References

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.

* OMG Unified Modeling Language (OMG UML), Version 2.5.1, formal/17-12-05
* OMG Meta Object Facility, version 2.5.1 (MOF), formal/19-10-01
* OMG XML Metadata Interchange, version 2.5.1 (XMI), formal/15-06-07
* OMG Object Constraint Language, version 2.4 (OCL), formal/14-02-03

Additional Information

How to Proceed

The rest of this document contains the technical content of this specification. The Tool-to-Tool - Software Bill of Material - Exchange Metamodel Standard (3T-SBOM-EMS) is a metamodel for defining and describing documents containing Software Bill of Material relative to a piece of software. It is independent of software implementation language and is highly independent of implementation details. It provides a common platform by which an end-users and tools can expose, share, consume such documents. 3T-SBOM-EMS is composed of multiple packages, with references to pre-existing OMG standards, which are outside the scope of this document.

* Clause 7. Specification overview - Provides background information on the organization of the Tool-to-Tool (3T) Software Bill of Materials (SBOM) Exchange Metamodel Standard (EMS) specification.
* Clause 8. The 3T-SBOM-EMS Artifact package defines fundation classes for structuring Software Bill of Material documents. All 3T-SBOM-EMS compliant tooling, repository, or efforts must support the Artifact package.
* Clause 8. The 3T-SBOM-EMS Relationship package defines classes for handling relationships between model elements. All 3T-SBOM-EMS Provenance compliant tooling, repository, or efforts must support the Relationship package
* Clause 8. The 3T-SBOM-EMS Annotation package defines classes for handling additional pieces of information to attach to model elements. All 3T-SBOM-EMS compliant tooling, repository, or efforts must support the Annotation package
* Clause 8. The 3T-SBOM-EMS Content package defines classes for handling more detailed pieces of information about the file content of the software under consideration in the SBoM document.
* Clause 8. The 3T-SBOM-EMS Licensing package defines classes for handling more detailed pieces of information about licensing and copyright. All 3T-SBOM-EMS IP protection compliant tooling, repository, or efforts must support the Licensing package.
* Clause 8. The 3T-SBOM-EMS Activity package defines classes for handling more information about actions involved in producing and in ensuring the quality and compliance of the software under consideration in the SBoM document. All 3T-SBOM-EMS Assurance and Pedigree compliant tooling, repository, or efforts must support the Activity package

Background of the model elements

The following clauses will list and detail the classes and enumerations from each of the 3T-SBOM-EMS model packages.

The 3T-SBOM-EMS is defining model elements that are designed as place-holders for specific pieces of information. The model itself does not require anyone to share or expose every possible piece of information, but it defines how to share and expose them when there is an agreement or requirement for them to be shared and exposed.

The 3T-SBOM-EMS model is also designed to support document-formatting as well as graph-formatting. The former is achieved by the serialization of instances of the classes from the model, according to serialization guidelines. The latter is achieved by a node-oriented modeling of concepts, with possible relationships between these.

As shown in figure 1, the Tool-to-Tool Software Bill of Materials Exchange Metamodel Standard metamodel consists of multiple packages: the Artifact Package, the Relationship Package, the Content Package, the Annotation Package, the Licensing Package, and the Activity Package.

Artifact Classes

This chapter presents the normative specification for the Tool-to-Tool Software Bill of Materials Exchange Metamodel Standard metamodel Artifact Classes. It begins with an overview of the Artifact Classes metamodel inheritance structure shown in Figure 2 followed by a description of each element. The inheritance from the MOF::Element class is key to ensure the 3T-SBOM-EMS meta model integrates with existing MOF-based meta models. The Element class is pivotal to the 3T-SBOM-EMS as it brings the annotation, relationship, ... capabilities to all inheriting classes. Then, the Artifact and Document classes are at the core of software bill of material as they identify the pieces of software detailed in the SBoM. An overview of the associations is shown in Figure 3 while Figure 4 displays attribute details as well.

Element Class

This class is the abstract parent class of all the classes from the 3T-SBOM-EMS specifications who needs annotations, relationships, involvement in build process, .... It supports a graph-based approach to Software Bill of Material modeling where salient elements are the nodes of a graph, that can be related together.

