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Abstract:

The Variability Exchange Language (VEL) enables the exchange of variability information among tools for variant management tools and systems development tools. VEL eliminates the cost of building customized interfaces by defining a standard way for information to be exchanged among corresponding tools. Using VEL, a variant management tool is able to read the variability from a development tool and pass configurations of selected system features to a development tool.

By defining a common variability data interface that can be implemented by both the development tools and the variant management tools, VEL enables a continuous development process for variable systems and more flexible use of tools.

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Table of Contents

[1 Introduction 7](#_Toc193924)

[1.1 Variants Management, System Variability, and Variation Points 7](#_Toc193925)

[1.2 Variability View and Variants Management Tools 7](#_Toc193926)

[1.3 IPR Policy 9](#_Toc193927)

[1.4 Terminology 9](#_Toc193928)

[1.5 Normative References 10](#_Toc193929)

[1.6 Non-Normative References 10](#_Toc193930)

[2 Overview of the Variability Exchange Language 11](#_Toc193931)

[2.1 VariationPoints and Variations 13](#_Toc193932)

[2.2 Variation Point Descriptions versus Variation Point Selections 13](#_Toc193933)

[2.3 Binding 13](#_Toc193934)

[2.4 Common Concepts 14](#_Toc193935)

[2.5 API 14](#_Toc193936)

[3 Variability Exchange Language Class Reference 15](#_Toc193937)

[3.1 ArtifactElement < artifact-element-type> 15](#_Toc193938)

[3.1.1 Description 15](#_Toc193939)

[3.1.2 Attribute uri 15](#_Toc193940)

[3.1.3 Attribute type 16](#_Toc193941)

[3.1.4 Adding arbitrary XML Elements 16](#_Toc193942)

[3.2 BindingTime <bindingtime-type> 17](#_Toc193943)

[3.2.1 Description 18](#_Toc193944)

[3.2.2 Attribute selected 18](#_Toc193945)

[3.2.3 Attribute name 19](#_Toc193946)

[3.2.4 Attribute condition 19](#_Toc193947)

[3.3 BindingTimeEnum <bindingtime-enum> 20](#_Toc193948)

[3.3.1 RequirementsTime 20](#_Toc193949)

[3.3.2 BluePrintDerivationTime 20](#_Toc193950)

[3.3.3 ModelConstructionTime 21](#_Toc193951)

[3.3.4 ModelSimulationTime 21](#_Toc193952)

[3.3.5 CodeGenerationTime 21](#_Toc193953)

[3.3.6 PreprocessorTime 21](#_Toc193954)

[3.3.7 CompileTime 21](#_Toc193955)

[3.3.8 LinkTime 21](#_Toc193956)

[3.3.9 FlashTime 21](#_Toc193957)

[3.3.10 PostBuild 21](#_Toc193958)

[3.3.11 PostBuildLoadable 21](#_Toc193959)

[3.3.12 PostBuildSelectable 21](#_Toc193960)

[3.3.13 RunTime 21](#_Toc193961)

[3.4 CalculatedParameterVariationPoint <calculated-parameter-variationpoint-type> 22](#_Toc193962)

[3.4.1 Description 23](#_Toc193963)

[3.4.2 Notes 23](#_Toc193964)

[3.5 CalculatedVariation <calculated-variation-type> 24](#_Toc193965)

[3.5.1 Description 25](#_Toc193966)

[3.5.2 Attribute expression 25](#_Toc193967)

[3.5.3 Binding 25](#_Toc193968)

[3.5.4 Notes 25](#_Toc193969)

[3.6 Capability <capability-type> 26](#_Toc193970)

[3.6.1 Description 26](#_Toc193971)

[3.6.2 Attribute importVariabilityExchangeModels 26](#_Toc193972)

[3.6.3 Attribute exportVariabilityExchangeModels 26](#_Toc193973)

[3.6.4 Attribute getConfiguration 27](#_Toc193974)

[3.6.5 Attribute setConfiguration 27](#_Toc193975)

[3.7 Expression <expression-type> 28](#_Toc193976)

[3.7.1 Description 28](#_Toc193977)

[3.7.2 Attribute type 29](#_Toc193978)

[3.7.3 Attribute datatype 29](#_Toc193979)

[3.7.4 SingleFeatureCondition 29](#_Toc193980)

[3.7.5 AndFeatureCondition 29](#_Toc193981)

[3.7.6 OrFeatureCondition 30](#_Toc193982)

[3.7.7 PVSCLExpression 30](#_Toc193983)

[3.7.8 OCLExpression 30](#_Toc193984)

[3.7.9 AUTOSARExpression 30](#_Toc193985)

[3.7.10 Representation of expressions and features in XML 30](#_Toc193986)

[3.7.10.1 Syntax for single-feature–condition 31](#_Toc193987)

[3.7.10.2 Syntax for and-feature-condition and or-feature-condition 31](#_Toc193988)

[3.8 ExpressionTypeEnum <expression-enum> 32](#_Toc193989)

[3.8.1 Description 32](#_Toc193990)

[3.9 Identifiable <identifiable-type> 33](#_Toc193991)

[3.9.1 Description 34](#_Toc193992)

[3.9.2 Attribute id 34](#_Toc193993)

[3.9.3 Attribute name 34](#_Toc193994)

[3.9.4 Attribute specialData 35](#_Toc193995)

[3.9.5 Notes 35](#_Toc193996)

[3.10 KeyValuePair <key-value-pair-type> 36](#_Toc193997)

[3.10.1 Description of Class KeyValuePair 37](#_Toc193998)

[3.10.2 Attribute key of Class KeyValuePair 37](#_Toc193999)

[3.10.3 Description of Class Value 37](#_Toc194000)

[3.10.4 Attribute value of Class Value 37](#_Toc194001)

[3.10.5 Attribute type of Class Value 37](#_Toc194002)

[3.10.6 XML Representation 37](#_Toc194003)

[3.11 OptionalStructuralVariationPoint <optional-structural-variaton-point-type> 38](#_Toc194004)

[3.11.1 Description 39](#_Toc194005)

[3.11.2 Notes 39](#_Toc194006)

[3.12 OptionalVariation <optional-variation-type> 40](#_Toc194007)

[3.12.1 Description 41](#_Toc194008)

[3.12.2 Attribute condition 41](#_Toc194009)

[3.12.3 Binding 41](#_Toc194010)

[3.12.4 Notes 41](#_Toc194011)

[3.13 ParameterVariationPoint <parameter-variationpoint-group> 42](#_Toc194012)

[3.13.1 Description 43](#_Toc194013)

[3.13.2 Notes 43](#_Toc194014)

[3.14 SpecialData <special-data-type> 44](#_Toc194015)

[3.14.1 Description 44](#_Toc194016)

[3.14.2 Attribute name 44](#_Toc194017)

[3.15 StructuralVariationPoint <structural-variationpoint-group> 46](#_Toc194018)

[3.15.1 Description 47](#_Toc194019)

[3.15.2 Notes 47](#_Toc194020)

[3.16 ValueVariation <value-variation-type> 48](#_Toc194021)

[3.16.1 Description 49](#_Toc194022)

[3.16.2 Attribute condition 49](#_Toc194023)

[3.16.3 Attribute value 50](#_Toc194024)

[3.16.4 Binding 50](#_Toc194025)

[3.16.5 Notes 50](#_Toc194026)

[3.17 VariabilityAPI 51](#_Toc194027)

[3.17.1 Description 51](#_Toc194028)

[3.17.2 Attribute version 51](#_Toc194029)

[3.17.3 Attribute capability 51](#_Toc194030)

[3.17.4 Method importVariabilityExchangeModels 51](#_Toc194031)

[3.17.5 Method exportVariabilityExchangeModels 51](#_Toc194032)

[3.17.6 Method getConfiguration 52](#_Toc194033)

[3.17.7 Method setConfiguration 52](#_Toc194034)

[3.18 VariabilityExchangeModel <variability-exchange-model-type> 53](#_Toc194035)

[3.18.1 Description 54](#_Toc194036)

[3.18.2 Attribute type 54](#_Toc194037)

[3.18.3 Attribute uri 55](#_Toc194038)

[3.19 VariabilityExchangeModels <variability-exchange-models-type> 56](#_Toc194039)

[3.19.1 Description 57](#_Toc194040)

[3.19.2 Attribute version 57](#_Toc194041)

[3.19.3 Attribute cabability 57](#_Toc194042)

[3.20 VariabilityAPITypeEnum <variability-api-enum> 58](#_Toc194043)

[3.20.1 Description 58](#_Toc194044)

[3.21 Variation <variation-type> 59](#_Toc194045)

[3.21.1 Description 60](#_Toc194046)

[3.21.2 Attribute selected 60](#_Toc194047)

[3.21.3 Attribute correspondingVariableArtifactElement 60](#_Toc194048)

[3.21.4 Notes 61](#_Toc194049)

[3.22 VariationPoint <variationpoint-type> 62](#_Toc194050)

[3.22.1 Description 62](#_Toc194051)

[3.22.2 Attribute bindingTime 62](#_Toc194052)

[3.22.3 Attribute correspondingVariableArtifactElement 63](#_Toc194053)

[3.22.4 Notes 63](#_Toc194054)

[3.23 VariationPointHierarchy <variationpoint-hierarchy-type> 64](#_Toc194055)

[3.23.1 Description 65](#_Toc194056)

[3.23.2 Attribute variationPoint 66](#_Toc194057)

[3.23.3 Notes 66](#_Toc194058)

[3.24 VariationDependency <variation-dependency-type> 67](#_Toc194059)

[3.24.1 Description 68](#_Toc194060)

[3.24.2 Attribute type 68](#_Toc194061)

[3.24.3 Attribute variation 68](#_Toc194062)

[3.24.4 Attribute condition 68](#_Toc194063)

[3.24.5 Formal Definition 68](#_Toc194064)

[3.24.6 Notes 69](#_Toc194065)

[3.25 VariationDependencyEnum <variation-dependency-enum> 70](#_Toc194066)

[3.25.1 Description 70](#_Toc194067)

[3.26 XorParameterVariationPoint < xor-parameter-variationpoint-type> 71](#_Toc194068)

[3.26.1 Description 72](#_Toc194069)

[3.26.2 Notes 72](#_Toc194070)

[3.27 XorStructuralVariationPoint <xor-structural-variationpoint-type> 73](#_Toc194071)

[3.27.1 Description 74](#_Toc194072)

[3.27.2 Notes 74](#_Toc194073)

[3.28 XorVariation <xor-variation-type> 75](#_Toc194074)

[3.28.1 Description 76](#_Toc194075)

[3.28.2 Attribute condition 76](#_Toc194076)

[3.28.3 Binding 76](#_Toc194077)

[3.28.4 Notes 76](#_Toc194078)

[4 Security Considerations 77](#_Toc194079)

[5 Conformance 78](#_Toc194080)

[Appendix A. Acknowledgments 79](#_Toc194081)

[Appendix B. Revision History 80](#_Toc194082)

# Introduction

VEL is an interoperability standard that enables the exchange of variability information among variant management tools and systems development tools. The essential tasks of a variants management tool are to represent and analyze the variability of a system abstractly and to define system configurations by selecting the desired system features. A system development tool captures information of a specific kind, such as requirements, architecture, component design, or tests. In order to support the development of variable systems a development tool either has to offer the capability to express and deal with variability directly, or an adaptor must be provided that adds this capability to the development tool.

