of the assurance case concept and articulated implicit requirements/needs for tools that would work with assurance case models and their exchange.

Additionally, the Open Platform for EvolutioNary Certification of Safety-critical Systems (OPENCOSS) effort in Europe was exploring different uses of assurance cases, including the creation of a Common Certification Language, and the OMG's Architecture Driven Modernization Task Force crafted a Structured Pattern Metamodel Standard (SPMS) that provided a

method for describing patterns within models. Together these new needs and the new openly available capabilities represented in OPENCOSS and SPMS offer a way forward.

This version 2.0 of SACM has been created as a major version release since pursuing another point release revision of SACM would appear to be incompatible with achieving the integration and harmonization that is critical to obtain wide-spread adoption and implementation within the tooling market and allow that market to deliver on some of the potential capabilities they could provide to address the emerging and evolving need for assurance case tools, such as:

- Improving the Understandability of an Assurance Case to a 3rd Party
- Improving Rigor of Assurance Cases through Modeling
- Allowing for Reexamination of Assumptions, Argument Structuring, and the Appropriateness of Evidence
- Allowing for Reuse of Sub-Claim/Evidence Constructs That "Work"
- Authoring/Sharing Libraries of Sub-Claims/Supporting Evidence
- Providing for Assurance Case Analytics/Validation
- Providing for Exchange of Assurance Cases (Import/Export)
- Providing for Enforcing Community of Interest Norms of Practice

The resulting metamodel in this version of SACM come from the ideas in the 2013 Berlin metamodel, along with the approaches utilized for modeling artifact- and process-related concepts in OPENCOSS Common Certification Language and the pattern metamodel and concepts from the SPMS.

2 Conformance

2.1 Introduction

The Structured Assurance Case Metamodel (SACM) specification defines the following three compliance points:

- Argumentation
- Artifact Model
- Assurance Case

2.2 Argumentation compliance point

Software that conforms to the SACM specification at the Argumentation compliance point shall be able to import and export XMI documents that conform with the SACM XML Schema produced by applying XMI rules to the normative MOF metamodel defined in the Argumentation subpackage of the SACM specification, including the common elements defined in the Common and Predefined diagrams of the SACM. The top object of the Argumentation package as a unit of interchange shall be the Argumentation::ArgumentPackage element of the SACM.

Conformance to the Argumentation compliance point does not entail support for the Evidence subpackage of SACM, or the terminology sub package of the SACM. The 'ArtifactElementCitation' class shall not be used.

This compliance point facilitates interchange of the structured argumentation documents produced by existing tools supporting existing structured argument notations such as the Goal Structuring Notation (GSN) and the Claims-Arguments-Evidence (CAE) notation which provide their own mapping onto SACM argumentation aspects. Further details of these mappings are given in Annex A.

2.3 Artifact model compliance point

Software that conforms to the specification at the Artifact Model compliance point shall be able to import and export XMI documents that conform with the SACM XML Schema produced by applying XMI rules to the normative MOF metamodel defined in this Artifact subpackage of the SACM specification, including the common elements defined in the Common and

Predefined diagrams of the SACM. The top object of the Evidence package as a unit of interchange shall be the ArtifactModel::ArtifactPackage element of the SACM.

Conformance to the Artifact model compliance point does not entail support for the Argumentation subpackage of SACM, or the terminology diagram of the SACM. This compliance point facilitates interchange of the packages of evidence. In particular, this compliance point facilitates development of evidence repositories in support of software assurance and regulatory compliance.

2.4 Assurance Case compliance point

Software that conforms to the specification at the Assurance Case compliance point shall be able to import and export XMI documents that conform with the SACM XML Schema produced by applying XMI rules to the normative MOF metamodel defined in this entire specification. The top object of the Assurance Case package as a unit of interchange shall be the SACM::AssuranceCasePackage element.

The Conformance clause identifies which clauses of the specification are mandatory (or conditionally mandatory) and which are optional in order for an implementation to claim conformance to the specification.

3 References

3.1 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

- ISO/IEC 15026-1:2013 Systems and software engineering - Systems and software assurance - Part 1: Concepts and vocabulary, 2013. <http://www.iso.org/iso/catalogue_detail.htm?csnumber=62526>
- ISO/IEC 15026-2: 2011 Systems and software engineering - Systems and software assurance - Part 2: Assurance case, 2011. <http://www.iso.org/iso/catalogue_detail.htm?csnumber=52926>
- OMG UML 2.5 Infrastructure Specification formal/15-03-01. <http://www.omg.org/spec/UML/>
- OMG Meta-Object Facility (MOF) version 2.5 formal/2015-06-05. <http://www.omg.org/spec/MOF/>
- OMG MOF XML Metadata Interchange (XMI) Specification, version 2.5.1, formal/2015-06-07 <http://www.omg.org/spec/XMI/>

3.2 Non-normative References

The following non-normative documents contain provisions which, through reference in this text, provide informative context for material in this specification.

- Goal Structuring Notation (GSN) Community Standard, Nov 2011. <http://www.goalstructuringnotation.info/documents/GSN_Standard.pdf>
- Open Platform for EvolutioNary Certification of Safety-critical Systems (OPENCOSS) WP4: Common Certification Language, 2012-2015. <http://www.opencoss-project.eu/node/7>
- Open Platform for EvolutioNary Certification of Safety-critical Systems (OPENCOSS) WP6: Evolutionary Evidential Chain, 2012-2015. <http://www.opencoss-project.eu/node/7>.
- Evidence management for compliance of critical systems with safety standards: A survey on the state of practice, Information and Software Technology 60: 1-15, Elsevier (North-Holland) (2015). <http://www.sciencedirect.com/science/article/pii/S0950584914002560>
- OMG Structured Pattern Metamodel Standard (SPMS), beta2, ptc/14-09-31 <http://www.omg.org/spec/SPMS/>

- Open Group Dependability Assurance Framework (O-DA), Jul 2013. <https://www2.opengroup.org/ogsys/catalog/C13F>
- OMG Dependability Assurance Framework for Safety-Sensitive Consumer Devices (DAF), beta1, May 2015. <http://www.omg.org/spec/DAF/>
- Infusion Pumps Total Product Life Cycle Guidance for Industry and FDA Staff, Dec 2014. <http://www.fda.gov/medicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm206153.htm>

4 Terms and Definitions

For the purposes of this specification, the following terms and definitions apply.

Argument

A body of information presented with the intention to establish one or more claims through the presentation of related supporting claims, evidence, and contextual information.

Assurance Case

A collection of auditable claims, arguments, and evidence created to support the contention that a defined system/service will satisfy its assurance requirements.

Claim

A proposition being asserted by the author or utterer that is a true or false statement.

Evidence

Objective artifacts being offered in support of one or more claims.

Evidence Repository

A software service providing access to, and information about, a collection of evidence items, such as records, documents, and other exhibits together with related information that facilitates management of evidence, the interpretation of evidence, and understanding the evidentiary support provided to claims.

Structured argument

A particular kind of argument where the relationships between the asserted claims, and from the evidence to the claims are explicitly represented.

5 Symbols

There are no symbols defined in this specification.

6 Additional Information

6.1 Changes to Adopted OMG Specifications [optional]

This specification completely replaces the SACM 1.1 specification.

6.2 Acknowledgements

The following companies submitted this specification:

- MITRE Corporation
- Adelard LLP
- KDM Analytics
- Lockheed Martin
- Benchmark Consulting
-

The following companies supported this specification:

- University of York
- Universidad Carlos III de Madrid
- Carnegie Mellon University
-

6.3 How to Proceed

The rest of this document contains the technical content of this specification.

Clause 7. Specification overview - Provides design rationale for the SACM Argumentation Metamodel specification.

Part 1 of the specification defines the normative common elements. This part includes three clauses. Material in this part of the specification is related to all compliance points.

Clause 8. SACM Base classes define the common base classes of the Structured Assurance Case Metamodel.

Clause 9. SACM Packages define the common packages of the Structured Assurance Case Metamodel.

Clause 10. SACM Terminology defines the common terminology classes of the Structured Assurance Case Metamodel.

Part 2 of the specification defines the SACM Argumentation metamodel. The Argumentation Metamodel defines the catalog of elements for constructing and interchanging structured statements describing argumentations. Material in this part of the specification is related to the Assurance Case and Argumentation compliance points, and is not required for the Evidence Container compliance point. This part includes a single clause. The non-normative Annex B contains some examples of the SACM XML interchange format for Argumentation, and describes how SACM Argumentation is related to existing graphical notations for describing structured arguments, such as the Goal Structuring Notation (GSN) and the Claims-ArgumentsEvidence (CAE) notation.

Clause 11. The SACM Argumentation Metamodel - Provides the details of the Argumentation Metamodel specification.

Part 3 of the specification defines the SACM Artifact Metamodel. The Artifact Metamodel defines the catalog of elements for constructing and interchanging precise statements involved in evidence-related efforts. This part includes a single clause. Material in this part of the specification is related to the Assurance Case and the Evidence Container compliance points, and it is not required for the Argumentation compliance point.

Clause 12 defines the key elements of the Artifact Metamodel.

7 Background and Rationale

7.1 The Need for Assurance Cases

All sectors of society are placing growing reliance on software-enabled and connected systems, both information systems and embedded systems. Adequate functioning of many of these systems is critical to the well-being of organizations and society. Today, these numerous, large, complex systems provide increased benefits by connecting with others and often directly or indirectly to the Internet.

However the societal and individual risks posed by attacks on, or in the maladaptive behavior of such systems, are significant enough to warrant a pro-active technology adoption approach whereby the emergent risks can be analyzed, explored, communicated, and ultimately accepted by those responsible for the assurance.

Thus, system suppliers face the task of engineering their products and services to meet these challenges and threats in such a way that users and other stakeholders can rationally possess the needed confidence in them – or at least judge their level of risk. This means that suppliers must not only ensure their delivery of adequate systems, but acquirers and users require the explicit, valid, well-reasoned, and evidence-supported grounds[1] for their confidence and decision making including related engineering conclusions and their uncertainty.

Historically assurance cases covering safety and security requirements for systems have been seen as an important tool for the interchange of assurance information.

To make system assurance more practical, automation and meaningful exchange of this assurance-related information is needed. System suppliers, tool vendors, acquirers, users, and others would benefit from a flexible and extensible means for its representation and exchange.

The concept of an assurance case is one that provides a framework for analyzing and communicating the assurance arguments and evidence that relates to a system under consideration. Suppliers and customers can see how the system lifecycle products (system requirements, design, testing, field experience, etc.) relate to and satisfy the assurance requirements, enabling sufficient confidence to be gained in the behavior and integration of the system within its operational context.

Simply put, an assurance case comprises the arguments and evidence that a system will meet its assurance requirements over its lifecycle.

7.2 Structured Arguments

Arguments have always been used - albeit informally - to communicate and persuade stakeholders that sufficient confidence can be had in a particular system. However these arguments are often spread over a range of system and management documentation, and it is difficult to see the argument as a whole in a clear way.

In the assurance domain an ‘argument’ is defined as “a connected series of statements or reasons intended to establish a position...; a process of reasoning”[2]. In attempting to persuade others of a position, we cite reasons why a claim should be accepted as true. These reasons are described as the premises of the argument, and the claim they support as its conclusion. These terms can be used to define the ‘normal form’ of an argument as:

Premise
Premise
Premise
So, Conclusion

This form reduces argument to its most primitive building blocks, for example:

Premise: All complex systems are susceptible to failure.

[1] Suppliers also need the same or similar case to justify release and deployment.
[2] Shorter Oxford English Dictionary, 6th Edition (2007).

Premise: Failures can lead to accidents.

Therefore,

Conclusion: Accidents can occur in complex safety-critical systems.

The terms ‘premise’ and ‘conclusion’ are relative. The premise of one reasoning step (e.g., that “All complex systems are susceptible to failure”) may itself need further reasoning support and will become the conclusion of a subsequent supporting argument. This gives rise to hierarchical argument structures (‘chains of reasoning’) in which arguments are established by the composition of a number of (premise-conclusion) reasoning steps in order to support an overall conclusion, as illustrated in Figure 7.1.

