

DaVinci Configurator AutomationInterface

Development Documentation of the AutomationInterface (AI)

DaVinci Configurator Team

January 31, 2019

© 2019

Vector Informatik GmbH
Ingersheimerstr. 24
70499 Stuttgart

Contents

1	Introduction	11
1.1	General	11
1.2	Facts	11
2	Getting started with Script Development	12
2.1	General	12
2.2	Automation Script Development Types	12
2.3	Script File	12
2.4	Script Project	14
2.4.1	Script Project Development	16
2.4.2	Java JDK Setup	17
2.4.3	IntelliJ IDEA Setup	17
2.4.4	Gradle Setup	18
3	AutomationInterface Architecture	19
3.1	Components	19
3.2	Languages	20
3.2.1	Why Groovy	20
3.3	Script Structure	21
3.3.1	Scripts	21
3.3.2	Script Tasks	21
3.3.3	Script Locations	22
3.4	Script loading	22
3.4.1	Internal Script Reload Behavior	22
3.5	Script editing	23
3.6	Licensing	23
3.7	Script Coding Conventions and Constraints	23
3.7.1	Usage of static fields	24
3.7.2	Usage of Outer Closure Scope Variables	24
3.7.3	States over script task execution	25
3.7.4	Usage of Threads	25
3.7.5	Usage of DaVinci Configurator private Classes Methods or Fields	25
4	AutomationInterface API Reference	26
4.1	Introduction	26
4.2	Script Creation	27
4.2.1	Script Task Creation	27
4.2.1.1	Script Creation with IDE Code Completion Support	28
4.2.1.2	Script Task isExecutableIf	29
4.2.2	Description and Help	29
4.3	Script Task Types	31
4.3.1	Available Types	31
4.3.1.1	Application Types	31
4.3.1.2	Project Types	32
4.3.1.3	UI Types	33
4.3.1.4	Generation Types	33
4.3.1.5	Workflow Types	34

4.4	Script Task Execution	36
4.4.1	Execution Context	36
4.4.1.1	Code Block Arguments	37
4.4.2	Task Execution Sequence	37
4.4.3	Script Path API during Execution	38
4.4.3.1	Path Resolution by Parent Folder	39
4.4.3.2	Path Resolution	39
4.4.3.3	Script Folder Path Resolution	40
4.4.3.4	Project Folder Path Resolution	40
4.4.3.5	SIP Folder Path Resolution	41
4.4.3.6	Temp Folder Path Resolution	41
4.4.3.7	Other Project and Application Paths	42
4.4.4	Script logging API	42
4.4.5	User Interactions and Inputs	43
4.4.5.1	UserInteraction	43
4.4.5.2	Progress Indication	44
4.4.6	Script Error Handling	46
4.4.6.1	Script Exceptions	46
4.4.6.2	Script Task Abortion by Exception	46
4.4.6.3	Unhandled Exceptions from Tasks	47
4.4.7	User defined Classes and Methods	48
4.4.8	Usage of Automation API in own defined Classes and Methods	49
4.4.8.1	Access the Automation API like the Script code{} Block	49
4.4.8.2	Access the Project API of the current active Project	49
4.4.9	User defined Script Task Arguments	50
4.4.9.1	User defined Argument Validators	51
4.4.9.2	Call Script Task with Task Arguments from Commandline	53
4.4.10	Stateful Script Tasks	54
4.4.11	ScriptAccess - Calling ScriptTasks	56
4.5	Project Handling	57
4.5.1	Projects	57
4.5.2	Accessing the active Project	57
4.5.3	Accessing Project Settings	59
4.5.4	Creating a new Project	61
4.5.4.1	Mandatory Settings	62
4.5.4.2	General Settings	62
4.5.4.3	Target Settings	63
4.5.4.4	Post Build Settings	64
4.5.4.5	Folders Settings	64
4.5.4.6	DaVinci Developer Settings	66
4.5.4.7	vVIRTUALtarget Settings	67
4.5.5	Opening an existing Project	69
4.5.5.1	Parameterized Project Load	69
4.5.5.2	Open Project Details	70
4.5.6	Create Ecu Configuration Report	70
4.5.7	Saving a Project	72
4.5.8	Opening AUTOSAR Files as Project	73
4.5.8.1	Raw AUTOSAR models as Project	74
4.6	Model	75
4.6.1	Introduction	75
4.6.2	Getting Started	75

4.6.2.1	Read the ActiveEcuC	75
4.6.2.2	Write the ActiveEcuC	79
4.6.2.3	Read the SystemDescription	82
4.6.2.4	Write the SystemDescription	83
4.6.3	BswmdModel in AutomationInterface	85
4.6.3.1	BswmdModel Package and Class Names	85
4.6.3.2	Reading with BswmdModel	85
4.6.3.3	Writing with BswmdModel	86
4.6.3.4	Sip DefRefs	87
4.6.3.5	BswmdModel DefRefs	87
4.6.3.6	Untyped Model with the DefRef API	88
4.6.3.7	Switching from Domain Models to BswmdModel	89
4.6.4	MDF Model in AutomationInterface	90
4.6.4.1	Reading the MDF Model	90
4.6.4.2	Reading the MDF Model by String	92
4.6.4.3	Writing the MDF Model	94
4.6.4.4	Simple Property Changes	94
4.6.4.5	Creating single Child Members (0:1)	95
4.6.4.6	Creating and adding Child List Members (0:*)	95
4.6.4.7	Updating existing Elements	98
4.6.4.8	Deleting Model Objects	99
4.6.4.9	Duplicating Model Objects	99
4.6.4.10	Special properties and extensions	100
4.6.4.11	Reverse Reference Resolution - ReferencesPointingToMe	102
4.6.4.12	Derived Containers	102
4.6.4.13	AUTOSAR Root Object	103
4.6.4.14	ActiveEcuC	103
4.6.4.15	DefRef based Access to Containers and Parameters	104
4.6.4.16	EcuC Parameter and Reference Value Access	105
4.6.5	SystemDescription Access	107
4.6.6	Transactions	108
4.6.6.1	Transactions API	108
4.6.6.2	Operations	110
4.6.7	Model Synchronization	111
4.6.8	PreBuild and PostBuild Variance (Post-build selectable)	112
4.6.8.1	Investigate Project Variance	112
4.6.8.2	Variant Model Objects	113
4.6.9	Additional Model API	115
4.6.9.1	User Annotations	115
4.7	Generation	117
4.7.1	Code Generation	117
4.7.1.1	Generation Settings	117
4.7.1.2	Generation of Generation Steps	120
4.7.1.3	Evaluate generation or validation results	121
4.7.2	Generation Task Types	122
4.7.3	Software Component Templates and Contract Phase Headers Generation	124
4.7.3.1	Swct Generation Settings	124
4.7.3.2	Generation with default Project Settings	124
4.7.3.3	Generation of all Software Components	124
4.7.3.4	Generation of one Software Component	125
4.7.3.5	Generation of multiple Software Components	126

4.7.3.6	Evaluate generation results	126
4.8	Validation	127
4.8.1	Introduction	127
4.8.2	Access Validation-Results	127
4.8.3	Model Transaction and Validation-Result Invalidation	128
4.8.4	Solve Validation-Results with Solving-Actions	128
4.8.4.1	Solver API	129
4.8.5	Advanced Topics	131
4.8.5.1	Access Validation-Results of a Model Object	131
4.8.5.2	Access Validation-Results of a DefRef	131
4.8.5.3	Filter Validation-Results using an ID Constant	132
4.8.5.4	Identification of a Particular Solving-Action	132
4.8.5.5	Validation-Result Description as MixedText	133
4.8.5.6	Further IValidationResultUI Methods	133
4.8.5.7	IValidationResultUI in a variant (Post-Build selectable) Project	134
4.8.5.8	Erroneous CEs of a Validation-Result	134
4.8.5.9	Examine Solving-Action Execution	136
4.8.5.10	Create a Validation-Result in a Script Task	137
4.8.5.11	Turn off auto-solving-action execution	139
4.9	Update Workflow	140
4.9.1	Method Overview	140
4.9.2	Example: Content of Input Files has changed.	140
4.9.3	Example: List of Input Files shall be changed	141
4.9.4	Prerequisites	141
4.10	Domains	143
4.10.1	Communication Domain	143
4.10.1.1	CanControllers	145
4.10.1.2	CanFilterMasks	146
4.10.2	Diagnostics Domain	147
4.10.2.1	DemEvents	148
4.10.3	Mode Management Domain	150
4.10.3.1	BswM Auto Configuration	150
4.10.4	Runtime System Domain	153
4.10.4.1	Component Port Connection	153
4.10.4.2	Data Mapping	170
4.10.4.3	Create Component Prototypes	190
4.10.4.4	Bridge between MDF and model abstractions	193
4.10.4.5	Task Mapping	195
4.10.4.6	Create Delegation Ports	219
4.10.4.7	Retrieving short name paths and fully qualified names	224
4.10.4.8	Origin Context	226
4.11	Persistency	230
4.11.1	Model Export	230
4.11.1.1	Export ActiveEcuc	230
4.11.1.2	Export PostBuild Variants (Post-build selectable)	230
4.11.1.3	Export PreBuild Variants	231
4.11.1.4	Advanced Exports	231
4.11.2	Model Import	234
4.11.2.1	Module Configuration Import	234
4.11.2.2	Specify import mode and module filter	235
4.12	Utilities	236

4.12.1	Constraints	236
4.12.2	Converters	237
4.13	Advanced Topics	239
4.13.1	Java Development	239
4.13.1.1	Script Task Creation in Java Code	239
4.13.1.2	Java Code accessing Groovy API	239
4.13.1.3	Java Code in dvgroovy Scripts	240
4.13.2	Unit testing API	241
4.13.2.1	JUnit4 Integration	241
4.13.2.2	Execution of Spock Tests	242
4.13.2.3	Registration of Unit Tests in Scripts	242
4.13.2.4	Model TestInfrastructure	243
4.13.2.5	Automation Project TestInfrastructure	243
4.14	Generator Testing	244
4.14.1	White-box tests	244
4.14.1.1	Step-by-step	244
4.14.1.2	Compilation	244
4.14.1.3	GeneratorTestingApi	245
4.14.1.4	Test OuputFile Generation	246
4.14.1.5	Test GeneratorResults and ValidationResults	247
5	Data models in detail	249
5.1	MDF model - the raw AUTOSAR data	249
5.1.1	Naming	249
5.1.2	The models inheritance hierarchy	249
5.1.2.1	MIObjekt and MDFObjekt	250
5.1.3	The models containment tree	250
5.1.4	The ECUC model	252
5.1.5	Order of child objects	252
5.1.6	AUTOSAR references	252
5.1.7	Model changes	253
5.1.7.1	Transactions	253
5.1.7.2	Undo/redo	253
5.1.7.3	Event handling	253
5.1.7.4	Deleting model objects	253
5.1.7.5	Access to deleted objects	254
5.1.7.6	Set-methods	254
5.1.7.7	Changing child list content	254
5.1.7.8	Change restrictions	254
5.2	Post-build selectable	255
5.2.1	Model views	255
5.2.1.1	What model views are	255
5.2.1.2	The IModelViewManager project service	255
5.2.1.3	Variant siblings	257
5.2.1.4	The Invariant model views	258
5.2.1.5	Accessing invisible objects	260
5.2.1.6	IViewedModelObject	261
5.2.2	Variant specific model changes	261
5.2.3	Variant common model changes	262
5.3	BswmdModel details	263
5.3.1	BswmdModel - DefinitionModel	263
5.3.1.1	Types of DefinitionModels	264

5.3.1.2	DefRef Getter methods of Untyped Model	265
5.3.1.3	References	267
5.3.1.4	Post-build selectable with BswmdModel	268
5.3.1.5	Creation ModelView of the BswmdModel	269
5.3.1.6	Lazy Instantiating	270
5.3.1.7	Optional Elements	270
5.3.1.8	Class and Interface Structure of the BswmdModel	270
5.3.1.9	BswmdModel write access	271
5.3.2	BswmdModel generation	275
5.3.2.1	DerivativeMapping	275
5.4	Model Utility Classes	275
5.4.1	AutosarUtil	275
5.4.2	AsrPath	275
5.4.3	AsrObjectLink	276
5.4.3.1	Restrictions of object links	276
5.4.4	DefRefs	276
5.4.4.1	TypedDefRefs	278
5.4.4.2	DefRef Wildcards	278
5.4.5	CeState	279
5.4.5.1	Getting a CeState object	279
5.4.5.2	IParameterStatePublished	279
5.4.5.3	IContainerStatePublished	280
5.5	Model Services	281
5.5.1	EcucDefinitionAccess	281
5.5.1.1	Post-build loadable	282
5.5.1.2	Post-build selectable	284
5.5.2	EcuConfigurationAccess	285
5.5.2.1	Post-build loadable	286
5.5.2.2	Post-build selectable	288
6	AutomationInterface Content	291
6.1	Introduction	291
6.2	Folder Structure	291
6.3	Script Development Help	291
6.3.1	AutomationInterfaceDocumentation PDF	291
6.3.2	Javadoc HTML Pages	292
6.3.3	Script Templates	292
6.4	Libs and BuildLibs	292
7	Automation Script Project	293
7.1	Introduction	293
7.2	Automation Script Project Creation	293
7.3	Project File Content	293
7.4	Deployment of the Jar File	294
7.5	IntelliJ IDEA Usage	294
7.5.1	Supported versions	294
7.5.2	Building Projects	294
7.5.3	Debugging with IntelliJ	295
7.5.4	Troubleshooting	296
7.6	Project Usage in different DaVinci Configurator Versions	297
7.7	Project Migration to newer DaVinci Configurator Version / SIP	298
7.8	Debugging Script Project	298

7.9	Build System	299
7.9.1	Jar Creation and Output Location	299
7.9.2	Gradle File Structure	299
7.9.2.1	projectConfig.gradle File settings	299
7.9.3	Advanced Build Topics	300
7.9.3.1	Usage of external Libraries (Jars) in the AutomationProject	300
7.9.3.2	Update IntelliJ IDEA project	301
7.9.3.3	Static Compilation of Groovy Code	302
7.9.3.4	Gradle Maven publishing of an AutomationProject	303
7.9.3.5	Gradle dvCfgAutomation API Reference	303
8	AutomationInterface Changes between Versions	305
8.1	Currently Supported Features	305
8.2	Changes in MICROSAR AR4-R21 - Cfg5.18	308
8.2.1	General	308
8.2.2	Automation Script Project	308
8.2.2.1	Groovy	308
8.2.2.2	Supported IntelliJ IDEA Version	308
8.2.2.3	BuildSystem	308
8.2.3	Unit testing API	308
8.2.4	Model TestInfrastructure	309
8.2.5	Automation Project TestInfrastructure	309
8.2.6	Generator Testing	309
8.2.7	Workflow	309
8.2.8	Project Settings	309
8.2.9	Runtime System Domain	309
8.2.9.1	Component Port Connection	309
8.2.9.2	Task Mapping	309
8.2.9.3	Origin Component Port	310
8.2.9.4	Origin Context Selection	310
8.2.9.5	Component Port Selection	310
8.3	Changes in MICROSAR AR4-R20 - Cfg5.17	311
8.3.1	General	311
8.3.2	Automation Script Project	311
8.3.2.1	BuildSystem	311
8.3.2.2	Supported IntelliJ IDEA Version	311
8.3.3	Persistency	311
8.3.3.1	Model Module Import	311
8.3.3.2	Model Export	311
8.3.4	BswmdModel	312
8.3.4.1	SIP DefRefs	312
8.3.5	Runtime System Domain	312
8.3.5.1	Component Port Selection	312
8.3.5.2	Communication Element Selection	312
8.3.5.3	Create Delegation Ports	312
8.3.5.4	Task Mapping	312
8.3.5.5	Simple API for connection between ports	312
8.3.5.6	Simple API for data mapping	313
8.3.5.7	Port Terminators	313
8.3.5.8	Data Mapping	313
8.3.5.9	Service Proxy Components	313
8.3.5.10	Retrieve Short Name Paths and Fully Qualified Names	313

8.3.5.11	More Examples	313
8.4	Changes in MICROSAR AR4-R19 - Cfg5.16	314
8.4.1	General	314
8.4.2	Automation Script Project	314
8.4.2.1	Groovy	314
8.4.2.2	BuildSystem	314
8.4.2.3	Supported IntelliJ IDEA Version	314
8.4.3	ScriptAccess	314
8.4.4	UserInteraction - Progress Indication	314
8.4.5	Project Handling	315
8.4.6	Model Automation API	315
8.4.6.1	Derived Containers	315
8.4.6.2	Variance API	315
8.4.6.3	CE State	315
8.4.6.4	MDF Modification API	315
8.4.7	Persistency	315
8.4.7.1	Model Export	315
8.4.8	Generation	316
8.4.8.1	Generation Steps	316
8.4.9	Runtime System Domain	316
8.4.9.1	Component Port Selection	316
8.4.9.2	Signal Instance Selection	316
8.4.9.3	Bridge between mdf and model abstractions	316
8.4.9.4	Create Component Prototypes	316
8.4.9.5	Task Mapping	316
8.5	Changes in MICROSAR AR4-R18 - Cfg5.15	317
8.5.1	General	317
8.5.2	Automation Script Project	317
8.5.2.1	Supported IntelliJ IDEA Version	317
8.5.2.2	BuildSystem	317
8.5.3	Script Execution	317
8.5.3.1	User defined arguments	317
8.5.4	Project Handling	317
8.5.5	Project Creation vVIRTUALtarget settings	317
8.5.6	Model changes	318
8.5.7	Model Automation API	319
8.5.7.1	IVarianceApi	319
8.5.7.2	Access methods	319
8.5.7.3	Reverse Reference Resolution - ReferencesPointingToMe	319
8.5.7.4	Operations	319
8.5.7.5	User Annotations	319
8.5.7.6	Variance	319
8.5.7.7	Model Synchronization	319
8.5.8	Persistency	319
8.5.9	Workflow	320
8.5.10	Validation	320
8.5.10.1	Validation-Result Access Methods	320
8.5.11	Generation	320
8.5.11.1	SWC Templates and Contract Headers Generation	320
8.5.12	BswmdModel	320
8.5.12.1	BswmdModel Groovy	320

8.5.12.2	DerivativeMapping	321
8.5.13	Mode Management Domain	321
8.5.14	Runtime System Domain	321
8.5.14.1	Data Mapping	321
8.6	Changes in MICROSAR AR4-R17 - Cfg5.14	322
8.6.1	General	322
8.6.2	Script Execution	322
8.6.2.1	Stateful Script Tasks	322
8.6.3	Automation Script Project	322
8.6.3.1	Groovy	322
8.6.3.2	Supported IntelliJ IDEA Version	322
8.6.3.3	BuildSystem	322
8.6.4	Converter Refactoring	322
8.6.5	UserInteraction	322
8.6.6	Project Load	323
8.6.6.1	AUTOSAR Arxml Files	323
8.6.7	Model	323
8.6.7.1	Transactions	323
8.6.7.2	MDF Model Read and Write	323
8.6.7.3	SystemDescription Access	324
8.6.7.4	ActiveEcuc	324
8.6.8	Persistency	324
8.6.9	Generation	324
8.6.10	BswmdModel	324
8.6.10.1	Writing with BswmdModel	324
8.6.11	BswmdModel Groovy	324
8.6.12	Diagnostics Domain	325
8.6.13	Communication Domain	325
8.6.14	Runtime System Domain	325
8.7	Changes in MICROSAR AR4-R16 - Cfg5.13	326
8.7.1	General	326
8.7.2	API Stability	326
8.7.3	Beta Status	326
9	Appendix	327
	Nomenclature	328
	Figures	329
	Tables	330
	Listings	331
	ToDoS	338

1 Introduction

1.1 General

The user of the DaVinci Configurator Pro can create scripts, which will be executed inside of the Configurator to:

- Create projects
- Update projects
- Manipulate the data model with an access to the whole AUTOSAR model
- Generate code
- Executed repetitive tasks with code, without user interaction
- More

The scripts are written by the *user* with the DaVinci Configurator AutomationInterface.