To interconnect variants management with systems development the information exchange among the corresponding tools must be established. A variants management tool must be able to read or extract the variability from a development tool and to pass a configuration, i.e. a set of selected system features, to the development tool. Up to now the interfaces that support this information exchange are built for each development tool anew. With VEL*,* a common interface is defined that can be implemented by both the development tools and the variants management tool, thus VEL eliminates the cost of building customized interfaces by defining a standard way for information to be exchanged between tools.

## Variants Management, System Variability, and Variation Points

Variants management is an activity that accompanies the whole system development process and, therefore, is orthogonal to the other development tasks. Like safety, security, and other system properties, variability cannot be built into a system at the end of the process. Rather, the desired variability has to be determined, analyzed, designed, implemented and tested continuously, starting at the very beginning of the process through to the final delivery of the system or the system variant respectively. That means that within each development stage – requirements analysis, design, implementation, test, documentation, etc. – variability is an aspect that has to be considered.

We consider as variable system a system that can be tailored by the system producer according to individual clients’ needs. All variants of a variable system are developed within one development process. In addition to the standard development tasks the process must also provide the means to tailor the system, i.e. to derive the client specific variant of the system. This may happen at different stages, also known as (variance) binding times.

Variability is embodied in variation points. Consider as example a requirements document. A requirement toward a variable system may be *optional*. In this case, two system variants can be formed by either selecting or deselecting the requirement. A set of requirements may be *alternatives*, then each selection of one of these requirements forms one system variant. Finally, a requirement may contain a *parameter*, and then each value that can be selected for this parameter yields a system variant.

The same definition of variation points holds for all other artifacts that are created in the development process – be it analysis or design models such as the views defined in the meta model, test specifications, code, documentation, or whatever. In each artifact there may be optional elements, alternative elements, and parameterized elements.

We do not specify here how these variation points are represented in the artifacts. Some artifact formats support the definition of variation points, in other cases appropriate means have to be added. This obviously also has an impact on the tools that are used to create and manage the artifacts. In some cases they are capable to express variation points. In other cases adaptors have to be built in order to incorporate variation points.

## Variability View and Variants Management Tools

It is an accepted best practice to define an explicit abstract variability view on a system under development to support variants management continuously throughout the process. This abstraction contains the bare information on the variability of the system. That means that it describes which variants exist, but does not describe how the variability is realized. The variability information is derived from an analysis of the commonalities, differences, and dependencies of the system’s variants and is often represented as a feature model.

A variants management tool supports the creation of an artifact – a variability model – that represents the abstract variability information. Moreover, it offers operations to select or deselect system features and via this feature configuration to specify the system’s variants.

The information of the variability view has to be connected with the system development artifacts in order to define how the feature selection (system configuration) determines the resolution of the variation points within these artifacts, i.e. the selection of a variation for each variation point. As soon as these connections are established a feature configuration can be carried over to a configuration of the variation points of the concerned artifact. The technical realization of this connection is addressed by the *Variability Exchange Language*.

At present there is no standard that would define how variation points are expressed in different artifacts. That means that a tool supplier who builds a variants management tool has to implement an individual interface to each other tool that is used in a development process to create the corresponding artifacts. The purpose of the *Variability Exchange Language* is to support the standardization of these interfaces by a common exchange format that defines which information is exchanged between a variants management tool and a tool that is used to manage a specific kind of artifacts in a development process. As mentioned above, such a tool may either be a tool that already supports the definition of variation points for the concerned artifact type, or it may be an adaptor that adds this capability to a base tool.

In fact, the *Variability Exchange Language* defines a requirement on tools or tool adaptors that intend to support variants management. Such a tool has to be able to extract the data that is defined in the *Variability Exchange Language* from the artifact that it manages and to incorporate the data that is sent from the variants management tool into this artifact. Beyond the exchange format, i.e. the contents of the information that is exchanged, also some basic operations are defined here. They define in which direction the variability information is intended to flow.

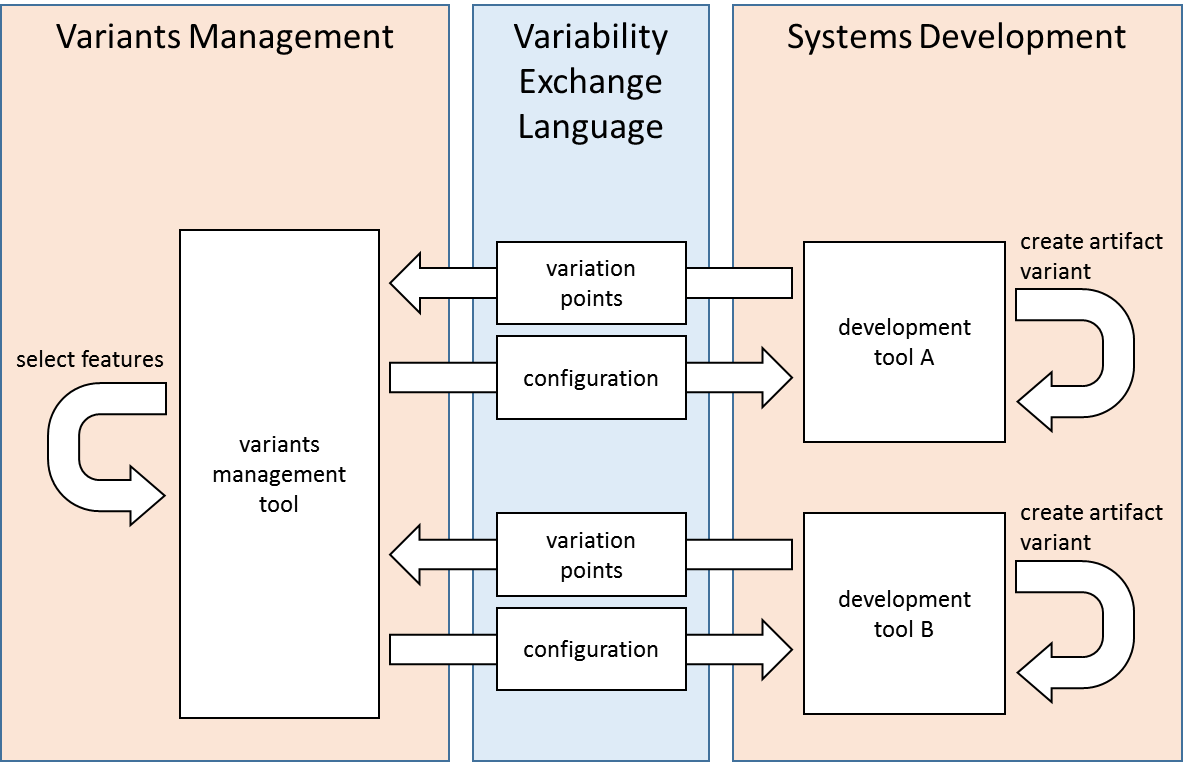


Figure 1 Use case for the Variability Exchange Language

A use case for the *Variability Exchange Language* can be defined as follows. Assume an artifact with variation points is given, for instance an artifact created with tool A in Figure 1. First the development tool has to collect the data defined in the *Variability Exchange Language,* essentially given by the variation points contained in the artifact. It passes this data to the variants management tool that builds a variability model based on the data. The variability model can be used to define a system configuration by selecting the desired system features. The corresponding data, i.e. the configuration, formatted according to the *Variability Exchange Language*, is passed back to the development tool or adaptor that uses this data to create or derive an artifact variant that corresponds to the system variant defined in the variants management tool.

Applying this scenario to all development tools and artifacts yields a consistent set of development artifacts for any system variant automatically. The variation points that correspond to customer relevant system features should coincide in all artifacts, i.e. they always induce the same variability model in the variants management tool. In addition to that there may also be internal variation points, for instance implementation variants that do not alter the visible properties of the system but are relevant for the system construction process. These variation points give rise to a staged variability model in which customer features are separated from internal features.

Since the system configuration is built once and for all in the variants management tool an identical configuration is passed to all development tools and thereby ensures consistency of the variants selection. It might only happen that internal features for instance are not interpreted by some development tool because it is not concerned with internal decisions, such as a requirements document or a system test.

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* **SHOULD** – This word, or the adjective "**RECOMMENDED**", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
* **SHOULD NOT** – This phrase, or the phrase "**NOT RECOMMENDED**" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
* **MAY** – This word, or the adjective "OPTIONAL", mean that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.)

Furthermore, we are using the following typographic conventions:

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* A word set in typewriter font is the name of an XML element or or XML code.
* A paragraph that is marked with a symbol on the margin is a constraint.

## Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.

**[****RFC8174]** Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<http://www.rfc-editor.org/info/rfc8174>>.

[**RFC3986**] Berners-Lee T., “Uniform Resource Identifier (URI): Generic Syntax”, RFC3986, <<http://tools.ietf.org/html/rfc3986>>.

[**XML**] „Extensible Markup Language (XML) 1.1 (Second Edition),“ 2006. [Online]. Available: <<http://www.w3.org/TR/2006/REC-xml11-20060816/>>.

[**OCL**] Object Constraint Language, <<http://www.omg.org/spec/OCL/>>.

[**AUTOSAR**] AUTOSAR, <<http://www.autosar.org/>>.

## Non-Normative References

**[****RFC3552]** Rescorla, E. and B. Korver, "Guidelines for Writing RFC Text on Security Considerations", BCP 72, RFC 3552, DOI 10.17487/RFC3552, July 2003, <<https://www.rfc-editor.org/info/rfc3552>>.

[PS] pure•systems GmbH, "pure::variants User's Guide," 2013. [Online]. Available: <<http://www.pure-systems.com/>>.

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# Overview of the Variability Exchange Language

The core of the *Variability Exchange Language* is given by the definition of variation points and their variations – by the classes VariationPoint and Variation (see Figure 2). In the following we immediately use the class names from the meta-model presented in Chapter 3 to discuss the corresponding concepts, such as VariationPoint and Variation. This chapter gives a survey on the main classes, in particular the ones shown in Figure 2.

A detailed specification of all classes is provided in Chapter 3.



Figure 2 An Overview of the Variability Exchange Language

A Variability Exchange Language document starts with a VariabilityExchangeModels element, which contains a number of VariabilityExchangeModel elements. Each VariabilityExchangeModel corresponds to one (or possibly several, but this is implementation dependent) artefacts with variable elements.

A VariabilityExchangeModel in turn contains a number of VariationPoints. Thus, a VariabilityExchangeModel describes the variable aspects of an artifact, *but only those*. All non-variable facets of the artifact are discarded because they are not necessary for our purpose.