SuperClass

MOF::Element

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| hashes : Hash [\*] | Element capturing the hashes. |

Document Class

This class represents the Software Bill of Material document. Its function is dual:

* Clearly identify the piece of software under consideration,
* Be referenced to attach additional pieces of information pertaining to the considered piece of software.

SuperClass

Element

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| hashes : Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| name : String [1] | The name of the document. |
| identifier : String [1] | The identifier of the document, unique within the namespace. |
| namespace : String [1] | The namespace of the identifier of the document. |
| author : String [1..\*] | The author(s) of the document. |
| specVersion : String [1] | The specification version with which the document complies to. |
| created : https://www.w3.org/TR/xmlschema11-2/#dateTime [1] | Document creation date time stamp |
| populationMethod : PopulationMethod [1] | The element capturing how the document content was produced. |

Associations (required)

The following table lists the class required associations:

| Association name:type[cardinality] | Description | Reverse association name |
| --- | --- | --- |
| artifacts : Artifact [1..\*] | The elelement(s) capturing the piece of software the document pertains to. | document |

Associations (optional)

The following table lists the class optional associations:

| Association name:type[cardinality] | Description | Reverse association name |
| --- | --- | --- |
| referencedArtifacts : ReferencedArtifact [\*] | The elelement(s) capturing references to other artifacts. | document |
| signature : Signature [0..1] | The elelement capturing the optional signature of the document. | document |

AbstractArtifact Class

This abstract class represents the components, assets, ... detailed or referenced in the Software Bill of Material documents.

SuperClass

Element

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| hashes : Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| name : String [1] | The name of the artifact. |
| version : String [1] | The version of the artifact. |
| license : String [0..1] | The license of the artifact. |
| identifier : String [1] | The identifier of the artifact, unique within the namespace. |
| namespace : String [1] | The namespace of the identifier of the artifact. |
| supplier : String [0..1] | The supplier of the artifact. |
| type : ArtifactType [1] | The type of the artifact. |

Artifact Class

This class represents the components, assets, ... detailed in the Software Bill of Material documents.

SuperClass

AbstractArtifact

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| name : String [1] | The name of the artifact. | AbstractArtifact |
| version : String [1] | The version of the artifact. | AbstractArtifact |
| license : String [0..1] | The license of the artifact. | AbstractArtifact |
| identifier : String [1] | The identifier of the artifact, unique within the namespace. | AbstractArtifact |
| namespace : String [1] | The namespace of the identifier of the artifact. | AbstractArtifact |
| supplier : String [0..1] | The supplier of the artifact. | AbstractArtifact |
| type : ArtifactType [1] | The type of the artifact. | AbstractArtifact |
| hashes : Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| summary : String [0..1] | Summary description of the artifact. |
| description : String [0..1] | Detailed description of the artifact. |

ReferencedArtifact Class

This class represents the components, assets, ... referenced in the Software Bill of Material documents.

SuperClass

AbstractArtifact

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| name : String [1] | The name of the artifact. | AbstractArtifact |
| version : String [1] | The version of the artifact. | AbstractArtifact |
| license : String [0..1] | The license of the artifact. | AbstractArtifact |
| identifier : String [1] | The identifier of the artifact, unique within the namespace. | AbstractArtifact |
| namespace : String [1] | The namespace of the identifier of the artifact. | AbstractArtifact |
| supplier : String [0..1] | The supplier of the artifact. | AbstractArtifact |
| type : ArtifactType [1] | The type of the artifact. | AbstractArtifact |
| hashes : Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| referenceDocument : Document [\*] | Reference to documents that detail the referenced artifact. |

Hash Class

This class represents the hash value using the provided hash algorithm of the related content: a document, a source file, a binary file, ... The following special situations should be processed as described:

* To compute the hash of an Artifact supported by the delivery of multiple physical files, the hash is computed as the hash of files' hash values, sorted alphabetically.
* To compute the hash of an element whose identifier and content includes the hash information, the hash is computed as the hash of all the elements, excluding the identifier and content including the hash information.