1.2 Facts

Installation The DaVinci Configurator Pro can execute customer defined scripts out of the box. No additional scripting language installation is required by the customer.

Languages The scripts are written in Groovy or Java. See 3.2 on page 20 for details.

Debugging Support The scripts can be debugged via IntelliJ IDEA. See 7.8 on page 298.

Documentation The AutomationInterface provides a comprehensive documentation:

- This document
- Javadoc HTML pages as class reference
- Script samples and templates
 - ScriptProject creation assistant in the DaVinci Configurator
- API documentation inside of an IDE
- Integrated Definition (BSWMD) description for all modules in the SIP

Code Completion You have code completion for Groovy and Java for the DaVinci Configurator AutomationInterface. You have to use IntelliJ IDEA for code completion.¹

There is also a SIP based code completion for contained Module, Container and Parameter definitions. This eases the traversal through the AUTOSAR model.

¹See chapter 7 on page 293 for details.

2 Getting started with Script Development

2.1 General

This chapter gives a short introduction of how to get started with script file or script project creation.

Attention: You need at least one of the **License Options .WF or .MD** to develop scripts. The script project creation assistant will not be available otherwise. Please note that the execution of a script requires no specific license.

2.2 Automation Script Development Types

The DaVinci Configurator supports two types of automation scripts:

- Script files (**.dvgroovy** files)
- Script projects (**.jar** files)

Script File The script file provides the **simplest way** to implement an automation script. When the script gets bigger you should migrate to a script project.

To create a script file proceed with chapter 2.3.

Script Project The script project is **more effort** to create and maintain, but provides IDE support for:

- Code completion
- Syntax highlighting
- API Documentation
- Debug support
- Build support

It is the **recommended way to develop** scripts, containing more tasks or multiple classes.

To create a script project proceed with chapter 2.4 on page 14.

2.3 Script File

The script file is the simplest way to implement an automation script. It could be sufficient for small tasks and if the developer does not need support by the tool during implementing the script and if debugging is not required.

Prerequisites Before you start, please make sure that you have a **SIP** containing a DaVinci Configurator 5 available on your system.

Creation Inside your SIP you find examples of automation script files. Create your own script folder and copy an example, e.g. ...ScriptSamples/SimpleScript.dvgroovy to your folder.

Rename the script file and open it in any text editor. In case of SimpleScript.dvgroovy it consists of several tasks. One of the tasks will print a "HelloApplication" string to the console.

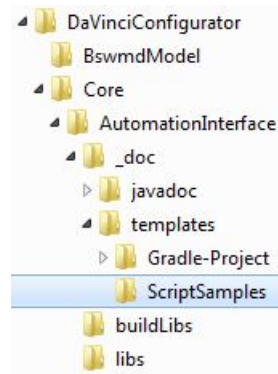


Figure 2.1: Script Samples location

Open the DaVinci Configurator inside your SIP. If not yet visible open the Views

- Script Locations
- Script Tasks

via the View menu.

In the **Script Locations** View select the location folder User@Machine. On its context menu you can **Add** a script location. Select your own script folder.

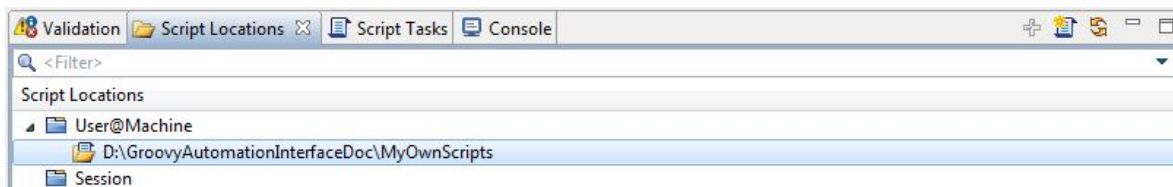


Figure 2.2: Script Locations View

Alternatively you could add the script location to the Session folder. In this case the script location would only be stored in the current session.

Switch to the **Script Tasks** View. It provides an overview over the tasks contained in your script.

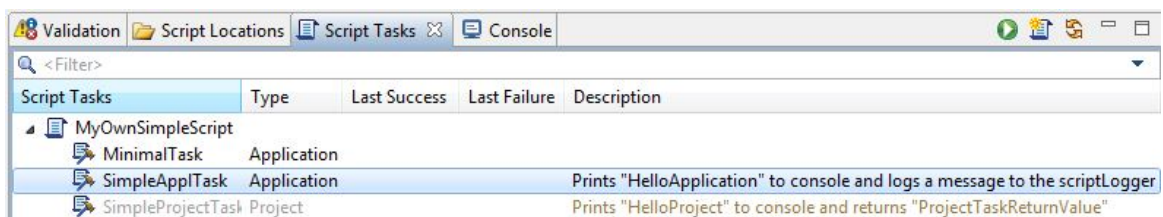


Figure 2.3: Script Tasks View

Execute the SimpleAppTask by double-click or by the Execute Command contained in its context menu or by the Execute Button of the Task View and check that "HelloApplication" is printed in the console.

You can modify the implementation according to your needs. For the AutomationInterface API Reference see chapter 4 on page 26. It is sufficient to edit and save the modifications in your editor. The file is automatically reloaded by the DaVinci Configurator then and can be executed immediately.

Debugging It is not possible to debug a script file, if you want to debug, please migrate to a script project, see chapter 2.4.

2.4 Script Project

The script project is the preferred way to develop an automation script, if the content is more than one simple task.

A script project is a normal IDE project (IntelliJ IDEA recommended), with compile bindings to the DaVinci Configurator AutomationInterface. It is also called "Automation Script Project" throughout this document.

The DaVinci Configurator will load a script project as a single `.jar` file. So the script project must be built and packaged into a `.jar` file before it can be executed by the DaVinci Configurator.

Prerequisites Before you start, **please make sure** that the following items are available on your system:

- **SIP** containing a DaVinci Configurator 5
- **Java JDK:** For the development with the IntelliJ IDEA a "Java SE Development Kit 8" (JDK 8) is required. Please install the JDK 8 as described in chapter 2.4.2 on page 17.
- **IDE:** For the script project development the *recommended* IDE is *IntelliJ IDEA*. Please install IntelliJ IDEA as described in chapter 2.4.3 on page 17.
- **Build system:** To build the script project the build system Gradle is required. See chapter 2.4.4 on page 18 for installation instructions.

Project Creation Open the DaVinci Configurator inside your SIP. If not yet visible open the following Views via the View menu:

- Script Locations
- Script Tasks

Switch to the View **Script Tasks** and select the Button **Create New Script Project....**



Figure 2.4: Create New Script Project... Button

Note: If the button is not available, please make sure you have least one of the **License Options .WF or .MD** to develop scripts.

The **New Automation Script Project** dialog is opened. Click *Next* because you are reading the document.

On the second page first you have to select a Script template on which the new project shall be based on. Please select **Default Automation Project** and click *Next*.

On the third page **Project Settings**, please specify the following items:

- **Script Project Name**
 - Define a name for your new project.
- **Project Location**
 - Select a parent folder in which your project shall be created in.
Note: A new folder with the project name is created in this folder.
- **Gradle Distribution URL**
 - Select one option:
 - * **Gradle Default**
 - This will download the required Gradle build system. To use this option you need **internet access**.
 - * **Custom URL**
 - Specify an URL to your own Gradle distribution.
New settings are displayed to specify the path. To setup your own Gradle build system see 2.4.4 on page 18.
- **Open IntelliJ IDEA**
 - Select this option if the project shall automatically be opened in IntelliJ IDEA after creation. In case IntelliJ IDEA is not installed on your system a warning will be issued.

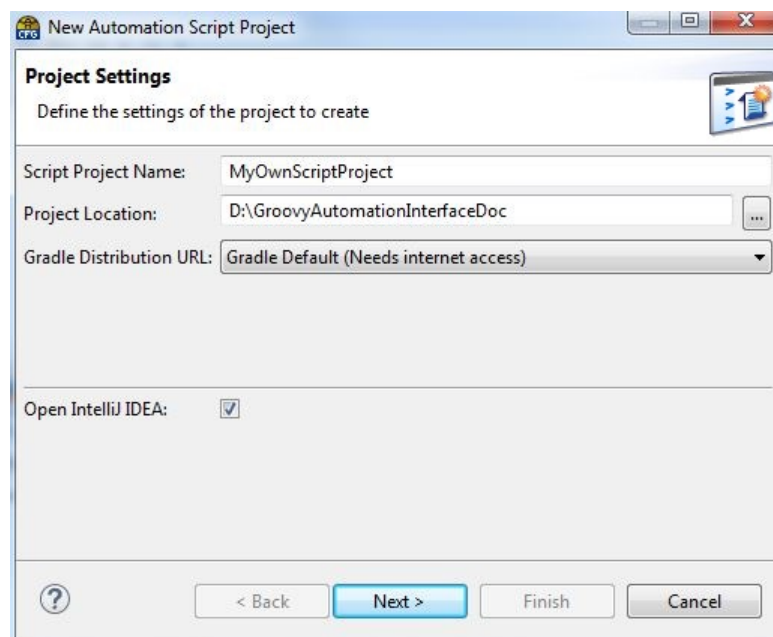


Figure 2.5: Project Settings

Proceed until the dialog is finished.

A new project will be created. Necessary tasks as setting up the IntelliJ IDEA and building the project are automatically initiated. At the end IntelliJ IDEA will be started with the created project.

You can now modify the implementation according to your needs. For the AutomationInterface API Reference see chapter 4 on page 26. To edit and rebuild the project use IntelliJ IDEA.

After each build the project is automatically reloaded by the DaVinci Configurator and can be executed there.

IntelliJ IDEA Usage Ensure that the Gradle JVM and the Project SDK are set in the IntelliJ IDEA Settings. For details see 2.4.3 on the following page.

Having modified and saved `MyScript.groovy` in the IntelliJ IDEA editor you can build the project by pressing the **Run Button provided in the toolbar**. The functionality of this Run Button is determined by the option selected in the Menu beneath this button. In this menu `<ProjectName> [build]` shall be selected.

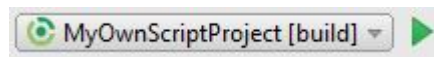


Figure 2.6: Project Build

For more information to IntelliJ IDEA usage please see chapter 7.5 on page 294. If you have trouble with IntelliJ, see 7.5.4 on page 296.

Debugging To debug the script project follow the instructions in chapter 7.8 on page 298.

DaVinci Configurator views The View **Script Tasks** provides an overview over the scripts and tasks contained in the project. The newly created project already contains a sample script file `MyScript.groovy`.

The **Default Automation Project** sample script file contains one task that prints a "Hello-Application" string to the console. Run and check it as already described in 2.3 on page 12. If you have selected a different Script Sample the `MyScript.groovy` will contain the sample code.

The View **Script Locations** contains the path to the script project build folder containing the built `.jar` file.

Jar Location The Jar location of the built script project is `<ProjectDir>/build/libs`. Gradle will automatically create the directories during the build and will generate the built `.jar` file.

2.4.1 Script Project Development

For more details to the development of a script project see chapter 7 on page 293.

2.4.2 Java JDK Setup

Install a JDK 8 on your system. The Java JDK website provides download versions for different systems. Download an appropriate version.

The architecture is not relevant, both x86 and x64 are valid.

The JDK is needed for the Java Compiler for IntelliJ IDEA and Gradle.

2.4.3 IntelliJ IDEA Setup

Install IntelliJ IDEA on your system. The IntelliJ IDEA website provides download versions for different applications. Download¹ a version that supports Java and Groovy and that is in the list of supported versions (see list 7.5.1 on page 294).

Code completion and compilation additionally require that the Project SDK is set. Therefore open the File -> **Project Structure** Dialog in IntelliJ IDEA and switch to the settings dialog for **Project**. If not already available set an appropriate option for the **Project SDK**. Please set the value to a valid Java JDK (see 2.4.2). **Do not** select a JRE.

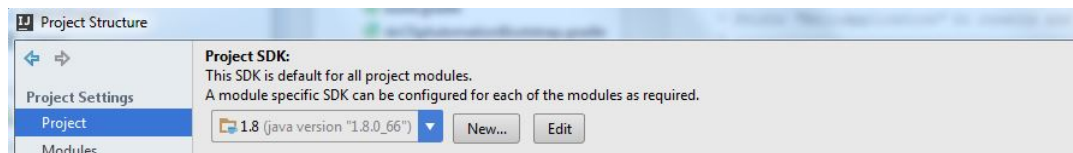


Figure 2.7: Project SDK Setting

To enable building of projects ensure that the Gradle JVM is set. Therefore open the File -> **Settings** Dialog in IntelliJ IDEA and find the settings dialog for **Gradle**. If not already available set an appropriate option for the **Gradle JVM**. Please set the value to the same Java JDK as the Project SDK above. **Do not** select a JRE.

If you do not have the Gradle settings, please make sure that the Gradle plugin inside of IntelliJ IDEA is installed. Open the File -> **Settings** Dialog then Plugins and select the Gradle plugin.

¹ Vector-Internal: If you are inside of the Vector intranet, you could download it from:
`file:///vistrpesfs1/project2/DaVinci/Eclipse/Platform/CFG5/BuildComponents/IntelliJ`

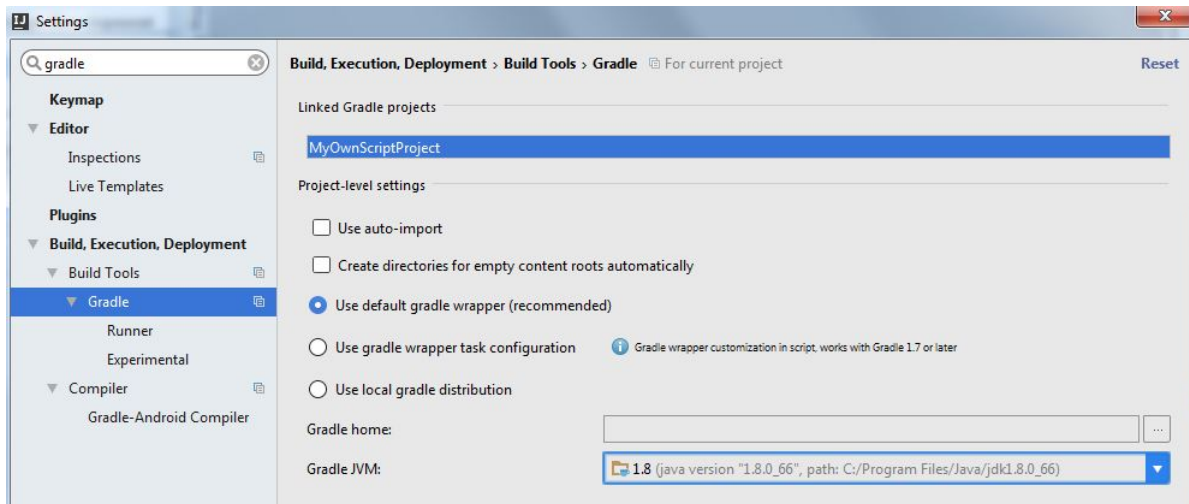


Figure 2.8: Gradle JVM Setting

2.4.4 Gradle Setup

If your system has internet access you can use the default Gradle Build System provided by the DaVinci Configurator. In this case you **do not** have to install Gradle. If you are a Vector internal user you could also **skip** the Gradle installation.

If you want to use your own Gradle Build System install it on your system. The Gradle website provides the required download version for the Gradle Build System. Please **download the version 4.0.1**. See chapter 7.9 on page 299 for more details to the Build System.

3 AutomationInterface Architecture

3.1 Components

The DaVinci Configurator consists of three components:

- Core components
- AutomationInterface (AI) - also called Automation API
- Scripting engine

The other part is the script provided by the user.

The Scripting engine will load the script, and the script uses the AutomationInterface to perform tasks. The AutomationInterface will translate the requests from the script into Core components calls.

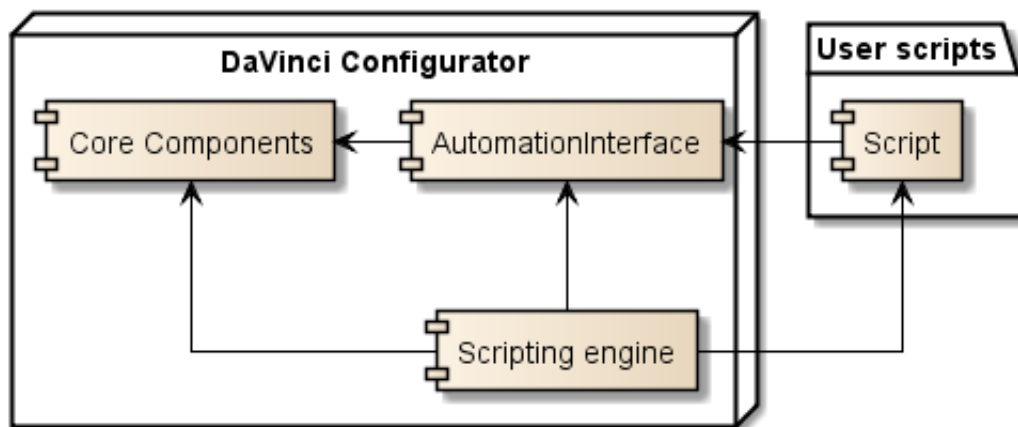


Figure 3.1: DaVinci Configurator components and interaction with scripts

The separation of the AutomationInterface and the Core components has multiple benefits:

- Stable API for script writers
 - Including checks, that the API will not break in following releases
- Well defined and documented API
- Abstraction from the internal heavy lifting
 - This ease the usage for the user, because the automation interfaces are tailored to the use cases.

PublishedApi All AutomationInterface classes are marked with a special annotation to **highlight** the fact that it is part of the published API. The annotation is called `@PublishedApi`.

So every class marked with `@PublishedApi` can be used by the client code. But if a class is **not** marked with `@PublishedApi` or is marked with `@Deprecated` it should not be used by any client code, nor shall a client call methods via reflection or other runtime techniques.

You should **not** access DaVinci Configurator private or package private classes, methods or fields.

3.2 Languages

The DaVinci Configurator provides out of the box language support for:

- Java¹
- Groovy²

The recommended scripting language is **Groovy** which shall be preferred by all users.