## VariationPoints and Variations

As shown in Figure 2, we distinguish between two different kinds of VariationPoints:

1. StructuralVariationPoints are variation points where the structure of a model changes during the binding process. StructuralVariationPoints define which elements are contained in a bound artifact. There are two kinds of structural variation points:
   1. OptionalStructuralVariationPoint – variation points that can be selected or deselected.
   2. XorStructuralVariationPoint – i.e. variation points that represent sets of alternatives from which exactly one can be selected.
2. ParameterVariationPoints are variation points which select a numerical value for a parameter during the binding process. They do not change the structure of an artifact. There are two kinds of parameter variation points:
   1. CalculatedParameterVariationPoint – variation points where the parameter value is calculated by an expression.
   2. XorParameterVariationPoint – variation points where the parameter value is selected from a list of values.

Each VariationPoint is associated with one or more Variations. The Variations enumerate the possible variants for their respective VariationPoints. When an artifact is bound, then one of these variations (OptionalStructuralVariationPoints also allow zero variations here) is selected to be included in the bound artifact, and all others are discarded.

Both Variations and VariationPoints may refer to artifact elements (correspondingVariableArtifactElement), for example the Simulink block or the line of code which correspond to the VariationPoint respectively Variation.

VariationPoints can further define dependencies on other variation points (VariationDependency), for example one variation point may require another variation points. This is useful to express technical dependencies in artifacts.

Furthermore, a VariationPoint may contain other VariationPoints to establish a hierarchy (VariationPointHierarchy), similarly to subsystem blocks in Simulink or hierarchies in software architectures.

## Variation Point Descriptions versus Variation Point Selections

A VariabilityExchangeModel as defined in Figure 2 can actually serve two different purposes:

* A *variation point description* lists all variation points and *all* their variations; that is it describes a complete product line.
* A *variation point description* also lists all variation points, but selects one (or zero for optional variation points) Variation for each variation point. The attribute selected of Variation is used for that purpose. Any such selection must be consistent with the expression or condition attribute of a Variation, as well as with dependencies between variation points.

Both variation point descriptions and variation point selections use the same structure; the attribute type of VariabilityExchangeModel determines how a VariabilityExchangeModel should be interpreted.

## Binding

The *Variability Exchange Language* does not make any assumptions on how the binding process for the associated artifact works. We do however provide a way to attach Conditions or Expressions to Variations:

* In a StructuralVariationPoint, a Variation comes with a Condition that determines whether the associated artifact element is part of a bound artifact.
* In a ParameterVariationPoint, the Variation determines a value for the associated artifact element. This is done either by computing it (CalculatedVariation) or selecting from one of several values (ValueVariation).

In a variation point description (see section 2.2) the result of the evaluation of a condition or expression in a Variation must be compatible with the attribute selected of a Variation. That is, if the attribute selected of a Variation has the value *true*, then its condition must also evaluate to *true*.

## Common Concepts

Most classes in the *Variability Exchange Language* are based on the class Identifiable, which provides them with a name and a unique identifier. Identifable also provide a way to attach application-specific data (SpecialData) to elements in the *Variability Exchange Language*.

## API

In addition to the contents of the exchange format basic operations of a Variability Interface are defined in the class VariabilityAPI. These operations cover the following operations:

* The import and export of VariabilityExchangeModels
* Getting and setting configurations, which are also VariabilityExchangeModels
* Getting information on the read or write access (Capability) to VariationPoints and VariabilityExchangeModels as configurations.

# Variability Exchange Language Class Reference

## ArtifactElement < artifact-element-type>



Figure 3 UML Diagram for class ArtifactElement

<xs:complexType name="artifact-element-type">

<xs:sequence>

<xs:any processContents="lax" minOccurs="0" maxOccurs="unbounded"/>

</xs:sequence>

<xs:attribute name="type" type="xs:string" use="optional"/>

<xs:attribute name="uri" type="xs:anyURI" use="optional"/>

</xs:complexType>

Listing 1 XML Schema for artifact-element-type

<optional-structural-variationpoint id="vp1">

<variation id="vp1v1">

**<corresponding-variable-artifact-element uri="file:///C:/SPES/file1.c"/>**

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

Listing 2 XML Example for artifact-element-type using URIs

<optional-structural-variationpoint id="vp2">

<variation id="vp2v1">

**<corresponding-variable-artifact-element type="simulink">**

**<simulink-id>12</simulink-id>**

**</corresponding-variable-artifact-element>**

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

Listing 3 XML Example for artifact-element-type using artifact-specific XML elements

### Description

An ArtifactElement is a reference to an element in an artifact.

### Attribute uri

The optional attribute uri is a reference to the artifact. The content of the attribute uri is a Uniform Resource Identifier.

* The attribute URI of an ArtifactElement should conform to the definition of Uniform Resource Locators as specified in [**RFC3986**].
* Although the attribute URI of ArtifactElement is optional, it is recommended to supply an URI instead of additional attributes (that is, arbitrary XML child elements as described in section 3.1.4) whenever possible.

### Attribute type

The optional attribute type specifies the type of artifact that is addressed by this ArtifactElement.

The attribute type is a string, not an enumeration so that new artifact types can be added without changing the XML schema. Nevertheless, the following types are predefined:

* simulink
* doors
* Although the attribute type of an ArtifactElement is defined as optional, it is recommended to supply a type.

### Adding arbitrary XML Elements

In the XML schema, the type artifact-element-type allows arbitrary XML child elements. This is implemented by using the <xs:any> element (see Listing 1), which permits the use of any XML element regardless of whether it is defined in the current schema. The type of the artifact is documented in the type attribute.

For example, Listing 3 shows a Variation whose corresponding variable artifact element is a Simulink block with the Identifier 12.

## BindingTime <bindingtime-type>



Figure 4 UML Diagram for class BindingTime

<xs:complexType name="bindingtime-type">

<xs:sequence>

<xs:element name="name"

type="bindingtime-enum"/>

<xs:element name="condition"

type="expression-type"

minOccurs="0"

maxOccurs="1" />

</xs:sequence>

<xs:attribute name="selected" type="xs:boolean" use="optional"/>

</xs:complexType>

Listing 4 XML Schema for bindingtime-type

<variability-exchange-model type="**variationpoint-description**" id="model">

<optional-structural-variationpoint id="vp1">

<bindingtime>

<name>**preprocessor**-time</name>

</bindingtime>

<variation id="vp1v1">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

<optional-structural-variationpoint id="vp2">

<bindingtime>

<name>**preprocessor-time**</name>

<condition type="single-feature-condition">

SmallSoftwareFootprint

</condition>

</bindingtime>

<bindingtime>

<name>**post-build**</name>

<condition type="single-feature-condition">

LargeSoftwareFootprint

</condition>

</bindingtime>

<variation id="vp2v1">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

</variability-exchange-model>

Listing 5 XML Example for binding-time-type in a variationpoint-configuration

<variability-exchange-model type="**variationpoint-configuration**" id="model">

<optional-structural-variationpoint id="vp1">

<bindingtime>

<name>**preprocessor-time**</name>

</bindingtime>

<variation id="vp1v1">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

<optional-structural-variationpoint id="vp2">

<bindingtime selected="false">

<name>**preprocessor-time**</name>

<condition type="single-feature-condition">

SmallSoftwareFootprint

</condition>

</bindingtime>

<bindingtime selected="true">

<name>**post-build**</name>

<condition type="single-feature-condition">

LargeSoftwareFootprint

</condition>

</bindingtime>

<variation id="vp2v1">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

</variability-exchange-model>

Listing 6 XML Example for binding-time-type in a variationpoint-configuration

### Description

The *binding time* of a variation point describes how the associated variability is resolved[[1]](#footnote-1). Common ways to resolve a variation point are

* A variation point is removed from its artefact. For example, the #ifdef / #endif idiom commonly found in a C preprocessor code removes part of the source code.
* A variation point is set to “inactive”. For example, an if statement may prevent certain code sections from being executed. This is typically used if the binding comes too late in the process and the code cannot be removed.
* A parameter is assigned a fixed value.

What exactly happens when a variation point is bound is implementation specific, and beyond the scope this document.

### Attribute selected

A VariationPoint may have more than one BindingTime attributes. This is useful if the decision for the binding time of the variation point is delayed. For example, it may not be clear from the beginning whether a particular subsystem is removed during code generation (binding time CodeGenerationTime, section 3.3.5) or just deactivated during startup (binding time PostBuild, section 3.3.10). This decision is made at some time during the build process.

* The attribute selected of a BindingTime shall be present if the VariabilityExchangeModel which contains the BindingTime is of type VariationPointSelection.
* The attribute selected has no effect if the type of the VariabilityExchangeModel is of type VariationPointDescription and thus shall be omitted.

If a VariationPoint has more than one bindingtime attribute, then the attribute selected is used to designate exactly one of the binding times as the binding time that is actually used for the binding:

* Let be a VariationPoint which and let be the values of the selected attributes of the BindingTimes of . Then the following conditions shall hold:
* If a BindingTime has both an attribute selected and an an attribute condition , then the following condition shall hold:

### Attribute name

The attribute name of a BindingTime is a textual representation of the binding time. It is of type BindingTimeEnum.

### Attribute condition

If a VariationPoint has multiple BindingTimes, then the attribute condition may be used to select one BindingTime as the actual BindingTime for .

* Let be a VariationPoint which and let be the conditons of the BindingTimes of . Then the following conditions shall hold:

In other words, if a VariationPoint has more than one BindingTime with a condition, then only one condition shall evaluate to true. Obviously, a condition is only useful if a VariationPoint has more than one BindingTime.

See section 3.2.2 for more information on condition is used to select a binding time.

## BindingTimeEnum <bindingtime-enum>



Figure 5 UML Diagram for enumeration BindingTimeEnum

<xs:simpleType name="bindingtime-enum">

<xs:restriction base="xs:string">

<xs:enumeration value="requirements-time"/>

<xs:enumeration value="blueprint-derivation-time"/>

<xs:enumeration value="model-construction-time"/>

<xs:enumeration value="model-simulation-time"/>

<xs:enumeration value="code-generation-time"/>

<xs:enumeration value="preprocessor-time"/>

<xs:enumeration value="compile-time"/>

<xs:enumeration value="link-time"/>

<xs:enumeration value="flash-time"/>

<xs:enumeration value="post-build"/>

<xs:enumeration value="post-build-loadable-time"/>

<xs:enumeration value="post-build-selectable-time"/>

<xs:enumeration value="run-time"/>

</xs:restriction>

</xs:simpleType>

Listing 7 XML Schema for bindingtime-enum

### RequirementsTime

At RequirementsTime, variants are bound by selecting a subset of the overall requirements for a product line.

### BluePrintDerivationTime

The binding time BlueprintDerivationTime stems from AUTOSAR. In AUTOSAR, Blueprints are predefined templates for partial models. When a blueprint is applied, the variation points in the blueprint indicate locations in the template where a template processor or even human developer needs to fill in more information.

### ModelConstructionTime

At ModelConstructionTime, variants are bound by modifying the artifact. This may involve deleting part of the model, but may also be achieved by adding new elements to a model or changing parts of the existing model, or a combination of all three.

### ModelSimulationTime

At ModelSimulationTime, variants are bound by excluding parts of the model during simulation. This is typically done by constructing the model in such a way that some parts are not used during the simulation.

### CodeGenerationTime

At CodeGenerationTime, variants are bound by generating code that is tailored for one or more variants.