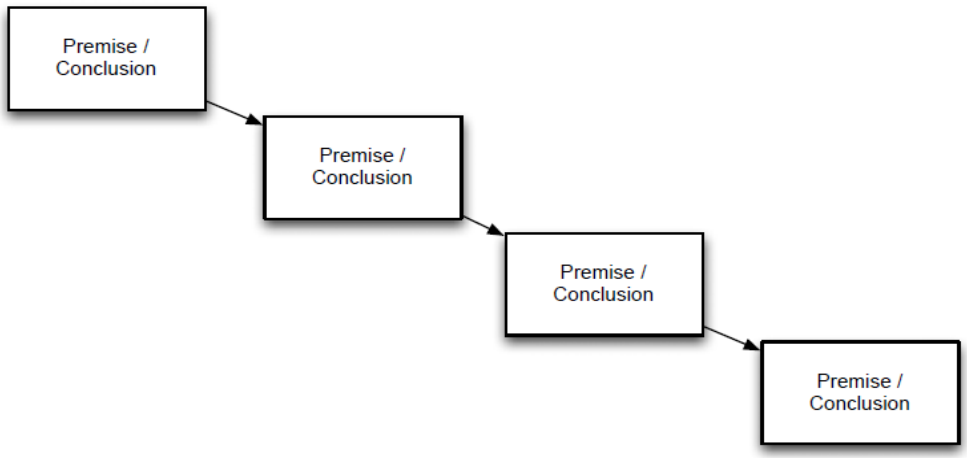


Figure 7.1 - Argument Chain Structure

Structured arguments are therefore one way to allow the communication of how a series of claims can establish a conclusion.

7.3 Arguments as asserted positions

It is important to note that the representation of an argument is not the same as a valid argument. The process of argument representation and communication is separate from that of argument evaluation. For example, an argument may include invalid reasoning, or may have a reliance on irrelevant or false information.

Therefore representations of arguments should be seen as positions that are effectively asserted by the authors or organizations that are putting forward the argument.

Clearly professional ethics require that assurance stakeholders should present arguments that they believe to be correct, valid, and relevant.

A key concept is that structured arguments allow users to express and declare what they consider the argument to be.

7.4 Structured Arguments in SACM

SACM contains those elements presented as fundamental to the expression and exchange of structured arguments.

As noted above, a typical natural language dictionary definition of an argument is that an argument comprises a series of linked premises (propositions), leading to a conclusion. From this we can derive a set of practical modeling approaches that allow users to link together propositions (claims) and to communicate how they consider that higher level claims be supported or derived from the lower level claims. Since a claim can be used to support one or more other claims, the general form of a directed graph emerges.

SACM aims to provide a modeling framework to allow users to express and exchange their argument structures. The representation of an argument in SACM does not imply that the argument is complete, valid, or correct. Similarly, the evaluation or acceptance of an argument by a separate party is not covered by the SACM. In the SACM model, structured

arguments comprise argument elements (primarily claims) that are being asserted by the author of the argument, together with relationships that are asserted to hold between those elements.

7.5 Precise statements related to evidence

In the simplest form, evidence consists of a collection of documents, records or artifacts that provide evidentiary support to a set of claims.

Artifacts may be structured together into composite artifacts or collections. For higher degrees of assurance it is pertinent to know how these artifacts have been created and managed over their lifecycle, and what techniques and resources were used in their generation – i.e., the provenance of the artifact.

The Artifact Metamodel defines the vocabulary for constructing and interchanging precise statements describing evidence-related efforts, including

- Describing artifacts and their properties and associated events
- Collection and management of evidence by participants, using resources, techniques, and activities, by describing the relationships between them
- Structuring of artifacts – e.g., as composite artifacts or collections

An extensible approach is presented whereby users of an Artifact Model may specify the relationships that hold between the artifact assets. If necessary a terminology package may be used to reuse common relationships.

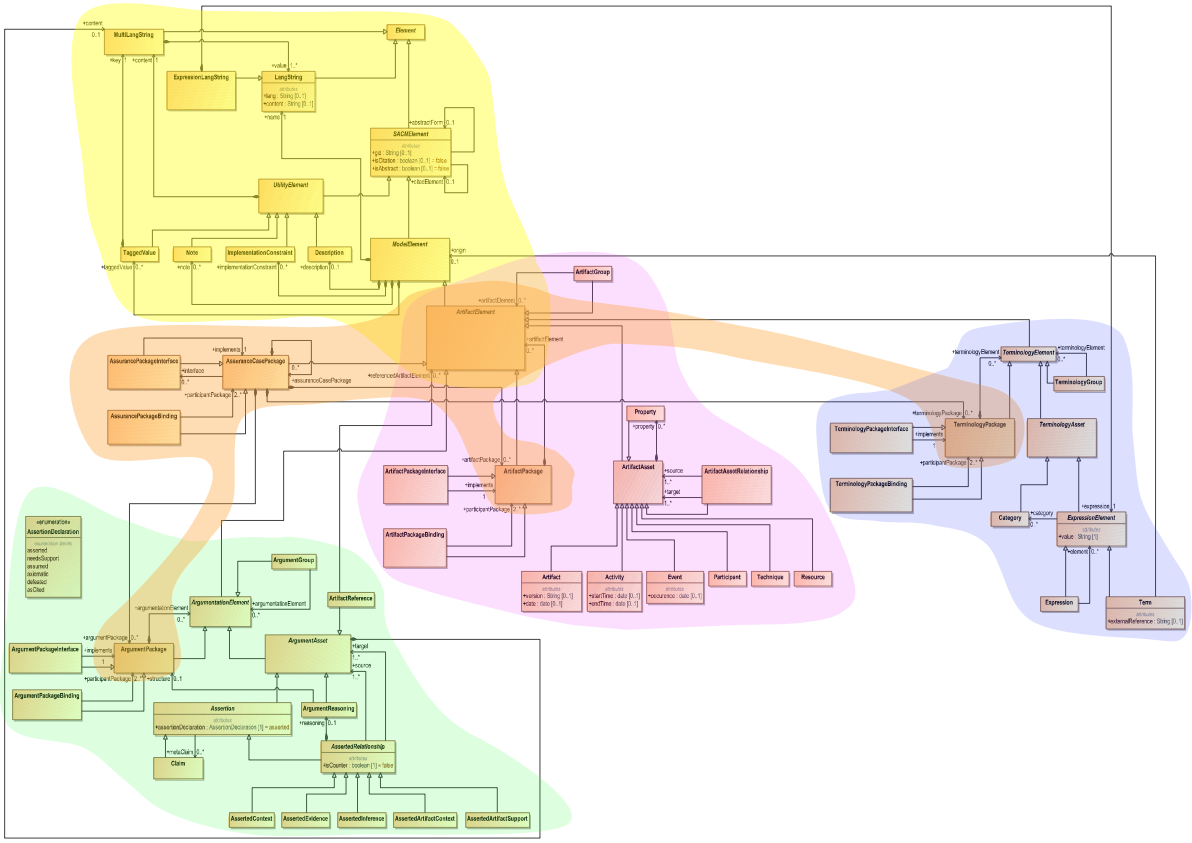
Describing artifacts – artifacts have properties and associated events. An artifact event can be used to communicate, for example, the review date or release date for the artifact.

Collection and Management of Evidence – can be described by means of an extensible set of relationships between participants, activities, resources and the associated evidence artifacts.

Structuring of artifacts – Artifacts may be part of a larger composite by means of artifact to artifact relationships, or within a common artifact package.

Part I - Common Elements

The first part of the specification defines the common elements of the Structured Assurance Case Metamodel, including the Base Classes, the Structured Assurance Case Terminology Classes, and the Structured Assurance Case Packages. Subsequent parts define the Argumentation Metamodel and the Artifact Metamodel.



ßYellow denotes items covered in Clause 8, Structured Assurance Case Base Classes.

Orange denotes items covered in Clause 9, Structured Assurance Case Packages.

Blue denotes items covered in Clause 10, Structured Assurance Case Terminology Classes.

Green denotes items covered in Clause 11, Argumentation Metamodel.

Purple denotes items covered in Clause 12, Artifact Metamodel.

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8 Structured Assurance Case Base Classes

8.1 General

This chapter presents the normative specification for the SACM Base Metamodel. It begins with an overview of the metamodel structure followed by a description of each element.

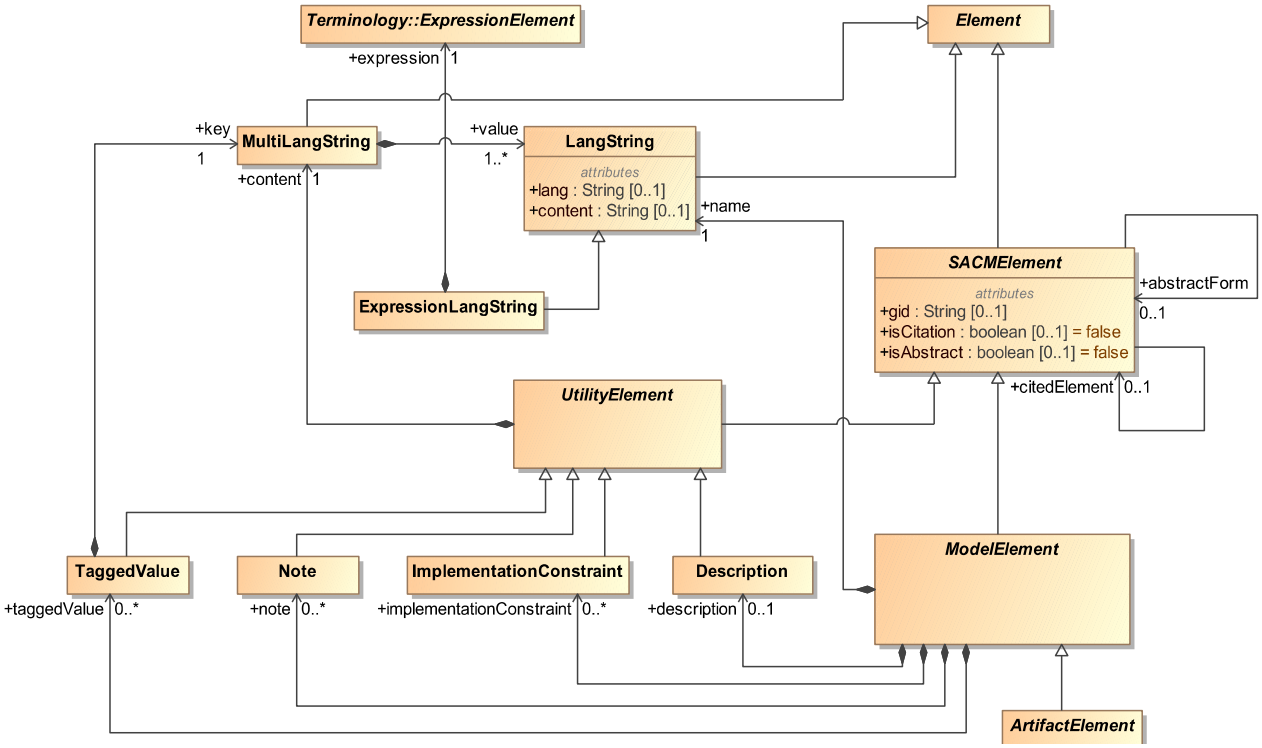


Figure 8.1 - Overall SACM Class Diagram

The Structured Assurance Case Base Classes express the foundational concepts and relationships of the base elements of the SACM metamodel and are utilized, through inheritance, by the bulk of the rest of the Structured Assurance Case Metamodel.

8.2 SACMElement (abstract)

SACMElement is the base class for SACM.

Superclass

MOF:Element

Attributes

gid:String[0..1] – a unique identifier that is unique within the scope of the model instance

isCitation[1]=false – a flag to indicate whether the SACMElement cites another SACMElement.

isAbstract[1]=false – a flag to indicate whether the SACMElement is considered to be abstract. For example, this can be used to indicate whether an element is part of a pattern or template.

~~None~~

Associations:

citedElement:SACMElement[0..1] – a reference to another SACMElement that the SACMElement cites

abstractForm:SACMElement[0..1] – an optional reference to another abstract SACMElement to which this concrete SACMElement conforms.

Semantics

All the elements of a structured assurance case effort created with SACM correspond to a SACMElement.

Constraints:

If citedElement is populated, isCitation must be true. OCL: self.citedElement <> null implies self.isCitation = true

When +abstractForm is used to refer to another SACMElement, +isAbstract of the SACMElement is false, and the +isAbstract of the referred SACMElement should be true. The referred SACMElement should be of the same type of the SACMElement. If ImplementationConstraints are expressed on the referred SACMElement, the SACMElement should satisfy these ImplementationConstraints.

8.3 LangString

LangString is the format SACM uses for description. It serves the same purpose as String but with the additional specification of the language used for the content.