3.2.1 Why Groovy

Flat Learning Curve Groovy is concise, readable with an expressive syntax and is easy to learn for Java developers³.

- Groovy syntax is 95%-compatible with Java⁴
- Any Java developer will be able to code in Groovy without having to know nor understand the subtleties of this language

This is very important for teams where there's not much time for learning a new language.

Domain-Specific Languages (DSL) Groovy has a flexible and malleable syntax, advanced integration and customization mechanisms, to integrate readable business rules in your applications.

The DSL features of Groovy are extensively used in DaVinci Automation API to provide simple and expressive syntax.

Powerful Features The Groovy language supports Closures, builders, runtime & compile-time meta-programming, functional programming, type inference, and static compilation.

Website The website of Groovy is <http://groovy-lang.org>. It provides a good documentation and starting guides for the Groovy language.

Groovy Book The book "**Groovy in Action, Second Edition**"⁵ provides a comprehensive guide to Groovy programming language. It is written by the developers of Groovy.

¹<http://http://www.java.com> [2016-05-09]

²<http://groovy-lang.org> [2016-05-09]

³Copied from <http://groovy-lang.org> [2016-05-09]

⁴Copied from http://melix.github.io/blog/2010/07/27/experience_feedback_on_groovy.html [2016-05-09]

⁵Groovy in Action, Second Edition by Dierk König, Paul King, Guillaume Laforge, Hamlet D'Arcy, Cédric Champeau, Erik Pragt, and Jon Skeet June 2015 ISBN 9781935182443
<https://www.manning.com/books/groovy-in-action-second-edition> [2016-05-09]

3.3 Script Structure

A script always contains one or more script tasks. A script is represented by an instance of `IScript`, the contained tasks are instances of `IScriptTask`.

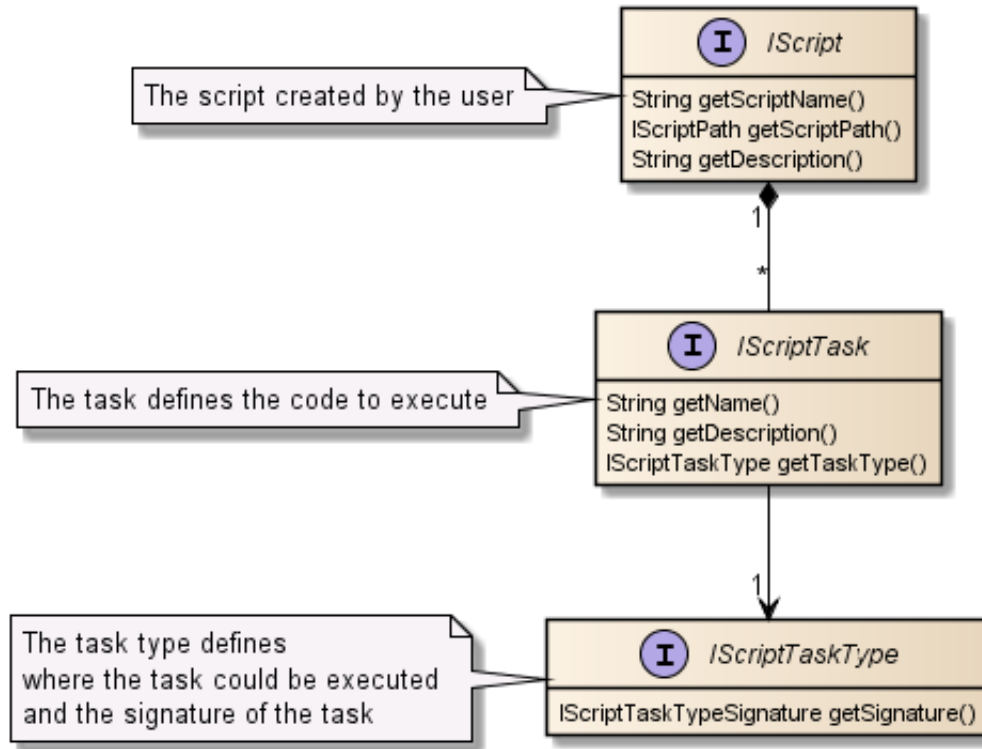


Figure 3.2: Structure of scripts and script tasks

You create the `IScript` and `IScriptTask` instance with the API described in chapter 4.2 on page 27.

The script task type (`IScriptTaskType`) defines where the task could be executed. It also defines the signature of the task's `code {}` block. See chapter 4.3 on page 31 for the available script task types.

3.3.1 Scripts

Script contain the tasks to execute and are loaded from the script locations specified in the DaVinci Configurator.

The DaVinci Configurator supports two types of automation scripts:

- Script files (`.dvgroovy` files)
- Script projects (`.jar` files)

For details to the script project, see chapter 7 on page 293.

3.3.2 Script Tasks

Script tasks are the executable units of scripts, which are executed at certain points in the DaVinci Configurator (specified by the `IScriptTaskType`). Every script task has a `code {}`

block, which contains the logic to execute.

3.3.3 Script Locations

Script locations define where script files are loaded from. These locations are edited in the DaVinci Configurator Script Locations view. You can also start the Configurator with the option `-scriptLocations` to specify additional locations.

The DaVinci Configurator could load scripts from different script locations:

- SIP
- Project
- User-defined directories
- More

3.4 Script loading

All scripts contained in the script locations are automatically loaded by the DaVinci Configurator. If new scripts are added to script locations these scripts are automatically loaded.

If a script changes during runtime of the DaVinci Configurator the whole script is reloaded and then executable, without a restart of the tool or a reload of the project.

This enables script development during the runtime of the DaVinci Configurator

- No project reload
- No tool restart
- Faster feedback loops

Note: A jar file of a script project *should be updated by the Gradle build system*, not by hand. Because the Java VM is holding a lock to the file. If you try to replace the file in the explorer you will get an error message.

3.4.1 Internal Script Reload Behavior

Your script can be loaded and unloaded automatically multiple times during the execution of the DaVinci Configurator. More precise, when a script is currently not used and there are memory constraints your script will be automatically unloaded.

If the script will be executed again, it is automatically reloaded and then executed. So it is possible that the script initialization code is called multiple times in the DaVinci Configurator lifecycle. But this is no issue, because the script and the tasks **shall not** have any internal state during initialization.

Memory Leak Prevention The feature above is implemented to prevent leaking memory from an automation script into the DaVinci Configurator memory. So when the memory run low, all unused scripts are unloaded, which will also free leaked memory of scripts.

But this **does not** mean that is impossible to construct memory leaks from an automation script. E.g. Open file handles without closing them will still cause a memory leak.

3.5 Script editing

The DaVinci Configurator does not contain any editing support for scripts, like:

- Script editor
- Debugger
- REPL (Read-Eval-Print-Loop)

These tasks are delegated to other development tools:

- IntelliJ IDEA (recommended)
- EclipseIDE
- Notepad++

See chapter 7 on page 293 for script development and debugging with IntelliJ IDEA.

3.6 Licensing

The DaVinci Configurator requires certain license options to develop and/or execute script tasks.

You need specific combinations of DaVinci Configurator licenses and options to develop and execute scripts.

For typical automation script tasks you need following licenses:

- Product license CFG PRO required for execution of script tasks
- Additional option .WF required for development and debugging

For generation script tasks for example you need a different license combination.

See chapter 4.3 on page 31 for details, which script task type requires which license.

Some script task may require different licenses or options during development or execution. It is also possible that the execution does not require any license at all. Normally you need more license options to develop scripts than you need to execute them.

3.7 Script Coding Conventions and Constraints

This section describes conventions, which you are advised to apply.

Requirement Levels - Wording

- Shall: This word, or the terms "Mandatory", "Required" or "Must", mean that the rule or convention is an absolute requirement.
- Shall not: This word, or the terms "Must not" mean that the rule or convention is an absolute prohibition.
- 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.

See also "RFC 2119: Key words for use in RFCs to Indicate Requirement Levels"⁶.

3.7.1 Usage of static fields

You **shall not** use any static fields in your script code or other written classes inside of your project. Except **static final** constants of simple immutable types like (normally compile time constants):

- int
- boolean
- double
- String
- ...

Static fields will cause memory leaks, because the fields are not garbage collected. Example:

```
scriptTask("Name"){
    code{
        MyClass.leakVariable.add("Leaked Memory")
    }
}

class MyClass{
    static List leakVariable = []
}
```

Listing 3.1: Static field memory leak

The use of static fields of the AutomationInterface is allowed.

3.7.2 Usage of Outer Closure Scope Variables

The same static field rule applies to variables passed from outer **Closure** scopes into a script task **code{}** block. You **shall not** cache/save data into such variables.

Example:

⁶<https://www.ietf.org/rfc/rfc2119.txt>


```
scriptTask("Name"){  
  def invalidVariable = [] //List  
  
  code{  
    invalidVariable.add("Leaked Memory")  
  }  
}
```

Listing 3.2: Memory leak with closure variable

3.7.3 States over script task execution

You **shall not** hold or save any states over multiple script task executions in your classes.

The script task should be state less. All states are provided by the Automation API or the data models.

If you need to cache data over multiple executions, see chapter 4.4.10 on page 54 for a solution.

3.7.4 Usage of Threads

A script task **shall not** create any `Thread`, `Executor`, `ThreadPool` or `ForkJoinPool` instances. If multithreading is required, the Automation API provides the corresponding methods.

A different thread will not provide any Automation APIs and will cause `IllegalStateExceptions`.

3.7.5 Usage of DaVinci Configurator private Classes Methods or Fields

A script task **should not** call or rely on any non published API or private (also package private) classes, methods or fields. You also should not use any reflection techniques to reflect about Configurator internal APIs. Otherwise it is not guaranteed that your script will work with other DaVinci Configurator versions. See 3.1 on page 19 for details about `PublishedApi`.

But it is valid to use reflection for your own script code.

4 AutomationInterface API Reference

4.1 Introduction

This chapter contains the description of the DaVinci Configurator AutomationInterface. The figure 4.1 shows the APIs and the containment structure of the different APIs.

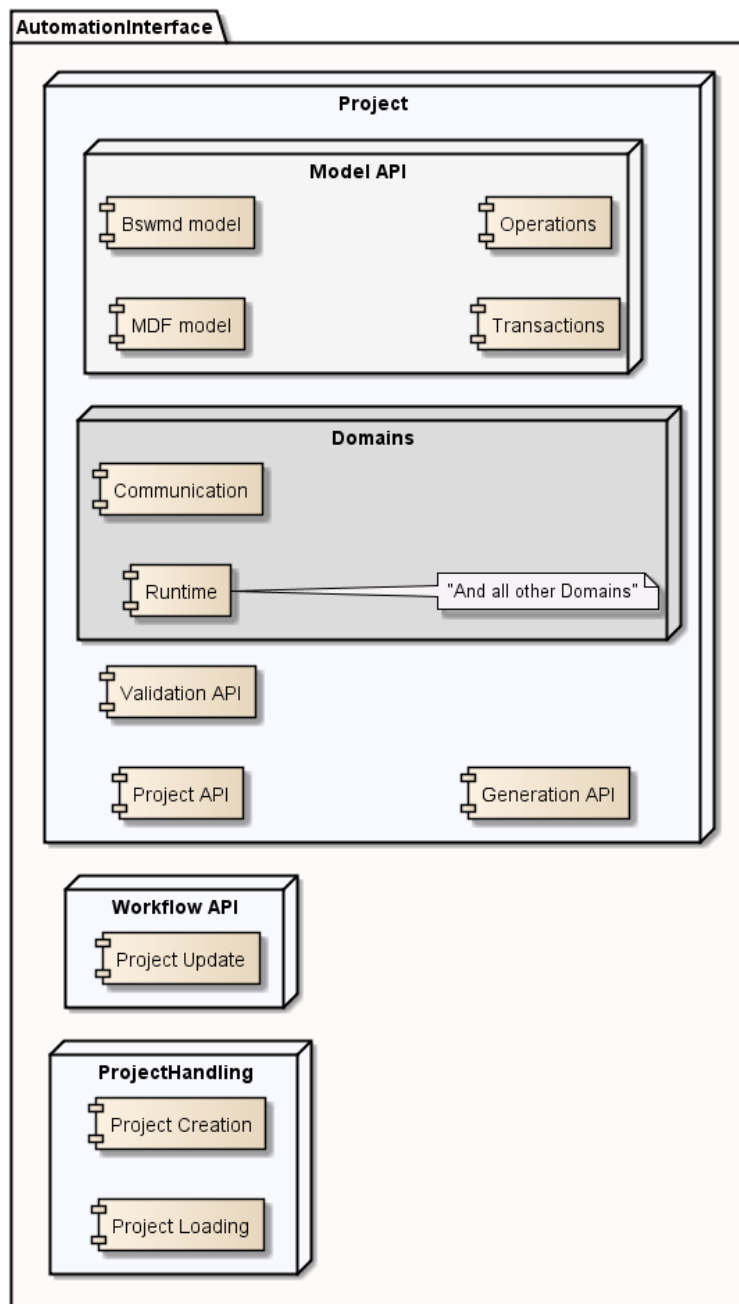


Figure 4.1: The API overview and containment structure

The components have an hierarchical order, where and when the components are usable. When a component is contained in another the component is only usable, when the other is active.

Usage examples:

- The Generation API is only usable inside of a loaded Project
- The Project creation API is only usable outside of a loaded Project

4.2 Script Creation

This section lists the APIs to create, execute and query information for script tasks. The sections document the following aspects:

- Script task creation
- Description and help texts
- Task executable query

4.2.1 Script Task Creation

To create a script task you have to call one of the `scriptTask()` methods. The last parameter of the `scriptTask` methods can be used to set additional options of the task. Every script task needs one `IScriptTaskType`. See chapter 4.3 on page 31 for all available task types.

The `code{ }` block is **required** for every `IScriptTask`. The block contains the code, which is executed when the task is executed.

Script Task with default Type The method `scriptTask()` will create an script task for the default `IScriptTaskType` `DV_PROJECT`.

```
scriptTask("TaskName"){  
    code{  
        // Task execution code here  
    }  
}
```

Listing 4.1: Task creation with default type

Script Task with Task Type You could also define the used `IScriptTaskType` at the `scriptTask()` methods.

The methods

- `scriptTask(String, IApplicationScriptTaskType, Closure)`
- `scriptTask(String, IProjectScriptTaskType, Closure)`

will create an script task for passed `IScriptTaskType`. The two methods differentiate, if a project is required or not. See chapter for all available task types 4.3 on page 31

```
scriptTask("TaskName", DV_APPLICATION){
    code{
        // Task execution code here
    }
}
```

Listing 4.2: Task creation with TaskType Application

```
scriptTask("TaskName", DV_PROJECT){
    code{
        // Task execution code here
    }
}
```

Listing 4.3: Task creation with TaskType Project

Multiple Tasks in one Script It is also possible to define multiple tasks in one script.

```
scriptTask("TaskName"){
    code{ }
}

scriptTask("SecondTask"){
    code{ }
}
```

Listing 4.4: Define two tasks in one script

4.2.1.1 Script Creation with IDE Code Completion Support

The IDE could not know which API is available inside of a script file. So a glue code is needed to tell the IDE, what API is callable inside of a script file.

The `ScriptApi.daVinci()` method enables the IDE code completion support in a script file. You have to write the `daVinci{ }` block and inside of the block the code completion is available. The following sample shows the glue code for the IDE:

```
import static com.vector.cfg.automation.api.ScriptApi.*

//daVinci enables the IDE code completion support
daVinci{

    // Normal script code here
    scriptTask("TaskName"){
        code{
            // Script task execution code here
        }
    }
}
```

Listing 4.5: Script creation with IDE support

The `daVinci{ }` block is only required for code completion support in the IDE. It has no effect during runtime, so the `daVinci{ }` is optional in script files (`.dvgroovy`)

4.2.1.2 Script Task isExecutableIf

You can set an `isExecutableIf` handler, which is called before the `IScriptTask` is executed. The code can evaluate, if the `IScriptTask` shall be executable. If the handler returns `true`, the code of the `IScriptTask` is executable, otherwise `false`. See class `IExecutableTaskEvaluator` for details.

The `Closure isExecutable` has to return a `boolean`. The passed arguments to the closure are the same as the `code{ }` block arguments.

Inside of the `Closure` a property `notExecutableReasons` is available to set reasons why it is not executable. It is highly recommended to set reasons, when the `Closure` returns `false`.

```
scriptTask("TaskName"){  
  
    isExecutableIf{ taskArgument ->  
        // Decide, if the task shall be executable  
        if(taskArgument == "CorrectArgument"){  
            return true  
        }  
        notExecutableReasons.addReason "The argument is not 'CorrectArgument'"  
        return false  
    }  
  
    code{ taskArgument ->  
        // Task execution code here  
    }  
}
```

Listing 4.6: Task with `isExecutableIf`

4.2.2 Description and Help

Script Description The script can have an optional description text. The description shall list what this script contains. The method `scriptDescription(String)` sets the description of the script.

The description shall be a short overview. The `String` can be multiline.

```
// You can set a description for the whole script  
scriptDescription "The Script has a description"  
  
scriptTask("Task"){  
    code{  
    }  
}
```

Listing 4.7: Script with description

Task Description A script task can have an optional description text. The description shall help the user of the script task to understand what the task does. The method `taskDescription(String)` sets the description of the script task.

The description shall be a short overview. The `String` can be multiline.

```
scriptTask("TaskName"){  
    taskDescription "The description of the task"  
  
    code{ }  
}
```

Listing 4.8: Task with description

Task Help A script task can also have an optional help text. The help text shall describe in detail what the task does and when it could be executed. The method `taskHelp(String)` sets the help of the script task.

The help shall be elaborate text about what the task does and how to use it. The `String` can be multiline.

The help text is automatically expanded with the help for user defined script task arguments, see `IScriptTaskBuilder.newUserDefinedArgument(String, Class, String)`.

```
scriptTask("TaskName"){  
    taskDescription "The short description of the task"  
    taskHelp """  
        The long help text  
        of the script with multiple lines  
  
        And paragraphs ...  
        """.stripIndent()  
    // stripIndent() will strip the indentation of multiline strings  
    // The three "" are needed, if you want to write a multiline string  
  
    code{ }  
}
```

Listing 4.9: Task with description and help text

4.3 Script Task Types

The `IScriptTaskType` instances define where a script task is executed in the DaVinci Configurator. The types also define the arguments passed to the script task execution and what return type an execution has.

Every script task needs an `IScriptTaskType`. The type is set during creation of the script tasks.

License Options For the common explanation of the required license options, see chapter 3.6 on page 23.