### PreprocessorTime

At PreProcessorTime, variants are bound by using a preprocessor that emits code only for specific variants. To do that, the code must contain appropriate preprocessor directives, for example #ifdef statements.

### CompileTime

At CompileTime, variation points are resolved by the compiler, for example by not generating code for certain variants (dead code elimination) or by using specific compiler switches.

### LinkTime

At Linktime, variants are bound by using only those files that are necessary for a particular variant are used to build a library or application.

### FlashTime

At FlashTime, variants are bound by (pre)loading variant specific data sets into the flash memory embedded device.

### PostBuild

At PostBuild, variants are bound by activating only certain parts of an application.

### PostBuildLoadable

At PostBuildLoadable, variants are bound by selecting a parameter set (typically stored in flash memory) at the launch of an application. PostBuildLoadable is often used as a synonym for PostBuild.

### PostBuildSelectable

At PostBuildSelectable, variants are bound by selecting one of several parameter sets (typically stored in flash memory) at the launch of an application. PostBuildSelectable is often used as a synonym for PostBuild.

### RunTime

At RunTime, variants are bound by switching between different program states or executing different parts of an application. Runtime is usually not regarded as a binding time, but is included for completeness here.

## CalculatedParameterVariationPoint <calculated-parameter-variationpoint-type>



Figure 6 UML Diagram for class CalculatedParameterVariationPoint

<xs:complexType name="calculated-parameter-variationpoint-type">

<xs:complexContent>

<xs:extension base="variationpoint-type">

<xs:sequence>

<xs:element name="variation" type="calculated-variation-type"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 8 XML Schema for calculated-parameter-variationpoint-type

<calculated-parameter-variationpoint id="vp1">

<variation id="vp1v1">

<expression type="pvscl-expression">6\*9</expression>

</variation>

</calculated-parameter-variationpoint>

Listing 9 XML Example for calculated-parameter-variationpoint-type

### Description

A CalculatedParameterVariatonPoint is a ParameterVariationPoint that defines a value for a variation point in an artifact. Unlike a XorParameterVariationPoint, which picks one value from a number of choices, a CalculatedParameterVariatonPoint uses an expression to define the value.

A CalculatedParameterVariatonPoint contains a single CalculatedVariation whose attribute expression defines the expression that is used to calculate the value for the associated variation point.

### Notes

* The class CalculatedParameterVariationPoint inherits from the class ParameterVariationPoint, which inherits from VariationPoint.

## CalculatedVariation <calculated-variation-type>



Figure 7 UML Diagram for class CalculatedVariation

<xs:complexType name="calculated-variation-type">

<xs:complexContent>

<xs:extension base="variation-type">

<xs:sequence>

<xs:element name="expression"

type="expression-type"

minOccurs="0" maxOccurs="1"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 10 XML Schema for calculated-variation-type

<calculated-parameter-variationpoint id="vp1">

**<variation id="vp1v1">**

**<expression type="pvscl-expression">6\*9</expression>**

**</variation>**

</calculated-parameter-variationpoint>

Listing 11 XML Example for calculated-variation-type

### Description

Each CalculatedParameterVariationPoint aggregates a single CalculatedVariation. A CalculatedVariation is a Variation that determines a value for a Calculated­VariationPoint.

### Attribute expression

The optional attribute expression of a CalculatedVariation specifies the expression that is used to compute the value of a CalculatedVariation.

* The attribute expression of a CalculatedVariation may return an arbitrary value. Which values are allowed depends on the artifact elements which are referenced by the attribute correspondingVariableArtifactElement (see 3.21.3).

### Binding

When a CalculatedParameterVariationPoint is bound, the expression of its CalculatedVariation is evaluated. The result of the evaluation gets assigned to the artifact element(s) which are referenced by the attribute corresponding­Variable­Artifact­Element (see section 3.21.3).

* A CalculatedParameterVariationPoint can only be bound when its CalculatedVariation has an attribute expression.

### Notes

* The class CalculatedVariation inherits from the class Variation.

## Capability <capability-type>



Figure 8 UML Diagram for class Capability

<xs:complexType name="capability-type">

<xs:sequence>

<xs:element name="import-variability-exchange-model" type="xs:boolean" />

<xs:element name="export-variability-exchange-model" type="xs:boolean" />

<xs:element name="get-configuration" type="xs:boolean" />

<xs:element name="set-configuration" type="xs:boolean" />

</xs:sequence>

</xs:complexType>

Listing 12 XML Schema for capability-type

<?xml version="1.0" encoding="UTF-8"?>

<variability-exchange-models id="root"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:noNamespaceSchemaLocation="../VariabilityExchangeLanguage.xsd">

<version>1</version>

**<capability>**

**<import-variability-exchange-model>true</import-variability-exchange-model>**

**<export-variability-exchange-model>true</export-variability-exchange-model>**

**<get-configuration>true</get-configuration>**

**<set-configuration>true</set-configuration>**

**</capability>**

</variability-exchange-models>

Listing 13 XML Example for capability-type

### Description

A Capability describes which operations are supported by a particular instance of VariabilityAPI. The rationale for introducing Capability is that not all implementations of the VariabilityAPI support all its operations.

### Attribute importVariabilityExchangeModels

The attribute getVariationPoints determines whether the operation importVariabilityExchangeModels of the class VariabilityAPI is supported:

* If getVariationPoints is , then the VariabilityAPI supports the operation importVariabilityExchangeModels.
* If getVariationPoints is , then the VariabilityAPI does not support the operation importVariabilityExchangeModels.

### Attribute exportVariabilityExchangeModels

The attribute setVariationPoints determines whether the operation exportVariabilityExchangeModels of the class VariabilityAPI is supported:

* If setVariationPoints is , then the VariabilityAPI supports the operation exportVariabilityExchangeModels.
* If setVariationPoints is , then the VariabilityAPI does not support the operation exportVariabilityExchangeModels.

### Attribute getConfiguration

The attribute getConfiguration determines whether the operation getConfiguration of the class VariabilityAPI is supported:

* If getConfiguration is , then the VariabilityAPI supports the operation getConfiguration.
* If getConfiguration is , then the VariabilityAPI does not support the operation getConfiguration.

### Attribute setConfiguration

The attribute setConfiguration determines whether the operation setConfiguration of the class VariabilityAPI is supported:

* If setConfiguration is , then the VariabilityAPI supports the operation setConfiguration.
* If setConfiguration is , then the VariabilityAPI does not support the operation setConfiguration.

## Expression <expression-type>



Figure 9 UML Diagram for class Expression

<xs:complexType name="expression-type">

<xs:simpleContent>

<xs:extension base="xs:string">

<xs:attribute name="type" type="expression-enum" use="required"/>

<xs:attribute name="datatype" type="xs:string" use="optional"/>

</xs:extension>

</xs:simpleContent>

</xs:complexType>

Listing 14 XML Schema for expression-type

<xor-structural-variationpoint id="vp1">

<variation id="vp1v1">

<condition type="**single-feature-condition**" datatype="bool">

Feature1

</condition>

</variation>

<variation id="vp1v2">

<condition type="**and-feature-condition**" datatype="bool">

Feature2,Feature3

</condition>

</variation>

<variation id="vp1v3">

<condition type="**or-feature-condition**" datatype="bool">

Feature4, Feature5, Feature6

</condition>

</variation>

<variation id="vp1v4">

<condition type="**pvscl-expression**" datatype="ps:boolean">

Feaure7 AND Feature8

</condition>

</variation>

</xor-structural-variationpoint>

Listing 15 XML Example for expression-type

### Description

. In the case of VEL, expressions fall into two categories:

* “Genuine” expressions which may return any kind of value. These are represented by the type PVSCLExpression.
* Constraints, which may only return Boolean values. These are represented by the SingleFeatureExpression, AndFeatureExpression and OrFeatureExpression. A constraint may also be of type PVSCLExpression; in this case the return value must be of type Boolean.

Technically, an Expression is a string whose syntax is determined by the attribute type. In the XML representation, the actual expression is contained in the inner text of the expression of condition element[[2]](#footnote-2).

* An expression shall not be an empty string.

### Attribute type

The attribute type defines the kind of expression in the inner text of the expression of condition element. There are several kinds of expressions:

* SingleFeatureExpression (single-feature-condition)
* AndFeatureExpression (and-feature-condition)
* OrFeatureExpression (or-feature-condition)
* PVSCLExpression (pvscl-expression)
* OCLExpression (ocl-expression)
* AUTOSARExpression (autosar-expression)

The individual expression types are explained in subsections 3.7.4, 3.7.5, 3.7.6, 3.7.7, 3.7.8 and 3.7.9.

### Attribute datatype

The attribute datatype constrains the return type of the expression. Since the possible values for datatype depend on the artifact(s) involved, they are not further standardized here.

* If the attribute datatype of an Expression exists, then the return type of the Expression should be compatible with the data type given by datatype.

### SingleFeatureCondition

A SingleFeatureCondition is a type of expression that models a Boolean condition whose literal is a single Feature.

The example in Listing 15 translates to the Boolean expression

* Formally, if a SingleFeatureCondition references the feature , then this translates into the Boolean expression

where is if feature is selected, and is is not selected.

* The datatype for an Expression of type SingleFeatureExpression should be Boolean.

See also section 3.7.10.1 on how single features are represented in XML.

### AndFeatureCondition

An AndFeatureCondition is a Condition that models a Boolean condition whose literals are features, and which are connected by a Boolean *AND*. The example in Listing 15 translates to the Boolean expression

* If an AndFeatureCondition references the features , then this translates into the following Boolean expression

where is if feature is selected, and otherwise.

* The datatype for an Expression of type AndFeatureCondition should be Boolean.

In the XML representation, an AndFeatureCondition is comma-separated list of features. See also section 3.7.10.2 on how features are represented in XML.

### OrFeatureCondition

An OrFeatureCondition is a special Condition that models a Boolean condition whose literals are features, and which are connected by a Boolean *OR*. The example in Listing 15 translates to the Boolean expression

* Formally, if a OrFeatureCondition references the features , then this translates into the following Boolean expression

where is if feature is selected, and otherwise.

* The datatype for an Expression of type OrFeatureCondition should be Boolean.

In the XML representation, an OrFeatureCondition is comma-separated list of features. See also section 3.7.10.2 on how features are represented in XML.

### PVSCLExpression

In terms of syntax and scope, PVSCLExpression is comparable to what most programming languages offer.

* An expression of type PVSCLExpression shall use the syntax defined by [PS].
* An expression of type PVSCLExpression shall be evaluated according to the rules defined in[PS].

### OCLExpression

An OCLExpression uses the expression syntax and semantics defined by OCL,

[**OCL**]

### AUTOSARExpression

An AUTOSARExpression uses the expression syntax and semantics defined by AUTOSAR, >.

[**AUTOSAR**]

### Representation of expressions and features in XML

A Feature is a reference to an element in a model that describes the variability of an artifact, typically a feature model. The exact nature of a feature model is beyond the scope of this document.