Superclass

MOF:Element

Attributes

lang:String[0..1] – a field to indicate the language used in the string.

content:String[0..1] – the content of the string

Semantics

LangString serves the same purpose as String, SACM uses LangString for description, which containing the information of the language it uses in the content.

8.4 ExpressionLangString

ExpressionLangString is used to denote a structured expression, it contains a description (LangString) and it also (optionally) points to an ExpressionElement in the Terminology Package.

Superclass

LangString

Attributes

expression:Terminology::ExpressionElement[1] (composition) – a reference to an ExpressionElement in the TerminologyPackage

Semantics

ExpressionLangString provides a means for description, it can also be used to link to an ExpressionElement in the Terminology package.

Constraints

If expression is not empty, then +content should be empty.

8.5 MultiLangString

MultiLangString, as its name suggests, provides a means to describe things using different languages.

Superclass

Element

Associatiions

value:LangString[1..*] (composition) – contains the descriptions which bear the same meaning but in different languages

Semantics

MultiLangString provides a means to describing things using different languages. It contains a list of ExpressionLangString, which the user can specify their languages and the descriptions in the languages.

Constraints

For each of the ExpressionLangString in the value property, their +lang should be unique.

8.6 ModelElement (abstract)

ModelElement is the base element for the majority of modeling elements.

Superclass

SACMElement

~~**Attributes**~~

~~**name: String – the name of the element**~~

~~**isAbstract: Boolean – a flag to indicate whether the ModelElement is considered to be abstract. This is used to indicate whether an element is part of a pattern or template.gid: String – a unique identifier that is unique within the scope of the model instance**~~

Associations

name:LangString[1] (composition) – the name of the ModelElement.

implementationConstraint: ImplementationConstraint [0..*] ~~– allows the description of any implementation constraint associated with converting the element from being abstract to being concrete~~ (composition) – a collection of implementation constraints.
description: Description[0..1] (composition) – the description of the ModelElement. ~~– the description of the element [0..1]~~

note:Note[0..*] (composition) – a collection of notes for the ModelElement. ~~Annotation [0..*] – a collection of annotations associated with the element.~~

taggedValue: TaggedValue [0..*] ~~– a collection of tagged values may be associated with each~~ (composition) – a collection of TaggedValues, TaggedValues can be used to describe additional features of a ModelElement

Semantics

All the individual and identifiable elements of a SACM model correspond to a ModelElement.

Constraints

ImplementationConstraints should only be specified if +isAbstract is true OCL: self.implmentationConstraint->size() > 0 implies self.isAbstract = true ~~ImplementationConstraints should only be specified if isAbstract is true.~~

8.7 UtilityElement (abstract)

UtilityElement is ~~an abstract~~ the base element for a number of ~~utility~~auxiliary elements which can be added to ModelElements.

Superclass

SACMElement

Associations

~~expression: Expression [1] – the expression object containing the value of the UtilityElement (see Terminology section 10)~~content:MultiLangString[0..1] (composition) – a MultiLangString to describe the content of the UtilityElement in (possibly) multiple languages

Semantics

UtilityElement supports the specification of additional information for a ModelElement.

8.8 ImplementationConstraint

~~This class~~ImpementationConstraint specifies details of any implementation constraints that must be satisfied whenever a referencing ModelElement is to be converted from *isAbstract = true* to *isAbstract = false.* For example in the context of a SACM pattern fragment, an element will need to satisfy the implementation rules of the pattern.

Superclass

UtilityElement

Semantics

ImplementationConstraints indicate the conditions to fulfill in order to allow an abstract ModelElement (isAbstract = true) to become non-abstract (isAbstract = false).

~~**Constraints**~~

~~ImplementationConstraints should only specified if isAbstract is true.~~

8.9 Description

Description is used to specify a description that may be associated with a ModelElement. In many cases Description is used to provide the 'content' of a SACM element. For example, it would be used to provide the text of a Claim.

Superclass

UtilityElement

Semantics

A Description provides details about ModelElements in relation to aspects such as their content or purpose. Therefore, Descriptions can be used to both characterize ModelElements and facilitate their understanding.

8.10 ArtifactElement (abstract)

ArtifactElement acts as the base class for elements in other SACM packages. Essentially, all elements which extend ArtifactElement is considered to be an artifact, and therefore can be referenced using Argument:ArtifactReference.

Superclass

ModelElement

Semantics

ArtifactElement corresponds to the base class for specifying all the identifiable units of data modelled and managed in a structured assurance case effort.~~Description~~

~~This class specifies a description that may be associated with a ModelElement. In many cases Description is used to provide the 'content' of a SACM element. For example, it would be used to provide the text of a Claim.~~

~~**Superclass**~~

~~UtilityElement~~

~~**Semantics**~~

~~A Description provides details about ModelElements in relation to aspects such as their content or purpose. Therefore, Descriptions can be used to both characterize ModelElements and facilitate their understanding.~~

8.11 Note

~~**Semantics**~~

~~TaggedValues can be used to specify attributes, and their corresponding values, for ModelElements. key: Expression – the key of the tagged value~~

~~**Attributes**~~

~~**Superclass**~~

~~UtilityElement~~

This class specifies a generic note that may be associated with a ModelElement. For example a note may include a number of explanatory comments.

Superclass

UtilityElement

Semantics

Notes are used to specify additional (typically optional) generic, unstructured, untyped information about a ModelElement. An example of this kind of information could be a comment about a ModelElement.

8.12 TaggedValue

This class represents a simple key/value pair that can be attached to any element in SACM. This is a simple extension mechanism to allow users to add attributes to each element beyond those already specified in SACM.

Superclass

UtilityElement

Associations

key:MultiLangString[1] (composition) – the key of the TaggedValue.

Semantics

TaggedValues can be used to specify attributes, and their corresponding values, for ModelElements.

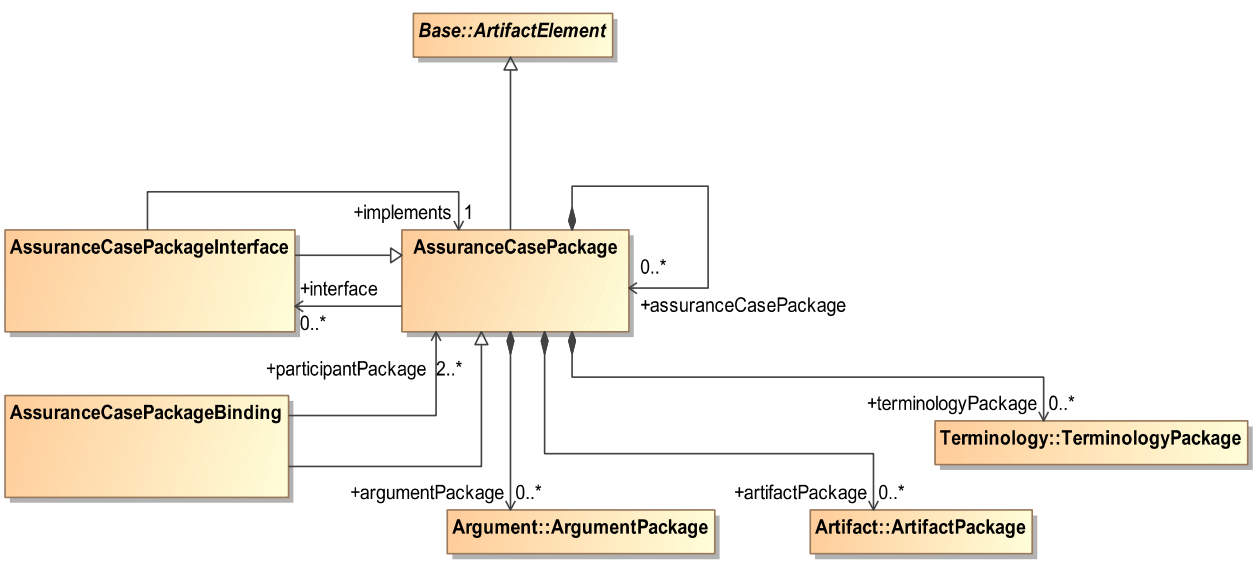
~~**Constraints**~~

~~TaggedValues should not be used to document attributes that already form part of SACM (e.g., ArtifactProperty).~~

9 Structured Assurance Case Packages

9.1 General

This chapter presents the normative specification for the SACM Packages Metamodel. It begins with an overview of the metamodel structure followed by a description of each element.



In SACM, the parent container element is AssuranceCasePackage. AssurancesCasePackages can be thought of assurance case 'modules'. Packages can contain other packages, including citations to other packages not contained within the same package hierarchy. Packages optionally can have a separately declared interface (AssuranceCasePackageInterface) (analogous to a public header file) that declares selected packages contained by a package.

Assurance cases (AssuranceCasePackages) consist of arguments (containined in ArgumentPackages), evidence descriptions (contained in ArtifactPackages) and Terminology definitions (contained in TerminologyPackages).

9.2 ~~ArtifactElement (abstract)~~

~~ArtifactElement is an abstract class that serves as a parent class for Artifacts and AssuranceCasePackage elements.~~

~~Superclass~~

~~ModelElement~~

~~Semantics~~

~~ArtifactElement correspond to the base class for specifying all the identifiable units of data modelled and managed in a structured assurance case effort.~~

9.3 AssuranceCasePackage

AssuranceCasePackage is an exchangeable element that may contain a mixture of artifacts, argumentation and terminology. When users exchange content, it is expected they use this as the top level container. It is a recursive container, and may contain one or more sub-packages.

This follows the existing practice of considering an assurance case when fully completed to comprise both argumentation and evidence, although each may be exchanged individually.

AssuranceCasePackage is a sub-class of Base::ArtifactElement. Semantically an AssuranceCasePackage can be considered as an artifact of evidence (e.g. from the perspective of another AssuranceCasePackage).

Superclass

Base::ArtifactElement

Associations

~~**assuranceCasePackageCitation: AssuranceCasePackageCitation [0..*] – a collection of optional citations to other AssuranceCasePackages**~~

assuranceCasePackage: AssuranceCasePackage [0..*] ~~– a number~~(composition) – a collection of optional sub-packages

interface: AssuranceCasePackageInterface [0..*] – a number of optional assurance case package interfaces that the current package may implement

artifactPackage: ArtifactPackage [0..*] (composition) – a number of optional artifact sub-packages

terminologyPackage: TerminologyPackage [0..*] (composition) – a number of optional terminology sub-packages

argumentPackage:Argument::ArgumentPackage[0..*] (composition) – a number of optional argument packages.

Semantics

AssuranceCasePackage is the root class for creating structured assurance cases.

9.4 AssuranceCasePackageInterface

AssuranceCasePackageInterface is a kind of AssuranceCasePackage that defines an interface that may be exchanged between users. An AssuranceCasePackage may declare one or more ArtifactPackageInterfaces.

Superclass

AssuranceCasePackage

Associations

implements:AssuranceCasePackage[1] – the AssuranceCasePackage that the AssuranceCasePackageInterface declares.

Semantics

AssuranceCasePackageInterface enables the declaration of the elements of an AssuranceCasePackage that might be referred to (cited) in another AssuranceCasePackage~~, thus the elements can be used for assurance in the scope of the latter AssuranceCasePackage~~. These declarations are provided by containing AssuranceCasePackageInterface(s)/ArgumentPackageInterface(s)/ArtifactPackageInterface(s)/TerminologyPackageInterface(s) to the packages contained by the AssuranceCasePackage (for which the interface provided).

Constraints

AssuranceCasePackageInterface are only allowed to contain the following: AssuranceCasePackageInterface, ArgumentPackageInterfaces, ArtifactPackageInterfaces, and TerminologyPackages.

~~AssuranceCasePackageCitation~~

~~AssuranceCasePackageCitation is used to cite another AssuranceCasePackage. The citation can be used where an assurance case author wishes to refer to an AssuranceCasePackage outside of the current AssuranceCasePackage hierarchy.~~

~~Superclass~~

~~ArtifactElement~~

~~Associations~~

~~citedPackage: AssuranceCasePackage – the existing AssuranceCasePackage being referenced.~~

~~Constraints~~

~~**The citedPackage referred to by a AssuranceCasePackageCitation must be outside of the containment hierarchy containing the citation.**~~OCL:

self.assuranceCasePackage->forall(acp|acp.oclIsTypeOf(AssuranceCasePackageInterface)) and

self.argumentPackage->forall(ap|ap.oclIsTypeOf(Argumentation::ArgumentPackageInterface)) and

self.artifactPackage->forall(ap|ap.oclIsTypeOf(Artifact::ArtifactPackageInterface)) and

self.terminologyPackage->forall(tp|tp.oclIsTypeOf(Terminology::TerminologyPackageInterface))

9.5 ~~ArgumentPackage~~AssuranceCasePackageBinding

~~ArgumentPackage is a container for the structured argument aspect of the assurance case. It contains the structure of assertions which comprise the structured argument.~~Sub-packages within the AssuranceCasePackage can be bound together by means of AssuranceCasePackageBindings. AssuranceCasePackageBindings bind the participant packages by means of ArgumentPackageBindings/TerminologyPackageBindings/ArtifactPackageBindings elements that bind the contained packages of the participant packages.