SuperClass

MOF::Element

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| value : String [1] | The result of the hash algorithm. |
| type : HashType [1] | The element capturing the algorithm used to compute the hash value. |

Signature Class

This class represents the signature elements of the related document. To compute the signature of a Document, ...

SuperClass

MOF::Element

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| keyId : String [1] | Identifier of the key signing the document |
| method : SignatureMethod [1] | Key signing method used to generate the signature |
| value : String [1] | Signature value |

HashType data type (enumeration)

HashType enumerated data type defines additional specifications of the of the algorithm used to compute the checksum.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| hashType\_sha1 | if the algorithm is SHA1. |
| hashType\_sha256 | if the algorithm is SHA-256. |
| hashType\_sha512 | if the algorithm is SHA-512. |
| hashType\_md5 | if the algorithm is MD5. |
| hashType\_other | if the algorithm doesn't fit into the above categories. |

SignatureMethod data type (enumeration)

SignatureMethod enumerated data type defines additional specifications of the of the signature method used to sign the document.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| signatureMethod\_RSASSA-PSS | in case of RSA Probabilistic signature scheme signature method. |
| signatureMethod\_ed25519 | in case of Elliptic curve digital signature algorithm based on TwistedEdwards curves signature method. |
| signatureMethod\_other | if the signature method doesn't fit into the above categories. |

ArtifactType data type (enumeration)

ArtifactType enumerated data type defines additional specifications of the of the type of artifact.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| artifactType\_file | if the detailed artifact is a file |
| artifactType\_framework | if the detailed artifact is a framework |
| artifactType\_library | if the detailed artifact is a library |
| artifactType\_application | if the detailed artifact is an application |
| artifactType\_operatingSystem | if the detailed artifact is an operating system |
| artifactType\_hardwareDevice | if the detailed artifact is a hardware device |
| artifactType\_other | if the detailed artifact type doesn't fit into the above categories. |

PopulationMethod data type (enumeration)

PopulationMethod enumerated data type defines additional specifications of the way the SBOM document was created.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| populationMethod\_declaration | if the SBOM document was created by human declaration when it is created. |
| populationMethod\_automated | if the SBOM document was created by an automated process when it is created. |
| populationMethod\_investigation | if the SBOM document was created by investigating the artifact to retrieve as much information as possible. |
| populationMethod\_other | if the population method doesn't fit into the above categories. |

Relationship Classes

This chapter presents the normative specification for the Tool-to-Tool Software Bill of Materials Exchange Metamodel Standard metamodel Relationship Classes. It begins with an overview of the Relationship Classes metamodel inheritance structure shown in Figure 5 followed by a description of each element. The association to and from the Element class is pivotal to the 3T-SBOM-EMS as it brings the relationship capabilities to all inheriting classes. An overview of the associations is shown in Figure 6 while Figure 7 displays attribute details as well.

Relationship Class

This class represents a relationship between two SBoM elements. It points at a source SBoM element and a target SBoM element, and indicates the nature of the relationship. It supports a graph-based approach to SBOM modeling where salient elements are the nodes of a graph, linked together via these relationships. Most of the time, these will be relationships between SBOM documents, but the 3T-SBOM-EMS model supports more advanced behaviors.

SuperClass

MOF::Element

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| type : RelationshipType [1] | The element capturing the type of relationships between source and target artifacts. |
| description : String [0..1] | Detailed description of the relationship between source and target artifacts, complementing the type of relationship. |

Associations (required)

The following table lists the class required associations:

| Association name:type[cardinality] | Description | Reverse association name |
| --- | --- | --- |
| source : 3T-SBOM-EMS-Artifact-Element [1] | The element capturing the source element. | sourceOfRelationship |
| target : 3T-SBOM-EMS-Artifact-Element [1] | The element capturing the target element. | targetOfRelationship |

Serialization comments

The following table lists serialization considerations:

| Attribute name | Serialization comment |
| --- | --- |
| source | This shared association can be serialized inline for readability and compactness purposes, both in the relationship element and in the source node element (as sourceOfRelationship association) |
| target | This shared association can be serialized inline for readability and compactness purposes, both in the relationship element and in the target node element (as targetOfRelationship association) |

RelationshipType data type (enumeration)