* In the XML, a feature is just a name. How exactly a Feature is mapped to its corresponding element in the feature model is implementation dependent and beyond the scope of this document.
* The name of a Feature shall be unique. That is, if features and have the same string representation, then they are assumed to refer to the same element

#### Syntax for single-feature–condition

* In the XML representation, a feature is a string that matches the following pattern:

\s\*[a-zA-Z\_]([a-zA-Z0-9\_]\*\s\*

That is, a feature is a sequence of characters which starts with a letter or an underscore followed by letters, digits and underscores.

An XML element of type expression-type whose attribute type has the value single-feature–condition must match to the above pattern.

#### Syntax for and-feature-condition and or-feature-condition

* In the XML representation, a comma-separated list of features is a string that matches the following pattern[[3]](#footnote-3):

\s\*[a-zA-Z\_]([a-zA-Z0-9\_]\*(\s\*,\s\*[a-zA-Z\_]([a-zA-Z0-9\_]\*)\*\s\*

An XML element of type expression-type whose attribute type has the value and-feature–condition or or-feature-condition must match to the above pattern.

## ExpressionTypeEnum <expression-enum>



Figure 10 UML Diagram for class ExpressionTypeEnum

<xs:simpleType name="expression-enum">

<xs:restriction base="xs:string">

<xs:enumeration value="single-feature-condition"/>

<xs:enumeration value="and-feature-condition"/>

<xs:enumeration value="or-feature-condition"/>

<xs:enumeration value="pvscl-expression"/>

<xs:enumeration value="ocl-expression"/>

<xs:enumeration value="autosar-expression"/>

</xs:restriction>

</xs:simpleType>

Listing 16 XML Schema for expression-enum

### Description

The enumeration ExpressionTypeEnum defines the possible values for the attribute type of the class Expression. The semantics of these expression types is explained in Section 3.7.

## Identifiable <identifiable-type>



Figure 11 UML Diagram for class Identifiable

<xs:complexType name="identifiable-type" abstract="true">

<xs:sequence>

<xs:element name="special-data"

type="special-data-type"

minOccurs="0"

maxOccurs="unbounded"/>

</xs:sequence>

<xs:attribute name="name" use="optional">

<xs:simpleType>

<xs:restriction base="xs:string">

<xs:minLength value="1"/>

</xs:restriction>

</xs:simpleType>

</xs:attribute>

<xs:attribute name="id" type="xs:ID" use="required"/>

</xs:complexType>

Listing 17 XML Schema for identifable-type

<optional-structural-variationpoint **id="vp1" name="optional variationpoint"**>

**<special-data name="CreatorInfo">**

**<data>**

**<key>Created</key>**

**<value type="xs:date">1998-11-17</value>**

**</data>**

**</special-data>**

<variation id="vp1v1" name="optional variation">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

Listing 18 XML Example for identifable-type (id attribute)

### Description

Identifiable is an *abstract* class that defines means to provide unique identifiers for elements of the variability exchange language. Identifiable is used as the base class for many classes of the *Variability Exchange Language*.

In the XML Schema, identifiable-type does not define an XML element of its own, but adds two new attributes id and name to any type that is an extension of identifiable-type.

<xs:complexType name="variationpoint-type" abstract="true">

<xs:complexContent>

**<xs:extension base="identifiable-type">**

<xs:sequence>

<xs:element name="bindingtime"

type="bindingtime-type"

minOccurs="0"

maxOccurs="unbounded"/>

<xs:element name="corresponding-variable-artifact-element"

type="artifact-element-type"

minOccurs="0"

maxOccurs="unbounded"/>

</xs:sequence>

**</xs:extension>**

</xs:complexContent>

</xs:complexType>

Figure 12 Use of identifiable-type in the XML Schema

### Attribute id

The attribute id of an Identifiable provides a unique identifier for an element.

In XML, id is an attribute of type xs:ID, which means that id is guaranteed to be unique within a *Variability Exchange Language* document. Other XML elements may use an attribute of type xs:IDREF to refer to an XML clement that is Identifiable.

* The value of the attribute id of an Identifiable shall be unique within a single *Variability Exchange Language* document. That is, the following condition holds:

Let and be the values of the id XML attributes of the XML elements and , with . Then and are the same elements.

This is consistent with the definition of the types xs:IDREF and xs:IDREFS in XML.

* The value of the attribute id of an Identifiable shall not change over the lifetime of the element which the Identifiable represents.

The reason for introducing the latter constraint is as follows. Imagine the following situation: the operations importVariabilityExchangeModels and getConfiguration return variability language exchange documents that contain information about the same variation point (in this context, “same” usually means that they refer to the same artifact elements).

Then, the attribute id should have an identical value in both the documents returned from importVariability­ExchangeModels and getConfiguration; otherwise there would be no way to match the variation points.

### Attribute name

The attribute name of an Identifiable provides a human readable name for an element. It is recommended (but not enforced by the XML Schema) that all the name attributes of the Identifiable elements in a *Variability Exchange Language* document have unique values.

* The value of the attribute name of an Identifiable is not guaranteed to be unique within a single variability exchange language document. It is however strongly recommended to use unique values for name attributes as well.
* The value of attribute name shall not be an empty string.

### Attribute specialData

Each Identifiable may aggregate one or more SpecialData objects. This makes sure that most elements in the *Variability Exchange Language* can be augmented with application specific data.

### Notes

* Identifiable is an abstract class. Most of the classes described in this document inherit from Identifiable.

## KeyValuePair <key-value-pair-type>

****

Figure 13 UML Diagram for class KeyValuePair

<xs:complexType name="key-value-pair-type">

<xs:sequence>

<xs:element name="key">

<xs:simpleType>

<xs:restriction base="xs:string">

<xs:minLength value="1"/>

</xs:restriction>

</xs:simpleType>

</xs:element>

<xs:element name="value">

<xs:complexType>

<xs:simpleContent>

<xs:extension base="xs:string">

<xs:attribute name="type" type="xs:string" use="optional"/>

</xs:extension>

</xs:simpleContent>

</xs:complexType>

</xs:element>

</xs:sequence>

</xs:complexType>

Figure 14 XML Schema for key-value-pair-type

<optional-structural-variationpoint id="vp1" name="optional variationpoint">

**<special-data name="CreatorInfo">**

**<data>**

**<key>Created</key>**

**<value type="xs:date">1998-11-17</value>**

**</data>**

**</special-data>**

<variation id="vp1v1" name="optional variation">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

Figure 15 XML Example for key-value-pair-type

### Description of Class KeyValuePair

Application specific data for VariationPoint and Variation objects is implemented by the class SpecialData, which aggregates a number of KeyValuePair elements. As the name already suggests, a KeyValuePair consists of a key and a value.

KeyValuePair is restricted to data that can be represented as strings. How key and value are interpreted is up to the application. It is strongly recommended to use the attribute key as some kind of (unique) identifier, and store the data associated with key in the attribute value.

### Attribute key of Class KeyValuePair

The attribute key of class KeyValuePair provides a way to identify a KeyValuePair.

* A SpecialData object shall not contain two or more KeyValueData objects whose attribute key have the same value.

### Description of Class Value

An object of class Value is a container for the value of a KeyValuePair.

### Attribute value of Class Value

The attribute value of an object of class Value contains the application specific data that is associated with the key of the KeyValuePair object which aggregates this object.

### Attribute type of Class Value

The attribute type of class Value can be used to indicate the data type of the value of a Value object. The contents of type are not standardized, but using XML data types such as xs:string or xs:date is recommended.

### XML Representation

* As shown in Figure 15, a key-value pair is implemented by the XML elements key and value, which are enclosed by a data element[[4]](#footnote-4). The elements key and value are XML strings.
* The XML representation of a Value object is an XML element named value which contains an arbitrary string. Its definition is based on the XML type xs:string and defines an additional attribute type which indicates the data type of the content.

## OptionalStructuralVariationPoint <optional-structural-variaton-point-type>



Figure 16 UML Diagram for class OptionalStructuralVariatonPoint

<xs:complexType name="optional-structural-variationpoint-type">

<xs:complexContent>

<xs:extension base="variationpoint-type">

<xs:sequence>

<xs:element name="variation"

type="optional-variation-type"

minOccurs="1"

maxOccurs="unbounded"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 19 XML Schema for optional-structural-variaton-point-type

<optional-structural-variationpoint id="vp1">

<variation id="vp1v1">

<condition type="single-feature-condition">feature1</condition>

</variation>

</optional-structural-variationpoint>

Listing 20 XML Example for optional-structural-variaton-point-type

<optional-structural-variationpoint id="vp2">

<variation id="vp2v1">

<condition type="single-feature-condition">Feature1</condition>

</variation>

<variation id="vp2v2">

<condition type="single-feature-condition">Feature2</condition>

</variation>

<variation id="vp2v3">

<condition type="single-feature-condition">Feature3</condition>

</variation>

</optional-structural-variationpoint>

Listing 21 XML Example for optional-structural-variaton-point-type with multiple variations

### Description

An OptionalStructuralVariationPoint is a VariationPoint that contains one or more OptionalVariation objects.

### Notes

* The class OptionalStructuralVariationPoint inherits from the class StructuralVariationPoint.

## OptionalVariation <optional-variation-type>



Figure 17 UML Diagram for class OptionalVariation

<xs:complexType name="optional-variation-type">

<xs:complexContent>

<xs:extension base="variation-type">

<xs:sequence>

<xs:element name="condition"

type="expression-type"

minOccurs="0" maxOccurs="1"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 22 XML Schema for optional-variation-type

<optional-structural-variationpoint id="vp1">

**<variation id="v1">**

<condition type="or-feature-expression">Feature1,Feature2</condition>

**</variation>**

</optional-structural-variationpoint>

Listing 23 XML Example for optional-variation-type

### Description

Each OptionalStructuralVariationPoint aggregates one or more OptionalVariation objects. An OptionalVariation is a Variation that determines whether an OptionalStructural­Variation­Point gets deleted or set inactive during the binding process.

### Attribute condition

The optional attribute condition of an OptionalVariation defines the expression that is used to compute the condition of an OptionalVariation.

* The attribute condition of an OptionalVariation shall return a Boolean value. That is, its datatype attribute (if present) should be a Boolean or a data type which can be converted into a Boolean.
* If an OptionalVariation has an attribute condition and an attribute selected (inherited from Variation), then the following condition shall hold:

### Binding

When an OptionalStructuralVariationPoint is bound, the condition of each of its OptionalVariations is evaluated. If the result of the evaluation is, then the artifact elements which are referenced by the attribute corresponding­Variable­Artifact­Element (see section 3.21.3) of the OptionalVariation get deleted or set inactive.

* An OptionalStructuralVariationPoint can only be bound when all its OptionalVariations have a condition.

### Notes

* The class OptionalVariation inherits from the class Variation.