Interfaces All task types implement the interface `IScriptTaskType`. The following figure show the type and the defined sub types:

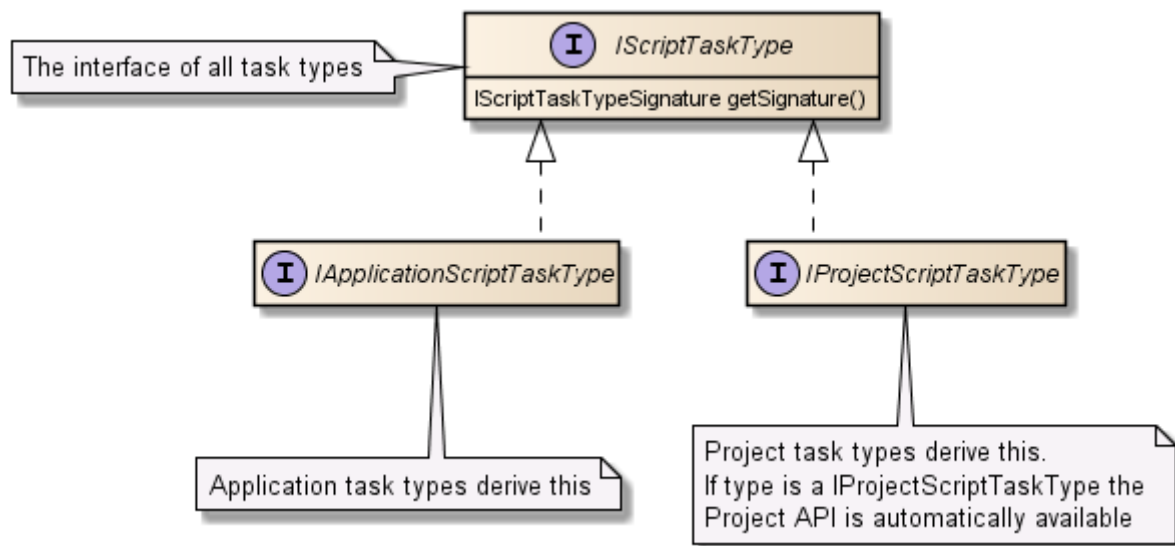


Figure 4.2: `IScriptTaskType` interfaces

4.3.1 Available Types

The class `IScriptTaskTypeApi` defines all available `IScriptTaskTypes` in the DaVinci Configurator. All task types start with the prefix `DV_`.

`None` at parameters and return types mean, that any arguments could be passed and return to or from the task. Normally it will be nothing. The arguments are used, when the task is called in unit tests for example.

4.3.1.1 Application Types

Application The type `DV_APPLICATION` is for application wide script tasks. A task could create/open/close/update projects. Use this type, if you need full control over the project handling, or you want to handle multiple project at once.

Name	Application
Code identifier	DV_APPLICATION
Task type interface	IApplicationScriptTaskType
Parameters	None
Return type	None
Execution	Standalone
Required license	Development: .WF Execution: CFG PRO

4.3.1.2 Project Types

Project The type `DV_PROJECT` is for project script tasks. A task could access the currently loaded project. Manipulate the data, generate and save the project. This is the default type, if no other type is specified.

Name	Project
Code identifier	DV_PROJECT
Task type interface	IProjectScriptTaskType
Parameters	None
Return type	None
Execution	Standalone
Required license	Development: .WF Execution: CFG PRO

Module activation The type `DV_ON_MODULE_ACTIVATION` allows the script to hook any Module Activation in a loaded project. Every `DV_ON_MODULE_ACTIVATION` task is automatically executed, when an "Activate Module" operation is executed. The script task is called after the module was created.

Name	Module activation
Code identifier	DV_ON_MODULE_ACTIVATION
Task type interface	IProjectScriptTaskType
Parameters	MIModuleConfiguration moduleConfiguration
Return type	Void
Execution	Automatically during module activation
Required license	Development: .WF Execution: CFG PRO

Module deactivation The type `DV_ON_MODULE_DEACTIVATION` allows the script to hook any Module Deactivation in a loaded project. Every `DV_ON_MODULE_DEACTIVATION` task is automatically executed, when an "Deactivate Module" operation is executed. The script task is called before the module is deleted.

Name	Module deactivation
Code identifier	DV_ON_MODULE_DEACTIVATION
Task type interface	IProjectScriptTaskType
Parameters	MIModuleConfiguration moduleConfiguration
Return type	Void
Execution	Automatically during module deactivation
Required license	Development: .WF Execution: CFG PRO

4.3.1.3 UI Types

Editor selection The type **DV_EDITOR_SELECTION** allows the script task to access the currently selected element of an editor. The task is executed in context of the selection and is not callable by the user without an active selection.

Name	Editor selection
Code identifier	DV_EDITOR_SELECTION
Task type interface	IProjectScriptTaskType
Parameters	MIObject selectedElement
Return type	Void
Execution	In context menu of an editor selection
Required license	Development: .WF Execution: CFG PRO

Editor multiple selections The type **DV_EDITOR_MULTI_SELECTION** allows the script task to access the currently selected elements of an editor. The task is executed in context of the selection and is not callable by the user without an active selection. The type is also usable when the DV_EDITOR_SELECTION apply.

Name	Editor multiple selections
Code identifier	DV_EDITOR_MULTI_SELECTION
Task type interface	IProjectScriptTaskType
Parameters	List<MIObject> selectedElements
Return type	Void
Execution	In context menu of an editor selection
Required license	Development: .WF Execution: CFG PRO

4.3.1.4 Generation Types

Generation Step The type **DV_GENERATION_STEP** defines that the script task is executable as a GenerationStep during generation. The user has to explicitly create an GenerationStep in the Project Settings Editor, which references the script task.

Name	Generation Step
Code identifier	DV_GENERATION_STEP
Task type interface	IProjectScriptTaskType
Parameters	EGenerationPhaseType phase
	EGenerationProcessType processType
	IValidationResultSink resultSink
Return type	Void
Execution	Selected as GenerationStep in GenerationProcess
Required license	Development: .MD Execution: none

See chapter 4.7.2 on page 122 for usage samples.

Custom Workflow Step The type **DV_CUSTOM_WORKFLOW_STEP** defines that the script task is executable as a CustomWorkflow step in the CustomWorkflow process. The user has to explicitly create an CustomWorkflow step in the Project Settings Editor, which references the script task.

Name	Custom Workflow Step
Code identifier	DV_CUSTOM_WORKFLOW_STEP
Task type interface	IProjectScriptTaskType
Parameters	None
Return type	Void
Execution	Selected as Custom Workflow Step in the Project Settings
Required license	Development: .WF Execution: CFG PRO

See chapter 4.7.2 on page 122 for usage samples.

Generation Process Start The type `DV_ON_GENERATION_START` defines that the script task is automatically executed when the generation is started.

Name	Generation Process Start
Task type interface	IProjectScriptTaskType
Code identifier	DV_ON_GENERATION_START
Parameters	List<EGenerationPhaseType> generationPhases List<IGenerator> executedGenerators
Return type	Void
Execution	Automatically before GenerationProcess
Required license	Development: .MD Execution: none

See chapter 4.7.2 on page 122 for usage samples.

Generation Process End The type `DV_ON_GENERATION_END` defines that the script task is automatically executed when the generation has finished.

Name	Generation Process End
Code identifier	DV_ON_GENERATION_END
Task type interface	IProjectScriptTaskType
Parameters	EGenerationProcessResult processResult List<IGenerator> executedGenerators
Return type	Void
Execution	Automatically after GenerationProcess
Required license	Development: .MD Execution: none

See chapter 4.7.2 on page 122 for usage samples.

4.3.1.5 Workflow Types

Successful update workflow The type `DV_ON_SUCCESSFUL_UPDATE_WORKFLOW` allows the script to access the loaded project during workflow after a successful update. Every `DV_ON_SUCCESSFUL_UPDATE_WORKFLOW` task is automatically executed, when the update has finished.

Name	On successful update workflow
Code identifier	DV_ON_SUCCESSFUL_UPDATE_WORKFLOW
Task type interface	IProjectScriptTaskType
Return type	Void
Execution	Automatically after successful update workflow
Required license	Development: .WF Execution: CFG PRO

Result file of the FilePreProcessing The type `DV_ON_FILE_PREPROCESSING_RESULT` allows the script to modify the result file created in the update workflow by the FilePreProcessing. Every `DV_ON_FILE_PREPROCESSING_RESULT` task is automatically executed, within the update workflow in the `PrepareSystemExtractActivity`. Scripts with this `ScriptTaskType` have only access to the `SystemExtract` model.

Name	On FilePreProcessing result
Code identifier	<code>DV_ON_FILE_PREPROCESSING_RESULT</code>
Task type interface	<code>IProjectScriptTaskType</code>
Parameters	None
Return type	<code>Void</code>
Execution	Automatically within the update workflow.
Required license	Development: .WF Execution: CFG PRO

FilePreProcessing input file The type `DV_ON_FILE_PREPROCESSING_INPUT_FILE` allows the script to modify every Autosar input file (.arxml) which is used in the update workflow except of `ProjectStandardConfiguration` files. Every `DV_ON_FILE_PREPROCESSING_INPUT_FILE` task is automatically executed, within the FilePreProcessing. Scripts with this `ScriptTaskType` will be executed for all Autosar input files and have only access to the model.

Name	On Autosar input file
Code identifier	<code>DV_ON_FILE_PREPROCESSING_INPUT_FILE</code>
Task type interface	<code>IProjectScriptTaskType</code>
Parameters	None
Return type	<code>Void</code>
Execution	Automatically within the FilePreProcessing of the update workflow.
Required license	Development: .WF Execution: CFG PRO

4.4 Script Task Execution

This section lists the APIs to execute and query information for script tasks. The sections document the following aspects:

- Script task execution
- Logging API
- Path resolution
- Error handling
- User defined classes and methods
- User defined script task arguments

4.4.1 Execution Context

Every `IScriptTask` could be executed, and retrieve passed arguments and other context information. This execution information of a script task is tracked by the `IScriptExecutionContext`.

The `IScriptExecutionContext` holds the context of the execution:

- The script task arguments
- The current running script task
- The current active script logger
- The active project, if existing
- The script temp folder
- The script task user defined arguments

The `IScriptExecutionContext` is also the entry point into every automation API, and provide access to the different API classes. The classes are describes in their own chapters like `IProjectHandlingApiEntryPoint` or `IWorkflowApiEntryPoint`.

The context is immediately active, when the code block of an `IScriptTask` is called.

Groovy Code The client sample illustrates the seamless usage of the `IScriptExecutionContext` class in Groovy:

```
scriptTask("taskName", DV_APPLICATION){
    code{ // The IScriptExecutionContext is automatically active here
        // Call methods of the IScriptExecutionContext
        def logger = scriptLogger
        def temp = paths.tempFolder

        // Use an automation API
        workflow{
            // Now the Workflow API is active
        }
    }
}
```

Listing 4.10: Access automation API in Groovy clients by the `IScriptExecutionContext`

In Groovy the `IScriptExecutionContext` is automatically activated inside of the `code{}` block.

Java Code For java clients the method `IScriptExecutionContext.getInstance(Class)` provides access to the API classes, which are seamlessly available for the groovy clients:

```
// Java code
// Passed from the script task:
IScriptExecutionContext scriptContext = ...;

// Retrieve automation API in Java
IWorkflowApi workflow = scriptContext.getInstance(IWorkflowApiEntryPoint.class)
    .getWorkflow();
IWorkflowContext workflowCtx = workflow.getWorkflow();

// In groovy code it would be:
workflow{

}
```

Listing 4.11: Access to automation API in Java clients by the `IScriptExecutionContext`

In Java code the context is always the first parameter passed to every task code (see `IScriptTaskCode`).

4.4.1.1 Code Block Arguments

The code block can have arguments passed into the script task execution. The arguments passed into the `code{ }` block are defined by the `IScriptTaskType` of the script task. See chapter 4.3 on page 31 for the list of arguments (including types) passed by each individual task type.

```
scriptTask("Task"){
    code{ arg1, arg2, ... -> // arguments here defined by the IScriptTaskType
    }
}

scriptTask("Task2"){
    // Or you could specify the type of the arguments for code completion
    code{ String arg1, List<Double> arg2 ->
    }
}
```

Listing 4.12: Script task code block arguments

The arguments can also be retrieved with `IScriptExecutionContext.getScriptTaskArguments()`.

4.4.2 Task Execution Sequence

The figure 4.3 on the next page shows the overview sequence when a script task gets executed by the user and the interaction with the `IScriptExecutionContext`. Note that the context gets created each time the task is executed.

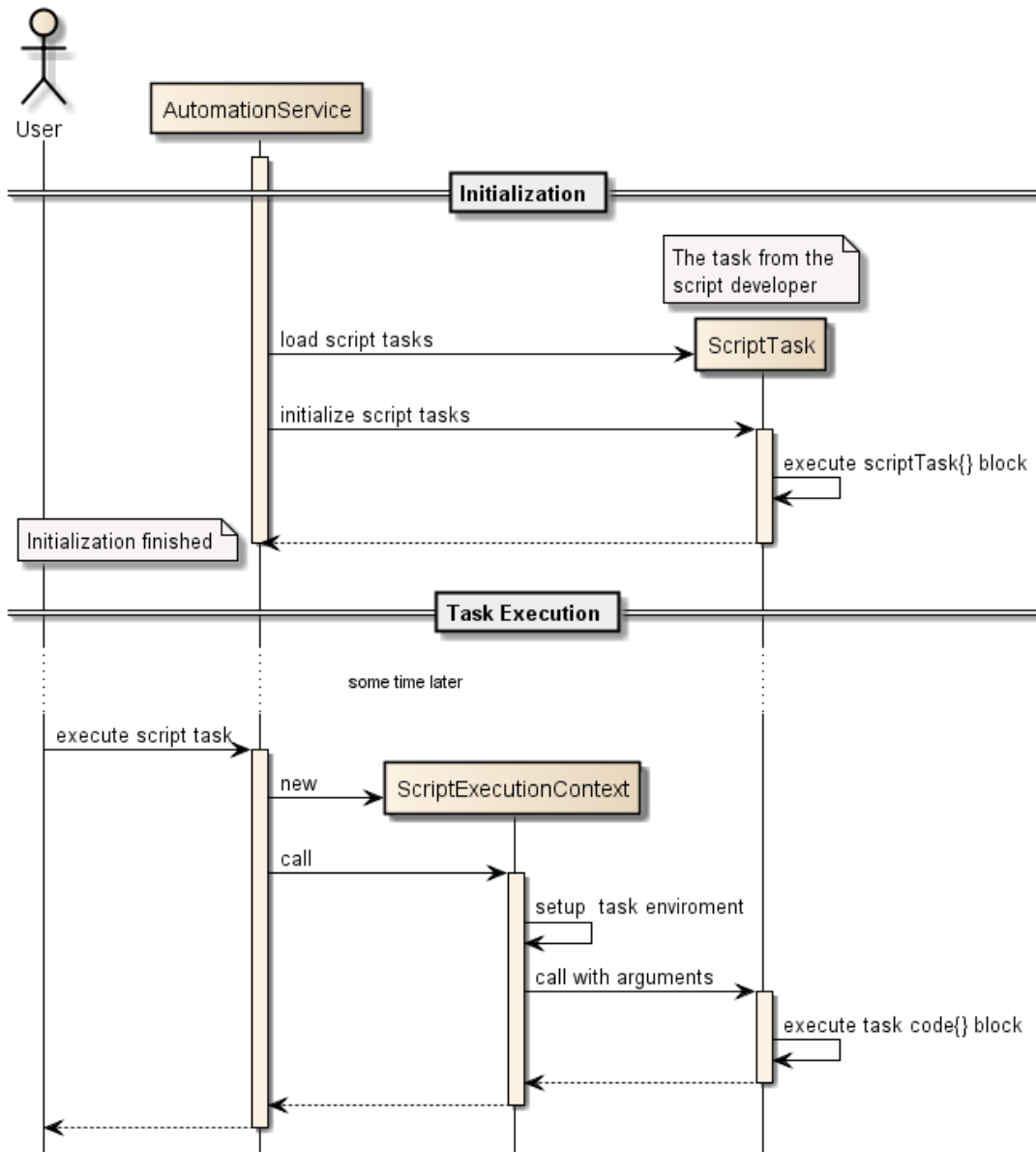


Figure 4.3: Script Task Execution Sequence

4.4.3 Script Path API during Execution

Script tasks could resolve relative and absolute file system paths with the `IAutomationPathsApi`.

As entry point call `paths` in a `code{ }` block (see `IScriptExecutionContext.getPaths()`).

There are multiple ways to resolve relative paths:

- by Script folder
- by Temp folder
- by SIP folder
- by Project folder
- by any parent folder

4.4.3.1 Path Resolution by Parent Folder

The `resolvePath(Path parent, Object path)` method resolves a file path relative to supplied parent folder.

This method converts the supplied path based on its type:

- A `CharSequence`, including `String` or `GString`. Interpreted relative to the parent directory. A string that starts with `file:` is treated as a file URL.
- A `File`: If the file is an absolute file, it is returned as is. Otherwise, the file's path is interpreted relative to the parent directory.
- A `Path`: If the path is an absolute path, it is returned as is. Otherwise, the path is interpreted relative to the parent directory.
- A `URI` or `URL`: The URL's path is interpreted as the file path. Currently, only `file:` URLs are supported.
- A `IHasURI`: The returned URI is interpreted as defined above.
- A `Closure`: The closure's return value is resolved recursively.
- A `Callable`: The callable's return value is resolved recursively.
- A `Supplier`: The supplier's return value is resolved recursively.
- A `Provider`: The provider's return value is resolved recursively.

The return type is `java.nio.file.Path`.

```
scriptTask("TaskName"){
    code{
        // Method resolvePath(Path, Object) resolves a path relative to the
        // supplied folder
        Path parentFolder = Paths.get('.')
        Path p = paths.resolvePath(parentFolder, "MyFile.txt")

        /* The resolvePath(Path, Object) method will resolve
        * relative and absolute paths to a java.nio.file.Path object.
        */
    }
}
```

Listing 4.13: Resolves a path with the `resolvePath()` method

4.4.3.2 Path Resolution

The `resolvePath(Object)` method resolves the `Object` to a file path. Relative paths are preserved, so relative paths are not converted into absolute paths.

This method converts the supplied path same as the `resolvePath(Path, Object)` method. The return type is `java.nio.file.Path`. See 4.4.3.1. But it does **NOT** convert relative paths into absolute.

```
scriptTask("TaskName"){
    code{
        // Method resolvePath() resolves a path and preserve relative paths
        Path p = paths.resolvePath("MyFile.txt")

        /* The resolvePath() method will resolve
         * relative and absolute paths to a java.nio.file.Path object.
         * Is also preserves relative paths.
         */
    }
}
```

Listing 4.14: Resolves a path with the resolvePath() method

4.4.3.3 Script Folder Path Resolution

The `resolveScriptPath(Object)` method resolves a file path relative to the script directory of the executed `IScript`.

This method converts the supplied path same as the `resolvePath(Path, Object)` method. The return type is `java.nio.file.Path`. See 4.4.3.1 on the previous page.

```
scriptTask("TaskName"){
    code{
        // Method resolveScriptPath() resolves a path relative to the script
        // folder
        Path p = paths.resolveScriptPath("MyFile.txt")

        /* The resolveScriptPath() method will resolve
         * relative and absolute paths to a java.nio.file.Path object.
         */
    }
}
```

Listing 4.15: Resolves a path with the resolveScriptPath() method

4.4.3.4 Project Folder Path Resolution

The `resolveProjectPath(Object)` method resolves a file path relative to the project directory (see `getDpaProjectFolder()`) of the current active project.