RelationshipType enumerated data type defines additional specifications of the nature of the relation between the SBOM documents.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| relationshipType\_contains | is to be used when the source element contains the target element. |
| relationshipType\_containedBy | is to be used when the source element is contained by the target element. |
| relationshipType\_descendantOf | is to be used when the source element is a descendant of (same lineage but postdates) the target element. |
| relationshipType\_ancestorOf | is to be used when the source element is an ancestor of (same lineage but pre-dates) the target element. |
| relationshipType\_variantOf | is to be used when the source element is a variant of (same lineage but not clear which came first) the target element. |
| relationshipType\_copyOf | is to be used when the source element is an exact copy of the target element. |
| relationshipType\_patchFor | is to be used when the source element is a patch file for (to be applied to) the target element. |
| relationshipType\_patchApplied | is to be used when the source element is a patch file that has been applied to the target element. |
| relationshipType\_dynamicLink | is to be used when the source element dynamically links to the target element. |
| relationshipType\_staticLink | is to be used when the source element statically links to the target element. |
| relationshipType\_hasPrerequisite | is to be used when the source element has as a prerequisite the target element. |
| relationshipType\_prerequisiteFor | is to be used when the source element is a prerequisite for the target element. |
| relationshipType\_testCaseOf | is to be used when the source element is a test case used in testing the target element. |
| relationshipType\_buildToolOf | is to be used when the source element is used to build the target element. |
| relationshipType\_testToolOf | is to be used when the source element is used to test the target element. |
| relationshipType\_devToolOf | is to be used when the source element is used to develop the target element. |
| relationshipType\_dataFile | is to be used when the source element is a data file used in the target element. |
| relationshipType\_metaFileOf | is to be used when the source element is a metafile of the target element. |
| relationshipType\_generatedFrom | is to be used when the source element was generated from the target element. |
| relationshipType\_generates | is to be used when the source element generates the target element. |
| relationshipType\_expendedFromArchive | is to be used when the source element is expanded from the archive owner of the Relationship. |
| relationshipType\_documentation | is to be used when the source element provides documentation of the target element. |
| relationshipType\_optionalComponentOf | is to be used when the source element is an optional component of the target element. |
| relationshipType\_packageOf | is to be used when the source element is packaged into the target element. |
| relationshipType\_amendment | is to be used when the target element amends the SBOM information in the source element. |
| relationshipType\_fileAdded | is to be used when the source element is a file added to the target element. |
| relationshipType\_fileModified | is to be used when the source element is a file that was modified from the target element. |
| relationshipType\_fileDeleted | is to be used when the source element is a file deleted from the target element. |
| relationshipType\_comesAfter | is to be used when the source element comes after the target element (useful for relationships between action artifacts). |
| relationshipType\_other | if the relationship doesn't fit into the above categories. |

Annotation Classes

This chapter presents the normative specification for the Tool-to-Tool Software Bill of Materials Exchange Metamodel Standard metamodel Annotation Classes. It begins with an overview of the Annotation Classes metamodel inheritance structure shown in Figure 8 followed by a description of each element. The association with the Element class is pivotal to the 3T-SBOM-EMS as it brings the annotation capabilities to all inheriting classes. An overview of the associations is shown in Figure 9 while Figure 10 displays attribute details as well.

AbstractAnnotation Class

This abstract class represents information to convey about the document, the document creation, the artifact, ... that is not part of the structured model. Annotations content can be part of the document or external, via a reference to external content. Annotation elements can be used to support:

* Exchange of information that are not part of the specification but that are agreed upon between consumer and supplier of the document,
* Information about artifact topics and technologies,
* Data Marking
* ...

SuperClass

Element

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| type : AnnotationType [1] | Element capturing the type of content in or referenced by the annotation. |
| element : 3T-SBOM-EMS-Artifact-Element [1] | Element capturing the artifact the annotation pertains to. |
| author : String [0..1] | Element capturing the author of the annotation. |
| created : https://www.w3.org/TR/xmlschema11-2/#dateTime [1] | Annotation creation date time stamp. |

Annotation Class

This class represents content included in the Software Bill of Material documents.