## ParameterVariationPoint <parameter-variationpoint-group>



Figure 18 UML Diagram for class ParamaterVariationPoint

<xs:group name="parameter-variationpoint-group">

<xs:choice>

<xs:element name="calculated-parameter-variationpoint"

type="calculated-parameter-variationpoint-type"/>

<xs:element name="xor-parameter-variationpoint"

type="xor-parameter-variationpoint-type"/>

</xs:choice>

</xs:group>

Listing 24 XML Schema for parameter-variationpoint-group

### Description

A ParameterVariationPoint defines a value for a variable element in an artifact, for example

* A value or a C-preprocessor symbol (#define)
* A initialization value for a variable or a constant in a programing language
* A value for a variable in a Matlab workspace

The artifact elements are referenced by the attribute correspondingVariableArtifactElement of the ParameterVariationPoint and the attribute correspondingVariableArtifactElement of its Variation(s) (see the classes VariationPoint and Variation in Figure 18)

### Notes

* The class ParameterVariationPoint is an abstract class which inherits from the class VariationPoint.
* There are two subclasses of ParameterVariationPoint: CalculatedParameter­VariationPoint und XorParameterVariationPoint.
* Like StructuralVariationPoint, ParameterVariationPoint is implemented in the XML schema as group, not a type. We chose to use a group here because a type would have established an extra XML element for ParameterVariationPoint, which would only have complicated the document structure.

## SpecialData <special-data-type>



Figure 19 UML Diagram for class SpecialData

<xs:complexType name="special-data-type">

<xs:sequence>

<xs:element name="data"

type="key-value-pair-type"

minOccurs="0"

maxOccurs="unbounded"/>

</xs:sequence>

<xs:attribute name="name" type="xs:string" use="optional"/>

</xs:complexType>

Figure 20 XML Schema for special-data-type

<optional-structural-variationpoint id="vp1" name="optional variationpoint">

**<special-data name="CreatorInfo">**

**<data>**

**<key>Created</key>**

**<value type="xs:date">1998-11-17</value>**

**</data>**

**</special-data>**

<variation id="vp1v1" name="optional variation">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

Figure 21 XML Example for special-data-type

### Description

The class SpecialData allows adding application specific information to VariationPoint and Variation objects. SpecialData aggregates a number of KeyValuePair elements which contain the actual information.

### Attribute name

The attribute name of a SpecialData indicates which kind of data is contained in the SpecialData structure. The values of name are not standardized; it is highly recommended to use a descriptive name that has a high probability of being unique.

* The attribute name of a SpecialData is optional.
* Any application that deals with variability information read from an artifact via methods exportVariabilityExchangeModels or getConfiguration (see Section 3.17) shall not read or write the information contained in SpecialData if its name is unknown to the application.
* If an application reads variability information from an artifact via methods exportVariabilityExchangeModels or getConfiguration (see Section 3.17), then changes this information, and later uses the methods importVariabilityExchangeModels or setConfiguration (see Section 3.17) to write the information to an artifact, then any SpecialData whose type is not known to the application may be in an undefined state. This is because the information contained in SpecialData may depend on the overall structure.

## StructuralVariationPoint <structural-variationpoint-group>



Figure 22 UML Diagram for class StructuralVariationPoint

<xs:group name="structural-variationpoint-group">

<xs:choice>

<xs:element name="optional-structural-variationpoint"

type="optional-structural-variationpoint-type"/>

<xs:element name="xor-structural-variationpoint"

type="xor-structural-variationpoint-type"/>

</xs:choice>

</xs:group>

Listing 25 XML Schema for structural-variationpoint-group

### Description

A StructuralVariationPoint determines whether one or more elements in an artifact gets deleted or set inactive during the binding process.

The artifact elements are referenced by the attribute correspondingVariableArtifactElement of the StructuralVariationPoint and the attribute correspondingVariableArtifactElement of its Variations (see the classes VariationPoint and Variation in Figure 22)

### Notes

* The class StructuralVariationPoint is an abstract class which inherits from the class VariationPoint.
* The class StructuralVariationPoint has two subclasses: Optional­Structural­VariationPoint and XorStructuralVariationPoint.
* Like ParameterVariationPoint, StructuralVariationPoint is implemented in the XML Schema as a group, not as a type. We choose to use a group here because a type would have established an extra XML element for StructuralVariationPoint, which would only have complicated the document structure.

## ValueVariation <value-variation-type>



Figure 23 UML Diagram for class ValueVariation

<xs:complexType name="value-variation-type">

<xs:complexContent>

<xs:extension base="variation-type">

<xs:sequence>

<xs:element name="condition"

type="expression-type"

minOccurs="0"

maxOccurs="1"/>

<xs:element name="value" type="xs:string"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 26 XML Schema for value-variation-type

<xor-parameter-variationpoint id="vp1">

**<variation id="vp1v1">**

**<condition type="single-feature-condition">Feature1</condition>**

**<value>1</value>**

**</variation>**

**<variation id="vp1v2">**

**<condition type="single-feature-condition">Feature2</condition>**

**<value>2</value>**

**</variation>**

**<variation id="vp1v3">**

**<condition type="single-feature-condition">Feature3</condition>**

**<value>3</value>**

**</variation>**

</xor-parameter-variationpoint>

Listing 27 XML Example for value-variation-type

### Description

A ValueVariation selects a value for the corresponding artifact element of a XorParameter­Variation­Point. The artifact element in question is referenced by its attribute correspondingVariableArtifactElement (see section 3.21.3).

Each XorParameter­Variation­Point contains one or more ValueVariation objects. When a XorParameter­Variation­Point gets bound, the attribute condition of each ValueVariation is evaluated. The condition may evaluate to for only one ValueVariation, and the attribute value of this ValueVariation is then used to provide a value for its correspondingVariableArtifactElement.

* Let be a XorParameterVariationPoint which and let be the values of the attribute selected of the ValueVariations of . Then the following conditions shall hold:

### Attribute condition

* When evaluated, the attribute condition of a ValueVariation shall return a Boolean value. That is, its datatype attribute (if present) should be a Boolean or a data type which can be converted into a Boolean.
* Let be the conditions of all the ValueVariations that are contained in a given XorParameter­Variation­Point. Then the following conditions shall hold
* If a ValueVariation has an attribute condition and an attribute selected (inherited from Variation), then the following condition shall hold:

### Attribute value

* The attribute value of a ValueVariation is a constant, not an expression.
* The data type (e.g. Boolean, Integer, Floating Point, or an enumeration) and range (e.g. 1…10) that is allowed for the attribute value of a ValueVariaton is defined by the artifact element that is associated with ValueVariation (see correspondingVariableArtifactElement, section 3.21.3).

### Binding

Each XorParameter­Variation­Point contains one or more ValueVariation objects. When a XorParameter­Variation­Point gets bound, the attribute condition of each ValueVariation is evaluated. The condition may evaluate to for only one ValueVariation, and the attribute value of this ValueVariation is then used to provide a value for its correspondingVariableArtifactElement.

* A XorParameter­Variation­Point can only be bound when all its ValueVariations have a condition.

### Notes

* The class ValueVariation inherits from the abstract class Variation.

## VariabilityAPI



Figure 24 UML Diagram for class VariabilityAPI

### Description

The class VariabilityAPI defines the methods that are available for exchanging variability information through the *Variability Exchange Language*.

### Attribute version

The attribute version documents the version of the variability language which is supported by this implementation of the *Variability Exchange Language*. It is a read-only attribute.

* The attribute version shall be a positive integer.
* See the attribute version of the class VariabilityExchangeModels (section 3.19.2) for further constraints on this attribute.

### Attribute capability

Not all implementations of the VariabilityAPI support all the methods that are shown in Figure 24. The attribute capability documents which of these methods – most importantly, importVariabilityExchangeModels, exportVariabilityExchangeModels, getConfiguration, and setConfiguration – are supported by this implementation of the VariabilityAPI.

### Method importVariabilityExchangeModels

The method importVariabilityExchangeModels synchronizes all changes in the artifacts with the VariabilityExchangeModels structure. This means that new variation points may be introduced, and existing variation points in the artifact may be changed or deleted.

* Let be the VariabilityExchangeModel objects which are contained by the parameter of type VariabilityExchangeModels object which is the input to the method importVariabilityExchangeModels. Then for all , the attribute type shall have the value VariationPointDescription.
* The method importVariabilityExchangeModels is only available if the attribute capability.setVariationPoints has the value .

### Method exportVariabilityExchangeModels

The method exportVariabilityExchangeModels reads information on the variation points in all available artifacts and returns a VariabilityExchangeModels structure.

* Let be the VariabilityExchangeModel objects which are contained by the VariabilityExchangeModels object which is returned from the method exportVariabilityExchangeModels. Then for all , the attribute type shall have the value VariationPointDescription .
* The method exportVariabilityExchangeModels is only available if the attribute capability.getVariationPoints is set to .

### Method getConfiguration

The method getConfiguration reads one or more variant configurations from an artifact.

* Let be the VariabilityExchangeModel objects which are contained by the VariabilityExchangeModels object which is returned from the method getConfiguration. Then for all , the attribute type shall have the value VariationPointConfiguration.
* The method getConfiguration is only available if the attribute capability.getConfiguration has the value .

### Method setConfiguration

The method setConfiguration writes one or more variant configurations to an artifact.

* Let be the VariabilityExchangeModel objects which are contained by the parameter of type VariabilityExchangeModels object which is the input to the method setConfiguration. Then for all , the attribute type shall have the value VariationPointConfiguration.
* The method setConfiguration is only available if the attribute capability.setConfiguration has the value .

## VariabilityExchangeModel <variability-exchange-model-type>



Figure 25 UML Diagram for class VariabilityExchangeModel

<xs:complexType name="variability-exchange-model-type">

<xs:complexContent>

<xs:extension base="identifiable-type">

<xs:sequence>

<xs:group ref="variationpoint-group"

minOccurs="0"

maxOccurs="unbounded"/>

</xs:sequence>

<xs:attribute name="type" type="variability-api-enum" use="required"/>

<xs:attribute name="uri" type="xs:anyURI" use="optional"/>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 28 XML schema for variability-exchange-model-type

<?xml version="1.0" encoding="UTF-8"?>

<variability-exchange-models id="root"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:noNamespaceSchemaLocation="../VariabilityExchangeLanguage.xsd">

<version>1</version>

<capability>

<import-variability-exchange-model>true</import-variability-exchange-model>

<export-variability-exchange-model>true</export-variability-exchange-model>

<get-configuration>true</get-configuration>

<set-configuration>true</set-configuration>

</capability>

<variability-exchange-model type="variationpoint-description" id="model1"

uri="file:///C:/SPES/file1.c">

…

</variability-exchange-model>

<variability-exchange-model type="variationpoint-description" id="model2"

uri="file:///C:/SPES/file2.c">

…

</variability-exchange-model>

<variability-exchange-model type="variationpoint-description" id="model3"

uri="file:///C:/SPES/file3.c">

…

</variability-exchange-model>

<variability-exchange-model type="variationpoint-description" id="model4"

uri="file:///C:/SPES/file4.c">

…

</variability-exchange-model>

</variability-exchange-models>

Listing 29 XML example for variability-exchange-model-type

### Description

A VariabilityExchangeModel is an artifact which may contain variation points. Examples for artifacts are

* C/C++ files
* Matlab/Simulink Models
* DOORS databases

### Attribute type

The attribute type of a VariabilitExchangeModel determines whether this model is a description of the variation points in the artifacts or defines a variant configuration:

* If the value of type is VariationPointDescription, then the attribute selected of all Variations (see section 3.21.2) and BindingTimes (see section 3.2.2) has no effect and shall be omitted.
* If the value of type is VariationPointConfiguration, then the attribute selected of all Variations (see section 3.21.2) and BindingTimes (see section 3.2.2) is not optional, and the attribute expression of CalculatedVariation must contain a constant.