This method converts the supplied path same as the `resolvePath(Path, Object)` method. The return type is `java.nio.file.Path`. See 4.4.3.1 on the preceding page.

There must be an active project to use this method. See chapter 4.5.2 on page 57 for details about active projects.


```
scriptTask("TaskName"){
    code{
        // Method resolveProjectPath() resolves a path relative active project
        // folder
        Path p = paths.resolveProjectPath("MyFile.txt")

        /* The resolveProjectPath() method will resolve
        * relative and absolute paths to a java.nio.file.Path object.
        */
    }
}
```

Listing 4.16: Resolves a path with the resolveProjectPath() method

4.4.3.5 SIP Folder Path Resolution

The resolveSipPath(Object) method resolves a file path relative to the SIP directory (see getSipRootFolder()).

This method converts the supplied path same as the resolvePath(Path, Object) method. The return type is java.nio.file.Path. See 4.4.3.1 on page 39.

```
scriptTask("TaskName"){
    code{
        // Method resolveSipPath() resolves a path relative SIP folder
        Path p = paths.resolveSipPath("MyFile.txt")

        /* The resolveSipPath() method will resolve
        * relative and absolute paths to a java.nio.file.Path object.
        */
    }
}
```

Listing 4.17: Resolves a path with the resolveSipPath() method

4.4.3.6 Temp Folder Path Resolution

The resolveTempPath(Object) method resolves a file path relative to the script temp directory of the executed IScript. A new temporary folder is created for each IScriptTask execution.

This method converts the supplied path same as the resolvePath(Path, Object) method. The return type is java.nio.file.Path. See 4.4.3.1 on page 39.

```
scriptTask("TaskName"){
    code{
        // Method resolveTempPath() resolves a path relative to the temp folder
        Path p = paths.resolveTempPath("MyFile.txt")

        /* The resolveTempPath() method will resolve
        * relative and absolute paths to a java.nio.file.Path object.
        */
    }
}
```

Listing 4.18: Resolves a path with the resolveTempPath() method

4.4.3.7 Other Project and Application Paths

The `IAutomationPathsApi` will also resolve any other Vector provided path variable like `$(EcucFile)`. The call would be `paths.ecucFile`, add the variable to resolve as a Groovy property.

Short list of available variables (not complete, please see DaVinci Configurator help for more details):

- `EcucFile`
- `OutputFolder`
- `SystemFolder`
- `AutosarFolder`
- more ...

```
scriptTask("TaskName", DV_PROJECT){
    code{
        // The property OutputFolder is the folder of the generated artifacts
        Path folder = paths.outputFolder
    }
}
```

Listing 4.19: Get the project output folder path

```
scriptTask("TaskName"){
    code{
        // The property sipRootFolder is the folder of the used SIP
        Path folder = paths.sipRootFolder
    }
}
```

Listing 4.20: Get the SIP folder path

4.4.4 Script logging API

The script task execution (`IScriptExecutionContext`) provides a script logger to log events during an execution. The method `getScriptLogger()` returns the logger. The logger can be used to log:

- Errors
- Warnings
- Debug messages
- More...

You shall **always prefer** the usage of the **logger** before using the `println()` of `stdout` or `stderr`.

In any code block without direct access to the script API, you can write the following code to access the logger: `ScriptApi.scriptLogger`

```
scriptTask("TaskName"){
    code{
        // Use the scriptLogger to log messages
        scriptLogger.info "My script is running"
        scriptLogger.warn "My Warning"
        scriptLogger.error "My Error"
        scriptLogger.debug "My debug message"
        scriptLogger.trace "My trace message"

        // Also log an Exception as second argument
        scriptLogger.error("My Error", new RuntimeException("MyException"))
    }
}
```

Listing 4.21: Usage of the script logger

The `ILogger` also provides a formatting syntax for the format String. The syntax is `{Index-Number}` and the index of arguments after the format String.

It is also possible to use the Groovy `GString` syntax for formatting.

```
scriptTask("TaskName"){
    code{ argument ->
        // Use the format methods to insert data
        scriptLogger.infoFormat("My script {0} with:{1}", scriptTask, argument)
    }
}
```

Listing 4.22: Usage of the script logger with message formatting

```
scriptTask("TaskName"){
    code{ argument ->
        // Use the Groovy GString syntax to insert data
        scriptLogger.info "My script $scriptTask with: $argument"
    }
}
```

Listing 4.23: Usage of the script logger with Groovy `GString` message formatting

4.4.5 User Interactions and Inputs

The `UserInteraction` and `UserInput` API provides methods to directly communicate with the user via `MessageBoxes`, `Input` dialogs or report progress of long running operations.

You should use the API only if you want do communicate directly with the user, because some API calls may block and wait for user interaction. So you should not use the API for batch jobs.

4.4.5.1 UserInteraction

The `UserInteraction` API provides methods to display messages to the user directly. In UI mode the `DaVinci Configurator` will prompt a message box and will block until the user has acknowledged the message. In console (non UI) mode, the message is logged to the console in a user logger.

The user logger will display error, warnings and infos by default. The logger name will not be displayed.

The user interaction is good to display information where the user has to respond to immediately. Please use the feature sparingly, because users do not like to acknowledge multiple messages for a single script task execution.

The code block `userInteractions{}` provides the API inside of the block. The following methods can be used:

- `errorToUser()`
- `warnToUser()`
- `infoToUser()`
- `messageToUser(ELogLevel, Object)`

The severity (error, warning, info) will change the display (icons, text) of the message box. No other semantic is applied by the severity.

```
scriptTask("TaskName", DV_APPLICATION){
    code{

        userInteractions{
            warnToUser("Warning displayed to the user as message box")
        }

        // You could also write
        userInteractions.errorToUser("Error message for the user")
    }
}
```

Listing 4.24: UserInteraction from a script

4.4.5.2 Progress Indication

If you perform long running operations in a script task, you should display some progress to the user, otherwise the user may cancel the whole execution. The progress API will display the progress of the currently running script task by the information provided by the script code.

The method `progress(String, Closure)` displays the passed message in progress information dialog and executed the code block. So the message is displayed until the code block has finished.

```
userInteractions.progress("The text for the user"){
    // Here the code of the long running operation
}
```

Listing 4.25: Display progress to the user

You could also nest multiple `progress()` calls. When a progress block is left, the parent progress text will be displayed again.

```
userInteractions{
  progress("The text for the user"){
    // Here the code of the long running operation
    progress("Inner operation"){
      // Here code of inner operation
    }
  }
  progress("Second operation"){
    //Code of the second operation
  }
}
```

Listing 4.26: Display progress to the user nested

The method `progress(String, int, Closure)` updates the progress information for the user with the message, during the code is running with work ticks.

It also indicates progress in the progress bar, but you have to set the total amount of work. The total work will be taken from the parent and sets the remaining work for the code block.

The root script task always starts with `totalWork` of 1000 ticks, so you have to consume 1000 ticks to fill the progress bar.

```
userInteractions{
  progress("The text for the user", 1000){
    worked(100)
    progress("Inner operation", 400){
      //100 ticks
      worked(200)
      //300 ticks
    }
    // half reached - 500 ticks
    progress("Inner operation", 200){
      worked(100)
      // 600 ticks reached
    }
    // 700 ticks reached
  }
  // All 1000 ticks done, the progress bar is now full!
}
```

Listing 4.27: Display progress to the user with progress bar work

Eclipse API You can also use the underlying Eclipse API to fine grain control the progress bar and information data. To do this use the `getProgressMonitor()` method to retrieve the Eclipse `SubMonitor`. See also the Eclipse API `SubMonitor.setWorkRemaining(int)` to scale your own work to different values (also more than 1000 ticks).

4.4.6 Script Error Handling

4.4.6.1 Script Exceptions

All exceptions thrown by any script task execution are sub types of `ScriptingException`.

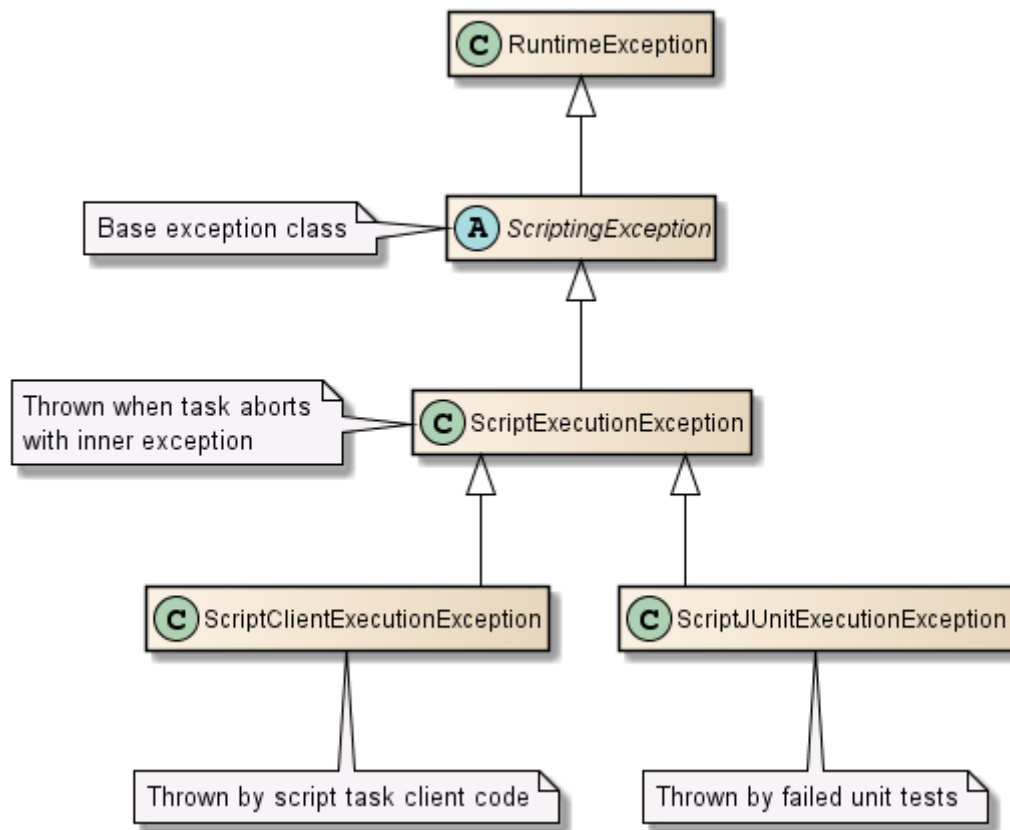


Figure 4.4: ScriptingException and sub types

4.4.6.2 Script Task Abortion by Exception

The script task can throw an `ScriptClientExecutionException` to abort the execution of an `IScriptTask`, and display a meaningful message to the user.

```

scriptTask("TaskName"){
    code{
        // Stop the execution and display a message to the user
        throw new ScriptClientExecutionException("Message to the User")
    }
}
  
```

Listing 4.28: Stop script task execution by throwing an `ScriptClientExecutionException`

Exception with Console Return Code An `ScriptClientExecutionException` with an return code of type `Integer` will also abort the execution of the `IScriptTask`.

But it *also changes the return code* of the console application, if the `IScriptTask` was executed in the console application. This could be used when the console application of the DaVinci Configurator is called for other scripts or batch files.

```
scriptTask("TaskName"){  
    code{  
        // The return code will be returned by the DvCmd.exe process  
        def returnCode = 50  
        throw new ScriptClientExecutionException(returnCode, "Message to the  
            User")  
    }  
}
```

Listing 4.29: Changing the return code of the console application by throwing an `ScriptClientExecutionException`

Reserved Return Codes The returns codes 0–20 are reserved for internal use of the DaVinci Configurator, and are not allowed to be used by a client script. Also negative returns codes are not permitted.

4.4.6.3 Unhandled Exceptions from Tasks

When a script task execution throws any type of `Exception` (more precise `Throwable`) the script task is marked as failed and the `Exception` is reported to the user.

4.4.7 User defined Classes and Methods

You can define your own methods and classes in a script file. The methods are called like any other method.

```
scriptTask("Task"){
    code{
        userMethod()
    }
}

def userMethod(){
    return "UserString"
}
```

Listing 4.30: Using your own defined method

Classes can be used like any other class. It is also possible to define multiple classes in the script file.

```
scriptTask("Task"){
    code{
        new UserClass().userMethod()
    }
}

class UserClass{
    def userMethod(){
        return "ReturnValue"
    }
}
```

Listing 4.31: Using your own defined class

You can also create classes in different files, but then you have to write imports in your script like in normal Groovy or Java code.

The script should be structured as any other development project, so if the script file gets too big, please refactor the parts into multiple classes and so on.

daVinci Block The classes and methods must be outside of the `daVinci{ }` block.

```
import static com.vector.cfg.automation.api.ScriptApi.*
daVinci{
    scriptTask("Task"){
        code{}
    }
}

def userMethod(){}

class UserClass{}
```

Listing 4.32: Using your own defined method with a daVinci block

Code Completion Note that the code completion for the Automation API will not work automatically in own defined classes and methods. You have to open for example a `scriptCode{}`

block. The chapter 4.4.8 describes how to use the Automation API for your own defined classes and methods.

4.4.8 Usage of Automation API in own defined Classes and Methods

In your own methods and classes the automation API is not automatically available differently as inside of the script task `code{}` block. But it is often the case, that methods need access to the automation API.

The class **ScriptApi** provides **static methods as entry points** into the automation API. The static methods either return the API objects, or you could pass a **Closure**, which will activate the API inside of the **Closure**.

4.4.8.1 Access the Automation API like the Script `code{}` Block

The `ScriptApi.scriptCode(Closure)` method provides access to all automation APIs the same way as inside of the normal script `code{}` block.

This is useful, when you want to call script code API inside of your own methods and classes.

```
def yourMethod(){
    // Needs access to an automation API
    ScriptApi.scriptCode{
        // API is now available
        workflow.update()
    }
}
```

Listing 4.33: `ScriptApi.scriptCode{}` usage in own method

The `ScriptApi.scriptCode()` method can be used to call API in Java style.

```
def yourMethod(){
    // Needs access to an automation API
    ScriptApi.scriptCode().workflow.update()
}
```

Listing 4.34: `ScriptApi.scriptCode()` usage in own method

Java note: The `ScriptApi.scriptCode()` returns the `IScriptExecutionContext`.

4.4.8.2 Access the Project API of the current active Project

The `ScriptApi.activeProject()` method provides access to the project automation API of the currently active project. This is useful, when you want to call project API inside of your own methods and classes.

```
def yourMethod(){
    // Needs access to an automation API
    ScriptApi.activeProject{
        // Project API is now available
        transaction{
            // Now model modifications are allowed
        }
    }
}
```

Listing 4.35: ScriptApi.activeProject{} usage in own method

The ScriptApi.activeProject() method returns the current active IProject.

```
def yourMethod(){
    // Needs access to an automation API
    IProject theActiveProject = ScriptApi.activeProject()
}
```

Listing 4.36: ScriptApi.activeProject() usage in own method

4.4.9 User defined Script Task Arguments

A script task can create IScriptTaskUserDefinedArgument, which can be set by the user (e.g. from the commandline) to pass user defined arguments to the script task execution. An argument can be optional or required. The arguments are type safe and checked before the task is executed.

Possible valueTypes are:

- String
- Boolean
- Void: For parameter where only the existence is relevant.
- File: The existence of the file is not checked by default. See argument validators.
- Path: Same as File
- Integer
- Long
- Double

The help text is automatically expanded with the help for user defined script task arguments.

```
scriptTask("TaskName"){
    // newUserDefinedArgument(String argName, Class<T> valueType, String help)
    def procArg = newUserDefinedArgument("p", Void, "Enables the processing of
    ...")
    code{
        if(procArg.hasValue){
            scriptLogger.info "The argument -p was defined"
        }
    }
}
```

Listing 4.37: Script task UserDefined argument with no value

```
scriptTask("TaskName"){
    /*
     * newUserDefinedArgument(String argName, Class<T> valueType, String help)
     */
    def countArg = newUserDefinedArgument("count", Integer,
                                           "The amount of elements to create")

    def nameArg = newUserDefinedArgument("name", String,
                                          "The element name to create")

    code{
        int count = countArg.value
        String name = nameArg.value

        scriptLogger.info "The arguments --name and --count were $name, $count"
    }
}
```

Listing 4.38: Define and use script task user defined arguments from commandline

```
scriptTask("TaskName"){
    /*
     * newUserDefinedArgument(String argName, Class<T> valueType,
     *                        T defaultValue, String help)
     */
    def procArg = newUserDefinedArgument("p", Double, 25.0, // The Default value
                                         "Help text ...")

    code{
        double value = procArg.value
        scriptLogger.info "The argument -p was $value"
    }
}
```

Listing 4.39: Script task UserDefined argument with default value

```
scriptTask("TaskName"){
    /*
     * newUserDefinedArgument(String argName, Class<T> valueType, String help)
     */
    def multiArg = newUserDefinedArgument("multiArg", String, "Help text ...")

    /*
     * The client calls the task with arguments:
     * --multiArg "ArgOne" --multiArg "ArgTwo"
     */
    code{

        List<String> values = multiArg.values // Call values instead of value
        scriptLogger.info "The argument --multiArg had values: $values"
    }
}
```

Listing 4.40: Script task UserDefined argument with multiple values

4.4.9.1 User defined Argument Validators

You could also specify a validator for the argument to check for special conditions, like the file must exist. This is helpful to provide a quick feedback to the user, if the task would be executable. Simply add the validator at the end of the `newUserDefinedArgument()` call. The validator code is called when the input is checked.

There are also default validators available, like:

- Constraints.IS_EXISTING_FOLDER
- Constraints.IS_EXISTING_FILE
- Constraints.IS_VALID_AUTOSAR_SHORT_NAME

Please see chapter 4.12.1 on page 236 for more available validators.

```
import com.vector.cfg.business.Constraints

scriptTask("TaskName"){
  /*
   * newUserDefinedArgument(String argName, Class<T> valueType,
   *                          T defaultValue, String help, Consumer<T> validator)
   */
  def contArg = newUserDefinedArgument("p", String,
                                       "Help text ...",
                                       Constraints.
                                       IS_VALID_AUTOSAR_SHORT_NAME_PATH)

  code{

    String value = contArg.value
    scriptLogger.info "The argument -p was $value"
  }
}
```

Listing 4.41: Script task UserDefined argument with predefined validator

Or you implement your own validation logic, by passing a `Closure`, which throws an exception, if the value is invalid.

```
scriptTask("TaskName"){
  /*
   * newUserDefinedArgument(String argName, Class<T> valueType,
   *                          T defaultValue, String help, Consumer<T> validator)
   */
  def procArg = newUserDefinedArgument("p", Integer, 20,
                                       "Help text ...",
                                       // The validator code
                                       { value ->
                                         if( value % 2){
                                           throw new IllegalArgumentException("The value has to be
                                           even.")
                                         }
                                       })

  code{
  }
}
```

Listing 4.42: Script task UserDefined argument with own validator

4.4.9.2 Call Script Task with Task Arguments from Commandline

The commandline option `taskArgs` is used to specify the arguments passed to a script task to execute:

```
--taskArgs <TASK_ARGS>    Passes arguments to the specified script tasks.
```

The arguments have the following syntax:

```
Syntax: --taskArgs "<TaskName>" "<Arguments to Task>"
        E.g. --taskArgs "MyTask" "-s --projectCfg MyFile.cfg"
```

If only one task is executed, the "`<TaskName>`" can be omitted.