Superclass

~~ArgumentationElement~~AssuranceCasePackage

Associations

~~**argumentPackageCitation: ArgumentPackageCitation [0..*] – an optional set of citations to other ArgumentPackages**~~

~~argumentPackage: ArgumentPackage [0..*] – an optional set of sub-ArgumentPackages, allowing for recursive~~

containment argumentAsset: ArgumentAsset [0..*] an optional set of ArgumentAssetsparticipantPackage:AssuranceCasePackage[2..*] – references to AssuranceCasePackages which the AssuranceCasePackageBinding binds together.

Semantics

ArgumentPackage is the base class for specifying the results of the argumentation efforts for a structured assurance case (i.e., an AssuranceCase).AssuranceCasePackageBinding binds peer AssuranceCasePackages together to indicate the relationship between these AssuranceCasePackages. The bindings between AssuranceCasePackages consist of the bindings of the packages (i.e. ArgumentPackageBindings, ArtifactPackageBindings and TerminologyPackageBindings) contained in the AssuranceCasePackages, together with an optional ArgumentationPackage that asserts the relationship between +participantPackage.

Constraints

The participantPackages should be either AssuranceCasePackage or AssuranceCasePackageInterfaces.

OCL:

self.participantPackage->forall(pp|pp.oclIsTypeOf(AssuranceCase::AssuranceCasePacka ge) or pp.oclIsTypeOf(AssuranceCase::AssuranceCasePackageInterface))

ArtifactAsset [0..*] – an optional set of ArtifactAsset elements, such as citations, artifacts, resources, activities, etc.

artifactPackage: ArtifactPackage [0..*] - an optional set of contained ArtifactPackage elements, allowing for recursive containment.

Semantics

ArtifactPackage is the base class for specifying and structuring the ArtifactAssets of a structured assurance case (i.e., an AssuranceCase).

9.6

9.7 artifactPackageCitation: ArtifactPackageCitation [0..*] – an optional set of citations to other ArtifactPackage elements artifactAsset:

9.8 ArtifactPackage

ArtifactPackage is a container element for the assets that are used as evidence or cited in support of a structured argument. These assets form the evidential basis for the assurance case.

Superclass

ArtifactElement

9.9 Associations

9.10

terminologyAsset: TerminologyAsset [0..*] – an optional set of terminology assets (expressions, terms and categories)

terminologyPackage: TerminologyPackage [0..*] – an optional set of contained TerminologyPackage elements, allowing for recursive containment.

Semantics

9.11 TerminologyPackage is the base class for specifying all the terminology needs and constraints (via TerminologyAssets) for a structured assurance case (i.e., an AssuranceCase).

9.12 ~~terminologyPackageCitation: TerminologyPackageCitation [0..*] – an optional set of citations to other TerminologyPackage elements~~ TerminologyPackage

~~TerminologyPackage is a container element for terminology that may be exchanged. Terminology can define terms, expressions or categories, used elsewhere in the assurance case.~~

~~**Superclass**~~

~~TerminologyElement~~

9.13 ~~Associations~~

10 Structured Assurance Case Terminology Classes

10.1 General

This chapter presents the normative specification for the SACM Terminology Metamodel. It begins with an overview of the metamodel structure followed by a description of each element.

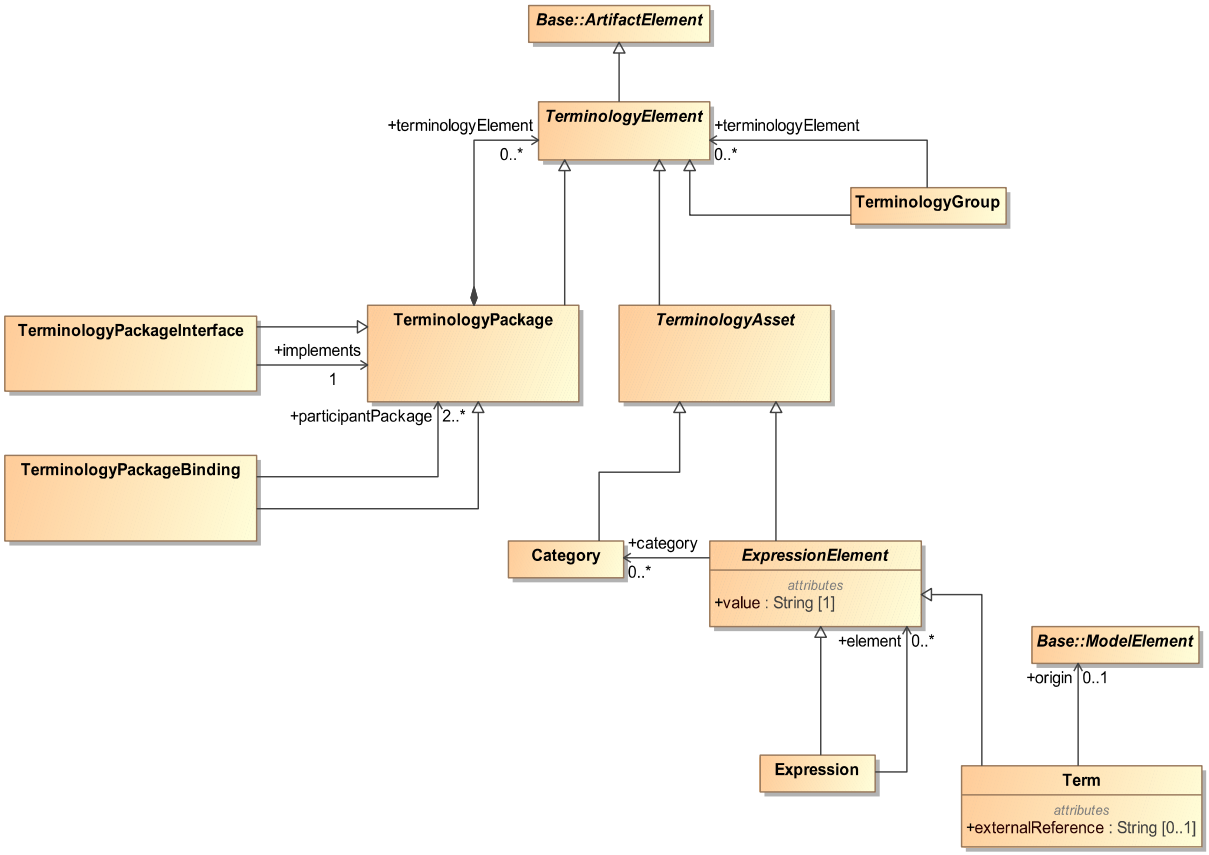


Figure ~~10.1~~10.1 - Terminology Class Diagram

This portion of the SACM metamodel describes and defines the concepts of term, expression and an external interface to terminology information from others. This area of the Structured Assurance Case Metamodel also provides the starting foundation for formalism in the assembly of terms into expressions without mandating the formalism for those that do not need it.

10.2 TerminologyElement (abstract)

TerminologyElement is an abstract class that serves as a parent class for all SACM terminology assets (TerminologyAsset) and the ~~packaging of these assets (TerminologyPackage and TerminologyPackageCitation).~~grouping of TerminologyElements (TerminologyGroup). TerminologyElement extends Base::ArtifactElement, this implies that all elements in the Terminology package are artifacts.

Superclass

~~ModelElement~~Base::ArtifactElement

Semantics

TerminologyElement is the base class for specifying the terminology aspects of an assurance case (AssuranceCasePackage).

10.3 Terminology~~Package~~Group

~~The TerminologyPackage Class is the container class for SACM terminology assets~~TerminologyGroup can be used to associate a number of TerminologyElements to a common group (e.g. representing a common type or purpose, or being of interest to a particular stakeholder).

Superclass

TerminologyElement

Associations

~~TerminologyAsset:TerminologyAsset[0..*]~~

~~The TerminologyAssets contained in a given instance of a TerminologyPackage.~~
~~terminologyPackage:TerminologyPackage[0..*]~~

~~The nested terminologyPackage contained in a given instance of a TerminologyPackageterminologyPackageCitation:TerminologyPackageCitation[0..*]~~

~~The nested terminologyPackageCitation contained in a given instance of a TerminologyPackage~~
terminologyElement[0..*] – an optional collection of TerminologyElements that are organised within the TerminologyGroup.

Semantics

~~TerminologyPackages contain the TerminologyAssets that can be used within the naming and description of SACM arguments and artifacts. TerminologyPackage elements can be nested, and can contain citations (references) to other TerminologyPackages.~~TerminologyGroup can be used to associate a number of TerminologyElements to a common group (e.g. representing a common type or purpose, or being of interest to a particular stakeholder). The name and the description of the TerminologyGroup should provide the semantic for understanding the TerminologyGroup. TerminologyGroups serve no structural purpose in the formation of the argument network, nor are they meant as a structural packaging mechanism (this should be done using TerminologyPackages).

10.4 TerminologyPackage

The TerminologyPackage is the container element for SACM terminology assets.

Superclass

TerminologyElement

Associations

TerminologyElement:TerminologyElement[0..*] (composition) – TerminologyElements contained in the TerminologyPackage, it can be either TerminologyPackage (and its sub-types) or TerminologyAssets (or its sub-types).

Semantics

~~TerminologyPackageCitation~~

~~The TerminlogyPackageCitation is a citation (reference) to another TerminologyPackage.~~

~~Superclass~~

~~TerminologyElement~~

~~Associations~~

~~citedPackage: TerminologyPackage[0..1]~~

~~The TerminologyPackage being cited by the TerminologyPackageCitation.~~

~~Semantics~~

~~TerminologyPackageCitations make it possible to cite other TerminologyPackages.For example, within a TerminologyPackage it can be useful to refer to another TerminologyPackage (to reference terminology) that is not contained with the same TerminologyPackage and is defined elsewhere.~~

~~Constraints~~

~~The citedPackage referred to by a TerminologyPackageCitation must be outside of the containment hierarchy containing the citation.~~

TerminologyPackage contains the TerminologyElements that can be used within the naming and description of SACM arguments and artifacts. TerminologyPackages can be nested.

10.5 TerminologyPackageInterface

TerminologyPackageInterface is a kind of TerminologyPackage that defines an interface that may be exchanged between users. An TerminologyPackage may declare one or more TerminologyPackageInterfaces.

Superclass

TerminologyElement

Associations

implements:TerminologyPackage[1] – the TerminologyPackage that the TerminologyPackageInterface declares.

Semantics

TerminologyPackageInterface enables the declaration of the elements of an TerminologyPackage that might be referred to (cited) in another TerminologyPackage, thus the elements can be used for assurance in the scope of the latter AssuranceCasePackage.

10.6 TerminologyPackageBinding

Elements within the TerminologyPackage can be bound together by means of TerminologyPackageBindings. TerminologyPackageBindings bind the participant packages by means of terminology elements that connect the cited elements of the participant packages.

Superclass

TerminologyPackage

Semantics

TerminologyPackageBinding binds TerminologyPackages together to indicate the relationship between two TerminologyPackages.

Constraints

The participantPackages should be either TerminologyPackage or TerminologyPackageInterface

OCL: self.participantPackage->forall(pp|pp.oclIsKindOf(Terminology::TerminologyPac kage))

10.7 TerminologyAsset (abstract)

The TerminologyAsset Class is the abstract class for the different types of terminology elements represented in SACM.

Superclass

TerminologyElement

Semantics

TerminologyAssets represent all of the elements required to model and categorize expressions in SACM (expressions and terminology categories).

10.8 Category

The Category class describes categories of ExpressionElements (Terms and Expressions) and can be used to group these elements within TerminologyPackages.

Superclass

TerminologyAsset

Semantics

Terms and ExpressionElements can be said to belong to Categories. Categories can group Terms, Expressions, or a mixture of both. For example, a Category could be used to describe the terminology associated with a specific assurance standard, project, or system.

10.9 ExpressionElement (abstract)

The ExpressionElement class is the abstract class for the elements in SACM that are necessary for modeling expressions.