See also section 3.21.2.

### Attribute uri

The attribute uri of a VariabilityExchangeModel defines the Uniform Resource Locator (URI, see [**RFC3986**]) of the artifact that is associated with the VariabilityExchangeModel.

## VariabilityExchangeModels <variability-exchange-models-type>



Figure 26 UML Diagram for class VariabilityExchangeModels

<xs:complexType name="variability-exchange-models-type">

<xs:sequence>

<xs:element name="version" type="xs:unsignedInt" fixed="1" />

<xs:element name="capability" type="capability-type" />

<xs:element name="variability-exchange-model"

type="variability-exchange-model-type"

minOccurs="0"

maxOccurs="unbounded" />

</xs:sequence>

</xs:complexType>

Listing 30 XML Schema for variability-exchange-models-type

<?xml version="1.0" encoding="UTF-8"?>

<variability-exchange-models id="root"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:noNamespaceSchemaLocation="../VariabilityExchangeLanguage.xsd">

<version>1</version>

<capability>

<import-variability-exchange-model>true</import-variability-exchange-model>

<export-variability-exchange-model>true</export-variability-exchange-model>

<get-configuration>true</get-configuration>

<set-configuration>true</set-configuration>

</capability>

<variability-exchange-model type="**variationpoint-description**" id="model1">

…

</variability-exchange-model>

<variability-exchange-model type="**variationpoint-configuration**" id="model2">

…

</variability-exchange-model>

</variability-exchange-models>

Listing 31 XML example for variability-exchange-models-type

### Description

VariabilityExchangeModels is the top level object of a *Variability Exchange Language* document. In the XML representation, variability-exchange-models is the root element of the XML document object.

### Attribute version

The attribute version of VariabilityExchangeModels defines the version of the *Variability Exchange Language* to which the *Variability Exchange Language* document conforms.

* The attribute version of VariabilityExchangeModels should be a positive non-zero Integer.
* If a specific implementation of the *Variability Exchange Language* supports version and a *Variability Exchange Language* document is in version , then the following conditions should hold:

1. The implementation shall reject the document if .
2. The implementation shall accept the document if .
3. The implementation may accept the document if .

In other words, an implementation of the *Variability Exchange Language* should never accept a document where the attribute version of the element VariabilityExchangeModels is a greater than the one that is supported by the implementation. It may, however accept a document with a smaller version number (backwards compatibility)., if both version numbers are equal, the document should be accepted[[5]](#footnote-5).

* The attribute version of VariabilityExchangeModels is read-only.

### Attribute capability

The attribute capability of VariabilityExchangeModels defines which API operations (see section 3.16.5) are supported by the implementation of the *Variability Exchange Language* that created the *Variability Exchange Language* document.

For more information see the class Capability.

## VariabilityAPITypeEnum <variability-api-enum>



Figure 27 UML Diagram for class VariabilityAPITypeEnum

<xs:simpleType name="variability-api-enum">

<xs:restriction base="xs:string">

<xs:enumeration value="variationpoint-description"/>

<xs:enumeration value="variationpoint-configuration"/>

</xs:restriction>

</xs:simpleType>

Listing 32 XML Schema for variability-api-type-enum

<?xml version="1.0" encoding="UTF-8"?>

<variability-exchange-models id="root"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:noNamespaceSchemaLocation="../VariabilityExchangeLanguage.xsd">

<version>1</version>

<capability>

<import-variability-exchange-model>true</import-variability-exchange-model>

<export-variability-exchange-model>true</export-variability-exchange-model>

<get-configuration>true</get-configuration>

<set-configuration>true</set-configuration>

</capability>

<variability-exchange-model type="**variationpoint-description**" id="model1">

…

</variability-exchange-model>

<variability-exchange-model type="**variationpoint-configuration**" id="model2">

…

</variability-exchange-model>

</variability-exchange-models>

Listing 33 XML example for variability-api-type-enum

### Description

The enumeration VariabilityAPITypeEnum differentiates between the two flavors of VariabilityExchangeModel objects:

1. VariationPointDescription
2. VariationPointConfiguration

See the class VariabilityExchangeModel for more details.

## Variation <variation-type>



Figure 28 UML Diagram for class Variation

<xs:complexType name="variation-type" abstract="true">

<xs:complexContent>

<xs:extension base="identifiable-type">

<xs:sequence>

<xs:element name="hierarchy"

type="variationpoint-hierarchy-type"

minOccurs="0" maxOccurs="1"/>

<xs:element name="depencency"

type="variation-dependency-type"

minOccurs="0" maxOccurs="unbounded"/>

<xs:element name="corresponding-variable-artifact-element"

type="artifact-element-type"

minOccurs="0" maxOccurs="unbounded"/>

</xs:sequence>

<xs:attribute name="selected" type="xs:boolean" use="optional"/>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Figure 29 XML Schema for variation-type

### Description

The abstract class Variation implements a variation of a variation point. Each instance of the class VariationPoint contains one or more instances of the class Variation.

There are four classes that derive from Variation, namely OptionalVariaton, XorVariation, CalculatedVariation and ValueVariation.

### Attribute selected

If the attribute type of a VariabilityExchangeModel has the value VariationPointConfiguration, then the attribute selected of a Variation decides wether is contained in the variation point configuration which is defined by the VariabilityExchangeModel which contains .

* If the attribute type of a VariabilityExchangeModel has the value VariationPointDescription, then no Variation in shall have an attribute selected.
* If the attribute type of a VariabilityExchangeModel has the value VariationPointConfiguration, then every Variation in shall have an attribute selected.
* If the attribute type of a VariabilityExchangeModel has the value VariationPointConfiguration, and the attribute selected of a Variation contained by has the value , then is a member of the variation point configuration defined by .
* If the attribute type of a VariabilityExchangeModel has the value VariationPointConfiguration, and the attribute selected of a Variation contained by has the value , then is not a member of the variation point configuration defined by .

### Attribute correspondingVariableArtifactElement

The attribute correspondingVariableArtifactElement of a Variation implements a reference to the artifact elements which correspond to .

* The attribute correspondingVariableArtifactElement is optional.
* If a Variation has more than one correspondingVariableArtifactElements then the URIs of do not need to point to the same artifacts. That is, the URI attributes of may have different values for each .

### Notes

* The class Variation inherits from the class Identifiable.
* The classes OptionalVariation, XorVariation, CalculatedVariation and ValueVariation inherit from Variation.

## VariationPoint <variationpoint-type>



Figure 30 UML Diagram for class VariationPoint

<xs:complexType name="variationpoint-type" abstract="true">

<xs:complexContent>

<xs:extension base="identifiable-type">

<xs:sequence>

<xs:element name="bindingtime"

type="bindingtime-type"

minOccurs="0" maxOccurs="unbounded"/>

<xs:element name="corresponding-variable-artifact-element"

type="artifact-element-type"

minOccurs="0" maxOccurs="unbounded"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:group name="variationpoint-group">

<xs:choice>

<xs:group ref="structural-variationpoint-group"/>

<xs:group ref="parameter-variationpoint-group"/>

</xs:choice>

</xs:group>

Listing 34 XML Schema for variationpoint-type

### Description

The abstract class VariationPoint describes a variationpoint in an artifact.

### Attribute bindingTime

The attribute bindingTime defines the binding time of a VariationPoint. For more information on the concept of binding times, see section 3.2.

* If a VariationPoint does not declare a BindingTime, then it is up to the binding process to define which binding time to use. For example, a process that uses a single binding time may not state an explicit binding time for its variation points.
* A VariationPoint may define more than one binding time. In this case, the attribute selected of the BindingTime elements decides which binding time is used in the actual binding process.
* If the VariabilityExchangeModel which contains a VariationPoint has the type VariationPointConfiguration, then let be the values of the attribute selected of the BindingTime attributes of . Then the following conditions must hold:

A consequence of the above condition is that if a VariationPoint in a VariationPointConfiguration has only a single BindingTime attribute , then the attribute selected of shall have the value .

How and when a value for the attribute selected is determined is beyond the scope of this document.

### Attribute correspondingVariableArtifactElement

The attribute correspondingVariableArtifactElement of a VariationPoint implements a reference to the artifact elements which correspond to .

* Not all VariationPoints have a correspondingVariableArtifactElement.
* If a VariationPoint has more than one correspondingVariableArtifactElements then the URIs of do not need to point to the same artifacts. That is, the URI attributes of may have different values for each .

### Notes

* The class VariationPoint inherits from the class Identifiable.
* There classes StructuralVariationPoint and ParameterVariationPoint inherit from the class VariationPoint.

## VariationPointHierarchy <variationpoint-hierarchy-type>



Figure 31 UML Diagram for class VariationPointHierarchy

<xs:complexType name="variationpoint-hierarchy-type">

<xs:complexContent>

<xs:extension base="identifiable-type">

<xs:sequence>

<xs:element name="variationpoint" minOccurs="1" maxOccurs="unbounded">

<xs:complexType>

<xs:attribute name="ref" type="xs:IDREF" use="required"/>

</xs:complexType>

</xs:element>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 35 XML Schema for variationpoint-hierarchy-type

<variability-exchange-model type="variationpoint-description" id="model">

<optional-structural-variationpoint id="**vp1**">

<variation id="vp1v1">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

<optional-structural-variationpoint id="vp2">

<variation id="vp2v1">

**<hierarchy id="vp2h1">**

**<variationpoint ref="vp1"/>**

**</hierarchy>**

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

</variability-exchange-model>

Listing 36 XML Example for variationpoint-hierarchy-type

### Description

Each Variation may contain a VariationPointHierarchy object. VariationPointHierarchy establishes a hierarchy among VariationPoints and Variations.

The hierarchy is a graph defined as follows:

* where is a VariationPoint in a *Variability Exchange Language* document[[6]](#footnote-6).
* Let be a VariationPoint which contains a Variation which contains a VariationPointHierarchy whose attribute ref refers to a VariationPoint . Then .
* No two VariationPointHierarchy elements may refer to the same VariationPoints. Formally, the following condition shall hold:
* must not contain cycles, that is, there cannot be a sequence. Formally, the following condition shall hold: (.

These conditions make sure that is a tree or a set of trees.

### Attribute variationPoint

The attribute variationPoint of a VariationPointHierarchy identifies the endpoint of a variationpoint hierarchy relation.

### Notes

* The class VariationPointHierarchy inherits from Identifiable.
* In the XML Schema, the attribute variationPoint of VariationPointHierarchy is not implemented as a XML attribute but as a separate XML element named variation with an XML attribute ref that implements the actual reference. This is because variation has an upper multiplicity greater than one, but XML attributes are restricted to an upper multiplicity of 1.