For multiple task arguments the following syntax apply:

```
Syntax: --taskArgs "<TaskName>" "<Arguments to Task>"
        "<TaskName2>" "<Arguments to Task2>"

        E.g. --taskArgs "MyTask" "-s --projectCfg MyFile.cfg"
              "Task2" "-d --saveTo saveFile.txt"
```

Note: The newlines in the listing are only for visualization.

If the task name is not unique, you can specify the full qualified name with script name

```
--taskArgs "MyScript:MyTask" "-s --projectCfg MyFile.cfg"
```

Arguments with spaces inside the script task argument could be quoted with "

```
--taskArgs "MyScript:MyTask" "-s --projectCfg \"Path to File\\MyFile.cfg\" -d"
```

The task help of a task will print the possible arguments of a script task.

```
--scriptTaskHelp taskName
```

4.4.10 Stateful Script Tasks

Script tasks normally have no state or cached data, but it can be useful to cache data during an execution, or over multiple task executions. The `IScriptExecutionContext` provides two methods to save and restore data for that purpose:

- `getExecutionData()` - caches data during one task execution
- `getSessionData()` - caches data over multiple task executions

Execution Data Caches data during a single script task execution, which allows to save calculated values or services needed in multiple parts of the task, without recalculating or creating it. Note: When the task is executed again the `executionData` will be empty.

```
scriptTask("TaskName"){
  code{
    // Cache a value for the execution
    executionData.myCacheValue = 500

    def val = executionData.myCacheValue // Retrieve the value anywhere
    scriptLogger.info "The cached value is $val"

    // Or access it from any place with ScriptApi.scriptCode like:
    def sameValue = ScriptApi.scriptCode.executionData.myCacheValue
  }
}
```

Listing 4.43: `executionData` - Cache and retrieve data during one script task execution

Session Data Caches data over multiple task executions, which allows to implement a stateful task, by saving and retrieving any data calculated by the task itself.

Caution: The data is saved globally so the usage of the `sessionData` can lead to memory leaks or `OutOfMemoryErrors`. You have to take care not to store too much memory in the `sessionData`.

The DaVinci Configurator will also free the `sessionData`, when the system run low on free memory. So you have to deal with the fact, that the `sessionData` was freed, when the script task getting executed again. But the data is not deallocated during a running execution.

```
scriptTask("TaskName"){
  // Setup - set the value the first time, this is only executed once (during
  // initialization)
  sessionData.myExecutionCount = 1

  code{
    // Retrieve the value
    def executionCount = sessionData.myExecutionCount

    scriptLogger.info "The task was executed $executionCount times"

    // Update the value
    sessionData.myExecutionCount = executionCount + 1
  }
}
```

Listing 4.44: `sessionData` - Cache and retrieve data over multiple script task executions

API usage Both methods `executionData` and `sessionData` return the same API of type `IScriptTaskUserData`.

The `IScriptTaskUserData` provides methods to retrieve and store properties by a key (like a `Map`). The retrieval and store methods are `Object` based, so any `Object` can be a key. The exception are `Class` instances (like `String.class`, which required that the value is an instance of the `Class`).

On retrieval if a property does not exist an `UnknownPropertyException` is thrown. Properties can be set multiple times and will override the old value. The keys of the properties used to retrieve and store data are compared with `Object.equals(Object)` for equality.

The listing below describes the usage of the API:

```
scriptTask("TaskName"){
  code{
    def val
    // The sessionData and executionData have the same API

    // You have multiple ways to set a value
    executionData.myCacheId = "VALUE"
    executionData.set("myCacheId", "VALUE")
    executionData["myCacheId"] = "VALUE"
    // Or with classes for a service locator pattern
    executionData.set(Integer.class, 50) // Possible for any Class
    executionData[Integer] = 50

    // There are the same ways to retrieve the values
    val = executionData.myCacheId
    val = executionData.get("myCacheId")
    val = executionData["myCacheId"]
    // Or with classes for a service locator pattern
    val = executionData.get(Integer.class)
    val = executionData[Integer]

    // You can also ask if the property exists
    boolean exists = executionData.has("myCacheId")
  }
}
```

Listing 4.45: `sessionData` and `executionData` syntax samples

4.4.11 ScriptAccess - Calling ScriptTasks

Sometimes it can be helpful to call other script tasks from inside your task. The `scripts{}` block or `getScripts()` method provides API to retrieve existing `IScripts` and call other `IScriptTasks` from your running `IScriptTask`.

Note: If you **just want to reuse code** of your own scripts in an automation script project, create a normal method containing the code and call it, instead of calling the task. The method is typesafe, has code completion support and is **much faster** than calling a script task.

Calling script tasks To call a task you need the name of the task and the `IScriptTaskType`. The `IScriptTaskType` determines the argument types and the return type of the script task. Then you can use `scripts.callScriptTask(String, Object...)` to call the script.

You could also use `callScriptTaskWithUserArgs(String, String, Object...)`, if you want to pass user defined arguments.

```
scriptTask("TaskName"){
    code{
        scripts.callScriptTask("OtherTask")
        //The same
        scripts{
            callScriptTask("OtherTask")
        }
    }
}

scriptTask("OtherTask"){
    code{
        //Other task code
    }
}
```

Listing 4.46: Call another script task from a script task

Calling script tasks with task arguments If the `IScriptTaskType` requires task arguments, you have to pass the arguments to the `callScriptTask()` methods. The return value of the method is the returned value of the called script task.

```
scriptTask("TaskName", DV_PROJECT){
    code{
        def arg1 = "First argument"
        def arg2 = 5
        def result = scripts.callScriptTask("OtherTask", arg1, arg2)
        // Result contains the calculated value of OtherTask
    }
}

scriptTask("OtherTask"){
    code{arg1, arg2 ->
        return arg1 + arg2
    }
}
```

Listing 4.47: Call another script task with arguments

4.5 Project Handling

Project handling comprises creating new projects, opening existing projects or accessing the currently active project.

`IProjectHandlingApi` provides methods to access to the active project, for creating new projects and for opening existing projects.

`getProjects()` allows accessing the `IProjectHandlingApi` like a property.

```
scriptTask('taskName') {  
  code {  
    // IProjectHandlingApi is available as "projects" property  
    def projectHandlingApi = projects  
  }  
}
```

Listing 4.48: Accessing `IProjectHandlingApi` as a property

`projects(Closure)` allows accessing the `IProjectHandlingApi` in a scope-like way.

```
scriptTask('taskName') {  
  code {  
    projects {  
      // IProjectHandlingApi is available inside this Closure  
    }  
  }  
}
```

Listing 4.49: Accessing `IProjectHandlingApi` in a scope-like way

4.5.1 Projects

Projects in the AutomationInterface are represented by `IProject` instances. These instances can be created by:

- Creating a new project
- Loading an existing project

You can only access `IProject` instances by using a `Closure` block at `IProjectHandlingApi` or `IProjectRef` class. This shall prevent memory leaks, by not closing open projects.

4.5.2 Accessing the active Project

The `IProjectHandlingApi` provides access to the active project. The active project is either (in descending order):

- The last `IProject` instance activated with a `Closure` block
 - Stack-based - so multiple opened projects are possible and the last (inner) `Closure` block is used.
- The passed project to a project task
- Or the loaded project in the current DaVinci Configurator in an application task

The figure 4.5 describes the behavior to search for the active project of a script task.

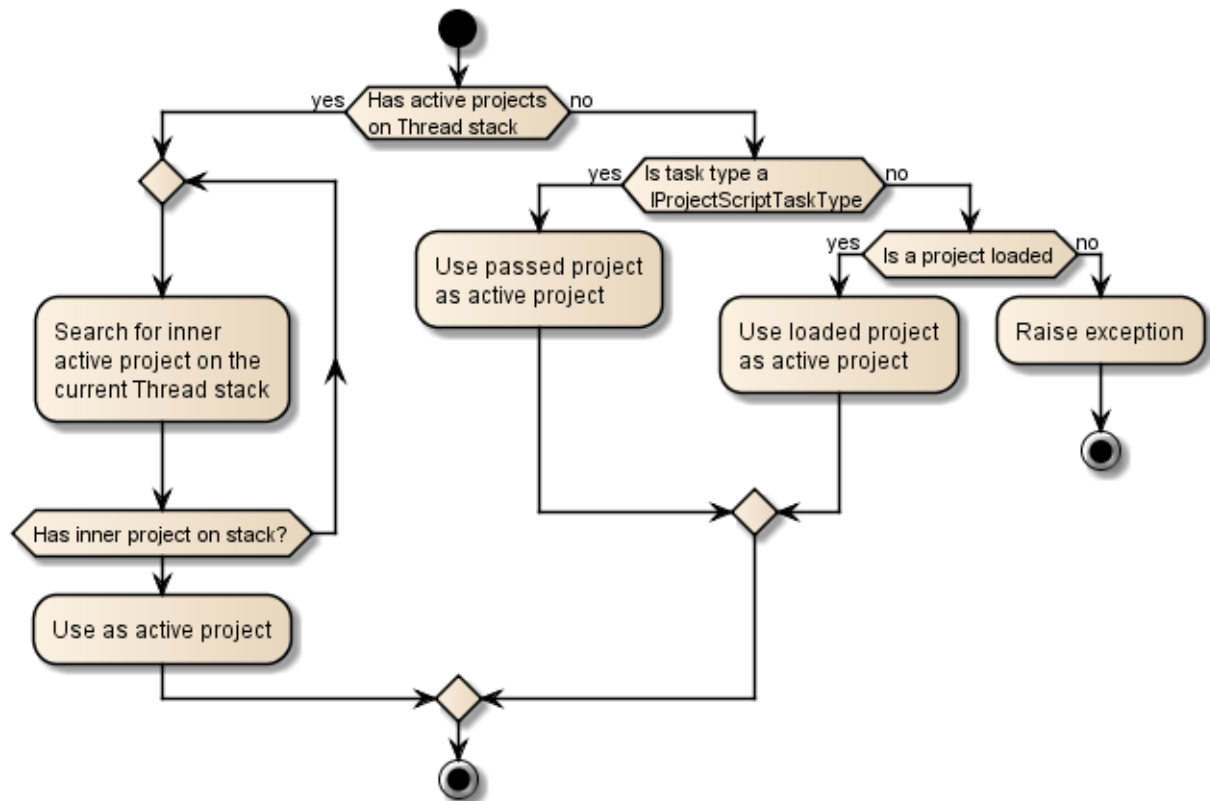


Figure 4.5: Search for active project in `getActiveProject()`

It is possible that there is no active project, e.g. no project was loaded.

You can switch the active project, by calling the `with(Closure)` method on an `IProject` instance.

```
// Retrieve theProject from other API like load a project
IProject theProject = ...;
theProject.with {
    // Now theProject is the new active project inside of this closure
}
```

Listing 4.50: Switch the active project

To access the active project you can use the `activeProject(Closure)` and `getActiveProject()` methods.

```
scriptTask('taskName') {
  code {
    if (projects.projectActive) {
      // active IProject is available as "activeProject" property
      scriptLogger.info "Active project: ${projects.activeProject.projectName}"
      projects.activeProject {
        // active IProject is available inside this Closure
        scriptLogger.info "Active project: ${projectName}"
      }
    } else {
      scriptLogger.info 'No project active'
    }
  }
}
```

Listing 4.51: Accessing the active IProject

`isProjectActive()` returns `true` if and only if there is an active `IProject`. If `isProjectActive()` returns `true` it is safe to call `getActiveProject()`.

`getActiveProject()` allows accessing the active `IProject` like a property.

`activeProject(Closure)` allows accessing the active `IProject` in a scope-like way. This will enable the project specific API inside of the `Closure`.

4.5.3 Accessing Project Settings

The `IProjectSettingsApiEntryPoint` enables querying or modifying the target project settings. The following section describes how the project settings of a project can be accessed and modified.

Use `getProjectSettings()` or `projectSettings(Closure)` to specify the project settings for a project.

`IProjectTargetApi` is the entry point for accessing and modifying the target settings.

Use `getTarget()` or `target(Closure)` to specify the target project settings.

Use the following methods to access the project settings. The example shows how to use the API.

```
scriptTask("TestsProjectSettings", DV_PROJECT) {
    code {
        activeProject {
            projectSettings {
                target{

                    // Get the available derivatives as collection
                    def newDerivative = getAvailableDerivatives().getFirst()
                    // Set the derivative setting with the new value
                    derivative(newDerivative)
                    // Returns an Optional containing the new value
                    getDerivative()

                    def newCompiler = getAvailableCompilers().getFirst()
                    compiler(newCompiler)
                    getCompiler()

                    def newPinLayout = getAvailablePinLayouts().getFirst()
                    pinLayout(newPinLayout)
                    getPinLayout()

                }
            }
        }
    } // code
} // scriptTask
```

Listing 4.52: Access and modify Project Settings - Variant 1

```
scriptTask("TestsProjectSettings", DV_APPLICATION) {
    code {
        projects.openProject(getDpaFileToLoad()) {
            projectSettings {
                target{

                    // Setting the returned valid pinLayout
                    pinLayout getAvailablePinLayouts().getAt(1)
                    // Called without parameter means calling the getter
                    pinLayout

                }
            }
        }
    } // code
} // scriptTask
```

Listing 4.53: Access and modify Project Settings - Variant 2

Available Derivatives `getAvailableDerivatives()` returns all possible input values for `setDerivative(DerivativeInfo)`.

Derivative Set the derivative for the project with `setDerivative(DerivativeInfo)`. The value given here must be one of the values returned by `getAvailableDerivatives()`.

Get Derivative `getDerivative()` returns the value of the current derivative project setting. Note: This function will return null if no derivative has been configured.

Available Compilers `getAvailableCompilers()` returns all possible input values for `setCompiler(ImplementationProperty)`. Note: the available compilers depend on the currently configured derivative. This method will return an empty collection if no derivative has been configured at the time it is called.

Compiler Set the compiler for the new project with `setCompiler(ImplementationProperty)`. The value given here must be one of the values returned by `getAvailableCompilers()`.

Get Compiler `getCompiler()` returns the value of the current compiler project setting. Note: If no compiler has been configured, it will return null.

Available PinLayouts `getAvailablePinLayouts()` returns all possible input values for `setPinLayout(ImplementationProperty)`. Note: The available pin layouts depend on the currently configured derivative. This method will return a empty collection if no derivative has been configured at the time it is called.

PinLayout Set the pinLayout of the selected derivative for the project with `setPinLayout(ImplementationProperty)`. The value given here must be one of the values returned by `getAvailablePinLayouts()`.

Get PinLayout `getPinLayout()` returns the value of the current pinLayout project setting. Note: If no pinLayout has been configured, it will return null.

4.5.4 Creating a new Project

The method `createProject(Closure)` creates a new project as specified by the given `Closure`. Inside the closure the `ICreateProjectApi` is available.

The new project is not opened and usable until `IProjectRef.openProject(Closure)` is called on the returned `IProjectRef`.

```
scriptTask('taskName', DV_APPLICATION) {
  code {
    def newProject = projects.createProject {
      projectName 'NewProject'
      projectFolder paths.resolveTempPath('projectFolder')
    }

    scriptLogger.info("Project created and saved to: $newProject")

    // Now open the project
    newProject.openProject{
      // Inside here the project can be used
    }
  }
}
```

Listing 4.54: Creating a new project (mandatory parameters only)

The next is a more sophisticated example of creating a project with multiple settings:

```
scriptTask('taskName', DV_APPLICATION) {
  code {
    def newProject = projects.createProject {

      projectName 'NewProject'
      projectFolder paths.resolveTempPath('projectFolder')

      general {
        author 'projectAuthor'
        version '0.9'
      }

      postBuild {
        loadable true
        selectable true
      }

      folders.ecucFileStructure = ONE_FILE_PER_MODULE
      folders.moduleFilesFolder = 'Appl/GenData'
      folders.templatesFolder = 'Appl/Source'

      target.vVIRTUALtargetSupport = false

      daVinciDeveloper.createDaVinciDeveloperWorkspace = false
    }
  }
}
```

Listing 4.55: Creating a new project (with some optional parameters)

The `ICreateProjectApi` contains the methods to parameterize the creation of a new project.

4.5.4.1 Mandatory Settings

Project Name Specify the name newly created project with `setProjectName(String)`. The name given here is postfixed with ".dpa" for the new project's .dpa file.

The following constraints apply:

- `Constraints.IS_VALID_PROJECT_NAME` 4.12.1 on page 236

Project Folder Specify the folder in which to create the new project in with `setProjectFolder(Object)`. The value given here is converted to `Path` using the converter `ScriptConverters.TO_SCRIPT_PATH` 4.12.2 on page 237.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

4.5.4.2 General Settings

Use `getGeneral()` or `general(Closure)` to specify the new project's general settings. The provided settings are defined in `ICreateProjectGeneralApi`.

Author The author for the new project can be specified with `setAuthor(String)`. This is an optional parameter defaulting to the name of the currently logged in user if the parameter is not provided explicitly.

The following constraints apply:

- `Constraints.IS_NON_EMPTY_STRING` 4.12.1 on page 236

Version The version for the new project can be specified with `setVersion(Object)`. This is an optional parameter defaulting to "1.0" if the parameter is not provided explicitly. The value given here is converted to `IVersion` using `ScriptConverters.TO_VERSION` 4.12.2 on page 237.

The following constraints apply:

- `Constraints.IS_NOT_NULL` 4.12.1 on page 236

Description The description for the new project can be specified with `setDescription(String)`. This is an optional parameter defaulting to "" if the parameter is not provided explicitly.

The following constraints apply:

- `Constraints.IS_NOT_NULL` 4.12.1 on page 236

Start Menu Entries `setCreateStartMenuEntries(boolean)` defines whether or not to create start menu entries for the new project. This is an optional parameter defaulting to `false` if the parameter is not provided explicitly.

4.5.4.3 Target Settings

Use `getTarget()` or `target(Closure)` to specify the new project's target settings for compiler, derivatives and pin layouts.

`ICreateProjectTargetApi` contains the API to specify the new project's target settings.

Available Derivatives `getAvailableDerivatives()` returns all possible input values for `setDerivative(DerivativeInfo)`.

Derivative Set the derivative for the new project with `setDerivative(DerivativeInfo)`. The new default project derivative refers to the first element in the collection returned by `getAvailableDerivatives()`. Call `setDerivative(DerivativeInfo)` if you would like change the derivative.

Available Compilers `getAvailableCompilers()` returns all possible input values for `setCompiler(ImplementationProperty)`. Note: the available compilers depend on the currently configured derivative. This method will return the empty collection if no derivative has been configured at the time it is called.

Compiler Set the compiler for the new project with `setCompiler(ImplementationProperty)`. The new default project compiler refers to the first element in the collection returned by `getAvailableCompilers()`. Call `setCompiler(ImplementationProperty)` if you would like change the compiler.