Superclass

TerminologyAsset

Attributes

value:String[1] – the value of the expression.

Associations

category: Category [0..*] – optionally associates the ExpressionElement with one or more terminology categories.

Semantics

ExpressionElements are used to model (potentially structured) expressions in SACM. ~~All ModelElements contain a Description whose value is provided by means of an Expression.~~

10.10 Expression

The Expression class is used to model both abstract and concrete phrases in SACM. Abstract Expressions are denoted by the inherited ~~isAbstract~~isAbstract:Boolean attribute being set true. A concrete expression (denoted by ~~isAbstract~~isAbstract:Boolean being false) is one that has a literal string value and references only concrete ExpressionElements.

Superclass

~~ArtifactElement~~ExpressionElement

~~Attributes~~

~~value: String – An attribute recording the value of the expression~~

Associations

element: ExpressionElement [0..*] – an optional reference to other ExpressionElements forming part of the ~~StructuredExpression~~structured Expression.

Semantics

Expressions are used to model phrases and sentences. These are defined using the value ~~attribute~~property~~. The value attribute can be a simple literal string~~. Alternatively, the expression can also be defined (using the value ~~string~~property) as a production rule involving other ExpressionElements. In this case, the value ~~string~~ must use a suitable (string) form for denoting the position of involved ExpressionElements (e.g. "$<ExpressionElement.name>$") within the production rule, and expressing production rule operators (e.g. Extended Backus-Naur Form operators).

Constraints

Where an Expression has associated ExpressionElements ~~these should be referenced by name within the Expression.value.~~

~~Where an Expression.value references ExpressionElements by name, these ExpressionElements should be associated (using the element association) with Expression.~~(the +element property), these should be referenced by name within the +value property.

Where the +value property references ExpressionElement by name, these ExpressionElements should be associated (using the +element property) with Expression.A concrete expression should have references to only concrete ExpressionElements

OCL: self.isAbstract = false implies self.element->forall(expr|expr.isAbstract = false).

10.11 Term

~~The~~ Term ~~class~~ is used to model both abstract and concrete terms in SACM. Abstract Terms can be considered placeholders for concrete terms and are denoted by the inherited ~~isAbstract~~isAbstract:Boolean ~~-~~attribute being set true. A concrete term is denoted by ~~isAbstract~~isAbstract:Boolean being false.

Superclass

ExpressionElement

Attributes

~~**value: String – An attribute recording the value of the Term**~~

externalReference: String~~— An~~[0..1] – an attribute recording an external reference (e.g., URI) to the object referred to by the Term

~~Superclass~~

~~ExpressionElement~~

Associations

origin:Base::ModelElement[0..1] – a reference which points to the origin of the Term.

Semantics

Term class is used to model both abstract and concrete terms in SACM. Abstract Terms can be considered placeholders for concrete terms and are denoted by the inherited ~~isAbstract~~isAbstract:Boolean attribute being set true. A concrete term is denoted by ~~isAbstract~~isAbstract:Boolean being false.

The externalReference attribute enables the referencing of the object signified by the term (i.e., the signifier). It also provides a mechanism whereby terms can reference concepts and terms defined in other ontology and terminology models.

~~TerminologyAssetCitation~~

~~The TerminologyAssetCitation is a citation (reference) to an ExpressionElement contained in another TerminologyPackage.~~

~~Superclass~~

~~ExpressionElement~~

~~Associations~~

~~citedElement:TerminologyAsset [1] The TerminologyAsset being cited by the TerminologyAssetCitation.~~

~~Semantics~~

~~TerminologyAssetCitations make it possible to cite TerminologyAssets from other TerminologyPackages when forming TerminologyPackages or Expressions.~~

~~For example, within a TerminologyPackage it can be useful to refer to TerminologyAssets within another TerminologyPackage (to reference terminology) that are not contained with the same TerminologyPackage and is defined elsewhere. Within an Expression it can also be useful to refer to TerminologyAssets within another TerminologyPackage that are not contained with the same TerminologyPackage and is defined elsewhere.~~

~~**Constraints**~~

~~**The citedElement referred to by a TerminologyAssetCitation must be outside of the containment hierarchy containing the citation.**~~

Part II - Argumentation Metamodel

This part of the specification defines the Argumentation Metamodel.

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11 SACM Argumentation Metamodel

11.1 General

This chapter presents the normative specification for the SACM Argumentation ~~Metamodel~~Package. It begins with an overview of the metamodel structure followed by a description of each element.

1~~ram DiagssArgumentation Cla~~

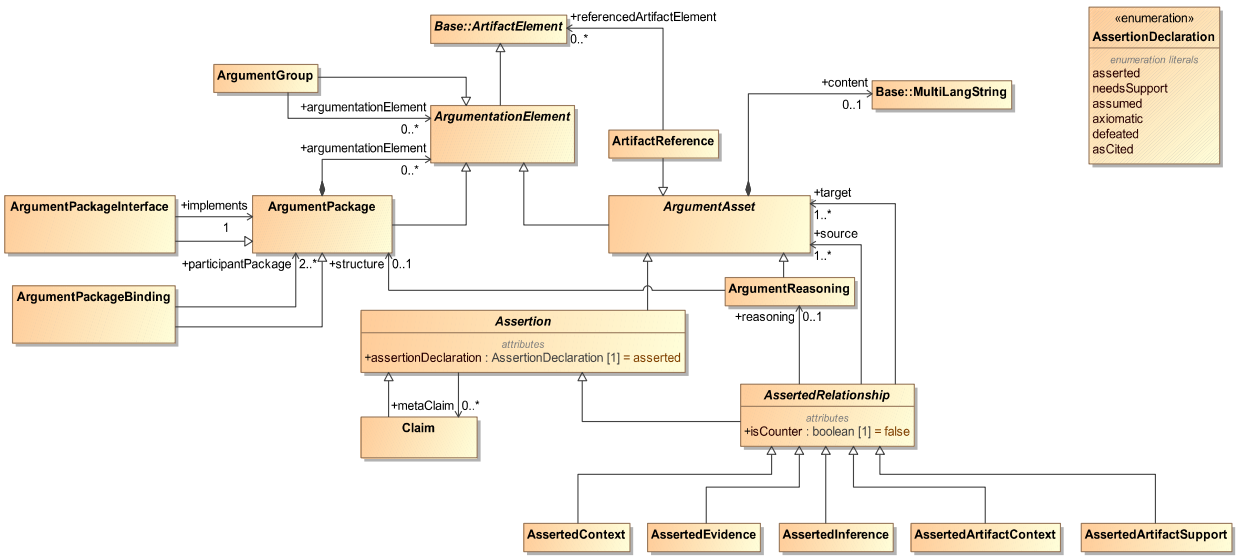

Figure ~~11.1~~11.1 - Argumentation ~~Class~~Package Diagram

This portion of the SACM model describes and defines the concepts required to model structured arguments. Arguments are represented in SACM through explicitly representing the Claims and citation of artifacts (e.g., as evidence) (~~ArtifactElementCitation~~ArtifactReference), and the 'links' between these elements – e.g., how one or more Claims are asserted to infer another Claim, or how one or more artifacts (referenced by ArtifactReference) are asserted as providing evidence for a Claim (AssertedEvidence). In addition to these core elements, in SACM it is possible to provide additional description of the ArgumentReasoning associated with inferential and evidential

relationships, represent counter-arguments ~~(through AssertedChallenge),~~and counter-evidence (through ~~AssertedCounterEvidence~~isCounter:Boolean), and represent how artifacts provide the context in which arguments should be interpreted (through AssertedContext.)

The packaging of structured arguments into 'modular' argument packages is enabled through ArgumentPackages, an optional declaration of an interface for the package (ArgumentPackageInterface) that ~~cites~~organizes a specific selection of the ArgumentElements contained within the package, and the ability to link (by means of an argument) two or more argument packages (through an ArgumentPackageBinding). It is also possible within a package to cite elements contained within other argument packages (through ~~using~~AssertedContext ~~ArgumentElementCitation~~).

~~In the following sections we describe these model elements in detail~~The packaging of structured arguments into 'modular' argument packages is enabled through ArgumentPackages, an optional declaration of an interface for the package (ArgumentPackageInterface) that organises a specific selection of the ArgumentElements contained within the package, and the ability to link (by means of an argument) two or more argument packages (through an ArgumentPackageBinding). It is also possible within a package to cite elements contained within other argument packages (through ArtifactReference).

11.2 ArgumentGroup

ArgumentGroup can be used to associate a number of ArgumentElements to a common group (e.g. representing a common type or purpose, or being of interest to a particular stakeholder).

Superclass

ArgumentationElement

Associations

argumentationElement:ArgumentationElement[0..*] – an optional collection of ArgumentationElements organised within the ArgumentGroup.

Semantics

ArgumentGroup can be used to associate a number of ArgumentElements to a common group (e.g. representing a common type or purpose, or being of interest to a particular stakeholder). The name and the description of the ArgumentGroup should provide the semantic for understanding the ArgumentGroup. ArgumentGroups serve no structural purpose in the formation of the argument network, nor are they meant as a structural packaging mechanism (this should be done using ArgumentPackages).

11.~~2.1~~3 ArgumentationElement ~~class~~ (abstract)

An ArgumentationElement is the top level element of the hierarchy for argumentation elements. ArgumentationElement extends Base::ArtifactElement. Subsequently, all argument elements are considered artifacts.

Superclass

Base::ArtifactElement

Semantics

The ArgumentationElement is a common class for all elements within a structured argument.

11.~~2.2~~4 ArgumentPackage Class

~~The~~ ArgumentPackage ~~Class~~ is the contain~~er classing~~ element for a structured argument represented using the SACM Argumentation Metamodel.

Superclass

ArgumentationElement

Associations

~~argumentAsset:ArgumentAsset[0..*]~~

~~The ArgumentAssets contained in a given instance of an ArgumentPackage.~~
~~argumentPackage:ArgumentationPackage[0..*]~~

~~The nested argumentPackage contained in a given instance of an ArgumentPackage~~
~~interface:ArgumentationPackage[0..*]~~

~~Reference to the declared interface for the ArgumentPackage.~~argumentationElement:ArgumentationElement[0..*] (composition) – a collection of ArgumentationElements forming a structured argument

Semantics

ArgumentPackages contain structured arguments. These arguments are composed of ArgumentAssets. ArgumentPackages elements can also be nested~~, and can contain citations (references) to other ArgumentPackages.~~

~~For example, arguments can be established through the composition of Claims (propositions) and the AssertedInferences between those Claims~~.

Constraints

~~11.2.3 ArgumentPackageCitation Class~~

~~The ArgumentPackageCitation is a citation (reference) to another ArgumentPackage.~~

~~Superclass~~

~~ArgumentPackage~~

~~Associations~~

~~citedPackage:ArgumentPackage[1]~~

~~The ArgumentPackage being cited by the ArgumentPackageCitation.~~

~~Semantics~~

~~ArgumentPackageCitations make it possible to cite other ArgumentPackages.~~

~~For example, within an ArgumentPackage it can be useful to refer to another ArgumentPackage that is not contained within the same ArgumentPackage.~~

~~Constraints~~

~~ArgumentPackageCitations have no contents other than the association to the citedPackage.~~

~~**The citedPackage referred to by an ArgumentPackageCitation must be outside of the containment hierarchy containing the citation.**~~

If an ArgumentPackage has nested ArgumentPackages, then it is only allowed to contain ArgumentPackages..

11.~~2.4~~5 ArgumentPackageBinding ~~Class~~

~~The ArgumentPackageBinding is a sub type of ArgumentPackage used to record the mapping (agreement) between two or more ArgumentPackages.~~ArgumentElement within the ArgumentPackage can be bound together by means of ArgumentPackageBinding. ArgumentPackageBinding bind the participant packages by means of argument elements that connect the cited elements of the participant packages.

Superclass

ArgumentPackage

Associations

participantPackage:ArgumentPackageInterface[2..*]

~~T~~ - the ArgumentPackages being mapped together by the ArgumentPackageBinding.

Semantics

ArgumentPackageBindings can be used to map resolved dependencies between the Claims of two or more ArgumentPackages.

For example, one ArgumentPackage may contain a claim that ~~is toBeSupported~~needsSupport (i.e. currently has no supporting argument). An ArgumentPackageBinding can be used to record the mapping ~~(~~by means of containing a structured argument linking ~~ArgumentAssetCitations to the claims in question) between this claim and a supporting claim in another ArgumentPackage.~~ArgumentElements that cite the claims in question.