## VariationDependency <variation-dependency-type>



Figure 32 UML Diagram for class VariationDependenxy

<xs:complexType name="variation-dependency-type">

<xs:complexContent>

<xs:extension base="identifiable-type">

<xs:sequence>

<xs:element name="variation"

minOccurs="1" maxOccurs="unbounded">

<xs:complexType>

<xs:attribute name="ref" type="xs:IDREF" use="required"/>

</xs:complexType>

</xs:element>

<xs:element name="condition"

type="expression-type"

minOccurs="0" maxOccurs="1"/>

</xs:sequence>

<xs:attribute name="type"

type="variation-dependency-enum"

use="required"/>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 37 XML Schema for variation-dependency-type

<variability-exchange-model type="variationpoint-description" id="model">

<optional-structural-variationpoint id="vp1">

<variation id="**vp1v1**">

<condition type="single-feature-condition">Feature1</condition>

</variation>

</optional-structural-variationpoint>

<optional-structural-variationpoint id="vp2">

<variation id="vp2v1">

**<depencency type="conflicts" id="vp2d1">**

**<variation ref="vp1v1"/>**

**</depencency>**

<condition type="single-feature-condition">Feature1</condition>

</variation>

<variation id="vp2v2">

<condition type="single-feature-condition">Feature2</condition>

</variation>

<variation id="vp2v3">

<condition type="single-feature-condition">Feature3</condition>

</variation>

</optional-structural-variationpoint>

</variability-exchange-model>

Listing 38 XML example for variation-dependency-type

### Description

A VariationDependency defines a dependency between Variation objects. Each Variation may have an arbitrary number of dependencies to other Variations. There are two types of variations: requires and conflicts.

If a Variation aggregates more than one VariationDependency, then all dependencies must be fulfilled.

### Attribute type

The attribute type of VariationDependency defines the type of a dependency. There are two types of dependencies:

* requires
* conflicts

The enumeration VariationDependencyEnum defines the values that are allowed for the attribute type.

### Attribute variation

The attribute variation of a VariationDependency defines the target of a dependency.

### Attribute condition

The optional attribute condition of a VariationDependency defines a condition under which the relation that is defined by the VariationDependency is effective.

### Formal Definition

* Let be a Variation which contains a VariationDependency , and let be the Variation to which the attribute variation of refers, and let be the value of the attribute type of . Furthermore, let be the content of the attribute condition of .

Then the condition of the VariationDependency , is defined as follows:

* If the attribute type of is requires, then
* If the attribute type of is conflicts, then
* Let be the VariationDependency objects contained by a Variation . Then the condition of , is defined as follows:
* Let be the conditions of all Variation objects in a *Variability Exchange Language*. Then the following condition shall hold:

### Notes

* The class VariationDependency inherits from Identifiable.
* In the XML Schema, the attribute variation is not implemented as a XML attribute but as a separate XML element named variation with an XML attribute ref that implements the actual reference. This is because variation has an upper multiplicity greater than one, but XML attributes are restricted to an upper multiplicity of 1 (that is, an XML element may not have multiple elements with the same name).

## VariationDependencyEnum <variation-dependency-enum>



Figure 33 UML Diagram for class VariationDependenyEnum

<xs:simpleType name="variation-dependency-enum">

<xs:restriction base="xs:string">

<xs:enumeration value="requires"/>

<xs:enumeration value="conflicts"/>

</xs:restriction>

</xs:simpleType>

Listing 39 XML Schema for variation-dependency-enum

### Description

The enumeration VariationDependencyEnum defines which values are allowed for the attribute type of VariationDependency. Currently, this enumeration defines two values:

* requires
* conflicts

For more information see VariationDependency.

## XorParameterVariationPoint < xor-parameter-variationpoint-type>



Figure 34 UML Diagram for class XorParameterVariationPoint

<xs:complexType name="xor-parameter-variationpoint-type">

<xs:complexContent>

<xs:extension base="variationpoint-type">

<xs:sequence>

<xs:element name="variation"

type="value-variation-type"

maxOccurs="unbounded" />

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 40 XML Schema for xor-parameter-variationpoint-type

<xor-parameter-variationpoint id="vp1">

<variation id="vp1v1">

<condition type="single-feature-condition">Feature1</condition>

<value>1</value>

</variation>

<variation id="vp1v2">

<condition type="single-feature-condition">Feature2</condition>

<value>2</value>

</variation>

<variation id="vp1v3">

<condition type="single-feature-condition">Feature3</condition>

<value>3</value>

</variation>

</xor-parameter-variationpoint>

Listing 41 XML Example for xor-parameter-variationpoint-type

### Description

A XorParameterVariationPoint contains a number of ValueVariation objects. During the binding process, the attribute condition of each ValueVariation objects is evaluated. As described in section 3.16.2, it is guaranteed that if all ValueVariation objects have a condition attribute, then there is exactly one ValueVariation whose condition evaluates to . The attribute value of this ValueVariation is then used to set the value of the associated artifact element.

### Notes

* The class XorParameterVariationPoint inherits from the class ParameterVariationPoint.
* The class XorParameterVariationPoint is modelled after the switch statement in the programming languages C or Java; it selects a single value from a list of values. The difference is that a switch in C or Java first evaluates a Boolean expression and then compares the result to a list of constants, while XorParameterVariationPoint evaluates a list of Boolean expressions and selects the one which returns .

## XorStructuralVariationPoint <xor-structural-variationpoint-type>



Figure 35 UML Diagram for XorStructuralVariationPoint

<xs:complexType name="xor-structural-variationpoint-type">

<xs:complexContent>

<xs:extension base="variationpoint-type">

<xs:sequence maxOccurs="unbounded">

<xs:element name="variation" type="xor-variation-type"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 42 XML Schema for xor-structural-variationpoint-type

**<xor-structural-variationpoint id="vp1">**

<variation id="vp1v1" name="Alternative 1">

<condition type="single-feature-condition">Feature1</condition>

</variation>

<variation id="vp1v2" name="Alternative 2">

<condition type="single-feature-condition">Feature2</condition>

</variation>

<variation id="vp1v3" name="Alternative 3">

<condition type="single-feature-condition">Feature3</condition>

</variation>

**</xor-structural-variationpoint>**

Listing 43 XML Example for xor-structural-variationpoint-type

### Description

A XorStructuralVariationPoint contains one or more XorVariations. Its purpose is to choose exactly one of several alternative Variations.

During the binding process, the attribute condition is evaluated for each XorVariation. As described in section 3.28.2, it is guaranteed that if all XorVariation objects have a condition attribute, then exactly one of those conditions evaluates to . The artifact element that corresponds to the XorVariation whose attribute condition evaluates to true is then removed or set inactive.

### Notes

* The class XorStructuralVariationPoint inherits from the class StructuralVariationPoint.

## XorVariation <xor-variation-type>



Figure 36 UML Diagram for XorVariation

<xs:complexType name="xor-variation-type">

<xs:complexContent>

<xs:extension base="variation-type">

<xs:sequence>

<xs:element name="condition"

type="expression-type"

minOccurs="0"

maxOccurs="1"/>

</xs:sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

Listing 44 XML Schema for xor-variation-type

<xor-structural-variationpoint id="vp1">

**<variation id="vp1v1" name="Alternative 1">**

**<condition type="single-feature-condition">Feature1</condition>**

**</variation>**

**<variation id="vp1v2" name="Alternative 2">**

**<condition type="single-feature-condition">Feature2</condition>**

**</variation>**

**<variation id="vp1v3" name="Alternative 3">**

**<condition type="single-feature-condition">Feature3</condition>**

**</variation>**

</xor-structural-variationpoint>

Listing 45 XML Example for xor-variation-type

### Description

A XorVariation is a kind of variation that choses Variation out of several alternative Variations.

* Let be a XorStructuralVariationPoint and let be the values of the selected attributes of the XorVariations which are aggregated by . Then the following conditions shall hold:

### Attribute condition

* When evaluated, the attribute condition of a XorVariation shall return a *Boolean* value. That is, its datatype attribute (if present) should be a Boolean or a data type which can be converted into a Boolean.
* Let be the conditions of all the XorVariations that are contained in a given XorStructuralVariation­Point. Then the following conditions must hold
* If a XorVariation has an attribute condition and an attribute selected (inherited from Variation), then the following condition shall hold:

### Binding

Each XorStructuralVariationPoint contains one or more XorVariations. When a XorStructuralVariationPoint gets bound, the attribute condition of each XorVariation is evaluated. For only one XorVariation the condition shall evaluate to . For all other XorVariations, the artifact elements that are referenced by its attribute correspondingVariableArtifactElement (see section 3.21.3) get deleted or set to inactive.

* A XorStructuralVariationPoint can only be bound when all its ValueVariations have a condition.

### Notes

* The class XorVariation inherits from the class Variation.

# Security Considerations

(**Note:** OASIS strongly recommends that Technical Committees consider issues that could affect security when implementing their specification and document them for implementers and adopters. For some purposes, you may find it required, e.g. if you apply for IANA registration.

While it may not be immediately obvious how your specification might make systems vulnerable to attack, most specifications, because they involve communications between systems, message formats, or system settings, open potential channels for exploit. For example, IETF [[RFC3552](#RFC3552)] lists “eavesdropping, replay, message insertion, deletion, modification, and man-in-the-middle” as well as potential denial of service attacks as threats that must be considered and, if appropriate, addressed in IETF RFCs.

In addition to considering and describing foreseeable risks, this section should include guidance on how implementers and adopters can protect against these risks

We encourage editors and TC members concerned with this subject to read *Guidelines for Writing RFC Text on Security Considerations,* IETF [[RFC3552](#RFC3552)], for more information.)

# Conformance

(**Note**: The [OASIS TC Process](https://www.oasis-open.org/policies-guidelines/tc-process#wpComponentsConfClause) requires that a specification approved by the TC at the Committee Specification Public Review Draft, Committee Specification or OASIS Standard level must include a separate section, listing a set of numbered conformance clauses, to which any implementation of the specification must adhere in order to claim conformance to the specification (or any optional portion thereof). This is done by listing the conformance clauses here.

For the definition of "conformance clause," see [OASIS Defined Terms](https://www.oasis-open.org/policies-guidelines/oasis-defined-terms-2017-05-26#dConformanceClause).

See "Guidelines to Writing Conformance Clauses":   
<http://docs.oasis-open.org/templates/TCHandbook/ConformanceGuidelines.html>.

Remove this note before submitting for publication.)

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Participants:

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1. Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision** | **Date** | **Editor** | **Changes Made** |
| 01 | 04. Febr. 2019 | Michael Schulze | Initial specification |

1. Contrary to what the term Binding*Time* suggests, this is not a point in time, but rather a phase in the build process. [↑](#footnote-ref-1)
2. For simplicity and consistency, XML elements of type expression-type are always named expression or condition. [↑](#footnote-ref-2)
3. In this pattern, \s donates a white space, typically a space or tab character,or a newline. [↑](#footnote-ref-3)
4. The XML element data is not strictly necessary, but makes it easier to extend the key-value pair implementation in the future, if neccessary. [↑](#footnote-ref-4)
5. Of course, the document might still be rejected later for another reason, for example a data type mismatch. [↑](#footnote-ref-5)
6. Strictly speaking, would be a set of nodes and there is bijective mapping between and the set of elements of type variationpoint-type in the DOM of the Variability Exchange Language document. We use a simplified language for the sake of clarity here. [↑](#footnote-ref-6)