Available Pin Layouts `getAvailablePinLayouts()` returns all possible input values for `setPinLayout(ImplementationProperty)`. Note: the available pin layouts depend on the currently configured derivative. This method will return the empty collection if no derivative has been configured at the time it is called.

Pin Layout Set the pin layout of the selected derivative for the new project with `setPinLayout(ImplementationProperty)`. The new default project pinLayout refers to the first element in the collection returned by `getAvailablePinLayouts()`. Call `setPinLayout(ImplementationProperty)` if you would like change the pinLayout.

vVIRTUALtarget Support `setvVIRTUALtargetSupport(boolean)` specifies whether or not to support the vVIRTUALtarget for the new project. This is an optional parameter defaulting to `false` if the parameter is not provided explicitly. See also `ICreateProjectApi.getVirtualTarget()` and `ICreateProjectVirtualTargetApi` for specifying further details (path to vVIRTUALtarget project, ...).

The following constraints apply:

- vVIRTUALtarget support may not be available depending on the purchased license

4.5.4.4 Post Build Settings

Use `getPostBuild()` or `postBuild(Closure)` to specify the new project's post build settings for Post-build selectable and or loadable projects.

`ICreateProjectPostBuildApi` contains the API to specify the new project's post build settings.

Post-build Loadable Support `setLoadable(boolean)` sets whether or not to support Post-build loadable for the new project. This is an optional parameter defaulting to `false` if the parameter is not provided explicitly.

Post-Build Selectable Support `setSelectable(boolean)` sets whether or not to support Post-build selectable for the new project. This is an optional parameter defaulting to `false` if the parameter is not provided explicitly.

4.5.4.5 Folders Settings

Use `getFolders()` or `folders(Closure)` to specify the new project's folders settings.

`ICreateProjectFolderApi` contains the methods to specify the new project's folders settings.

Module Files Folder Set the module files folder for the new project with `setModuleFilesFolder(Object)`. This is an optional parameter defaulting to `"/Appl/GenData"` if the parameter is not provided explicitly. The value given here is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

Templates Folder Set the templates folder for the new project with `setTemplatesFolder(Object)`. This is an optional parameter defaulting to `"/Appl/Source"` if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

Service Components Folder Set the service component files folder for the new project with `setServiceComponentFilesFolder(Object)`. This is an optional parameter defaulting to `"/Config/ServiceComponents"` if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

Application Components Folder Set the application component files folder for the new project with `setApplicationComponentFilesFolder(Object)`. This is an optional parameter defaulting to `"/Config/ApplicationComponents"` if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

Log Files Folder Set the log files folder for the new project with `setLogFilesFolder(Object)`. This is an optional parameter defaulting to `"/Config/Log"` if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

Measurement And Calibration Files Folder Set the measurement and calibration files folder for the new project with `setMeasurementAndCalibrationFilesFolder(Object)`. This is an optional parameter defaulting to `"/Config/McData"` if the parameter is not provided explicitly.

The folder object passed to the method is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

AUTOSAR Files Folder Set the AUTOSAR files folder for the new project with `setAuto-sarFilesFolder(Object)`. This is an optional parameter defaulting to `"/Config/AUTOSAR"` if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236

ECUC File Structure The literals of `EEcucFileStructure` define the alternative ECUC file structures supported by the new project. The following alternatives are supported:

`SINGLE_FILE` results in a single ECUC file containing all module configurations.

`ONE_FILE_PER_MODULE` results in a separate ECUC file for each module configuration all located in a common folder.

`ONE_FILE_IN_SEPARATE_FOLDER_PER_MODULE` results in a separate ECUC file for each module configuration each located in its separate folder.

Set the ECUC file structure to use for the new project with the method `setEcucFileStructure(EEcucFileStructure)`. This is an optional parameter defaulting to `EEcucFileStructure.SINGLE_FILE` if the parameter is not provided explicitly.

4.5.4.6 DaVinci Developer Settings

Use `getDaVinciDeveloper()` to specify the new project's DaVinci Developer settings.

`ICreateProjectDaVinciDeveloperApi` contains the methods for specifying the new project's DaVinci Developer settings.

Create DEV Workspace `setCreateDaVinciDeveloperWorkspace(boolean)` specifies whether or not to create a DaVinci Developer workspace for the new project. This is an optional parameter defaulting to `true` if and only if a compatible DaVinci Developer installation can be detected and the parameter is not provided explicitly.

DEV Executable Set the DaVinci Developer executable for the new project with `setDaVinciDeveloperExecutable(Object)`. This is an optional parameter defaulting to the location of a compatible DaVinci Developer installation (if there is any) if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_SCRIPT_PATH` 4.12.2 on page 237.

The following constraints apply:

- The path must points to a compatible DaVinci Developer executable (DaVinciDEV.exe).

DEV Workspace Set the DaVinci Developer workspace for the new project with `setDaVinciDeveloperWorkspace(Object)`. This is an optional parameter defaulting to `"/Config/Developer/<ProjectName>.dcf"` if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_PATH` 4.12.2 on page 237. Normally a relative path (to be interpreted relative to the project folder) should be given here.

The following constraints apply:

- `Constraints.IS_DCF_FILE` 4.12.1 on page 237
- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 236 (applies to the parent `Path` of the given `Path` to the DaVinci Developer executable)

Import Mode Preset `setUseImportModePreset(boolean)` specifies whether or not to use the import mode preset for the new project. This is an optional parameter defaulting to `true` if the parameter is not provided explicitly.

Object Locking `setLockCreatedObjects(boolean)` specifies whether or not to lock created objects for the new project. This is an optional parameter defaulting to `true` if the parameter is not provided explicitly.

Selective Import The literals of `ESelectiveImport` define the alternative modes for the selective import into the DaVinci Developer workspace during project updates. The following alternatives are supported:

`ALL` results in selective import for all elements.

`COMMUNICATION_ONLY` results in selective import for communication elements only.

Set the selective import mode for the new project with `setSelectiveImport(ESelectiveImport)`. This is an optional parameter defaulting to `ESelectiveImport.ALL` if the parameter is not provided explicitly.

4.5.4.7 vVIRTUALtarget Settings

Use `getVirtualTarget()` to specify the new project's vVIRTUALtarget settings. The vVIRTUALtarget support may not be available depending on the purchased license.

```

scriptTask('ProjectCreation', DV_APPLICATION) {
    code {
        def prjFolder = paths.resolveTempPath('projectFolder')

        def newProject = projects.createProject {
            projectName 'tpVttFullyCustom'
            projectFolder prjFolder

            target {
                vVIRTUALtargetSupport = true
            }

            virtualTarget {
                createVirtualTargetProjectFile = true
                virtualTargetExecutable = getCustomVttExe()
                virtualTargetProject = new File(prjFolder.toFile(), "/MyVtt/custom.vttproj")
            }
        }

        scriptLogger.info("Project created and saved")
    }
}

```

Listing 4.56: Creating a new project with custom VTT settings

Create vVIRTUALtarget project file `setCreateVirtualTargetProjectFile(boolean)` specifies whether or not to create a vVIRTUALtarget project file for the new project. This is an optional parameter defaulting to `true`. However the vVIRTUALtarget project file is only created when `ICreateProjectTargetApi.vVIRTUALtargetSupport(boolean)` evaluates to `true`.

vVIRTUALtarget Project Set the path to the vVIRTUALtarget project (*.vttproj) for the new project with `setVirtualTargetProject(Object)`. This is an optional parameter defaulting to `./Config/VTT/ProjectName.vttproj` if the parameter is not provided explicitly. See also `ICreateProjectTargetApi.setvVIRTUALtargetSupport(boolean)` and `ICreateProjectVirtualTargetApi.setCreateVirtualTargetProjectFile(boolean)` at which both have to be `true` to force the creation of the vVIRTUALtarget project.

The value given here is converted to `Path` using `ScriptConverters.TO_SCRIPT_PATH` 4.12.2 on page 237.

vVIRTUALtarget Executable Set the vVIRTUALtarget executable (VttCmd.exe) for the new project with `setVirtualTargetExecutable(Object)`. This is an optional parameter defaulting to the location of the currently registered installation (if there is any) if the parameter is not provided explicitly.

The value given here is converted to `Path` using `ScriptConverters.TO_SCRIPT_PATH` 4.12.2 on page 237.

4.5.5 Opening an existing Project

You can open an existing DaVinci Configurator Dpa project with the automation interface.

The method `openProject(Object, Closure)` opens the project at the given .dpa file location, delegates the given code to the opened `IProject`.

The project is automatically closed after leaving the `Closure` code of the `openProject(Object, Closure)` method.

The `Object` given as .dpa file is converted to `Path` using `ScriptConverters.TO_SCRIPT_PATH` 4.12.2 on page 237

```
scriptTask('taskName', DV_APPLICATION) {
    code {
        // replace getDpaFileToLoad() with the path to the .dpa file to be loaded
        projects.openProject(getDpaFileToLoad()) {

            // the opened IProject is available inside this Closure
            scriptLogger.info 'Project loaded and ready'

        }
    }
}
```

Listing 4.57: Opening a project from .dpa file

4.5.5.1 Parameterized Project Load

You can also configure how a Dpa project is loaded, e.g. by disabling the generators.

The method `parameterizeProjectLoad(Closure)` returns a handle on the project specified by the given `Closure`. Using the `IOpenDpaProjectApi`, the `Closure` may further customize the project's opening procedure.

The project is not opened until `openProject()` is called on the returned `IProjectRef`.

```
scriptTask('taskName', DV_APPLICATION) {
    code {
        def project = projects.parameterizeProjectLoad {
            // replace getDpaFileToLoad() with the path to the .dpa file to be loaded
            dpaFile getDpaFileToLoad()
            // prevent activation of generators and validation
            loadGenerators false
            enableValidation false
        }

        project.openProject {
            // the opened IProject is available inside this Closure
            scriptLogger.info 'Project loaded and ready'
        }
    }
}
```

Listing 4.58: Parameterizing the project open procedure

`IOpenProjectApi` contains the methods for parameterizing the process of opening a project.

DPA File The method `setDpaFile(Object)` sets the .dpa file of the project to be opened. The value given here is converted to `Path` using `ScriptConverters.TO_SCRIPT_PATH` 4.12.2 on page 237.

Generators Using `setLoadGenerators(boolean)` specifies whether or not to activate generators (including their validations) for the opened project.

Validation `setEnableValidation(boolean)` specifies whether or not to activate validation for the opened project.

4.5.5.2 Open Project Details

`IProjectRef` is a handle on a project not yet loaded but ready to be opened. This could be used to open the project.

`IProjectRef` instances can be obtained from form the following methods:

- `IProjectHandlingApi.createProject(Closure)` 4.5.4 on page 61
- `IProjectHandlingApi.parameterizeProjectLoad(Closure)` 4.5.5 on the previous page

The `IProject` is not really opened until `IProjectRef.openProject(Closure)` is called. Here, the project is opened and the given `Closure` is executed on the opened project. When `IProjectRef.openProject(Closure)` returns the project has already been closed.

Advanced Open Project Use Cases The method `IProjectRef.advanced()` provides methods for advanced usages of `IProject` instances. For example you can open a project which will not be closed when the open stack frame is left. This can be helpful for unit tests.

- `IProjectRefAdvancedUsage.openProject()`: Open the project and return the `IProject` as reference, but you have to manually close the project.

The `IProjectRefAdvancedUsage` API this only for special use cases, with have very narrow scope. If you are not sure that you need it don't use it.

4.5.6 Create Ecu Configuration Report

The `ICreateEcucReportApiEntryPoint` enables creating an Ecu Configuration report. The following section describes how an Ecu Configuration report can be created. If no report settings are set the defaults will take place.

Use `getCreateEcucReport()` or `createEcucReport(Closure)` to specify the ecuc report settings. The report gets created after the closure gets closed.

`ICreateEcucReportApi` is the entry point for setting the Ecu Configuration report settings.

See examples below to create an Ecu Configuration report.

```
scriptTask("TestEcucReportCreation", DV_PROJECT) {
    code {

        // Use default ecuc report settings
        activeProject.createEcucReport

    } // code
} // scriptTask
```

Listing 4.59: Create Ecu Configuration Report with default settings

```
scriptTask("TestEcucReportCreation", DV_PROJECT) {
    code { outputAsPath ->
        activeProject {

            // Use closure to get access to the ecuc report settings
            createEcucReport {

                // Set only those options for which to change the default value
                outputPath                outputAsPath
                // default: <ProjectFolder>/Log/EcucReport.html
                addAnnotations              true           // default: true
                addPlatformFunction        true           // default: true
                createXmlReportFile         false          // default: false
                overwriteExistingReportFile true           // default: true
                openReportAfterGeneration  false          // default: true
            }

        }
    } // code
} // scriptTask
```

Listing 4.60: Create Ecu Configuration Report

outputFilePath *Default: Log directory e.g. <ProjectFolder>/Log/EcucReport.html* - Sets the output file path.

addAnnotations *Default: true* - Specify if user annotations should be shown in the report.

addPlatformFunctions *Default: true* - Specify if platform functions should be shown in the report.

createXmlReportFile *Default: false* - Specify if a xml report file should be created beside the html report file.

overwriteExistingReportFile *Default: true* - Specify if an existing report file should be overwritten.

openReportAfterGeneration *Default: true* - Specify if the created report file should be opened afterwards.

4.5.7 Saving a Project

`IProject.saveProject()` saves the current state including all model changes of the project to disc.

```
scriptTask('taskName', DV_APPLICATION) {  
  code {  
    // replace getDpaFileToLoad() with the path to the .dpa file to be loaded  
    def project = projects.openProject(getDpaFileToLoad()) {  
  
      // modify the opened project  
      transaction {  
        operations.activateModuleConfiguration(sipDefRef.EcuC)  
      }  
  
      // save the modified project  
      saveProject()  
    }  
  }  
}
```

Listing 4.61: Opening, modifying and saving a project

4.5.8 Opening AUTOSAR Files as Project

Sometimes it could be helpful to load AUTOSAR `arxml` files instead of a full-fledged DaVinci Configurator project. For example to modify the content of a file for test cases with the AutomationInterface, instead of using an XML editor.

You could load multiple `arxml` files into a temporary project, which allowed to read and write the loaded file content with the normal model APIs.

The following elements are loaded by default, without specifying the AUTOSAR files:

- ModuleDefinitions from the SIP: To allow the usage of the BswmdModel
- AUTOSAR standard definition: Refinement resolution of definitions

Caution: Some APIs and services may not be available for this type of project, like:

- Update workflow: You can't update a non existing project
- Validation: The validation is disabled by default
- Generation: The generators are not loaded by default

The method `parameterizeArxmlFileLoad(Closure)` allows to load multiple `arxml` files into a temporary project. The given `Closure` is used to customize the project's opening procedure by the `IOpenArxmlFilesProjectApi`.

The `arxml` file project is not opened until `openProject()` is called on the returned `IProjectRef`.

```
scriptTask('taskName', DV_APPLICATION) {
  code {
    def project = projects.parameterizeArxmlFileLoad {
      // Add here your arxml files to load
      arxmlFiles(arxmlFilesToLoad)
      rawAutosarDataMode = true
    }
    project.openProject {
      scriptLogger.info 'Project loaded and ready'
    }
  }
}
```

Listing 4.62: Opening Arxml files as project

Arxml Files Add `arxml` files to load with the method `arxmlFiles(Collection)`. Multiple files and method calls are allowed. The given values are converted to `Path` instances using `ScriptConverters.TO_SCRIPT_PATH` 4.12.2 on page 237.

Raw AUTOSAR Data Mode the method `setRawAutosarDataMode(boolean)` specifies whether or not to use the raw AUTOSAR data model.

Currently only this mode is supported! You have to set `rawAutosarDataMode = true`.

Note: In raw mode most of the provided services and APIs will be disabled, see below for details.

4.5.8.1 Raw AUTOSAR models as Project

Sometimes it could be helpful to create an empty AUTOSAR model or load single ARXML file. This is called raw mode (`IProjectHandlingRawApi`).

You could for example create an empty AUTOSAR model add elements and then export the snippet as an ARXML file.

In raw mode most of the provided services and APIs will disabled, like:

- Ecuc access
- BswmdModel support
- Generation
- Validation
- Workflow
- Domain API
- ChangeInspector
- and more

Empty AUTOSAR model The `emptyAutosarModel(String, Closure)` method creates a new empty AUTOSAR model, only containing one `MIARPackage` created by this method with the path `AsrPath`.

The passed AUTOSAR version defines the version of the AUTOSAR model, the version is specified in the format "4.2.1" or "4.0.3", ...

```
scriptTask("taskName", DV_APPLICATION) {
  code {
    def asrPkgToCreate = AsrPath.create("/MyPkg")
    def autosarVersion = "4.2.1"

    projects.raw.emptyAutosarModel(autosarVersion, asrPkgToCreate) {
      modelProject, myPkg ->
      // modelProject is the created IProject
      // myPkg is the MIARPackage specified above with asrPkgToCreate

      // Now you could use the model like any other project:
      transaction{
        // For example create a new sub package:
        def mySubPkg = myPkg.subPackage.byNameOrCreate("MySubPkg")
      }

      // Then export the package content
      def exportFolder = paths.getTempFolder()
      persistency.modelExport.exportModelTree(exportFolder, myPkg)
    }
  }
}
```

Listing 4.63: Create an empty AUTOSAR model

4.6 Model

4.6.1 Introduction

The model API provides means to retrieve AUTOSAR model content and to modify AUTOSAR data. This comprises Ecuc data (module configurations and their content) and System Description data.

In this chapter you'll first find a brief introduction into the model handling. Here you also find some simple cut-and-paste examples which allow starting easily with low effort. Subsequent sections describe more and more details which you can read if required.

Chapter 5 on page 249 may additionally be useful to understand detailed concepts and as a reference to handle special use cases.

4.6.2 Getting Started

The model API basically provides two different approaches:

- The **MDF model** is the low level AUTOSAR model. It stores all data read from AUTOSAR XML files. Its structure is based on the AUTOSAR MetaModel. In 5.1 on page 249 you find detailed information about this model.
- The **BswmdModel** is a model which wraps the MDF model to provide convenient and type-safe access to the Ecuc data. It contains, definition based classes for module configurations, containers, parameters and references. The class `CanGeneral` for example as type-safe implementation in contrast to the generic AUTOSAR class `MIContainer` in MDF.

It is strongly recommended to use the BswmdModel model to deal with Ecuc data because it simplifies scripting a lot.

4.6.2.1 Read the ActiveEcuc

This section provides some typical examples as a brief introduction for reading the Ecuc by means of the BswmdModel. See chapter 4.6.3.2 on page 85 for more details.