~~An ArgumentPackageInterface~~ArgumentPackageBinding is a sub type of ArgumentPackage ~~that can be used to create an explicit interface to an existing~~, it is used to record the argument that connects the arguments of two or more ArgumentPackages.

Constraints

~~**The 'root' ArgumentAssets contained by an ArgumentPackageBinding (i.e. the ArgumentAssets only associated as target of an AssertedRelationship) and 'leaf' ArgumentAssets (i.e. the ArgumentAssets only associated as source of an AssertedRelationship) must be ArgumentAssetCitations to Claims or ArtifactElementCitations contained within the ArgumentPackages associated by the participantPackage association.**~~

The participantPackages should be only ArgumentPackages

OCL: self.participantPackage->forall(pp|pp.oclIsTypeOf(Argument::ArgumentPackage))

The ArgumentElements contained by an ArgumentPackageBinding must be ArgumentElement citations to ArgumentElements contained within the ArgumentPackages associated by the participantPackage association.

11.~~2.5~~6 ArgumentPackageInterface ~~Class~~

ArgumentPackageInterface is a kind of ArgumentPackage that defines an interface that may be exchanged between users. An ArgumentPackage may declare one or more ArgumentPackageInterface.

Superclass

ArgumentPackage

Associations

implements:ArgumentPackage[1] – a reference to the ArgumentPackage which the ArgumentPackageInterface declares.

Semantics

ArgumentPackageInterfaces can be used to declare (by means of containing ~~ArgumentAssetCitations~~ArgumentElement based citations) the ArgumentAssets contained in an ArgumentPackage that form part of the explicit, declared, interface of the ArgumentPackage.

For example, whilst an ArgumentPackage may contain many Claims, it may be desirable to create an ArgumentPackageInterface that cites only a subset of those claims that are intended to be mapped / used (e.g. by means of an ArgumentPackageBinding) by other ArgumentPackages. There may be more than one ArgumentPackageInterface for a given ArgumentPackage that reveal different aspects of the ArgumentPackage for different audiences.

Constraints

ArgumentPackageInterfaces are only allowed ~~to contain ArgumentAssetCitations to ArgumentAssets within the ArgumentPackage with which this ArgumentPackageInterface is associated (by the interface association).~~with isCitation=true and +citedElement refer to ArgumentAssets within the ArgumentPackage implementation referred to by implements.

11.~~2.6~~7 ArgumentAsset ~~Class~~ (abstract)

~~The~~ ArgumentAsset ~~Class~~ is the abstract ~~class~~bsse element for the elements of any structured argument represented in SACM.

Superclass

ArgumentationElement

Associations

content:Base::MultiLangString[0..1] (composition) – the content of the ArgumentAsset defined in possibly multiple languages

~~Superclass~~

~~ArgumentationElement~~

Semantics

ArgumentAssets represent the constituent building blocks of any structured argument contained in an ArgumentPackage.

For example, ArgumentAssets can represent the Claims made within a structured argument contained in an ArgumentPackage.

11.8 AssertionDeclaration (Enumeration)

AssertionDeclaration provides a list of declarations which can be used to declare the state of an Assertion.

Superclass

N/A

Enumeration Litterals

asserted – the default enumeration literal, indicating that an Assertion is asserted. needsSupport – a flag indicating that further argumentation has yet to be provided to support the Assertion.

assumed – a flag indicating that the Assertion being made is declared by the author as being assumed to be true rather than being supported by further argumentation.

axiomatic – a flag indicating that the Assertion being made by the author is axiomatically true, so that no further argumentation is needed.

defeated – a flag indicating that the Assertion is defeated by counter-evidence and/or argumentation.

asCited – a flag indicating that because the Assertion is cited, the AssertionDeclaration should be transitively derived from the value of the AssertionDeclaration of the cited Assertion.

Semantics

AssertionDeclaration provides a list of declarations which indicate the state of an Assertion.

11.9 ArtifactReference

ArtifactReference enables the citation of an artifact as information that relates to the structured argument.

Superclass

ArgumentAsset

Associations

referencedArtifactElement:Base::ArtifactElement[0..*] – reference to a collection of ArtifactElements.

Semantics

It is necessary to be able to cite artifacts that provide supporting evidence, context, or additional description with in an argument structure. ArtifactReferences allow there to be an objectified citation of this information within the structured argument, thereby allowing the relationship between this artifact and the argument to also be explicitly declared.

2~~1~~1.~~2.7~~10 Assertion ~~Class~~ (abstract)

Assertions are used to record the propositions of Argumentation (including both the Claims about the subject of the argument and the structure of the Argumentation being asserted). Propositions can be true or false, but cannot be true and false simultaneously.

Superclass

ArgumentAsset

Attributes

assertionDeclaration:AssertionDeclaration[1] = asserted – the declaration indicating the state of the Assertion.

Associations

metaClaim:Claim[0..*]

- references Claims concerning (i.e., about) the Assertion (e.g., regarding the confidence in the Assertion)

Semantics

Structured arguments are declared by stating claims, citing evidence and contextual information, and asserting how these elements relate to each other.

3~~11.2.8 Artifact~~ElementCitation ~~Class~~

~~The ArtifactElementCitation Class enables the citation of an artifact that relates to the structured argument.~~

~~Superclass~~

~~ArgumentAsset~~

~~Attributes~~

~~externalReference: String An attribute recording a URL to external evidence.~~

~~Associations~~

~~citedArtifact:ArtifactElement[0..1]~~

~~The ArtifactElements cited by the current ArtifactElementCitation object.~~

~~Semantics~~

~~It is necessary to be able to cite artifacts that provide supporting evidence, context, or additional description for the core reasoning of the recorded argument. ArtifactElementCitations allow there to be an objectified citation of this information within the structured argument, thereby allowing the relationship between this artifact and the argument to also be explicitly declared.~~

~~The externalReference attribute can be used when wishing to cite an Artifact not being modeled by an SACM ArtifactElement.~~

4~~11.2.9 ArgumentAssetCitation Class~~

~~The ArgumentAssetCitation cites an ArgumentAsset within another ArgumentPackage, for use within the current ArgumentPackage.~~

~~Superclass~~

~~ArgumentAsset~~

~~Associations~~

~~citedAsset:ArgumentAsset[0..*]~~

~~References an ArgumentAsset within another ArgumentPackage.~~

~~**Semantics**~~

~~Within an ArgumentPackage it can be useful to be able to cite elements of another ArgumentPackage (i.e., ArgumentAssets) to act as explicit proxies for those elements acting within the argumentation structure. For example, in supporting a Claim it may be useful to cite a Claim contained within another ArgumentPackage.~~

~~**Constraints**~~

~~**The citedAsset referred to by an ArgumentAssetCitation must be outside of the containment hierarchy containing the citation.**~~

11.~~2.10~~11 Claim ~~Class~~

Claims are used to record the propositions of any structured argument contained in an ArgumentPackage. Propositions are instances of statements that could be true or false, but cannot be true and false simultaneously.

Superclass

Assertion

~~Attributes~~

~~assumed: Boolean~~

~~An attribute recording whether the claim being made is declared as being assumed to be true rather than being supported by further reasoning.~~

~~toBeSupported: Boolean~~

~~An attribute recording whether further reasoning has yet to be provided to support the Claim (e.g. further evidence to be cited).~~

Semantics

The core of any argument is a series of claims (premises) that are asserted to provide sufficient reasoning to support a (higher-level) claim (a conclusion).

A Claim that is intentionally declared without any supporting evidence or argumentation can be declared as being assumed ~~to be true~~(i.e. assertionDeclared = assumed). It is an assumption. However, it should be noted that a Claim that is not 'assumed' (i.e., ~~assumed = false~~assertionDeclaration = asserted) is not being declared as false. However, there is the expectation of the provision of a supporting argument structure (e.g. it may represent part of an incomplete structure).

A Claim that is intentionally declared as requiring further evidence or argumentation ~~can be denoted by setting toBeSupported to be true~~can be denoted by setting +assertionDeclaration to "needsSupport".

A Claim that is being declared as axiomatically true can be denoted by setting +assertionDeclaration to "axiomatic".

A Claim that is defeated by counter evidence can be denoted by setting +assertionDeclaration to "defeated".

A Claim which cites another claim and supported by the cited claim can be denoted by setting +assertionDeclaration to "asCited".

Constraints

Self.assumed and self.toBeSupported cannot both be true simultaneously.

11.~~2.11~~12 ArgumentReasoning ~~Class~~

ArgumentReasoning can be used to provide additional description or explanation of the asserted ~~inference or challenge~~relationship. For example, it can be used to provide description of an AssertedInference that connects one or more Claims (premises) to another Claim (conclusion). ArgumentReasoning elements are therefore related to AssertedInferences ~~and AssertedChallenges~~, AssertedContexts, and AssertedEvidence. It is also possible that ArgumentReasoning elements can

refer to other structured Arguments as a means of documenting the detail of the argument that establishes the asserted inferences, contexts, and evidence.

Superclass

~~Reasoning~~~~Element~~ArgumentAsset

Associations

structure:ArgumentPackage[0..1]

~~0~~ - optional reference to another the ArgumentPackage that provides the detailed structure of the argument being described by the ArgumentReasoning.

Semantics

The AssertedRelationship that relates one or more Claims (premises) to another Claim (conclusion), or evidence cited by an Artifact~~ElementCitation~~Reasoning to a Claim, may not always be obvious. In such cases ArgumentReasoning can be used to provide further description of the reasoning involved.

11.~~2.12~~13 AssertedRelationship ~~Class~~ (abstract)

~~The~~ AssertedRelationship ~~Class~~ is the abstract association class that enables the ArgumentAssets of any structured argument to be linked together. The linking together of ArgumentAssets allows a user to declare the relationship that they assert to hold between these elements.

Superclass

Assertion

Attributes

isCounter:Boolean[1] = false – a flag indicating that the AssertedRelationship counters its declared purposes (e.g. setting isCounter = true for an AssertedEvidence indicates that the relationship is a counter-evidence).

Associations

source:ArgumentAsset[1..*]~~Associations~~

~~source:ArgumentAsset[0..*]~~

~~R~~ - reference to the ArgumentAsset(s) that are the source (start-ing point) of the relationship.

target:ArgumentAsset[~~0~~1..*]

~~R~~ - reference to the ArgumentAsset(s) that are the target (end-ing point) of the relationship.

reasoning:ArgumentReasoning~~[0..*]~~[0..1] – an optional reference to the a description of the reasoning underlying the AssertedRelationship.

~~Reference to the ArgumentReasoning being described by the ArgumentReasoning.~~

Semantics

In SACM, the structure of an argument is declared through the linking together of primitive ArgumentAssets. For example, a sufficient inference can be asserted to exist between two claims (“Claim A implies Claim B”) or sufficient evidence can be asserted to exist to support a claim (“Claim A is evidenced by Evidence B”). An inference asserted between two claims (A – the source – and B – the target) denotes that the truth of Claim A is said to infer the truth of Claim B.

11.~~2.13~~14 AssertedInference ~~Class~~

~~The~~ AssertedInference association ~~class~~ records the inference that a user declares to exist between one or more Assertion (premise~~s~~) and another Assertion (conclusion). It is important to note that such a declaration is itself an assertion on behalf of the user.

Superclass

AssertedRelationship

Semantics

The core structure of an argument is declared through the inferences that are asserted to exist between Assertions (e.g., Claims). For example, an AssertedInference can be said to exist between two claims (“Claim A implies Claim B”). An AssertedInference between two claims (A – the source – and B – the target) denotes that the truth of Claim ~~A~~B is said to infer the truth of Claim ~~B~~A.

~~Constraints~~

~~The source of AssertedInference relationships must be Claims, or ArgumentElementCitations that cite a Claim.~~

~~The target of AssertedInference relationships must be Assertions, or ArgumentElementCitations that cite an Assertion.~~

11.~~2.14~~15 AssertedEvidence ~~Class~~

~~The~~ AssertedEvidence association ~~class~~ records the declaration that one or more artifacts of Evidence (cited by Artifact~~ElementCitations~~Reference) provide information that helps establish the truth of a Claim. It is important to note that such a declaration is itself an assertion on behalf of the user. The artifact (cited by an Artifact~~ElementCitation~~Referemce) may provide evidence for more than one Claim.

Superclass

AssertedRelationship

Semantics

Where evidence (cited by Artifact~~ElementCitation~~Reference) exists that helps to establish the truth of a Claim in the argument, this relationship between the Claim and the evidence can be asserted by an AssertedEvidence association. An AssertedEvidence association between an artifact cited by an Artifact~~ElementCitation~~Reference and a Claim (A – the source evidence cited – and B – the target claim) denotes that the evidence cited by A is said to help establish the truth of Claim B.