SuperClass

AbstractAnnotation

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| type : AnnotationType [1] | Element capturing the type of content in or referenced by the annotation. | AbstractAnnotation |
| element : 3T-SBOM-EMS-Artifact-Element [1] | Element capturing the artifact the annotation pertains to. | AbstractAnnotation |
| author : String [0..1] | Element capturing the author of the annotation. | AbstractAnnotation |
| created : https://www.w3.org/TR/xmlschema11-2/#dateTime [1] | Annotation creation date time stamp. | AbstractAnnotation |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| expression : String [1..\*] | Text body of the annotation. |

ExternalAnnotation Class

This class represents external content referenced by the Software Bill of Material documents.

SuperClass

AbstractAnnotation

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| type : AnnotationType [1] | Element capturing the type of content in or referenced by the annotation. | AbstractAnnotation |
| element : 3T-SBOM-EMS-Artifact-Element [1] | Element capturing the artifact the annotation pertains to. | AbstractAnnotation |
| author : String [0..1] | Element capturing the author of the annotation. | AbstractAnnotation |
| created : https://www.w3.org/TR/xmlschema11-2/#dateTime [1] | Annotation creation date time stamp. | AbstractAnnotation |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| uri : String [1] | URI where to find the external content. |

AnnotationType data type (enumeration)

AnnotationType enumerated data type defines additional specifications of the of the nature of the annotation content.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| annotationType\_comment | in case of general comments. |
| annotationType\_topic | in case of topics, keywords, ... to associate with an element. |
| annotationType\_other | if the external reference type doesn't fit into the above categories. |

Content Classes

This chapter presents the normative specification for the Tool-to-Tool Software Bill of Materials Exchange Metamodel Standard metamodel Content Classes. It begins with an overview of the Content Classes metamodel inheritance structure shown in Figure 11 followed by a description of each element. The inheritance from the Element class is key as it brings the annotation, relationship, ... capabilities to all inheriting classes in the Content Package. An overview of the associations is shown in Figure 12 while Figure 13 displays attribute details as well.

AbstractFile Class

This abstract class represents physical deliverable files detailed or referenced in the Software Bill of Material documents. It is composed of:

* A name,
* A relative path to identify the file within the root location of the parent package.

SuperClass

Element

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| relativeFilePath : String [1] | The path of the file relative to its package |
| type : FileType [1] | The element capturing the type of file. |

Associations (optional)

The following table lists the class optional associations:

| Association name:type[cardinality] | Description | Reverse association name |
| --- | --- | --- |
| snippets : Snippet [\*] | The element(s) capturing snippet(s) of code from the file that require(s) detailing. | file |

File Class

This class represents physical deliverable files detailed in the Software Bill of Material documents.

SuperClass

AbstractFile

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| relativeFilePath : String [1] | The path of the file relative to its package | AbstractFile |
| type : FileType [1] | The element capturing the type of file. | AbstractFile |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| artifacts : 3T-SBOM-EMS-Artifact-Artifact [1..\*] | The element capturing the referenced document that identifies and defines the file. |

ReferencedFile Class

This class represents physical deliverable files referenced in the Software Bill of Material documents. It must identify the ReferencedArtifact it is part of.

SuperClass

AbstractFile

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| relativeFilePath : String [1] | The path of the file relative to its package | AbstractFile |
| type : FileType [1] | The element capturing the type of file. | AbstractFile |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| artifacts : 3T-SBOM-EMS-Artifact-ReferencedArtifact [1..\*] | The element capturing the referenced document that identifies and defines the file. |

Snippet Class

This class represents snippets of physical deliverable files. It is composed of:

* A byte range,
* When applicable, a line range.