Constraints

The source of AssertedEvidence relationships must be Artifact~~ElementCitation~~Reference.

OCL:

~~The target of AssertedEvidence relationships must be Assertions, or ArgumentElementCitations that cite an Assertion.~~

~~11.2.15 AssertedChallenge Class~~

~~The AssertedChallenge association class records the challenge (i.e. counter-argument) that a user declares to exist between one or more Claims and another Claim. It is important to note that such a declaration is itself an assertion on behalf of the user.~~

~~Superclass~~

~~AssertedRelationship~~

~~Semantics~~

~~An AssertedChallenge by Claim A (source) to Claim B (target) denotes that the truth of Claim A challenges the truth of Claim B (i.e., Claim A leads towards the conclusion that Claim B is false).~~

~~Constraints~~

~~The source of AssertedChallenge relationships must be Claims, or ArgumentElementCitations that cite a Claim.~~

~~The target of AssertedChallenge relationships must be Assertions, or ArgumentElementCitations that cite an Assertion.~~

11.2.16 AssertedCounterEvidence Class

AssertedCounterEvidence can be used to associate evidence (cited by ArtifactElementCitations) to a Claim, where this evidence is being asserted to infer that the Claim is false. It is important to note that such a declaration is itself an assertion on behalf of the user.

Superclass

AssertedRelationship

Semantics

An AssertedCounterEvidence association between some evidence cited by an InformationNode and a Claim (A – the source evidence cited – and B – the target claim) denotes that the evidence cited by A is counter-evidence to the truth of Claim B (i.e., Evidence A suggests the conclusion that Claim B is false).

Constraints

The source of AssertedCounterEvidence relationships must be ArtifactElementCitation.

The target of AssertedCounterEvidence relationships must be Assertions, or ArgumentElementCitations that cite an Assertion.self.source->forall(s|s.oclIsTypeOf(ArtifactReference))

11.2.1716 AssertedContext Class

The AssertedContext association class can be used to declare that the artifact cited by an ArtifactElementCitationReference(s) provides the context for the interpretation and scoping of a Claim or ArgumentReasoning element. In addition, the AssertedContext association class can be used to declare a Claim asserted as necessary context (i.e. a precondition) for another Assertion or ArgumentReasoning.

Superclass

AssertedRelationship

Semantics

Contextual information often needs to be cited in order to make clear the interpretation and scope of a Claim or ArgumentReasoning description. For example, a Claim can be said to be valid only in a defined context ("Claim A is asserted to be true only in a context as defined by the information cited by Artifact B" or conversely "InformationItem B is the asserted context for Claim A"). A declaration (AssertedContext) of context (ArtifactElementCitation B) for a ReasoningElement A records that B is asserted to be contextual information required for the interpretation and scoping of A (i.e., B defines the context where the reasoning presented by A is asserted as true).

Contextual Claims often need to be cited as preconditions for an Assertion Claim or ArgumentReasoning. For example, a Claim may be asserted only in the context of another claim ("Claim A is asserted to be true only in a context where Claim B is true". Similarly, a description of ArgumentReasoning A may only be considered true in a context where Claim B is true".

Constraints

The source of AssertedContext relationships must be ArtifactElementCitations or Claims.

The target of AssertedContext relationships must be Assertions, ArgumentElementCitations that cite an Assertion, "ArgumentReasoning" elements or ArgumentElementCitations that cite ArgumentReasoning elements.

11.17 AssertedArtifactSupport

AssertedArtifactSupport records the assertion that one or more artifacts support another artifact.

Superclass

AssertedRelationship

Semantics

The truth of the assertions associated with an artifact are supported by the assertions that are associated with one or more other artifacts. Note: this can be an ambiguous relationship if the nature of these Assertions is unclear. In such cases, it would be clearer to declare explicit AssertedInferences between Claims drawn out from the ArtifactReference.

Constraints

The source and target of AssertedArtifactSupport must be of type ArtifactReference.

11.18 AssertedArtifactContext

AssertedArtifactContext records the assertion that one or more artifacts provide context for another artifact.

Superclass

AssertedRelationship

Semantics

One or more other artifacts provide the necessary context in which the assertions associated with another artifact should be understood. Note: this can be an ambiguous relationship if the nature of these Assertions is unclear. In such cases, it would be clearer to declare explicit AssertedContext between Claims drawn out from the ArtifactReference.

Constraints

The source and target of AssertedArtifactContext must be of type ArtifactReference.

Part III - Artifact Metamodel

This part of the specification defines the Artifact Metamodel.

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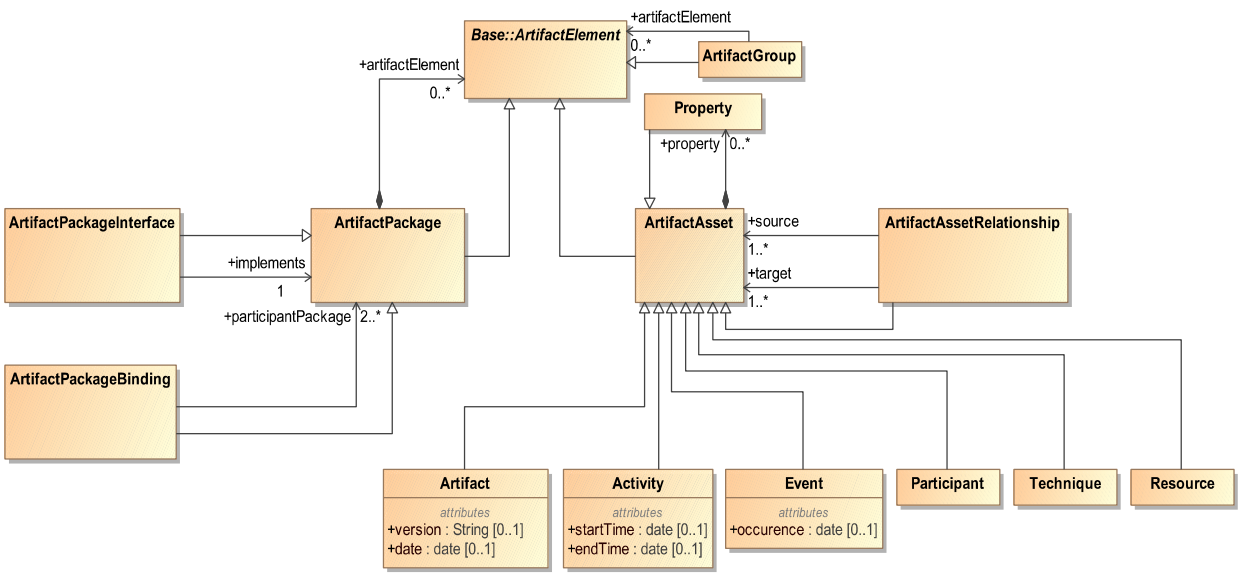
12 Artifact Classes

12.1 General

This chapter presents the normative specification for the SACM Artifact ~~Metamodel~~Package. It begins with an overview of the metamodel structure followed by a description of each element.



Artifacts correspond to the main evidentiary elements of an assurance case. By means of assertions (~~AssertedEvidence and AssertedCounterEvidence~~AssertedEvidence with isCounter = true/false), artifacts ~~are used for~~can be referenced (using ArtifactReferences) as supporting claims and arguments.

In general, artifacts are managed when the corresponding objects are available. For example, a test case is linked to the requirement that validates once the test case has already been created. However, artifact management might also require the specification of patterns (or templates) in order to allow a user, for instance, to indicate that a given artifact must be created but it has not yet. A common scenario of this situation corresponds to the process during which a supplier and a certifier have to agree upon the artifacts that the supplier will have to provide as assurance evidence for a system. As a result of this process, artifact patterns could be specified, and such patterns would need to be made concrete during the lifecycle of the system. Artifact patterns are specified by means of the attribute 'isAbstract' (~~Model~~SACMElement). For example, a supplier and a certifier might agree upon the need for maintaining a hazard log during a system's lifecycle. Such a hazard log would initially be modeled as an Artifact that is abstract. Once created, the value of this attribute of the hazard log would be 'false'. The specification of artifact patterns also facilitates their reuse, as the corresponding artifacts might have to be created in the scope of more than one assurance case effort. Using again hazard logs as an example, their structure might be the same for several systems, thus all the corresponding hazard logs might be based on a same abstract Artifact.

When made concrete, an Artifact can relate to many different types of information necessary for developing confidence in the Artifact and thus for assurance purposes. Such information can be regarded as meta-data or provenance information about an Artifact, provides information about its management, and is specified with the rest of specializations of ArtifactAsset ~~(different to ArtifactAssetCitation)~~. Using a design specification as an example, properties (~~Artifact~~Property) could be specified regarding its quality (completeness, consistency...), and it would have a lifecycle with events such as its creation and modifications. The specification could be created by using UML (Technique) in an Activity named 'Specify system design', stored in a Resource corresponding to a diagram created with some modeling tool, and later used as input for another Activity called 'Verify system design'. A given person (Participant) playing the role of system designer could be the owner of the design specification, which would also relate to other artifacts: the requirements specification that satisfies, the architecture that implements, its verification report, etc. ~~Further relationships might be specified between other artifact assets, such precedence between activities ('Specify system design' precedes 'Verify system design') and the participants in an Activity.~~Associations between Artifacts and Activities /Events/Participants/ Resources/Techniques, and between Aritfacts and Activities /Events/Participants/ Resources/Techniques Participants can be recorded by means ArtifactAssetRelationships.

12.2 ArtifactPackage

ArgumentPackage is the containing element for artifacts involved in a structured assurance case.

Superclass

Base::ArtifactElement

Associations

artifactElement:Base::ArtifactElement[0..*] (composition) – a collection of ArtifactElements forming a artifact package in a structured assurance case.

Semantics

ArtifactPackages contain ArtifactElements that represent the artifact forming part of a structured assurance case. ArtifactPackages can also be nested.

12.3 ArtifactGroup

ArtifactGroup can be used to associate a number of ArtifactElements to a common group (e.g. representing a common type or purpose, or being of interest to a particular stakeholder).

Superclass

Base::ArtifactElement

Associations

artifactElement:ArtifactElement[0..*] – an optional collection of ArtifactElements organised within the ArtifactGroup.

Semantics

~~**ArtifactPackageCitation**~~

~~ArtifactPackageCitation is used to cite another ArtifactPackage. The citation can be used where an assurance case author wishes to refer to an existing ArtifactPackage.~~

~~**Superclass**~~

~~ArtifactPackage~~

~~**Associations**~~

~~citedPackage: ArtifactPackage [1] – the ArtifactPackage cited by the ArtifactPackageCitation~~

~~**Semantics**~~

~~ArtifactPackageCitations enable the reference, in a given ArtifactPackage, to another ArtifactPackage.~~

~~**Constraints**~~

~~ArtifactPackageCitations have no contents other than the association to the citedPackage.~~ArtifactGroup can be used to associate a number of ArtifactElements to a common group (e.g. representing a common type or purpose, or being of interest to a particular stakeholder). The name and the description of the ArtifactGroup should provide the semantic for understanding the ArtifactGroup. ArtifactGroups serve no structural purpose in the formation of the argument network, nor are they meant as a structural packaging mechanism (this should be done using ArtifactPackage).

12.4 ArtifactPackageBinding

The ArtifactPackageBinding is a sub type of ArtifactPackage used to record ArtifactAssetRelationships between the ArtifactAssets of two or more ArtifactPackages.

Superclass

ArtifactPackage

Associations

participantPackage:ArtifactPackage~~Interface~~[2..*]

~~T~~ - the ArtifactPackages containing the ArtifactAssets being related together by the ArtifactPackageBinding.

Semantics

ArtifactPackageBindings can be used to map dependencies between the cited ArtifactAssets of two or more ArtifactPackages. For example, a binding could be used to record a ‘derivedFrom’ ArtifactAssetRelationship between the ArtifactAsset of one package to the ArtifactAsset of another.

Contraints

~~ArtifactPackageBindings must only contain ArtifactAssetRelationships with source and target ArtifactAssetCitations citing ArtifactsAssets contained within the ArtifactPackageInterfaces associated by participantPackage.~~ArtifactPackageBindings must only contain ArtifactAssetRelationships with source and target

Artifacts, with isCitation = true citing ArtifactAssets contained within the ArtifactPackages associated by participantPackage.

12.5 ArtifactPackageInterface

ArtifactPackageInterface is a kind of ArtifactPackage that defines an interface that may be exchanged between users. ~~A typical use case might be for a component supplier to provide its customers with ArtifactPackageInterfaces that contain the relevant supplier's ArtifactElements for the customers' ArtifactPackages.~~ An ArtfefactPackage may ~~also declare that it implements or conforms to a particular~~define one or more ArtifactPackageInterfaces.

Superclass

ArtifactPackage

Associations~~artifactPackageCitation: ArtifactPackageCitation [0..*] – an optional set of citations to other ArtifactPackage elements~~

~~artifactAsset: ArtifactAsset [0..*] – an optional set of ArtifactAsset elements, such as citations, artifacts, resources, activities, etc.~~

~~artifactPackage: ArtifactPackage [0..*] - an optional set of contained ArtifactPackage elements, allowing for recursive containment.~~implements:ArtifactPackage[1] - a reference to the ArtifactPackage which the ArtifactPackageInterface declares.

Semantics

ArtifactPackageInterface enables the declaration of the elements of an ArtifactPackage that might be referred to (cited) in another ArtifactPackage~~, thus the elements can be used for assurance in the scope of the latter ArtifactPackage~~.

Constraints

~~ArtifactPackageInterfaces are only allowed to contain ArtifactAssetCitations to ArtifactAssets within the ArtifactPackage with which this ArtifactPackageInterface is associated (by the interface association).~~ArtifactPackageInterfaces are only allowed to contain Artifacts with +isCitation=true citing ArtifactAssets within the ArtifactPackage with which this ArtifactPackageInterface is associated.

12.6 ArtifactAsset ~~class~~ (abstract)

~~The~~ ArtifactAsset ~~class~~ represents the artifact-specific pieces of information of an assurance case, in contrast to the argument-specific pieces of information.

Superclass

Base::ArtifactElement

Association

property:Property[0..*] (composition) – an optional collection of Propert(ies) which enable the specification of the characteristics of an ArtifactAsset.

Semantics

Information about artifacts is essential for any assurance case. The artifacts correspond, for instance, to the evidence provided in support of the arguments and claims of an assurance case. It is also important to have access to related pieces of information such as the provenance of an artifact, its lifecycle, and its properties. All this information might have to be consulted for developing confidence in the validity of an assurance case.~~12.5.1 ArtifactAssetCitation class~~

~~The ArtifactAssetCitation class allows an ArtifactPackage to refer to the components of another ArtifactPackage.~~

~~Superclass~~

~~ArtifactAsset~~

~~**Associations**~~

~~citedAsset:ArtifactAsset[1]~~

~~The ArtifactAsset that the ArtifactAssetCitation cites~~

~~**Constraints**~~

~~The citedAsset of an ArtifactAssetCitation must be part of an ArtifactPackageInterface.~~

~~The citedAsset of an ArtifactAssetCitation must be part of a different ArtifactPackage.~~

~~The citedAsset of an ArtifactAssetCitation cannot be an ArtifactAssetCitation.~~

~~The citedAsset of an ArtifactAssetCitation cannot be an ArtifactAssetRelationship.~~

~~**Semantics**~~

~~**ArtifactAssets belong to single ArtifactPackages. Nonetheless, the ArtifactAssets can be referred to in other ArtifactPackages in order to, for instance, specify that a relationship exists between ArtifactAssets of different ArtifactPackages. For example, an ArtifactPackage might be specified for all the V&V results of an assurance case, and another for the requirements specifications. The fist ArtifactPackage might refer to the second for further specifying that a given V&V result corresponds to the validation of a given requirement.**~~

12.~~5.~~27 Artifact ~~class~~

~~The~~ Artifact ~~class~~ represents the distinguishable units of data used in a~~n~~ structured assurance case.

Superclass

ArtifactAsset

Attributes

version: String[0..1] - the
~~The~~ version of the ~~A~~artifact

date: Date[0..1] -
~~T~~the date on which the artifact was created.

~~**Associations**~~

~~artifactProperty::ArtifactProperty[0..*]~~
~~The ArtifactProperties of the Artifact~~

~~artifactEvent::ArtifactEvent[0..*]~~
~~The set of ArtifactEvents that represent the lifecycle of the Artifact~~

Semantics

Artifacts correspond to the main evidentiary support for the arguments and claims of an assurance case: an Artifact can play the role of evidence of a Claim (AssertedEvidence), or of counterevidence (AssertedCountedEvidence with isCounter = true). An Artifact can take several forms, such as a diagram, a plan, a report, or a specification, both in electronic (e.g., a pdf file) or physical (e.g., a paper document) formats. Typical examples of Artifacts include system lifecycle plans, dependability (e.g., safety) analysis results, system specifications, and V&V results.

12.~~5.38~~ ~~Artifact~~Property ~~class~~

~~The Artifact~~Property ~~class~~ enables the specification of the characteristics of an Artifact.

Superclass

ArtifactAsset

Semantics

An Artifact can have different, specific characteristics independent of the argumentation structure in which the Artifact is used. Some can be objective (e.g., the result of a test case execution, as passed or not passed) and others can be based on a person's judgement (e.g., regarding a quality aspect of a report).

12.~~5.49~~ ~~Artifact~~Event ~~class~~

~~The Artifact~~Event ~~class~~ enables the specification of the events in the lifecycle of an Artifact.

Superclass

ArtifactAsset

Attributes

date: Date[0..1] -
~~T~~ the date on which the ~~Artifact~~Event occurred.

Semantics

Artifacts change during their lifecycle, and different types of happenings can occur at different moments: creation, modification, revocation... ~~Artifact~~Events serve to maintain a history log of an Artifact, and can be consulted to know how an Artifact has evolved and to develop confidence in its adequate management.

12.~~5.510~~ Resource ~~class~~

~~The~~ Resource ~~class~~ corresponds to the tangible objects representing an Artifact.

Superclass

ArtifactAsset

Attributes

~~location: String~~
~~The~~location:Base::MultiLangString (composition) – the path or URL specifying the location of the Resource, can be in multiple languages.

Semantics

Artifacts are located and accessible somewhere, usually in the form of some electronic file for an assurance case. Such information is specified by means of Resources.

12.~~5.611~~ Activity ~~class~~

~~The~~ Activity ~~class~~ represents units of work related to the management of ArtifactAssets.

Superclass

ArtifactAsset

Attributes

startTime: Date[0..1] -
~~T~~time when the ~~A~~activity started.

endTime: Date[0..1] -
~~T~~time when the ~~A~~activity ended.

Semantics

The Artifacts used in an assurance case are the result of and managed via the execution of processes, which consist of Activities: specification of requirements, design of the system, integration of system components, etc. ArtifactActivityRelationships can be used to specify the relationship between Activities and Artifacts. Activities can, for instance, be described as using a given Artifact as input or producing an Artifact as output. Activities can be related to one another using ActivityRelationships (e.g., 'preceding'). The purpose of an activity can be specified in its description.

12.~~5.7~~12 Technique ~~class~~

~~The~~ Technique ~~class~~ represents techniques associated with Artifacts (e.g., associated with the creation, inspection, review or analysis of an Artifact).

Superclass

ArtifactAsset

Semantics

Artifacts are created, or managed from a more general perspective, via some method whose use results in specific characteristics for the Artifacts. For example, the use of UML (as a Technique) for designing a system results in a design specification with a set of UML diagrams that could represent static and dynamic internal aspects of the system.

12.~~5.8~~13 Participant ~~class~~

~~The~~ Participant ~~class~~ enables the specification of the parties involved in the management of ArtifactAssets.

Superclass

ArtifactAsset

Semantics

Different parties can participate in an assurance case effort, such as specific people, organizations, and tools.

12.~~5.9~~ 14 ArtifactAssetRelationship ~~class~~

~~The~~ ArtifactAssetRelationship ~~class~~ enables the ArtifactAssets of an ~~AssuranceCase~~structured assurance case to be linked together. The linking together of ArtifactAssets allows a user to specify that a relationship exists between the assets.

Superclass

ArtifactAsset

Associations

source:ArtifactAsset[~~0~~1..*]
~~T~~ - the source of the ArtifactAssetRelationship

target:ArtifactAsset[0..*]
T - the target of the ArtifactAssetRelationship

Constraints

The source or target of an ArtifactAssetRelationship cannot be another ArtifactAssetRelationship.

Semantics

An ArtifactAsset can be related to other ArtifactAssets. This kind of information is specified by means of ArtifactAssetRelationships, which can also have a specific type depending on the ArtifactAssets being linked together. name and description of the ArtifactAssetRelationship can be used to describe the semantics of the ArtifactAssetRelationship.

:

Semantics

The specific Resources where an Artifact is located are specified by means of ArtifactResourceRelationships.

, or an Artifact AssetCitation citing a Resource.

The target of an ArtifactActivityRelationship must be a Resource, or an ArtifactAssetCitation citing an Artifact

ArtifactResourceRelationship class

The ArtifactResourceRelationship class enables an Artifact and a Resource to be linked together.

Superclass

ArtifactAssetRelationship

Constraints

The source of an ArtifactActivityRelationship must be an Artifact5.15.

Semantics

The information about the roles and functions that a Participant plays with regard to other ArtifactAssets is specified by means of ParticipantRoleRelationships. Examples of roles and functions include the owner of an Artifact, the executor of an Activity, and possible relationships between Participants (e.g., supervisor).

512. or an ArtifactAssetCitation citing a Participant

ParticipantRoleRelationship class

The ParticipantRoleRelationships class enables a Participant to be linked to other ArtifactAssets.

Superclass

ArtifactAssetRelationship

Constraints

The source of an ParticipantRoleRelationship must be a Participant5.14.

Semantics

Artifacts result from the application of Techniques, such as the application of UML for a design specification. ArtifactTechniqueRelationships are used to specify such a kind of information.

612., or an ArtifactAssetCitation citing a Technique.

The target of an ArtifactActivityRelationship must be a Technique, or an ArtifactAssetCitation citing an Artifact

ArtifactTechniqueRelationship class

The ArtifactTechniqueRelationship class enables an Artifact and a Technique to be linked together.

Superclass

ArtifactAssetRelationship

Constraints

The source of an ArtifactActivityRelationship must be an Artifact5.13.

Semantics

Artifacts are managed in the scope of Activities, which usually use the Artifact as input and output. Such information is specified by means of ArtifactActivityRelationships.

712., or an ArtifactAssetCitation citing an Activity.

The target of an ArtifactActivityRelationship must be an Activity, or an ArtifactAssetCitation citing an Artifact

ArtifactActivityRelationship class

The ArtifactActivityRelationships class enables an Artifact and an Activity to be linked together.

Superclass

ArtifactAssetRelationship

Constraints

The source of an ArtifactActivityRelationship must be an Artifact**5.12**.

Semantics

ActivityRelationships aim to support the specification of how Activities, and citations to them, relate each other: an Activity that precedes another, an Activity decomposed into others, etc.

812. or ArtifactAssetCitations citing an Activity ActivityRelationship class

The ActivityRelationship class enables two Activities to be related together.

Superclass

ArtifactAssetRelationship

Constraints

The source and target of an ActivityRelationship must be Activities5.11.

Semantics

The Artifacts managed during a system's lifecycle do not exist in isolation, but relationships typically exist between them: the test cases that validate some requirement, the design standard followed in a design specification, etc. These relationships are specified by means of ArtifactRelationships.

912., or ArtifactAssetCitations citing an Artifact ArtifactRelationship class

The ArtifactRelationship class enables two Artifacts to be linked together.

Superclass

ArtifactAssetRelationship

Constraints

~~The source and target of an Artifact~~~~Relationhsip must be Artifact~~~~S5.1012.~~# Annex A: Mappings from existing industrial notations for assurance cases

(informative)

A.1 Goal Structuring Notation (GSN)

Details of the of the mapping between GSN elements and SACM, and the available relevant tool support, are maintained at the following URL:

http://www.goalstructuringnotation.info/gsn-metamodel

A.2 Claims, Arguments, Evidence (CAE)

Details of the mapping between CAE elements and SACM, and the available relevant tool support, are maintained at the following URL:

http://www.adelard.com/asce/choosing-asce/standardisation.html

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Annex B: Examples of Assurance Cases in SACM 2.0 XMI

(informative)

B.1 Example Assurance Cases

Examples of SACM 2.0 Assurance Cases with HTML renderings, graphical depictions, and machine readable XMI are maintained at the following URL:

http://www.goalstructuringnotation.info/sacm-examples

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