SuperClass

Element

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| byteRangeLowerBound : Integer [1] | Lower bound of a range of positive integer values identifying the byte range of the snippet within its parent file. |
| byteRangeUpperBound : Integer [1] | Upper bound of a range of positive integer values identifying the byte range of the snippet within its parent file. |
| lineRangeLowerBound : Integer [0..1] | Lower bound of a range of positive integer values identifying the line range of the snippet within its parent file. |
| lineRangeUpperBound : Integer [0..1] | Upper bound of a range of positive integer values identifying the line range of the snippet within its parent file. |

Constraints

The following table lists the constraints that exist on class attributes:

| Attribute name | Description |
| --- | --- |
| lineRangeLowerBound | The lower boud integer must be positive |
| lineRangeUpperBound | The upper boud integer must be greater than the lower bound |
| byteRangeLowerBound | The lower boud integer must be positive |
| byteRangeUpperBound | The upper boud integer must be greater than the lower bound |

FileType data type (enumeration)

FileType enumerated data type defines additional specifications of the the nature of the file.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| fileType\_source | if the file is human readable source code (.c, .html, etc.) |
| fileType\_binary | if the file is a compiled object, target image or binary executable (.o, .a, etc.) |
| fileType\_archive | if the file represents an archive (.tar, .jar, etc.) |
| fileType\_application | if the file is associated with a specific application type (MIME type of application/\*) |
| fileType\_audio | if the file is associated with an audio file (MIME type of audio/\* , e.g. .mp3) |
| fileType\_text | if the file is human readable text file (MIME type of text/\*) |
| fileType\_image | if the file is associated with an picture image file (MIME type of image/\*, e.g., .jpg, .gif) |
| fileType\_video | if the file is associated with a video file type (MIME type of video/\*) |
| fileType\_documentation | if the file serves as documentation |
| fileType\_spdx | if the file is an SPDX document |
| fileType\_other | if the file doesn't fit into the above categories (generated artifacts, data files, etc.) |

Licensing Classes

This chapter presents the normative specification for the Tool-to-Tool Software Bill of Materials Exchange Metamodel Standard metamodel Licensing Classes. It begins with an overview of the Licensing Classes metamodel inheritance structure shown in Figure 14 followed by a description of each element. The inheritance from the Element class is key as it brings the annotation, relationship, ... capabilities to all inheriting classes in the Licensing Package. An overview of the associations is shown in Figure 15 while Figure 16 displays attribute details as well.

AbstractLicensingInformation Class

This abstract class represents the detailed licensing information, detailing the Intellectual Property of the piece of software or of its constituant elements, as copyright or detailed licenses. It is designed to extend the SBoM document when the document data license attribute is not enough.

SuperClass

Element

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| artifacts : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The artifact(s) to which the licensing information applies. |
| files : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The file(s) to which the licensing information applies. |

CopyrightInformation Class

This class represents the copyright information.

SuperClass

AbstractLicensingInformation

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| artifacts : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The artifact(s) to which the licensing information applies. | AbstractLicensingInformation |
| files : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The file(s) to which the licensing information applies. | AbstractLicensingInformation |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| expression : String [1] | Copyright expression. |

LicenseInformation Class

This class represents the license information.

SuperClass

AbstractLicensingInformation

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| artifacts : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The artifact(s) to which the licensing information applies. | AbstractLicensingInformation |
| files : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The file(s) to which the licensing information applies. | AbstractLicensingInformation |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| expression : String [1] | License expression. |
| type : LicenseInformationType [1] | License information type. |
| licenseReferences : LicenseReference [\*] | License references involved in the expression. |

LicenseReference Class

This class represents a license reference, when the license is use is not standard.

SuperClass

AbstractLicensingInformation

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| artifacts : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The artifact(s) to which the licensing information applies. | AbstractLicensingInformation |
| files : 3T-SBOM-EMS-Artifact-AbstractArtifact [\*] | The file(s) to which the licensing information applies. | AbstractLicensingInformation |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| identifier : String [1] | License reference identification, unique only within the document. |
| name : String [1] | License reference name. |
| expression : String [1] | License reference extracted text. |
| urls : String [\*] | License reference pointers to the official source of the non-standard license. |

LicenseInformationType data type (enumeration)

LicenseInformationType enumerated data type defines additional specifications of the type of the license information.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| licenseInformationType\_declared | in case of declared license information. |
| licenseInformationType\_concluded | in case of concluded license information. |
| licenseInformationType\_distributed | in case of distributed license information. |
| licenseInformationType\_other | if the license information doesn't fit into the above categories. |

Activity Classes

This chapter presents the normative specification for the Tool-to-Tool Software Bill of Materials Exchange Metamodel Standard metamodel Activity Classes. It begins with an overview of the main Activity Classes metamodel inheritance structure shown in Figure 17 followed by a description of each element. The inheritance from the Element class is key as it brings the annotation, relationship, ... capabilities to all inheriting classes in the Activity Package. An overview of the associations is shown in Figure 18 while Figure 19 displays attribute details as well.

Activity Class

This class represents action performed during the production process of the piece of software, to build it or to ensure its quality or compliance. It is worth noting that:

* The activity elements can be linked together via the relationships, supporting informative sequences of actions,
* The activity elements can be linked together via the flow of materials and products, supporting detailed sequences of actions,
* The activity elements can be linked to any other SBoM elements used as input or produced as output of the action. Most of the time, these will be file items, but the 3T-SBOM-EMS model supports more advanced behaviors.

SuperClass

Element

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| command : String [1] | Activity command line, with its arguments and parameters. |

Associations (required)

The following table lists the class required associations:

| Association name:type[cardinality] | Description | Reverse association name |
| --- | --- | --- |
| products : 3T-SBOM-EMS-Artifact-Element [1..\*] | The element(s) capturing the element(s) output of the action. | productOfActivities |

Associations (optional)

The following table lists the class optional associations:

| Association name:type[cardinality] | Description | Reverse association name |
| --- | --- | --- |
| materials : 3T-SBOM-EMS-Artifact-Element [\*] | The element(s) capturing the artifact(s) input of the action. | materialOfActivities |
| resources : 3T-SBOM-EMS-Artifact-Element [\*] | The element(s) capturing the artifact(s) resources of the action. | resourceOfActivities |
| environment : Environment [\*] | The element(s) capturing the environment of the action, such as environment variables, tool description, ... | environmentOfActivities |
| runs : Run [\*] | The element(s) capturing the execution(s) of the action. | runsOfActivities |

Creation Class

This class represents action performed to produce the piece of software, thus transforming the sofwtare.This covers the following activities:

* Commits,
* Compilations,
* Builds,
* ...

SuperClass

Activity

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| command : String [1] | Activity command line, with its arguments and parameters. | Activity |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| type : CreationType [1] | Creation type. |

Assessment Class

This class represents action performed to ensure its quality or compliance, without transforming the software. This covers the following activities:

* Code reviews,
* Vulnerability scans,
* ...

SuperClass

Activity

Attributes (inherited)

The following table lists the inherited attributes and the parent class the attributes are inherited from:

| Attribute name:type[cardinality] | Description | Parent Class name |
| --- | --- | --- |
| command : String [1] | Activity command line, with its arguments and parameters. | Activity |
| hashes : 3T-SBOM-EMS-Artifact-Hash [\*] | Element capturing the hashes. | Element |

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| type : AssessmentType [1] | Assessment type. |

Run Class

This class represents run(s) of action performed during the production process of the piece of software, to build it or to ensure its quality or compliance.

SuperClass

MOF::Element

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| actor : String [1] | The element capturing the person, organization, system performing the action. |
| created : https://www.w3.org/TR/xmlschema11-2/#dateTime [1] | Run date time stamp |

Environment Class

This class represents the environment of the action performed during the production process of the piece of software, to build it or to ensure its quality or compliance.

SuperClass

MOF::Element

Attributes

The following table lists the class own attributes:

| Attribute name:type[cardinality] | Description |
| --- | --- |
| key : String [1] | The key part of key-value capture of the activity environment. |
| value : String [1] | The value part of key-value capture of the activity environment. |

CreationType data type (enumeration)

CreationType enumerated data type defines additional specifications of the type of the build activity.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| creationType\_commit | in case of commit activity. |
| creationType\_compile | in case of compile activity. |
| creationType\_build | in case of link activity. |
| creationType\_other | if the build type doesn't fit into the above categories. |

AssessmentType data type (enumeration)

AssessmentType enumerated data type defines additional specifications of the type of the assessment activity.

Literal values

| Enumeration literal name | Description |
| --- | --- |
| assessmentType\_codeReview | in case of code review. |
| assessmentType\_vulnerability | in case of vulnerability scan. |
| assessmentType\_other | if the assessment type doesn't fit into the above categories. |