The following example specifies no types for the local variables. It therefore requires no import statements. A drawback on the other hand is that the type is only known at runtime and you have no type support in the IDE:

```
scriptTask("TaskName"){
  code {
    // Gets the module DefRef searching all definitions of this SIP
    def moduleDefRef = sipDefRef.EcuC

    // Creates all BswmdModel instances with this definition. A List<EcuC>
    // in this case.
    def ecucModules = bswmdModel(moduleDefRef)

    // Gets the EcucGeneral container of the first found module instance
    def ecuc = ecucModules.single
    def ecucGeneral = ecuc.ecucGeneral

    // Gets an (enum) parameter of this container
    def cpuType = ecucGeneral.CPUType
  }
}
```

Listing 4.64: Read with BswmdModel objects starting with a module DefRef (no type declaration)

In contrast to the listing above the next one implements the same behavior but specifies all types:

```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.EcuC
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.
    EcucGeneral
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.cputype.
    CPUType
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.cputype.
    ECPUType

scriptTask("TaskName"){
  code {
    // Gets the ecuc module configuration
    EcuC ecuc = bswmdModel(EcuC).single

    // Gets the EcucGeneral container
    EcucGeneral ecucGeneral = ecuc.ecucGeneral

    // Gets an enum parameter of this container
    CPUType cpuType = ecucGeneral.CPUType
    if (cpuType.value == ECPUType.CPU32Bit) {
      "Do something ..."
    }
  }
}
```

Listing 4.65: Read with BswmdModel objects starting with a module class (strong typing)

The `bswmdModel()` API takes an optional closure argument which is being called for each created `BswmdModel` object. This object is used as parameter of the closure:

```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.EcuC
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.cputype.
    ECPUType

scriptTask("TaskName"){
    code {
        // Executes the closure with all instances of this definition
        bswmdModel(EcuC) {
            // The related BswmdModel instance is parameter of this closure
            ecuc ->

            if (ecuc.ecucGeneral.CPUType.value == ECPUType.CPU32Bit) {
                "Do something ..."
            }
        }
    }
}
```

Listing 4.66: Read with `BswmdModel` objects with closure argument

Additionally to the `DefRef`, an already available MDF model object can be specified to create the related `BswmdModel` object for it:

```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.
    EcucGeneral
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.cputype.
    ECPUType

scriptTask("TaskName"){
    code {
        // Gets the MDF model instance of the Ecuc General container
        def container = mdfModel(EcucGeneral.DefRef).single

        // Executes the closure with this MDF object instance
        bswmdModel(container, EcucGeneral.DefRef) {
            // The related BswmdModel instance is parameter of this closure
            ecucGeneral ->

            if (ecucGeneral.CPUType.value == ECPUType.CPU32Bit) {
                "Do something ..."
            }
        }
    }
}
```

Listing 4.67: Read with `BswmdModel` object for an MDF model object

For a generic access to Ecu configuration structure (e.g. to use the script with different SIPs and different platforms/derivatives) the untyped model in combination with `SipDefRefs` can

be used. See chapter 4.6.3.4 on page 87 and 4.6.3.6 on page 88 for more details:

```
// Required imports
import com.vector.cfg.gen.core.bswmdmodel.GIContainer
import com.vector.cfg.gen.core.bswmdmodel.GIPParameter

scriptTask("TaskName"){
    code {

        GIContainer ecucGen = bswmdModel(sipDefRef.EcucGeneral).single

        GIPParameter<Boolean> ecuCSafeBswChecks = ecucGen.getParameter(sipDefRef
            .EcuCSafeBswChecks)

        if (ecuCSafeBswChecks.valueMdf.booleanValue()) {
            "Do something ..."
        }
    }
}
```

Listing 4.68: Read with BswmdModel objects with the untyped model (DefRefAPI)

4.6.2.2 Write the ActiveEcuc

This section provides some typical examples as a brief introduction for writing the Ecuc by means of the BswmdModel. See chapter 4.6.3.3 on page 86 for more details.

For the most cases the entry point for writing the ActiveEcuc is a (existing) module configuration object which can be retrieved with the `bswmdModel()` API. Because the model is in read-only state by default, every call to an API which creates or deletes elements has to be executed in a `transaction()` block.

```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.EcuC
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.
    EcucGeneral

scriptTask("TaskName"){
    code {
        transaction {
            // Gets the first found ecuc module instance
            EcuC ecuc = bswmdModel(EcuC).single

            //Gets the EcucGeneral container or create one if it is missing
            EcucGeneral ecucGeneral = ecuc.ecucGeneralOrCreate

            // Gets an boolean parameter of this container or create one if it
            // is missing
            def ecuCSafeBswChecks = ecucGeneral.ecuCSafeBswChecksOrCreate

            // Sets the parameter value to true
            ecuCSafeBswChecks.value = true
        }
    }
}
```

Listing 4.69: Write with BswmdModel required/optional objects

```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.EcuC
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecuchardware.
    ecuccoredefinition.EcucCoreDefinition

scriptTask("TaskName"){
    code {
        transaction {
            // Gets the first found ecuc module instance
            EcuC ecuc = bswmdModel(EcuC).single

            //Gets the EcucCoreDefinition list (creates ecucHardware if it is
            //missing)
            def ecucCoreDefinitions = ecuc.ecucHardwareOrCreate.
                ecucCoreDefinition

            //Adds two EcucCores
            EcucCoreDefinition core0 = ecucCoreDefinitions.createAndAdd("
                EcucCore0")
            EcucCoreDefinition core1 = ecucCoreDefinitions.createAndAdd("
                EcucCore1")

            if(ecucCoreDefinitions.exists("EcucCore0")) {
                //Sets EcucCoreId to 0
                ecucCoreDefinitions.byName("EcucCore0").ecucCoreId.setValue(0);
            }

            //Creates a new EcucCore by method 'byNameOrCreate'
            EcucCoreDefinition core2 = ecucCoreDefinitions.byNameOrCreate("
                EcucCore2");
        }
    }
}
```

Listing 4.70: Write with BswmdModel multiple objects

```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.EcuC
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.
    EcucGeneral

scriptTask("TaskName"){
    code {
        transaction {
            // Gets the first found ecuc module instance
            EcuC ecuc = bswmdModel(EcuC).single

            //Duplicates container 'EcucGeneral' and all its children
            EcucGeneral ecucGeneral_Dup = ecuc.ecucGeneral.duplicate()
        }
    }
}
```

Listing 4.71: Write with BswmdModel - Duplicate a container


```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.
    EcucGeneral

scriptTask("TaskName"){
    code {
        transaction {
            // Gets the first found ecuc module instance
            EcucGeneral ecucGeneral = bswmdModel(EcucGeneral).single

            //Deletes 'ecucGeneral' from model
            ecucGeneral.moRemove()

            //Checks if the container 'ecucGeneral' was removed from repository
            if(ecucGeneral.moIsRemoved()) {
                "Do something ..."
            }
        }
    }
}
```

Listing 4.72: Write with BswmdModel - Delete elements

4.6.2.3 Read the SystemDescription

This section contains only one example for reading the SystemDescription by means of the MDF model. See chapter 4.6.4.1 on page 90 for more details.

```
// Required imports
import com.vector.cfg.model.mdf.ar4x.swcomponenttemplate.datatype.
    dataprototypes.*
import com.vector.cfg.model.mdf.ar4x.commonstructure.datadefproperties.*

scriptTask("mdfModel", DV_PROJECT){
  code {
    // Create a type-safe AUTOSAR path
    def asrPath =
      AsrPath.create("/PortInterfaces/PiSignal_Dummy/DeSignal_Dummy",
        MIVariableDataPrototype)

    // Enter the MDF model tree starting at the object with this path
    mdfModel(asrPath) { MIVariableDataPrototype prototype ->

      // Traverse down to the swDataDefProps
      prototype.swDataDefProps { MISwDataDefProps swDataDefPropsParam ->

        // swDataDefPropsVariant is a List<MISwDataDefPropsConditional>
        // Execute the following for ALL elements of this List
        swDataDefPropsParam.swDataDefPropsVariant {
          MISwDataDefPropsConditional swDataDefPropsCondParam ->

            // Resolve the dataConstr reference (type MIDataConstr)
            def target = swDataDefPropsCondParam.dataConstr.refTarget

            // Get the swCalibrationAccess enum value
            def access = swDataDefPropsCondParam.swCalibrationAccess
            assert access == MISwCalibrationAccessEnum.NOT_ACCESSIBLE

          }
        }
      }
    }
  }
}
```

Listing 4.73: Read system description starting with an AUTOSAR path in closure

The same sample as above, but in property access style instead of closures:

```
// Create a type-safe AUTOSAR path
def asrPath =
  AsrPath.create("/PortInterfaces/PiSignal_Dummy/DeSignal_Dummy",
    MIVariableDataPrototype)

def prototype = mdfModel(asrPath)
def swDataDefPropsParam = prototype.swDataDefProps

// Execute the following for ALL swDataDefPropsVariant
swDataDefPropsParam.swDataDefPropsVariant.each{ swDataDefPropsCondParam ->
  // Resolve the dataConstr reference (type MIDataConstr)
  def target = swDataDefPropsCondParam.dataConstr.refTarget

  // Get the swCalibrationAccess enum value
  def access = swDataDefPropsCondParam.swCalibrationAccess
  assert access == MISwCalibrationAccessEnum.NOT_ACCESSIBLE
}
```

Listing 4.74: Read system description starting with an AUTOSAR path in property style

4.6.2.4 Write the SystemDescription

Writing the system description looks quite similar to the reading, but you have to use methods like (see chapter 4.6.4.3 on page 94 for more details):

- `get<Element>OrCreate()` or `<element>OrCreate`
- `createAndAdd()`
- `byNameOrCreate()`

You have to open a transaction before you can modify the MDF model, see chapter 4.6.6 on page 108 for details.

The following samples show the different types of write API:

```
transaction{
  // The asrPath points to an MIVariableDataPrototype
  mdfModel(asrPath) { dataPrototype ->
    dataPrototype.category = "NewCategory"
  }
}
```

Listing 4.75: Changing a simple property of an MIVariableDataPrototype

```
transaction{
  // The asrPath points to an MIVariableDataPrototype
  mdfModel(asrPath) {
    int count = 0
    assert adminData == null
    adminDataOrCreate {
      count++
    }
    assert count == 1
    assert adminData != null
  }
}
```

Listing 4.76: Creating non-existing member by navigating into its content with `OrCreate()`

```
transaction{
  // The asrPath points to an MIVariableDataPrototype
  mdfModel(asrPath) {
    assert adminData.sdg.empty

    adminData {
      sdg.createAndAdd(MISdg) {
        gid = "NewGidValue"
      }
    }

    assert adminData.sdg.first.gid == "NewGidValue"
  }
}
```

Listing 4.77: Creating new members of child lists with createAndAdd() by type

```
transaction{
  // The path points to an MISenderReceiverInterface
  mdfModel(asrPath) { sendRecIf ->
    def dataList = sendRecIf.dataElement

    def dataElement = dataList.byNameOrCreate("MyDataElement")
    dataElement.name = "NewName"

    def dataElement2 = dataList.byNameOrCreate("NewName")

    assert dataElement == dataElement2
  }
}
```

Listing 4.78: Updating existing members of child lists with byNameOrCreate() by type

4.6.3 BswmdModel in AutomationInterface

The AutomationInterface contains a generated BswmdModel. The BswmdModel provides classes for all Ecuc elements of the AUTOSAR model (ModuleConfigurations, Containers, Parameter, References). The BswmdModel is automatically generated from the SIP of the DaVinci Configurator.

You should use the BswmdModel whenever possible to access Ecuc elements of the AUTOSAR model. For accessing the Ecuc elements with the BswmdModel, see chapter 4.6.3.2.

For a detailed description of the BswmdModel, see chapter 5.3.1 on page 263.

4.6.3.1 BswmdModel Package and Class Names

The generated model is contained in the Java package `com.vector.cfg.automation.model.ecuc`. Every Module has its own sub packages with the name:

- `com.vector.cfg.automation.model.ecuc.<AUTOSAR-PKG>.<SHORTNAME>`
 - e.g. `com.vector.cfg.automation.model.ecuc.microsar.dio`
 - e.g. `com.vector.cfg.automation.model.ecuc.autosar.ecucdefs.can`

The packages then contain the class of the element like `Dio` for the module. The full path would be `com.vector.cfg.automation.model.ecuc.microsar.dio.Dio`.

For the container `DioGeneral` it would be:

- `com.vector.cfg.automation.model.ecuc.microsar.dio.diogeneral.DioGeneral`

To use the BswmdModel in script files, you have to write an import, when accessing the class:

```
//The required BswmdModel import of the class Dio
import com.vector.cfg.automation.model.ecuc.microsar.dio.Dio

scriptTask("TaskName"){
    code{
        Dio.DefRef //Usage of the class Dio
    }
}
```

Listing 4.79: BswmdModel usage with import

4.6.3.2 Reading with BswmdModel

The `bswmdModel()` methods provide entry points to start navigation through the `ActiveEcuc`. Client code can use the `Closure` overloads to navigate into the content of the found bswmd objects. Inside the called closure the related bswmd object is available as closure parameter.

The following types of entry points are provided here:

- `bswmdModel(WrappedTypedDefRef)` searches all objects with the specified definition and returns the BswmdModel instances.
- `bswmdModel(Class)` searches all objects with the specified class and returns the BswmdModel instances. Finds the same elements as above.

- `bswmdModel(MIHasDefinition, WrappedTypedDefRef)` returns the `BswmdModel` instance for the provided MDF model instance.
- `bswmdModel(Class, String)` searches all objects with the specified class and the matching path, see `IMdfModelApi.mdfModel(String)` or chapter 4.6.4.2 on page 92 for details.

When a closure is being used, the object found by `bswmdModel()` is provided as parameter when the closure is called.

The `bswmdModel()` method itself returns the found objects too. Retrieving the objects member and children (`Container`, `Parameter`) as properties or methods are then possible directly using the returned object.

Examples:

```
code {  
    // Gets the ecuc module configuration  
    EcuC ecuc = bswmdModel(EcuC).single  
}
```

Listing 4.80: Read with `BswmdModel` the `EcuC` module configuration

Or the same with a `DefRef` instead of a `Class`:

```
code {  
    // Gets the ecuc module configuration  
    EcuC ecuc = bswmdModel(EcuC.DefRef).single  
}
```

Listing 4.81: Read with `BswmdModel` the `EcuC` module configuration with `DefRef`

For more usage samples please see chapter 4.6.2.1 on page 75.

4.6.3.3 Writing with `BswmdModel`

As well as for reading with `BswmdModel` the entry points for writing with `BswmdModel` are also the `bswmdModel()` methods. There has to be at least one existing element in the `ActiveEcuC` from which the navigation can be started. For the most cases the entry point for writing the `ActiveEcuC` is the module configuration.

Example:

```
code {  
    transaction {  
        // Gets the ecuc module configuration  
        EcuC ecuc = bswmdModel(EcuC).single  
  
        //Gets the EcucGeneral container or create one if it is missing  
        EcucGeneral ecucGeneral = ecuc.ecucGeneralOrCreate  
    }  
}
```

Listing 4.82: Write with `BswmdModel` the `EcucGeneral` container

For more usage samples please see chapter 4.6.2.2 on page 79.

The model is in read-only state by default, so no objects could be created. For this reason all calls which creates or deletes elements has to be executed within a `transaction()` block.

See 5.3.1.9 on page 271 for more details to the BswmdModel write API.

4.6.3.4 Sip DefRefs

The `sipDefRef` API provides access to retrieve generated `DefRef` instances from the SIP without knowing the correct Java/Groovy imports. This is mainly useful in script files, where no IDE helps with the imports.

If you are using an Automation Script Project you can ignore this API and use the `DefRefs` provided by the generated classes, which is superior to this API, because they are typesafe and compile time checked. See 4.6.3.5 for details.

The listing show the usage of the `sipDefRef` API with short names and definition paths.

```
code{
    def theDefRef
    // You can call sipDefRef.<ShortName>
    theDefRef = sipDefRef.EcuGeneral
    theDefRef = sipDefRef.Dio
    theDefRef = sipDefRef.DioPort

    // Or you can use the [] notation
    theDefRef = sipDefRef["Dio"]
    theDefRef = sipDefRef["DioChannelGroup"]

    // If the DefRef is not unique you have to specify the full definition
    theDefRef = sipDefRef["/MICROSAR/EcuC/EcuGeneral"]
    theDefRef = sipDefRef["/MICROSAR/Dio"]
    theDefRef = sipDefRef["/MICROSAR/Dio/DioConfig/DioPort"]

    //Wildcards are also allowed
    theDefRef = sipDefRef["/[ANY]/Adc"]
}
```

Listing 4.83: Usage of the `sipDefRef` API to retrieve `DefRefs` in script files

You can also check if a certain `DefRef` exists in the currently loaded SIP. The method `hasDefRef(String)` returns `true`, if the definition exists. This is helpful to check for existence of the definition before using it to prevent e.g. `LinkageErrors`.

```
if(sipDefRef.hasDefRef("Dio")){
    // Now we know the Dio module exists in the SIP
    def theDefRef = sipDefRef.Dio
}
```

Listing 4.84: Check if a definition exists in the SIP

4.6.3.5 BswmdModel DefRefs

The generated `BswmdModel` classes contain `DefRef` instances for each definition element (Modules, Containers, Parameters). You should always prefer this API over the `Sip DefRefs`, because this is type safe and checked during compile time.

You can use the `DefRefs` by calling `<ModelClassName>.DefRef`. The literal `DefRef` is a `static constant` in the generated classes.

For simple parameters like Strings, Integer there is no generated class, so you have to call the method on its parent container like `<ParentContainerClass>.<ParameterShortName>DefRef`.

There exist generated classes for Parameters of type **Enumeration** and **References** to Container and therefore you have both ways to access the DefRef:

- `<ModelClassName>.DefRef` or
- `<ParentContainerClass>.<ParameterShortName>DefRef`

To use the DefRefs of the classes you have to add imports in script files, see chapter 4.6.3.1 on page 85 for required import names.

```
// Required imports
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.
    EcucGeneral
import com.vector.cfg.automation.model.ecuc.microsar.ecuc.ecucgeneral.cputype.
    CPUType

scriptTask("TaskName"){
    code {
        def theDefRef

        //DefRef from EcucGeneral container
        theDefRef = EcucGeneral.DefRef

        //DefRef from generated parameter
        theDefRef = CPUType.DefRef
        //Or the same
        theDefRef = EcucGeneral.CPUTypeDefRef

        //DefRef from simple parameter
        theDefRef = EcucGeneral.AtomicBitAccessInBitfieldDefRef
        theDefRef = EcucGeneral.DummyFunctionDefRef
    }
}
```

Listing 4.85: Usage of generated DefRefs from the bswmd model

4.6.3.6 Untyped Model with the DefRef API

The untyped Model provides an generic access to the Ecu configuration structure via DefRefs. There are NO generated classes for the Definition structure.

To use the untyped Model, the `SipDefRefs` can be used:


```
// Required imports
import com.vector.cfg.gen.core.bswmdmodel.GIModuleConfiguration
import com.vector.cfg.gen.core.bswmdmodel.GIContainer
import com.vector.cfg.gen.core.bswmdmodel.GIParameter

scriptTask("TaskName"){
    code {

        GIModuleConfiguration ecuc = bswmdModel(sipDefRef.EcuC).single

        // If the short name is not unique, you can use the full definition as
        // string (DefRef wildcards are allowed, e.g. [/ANY])

        GIContainer ecucPduCollection = ecuc.getSubContainer(sipDefRef["/
MICROSAR/EcuC/EcucPduCollection"])

        List<GIContainer> pdus = ecucPduCollection.getSubContainers(sipDefRef["
/MICROSAR/EcuC/EcucPduCollection/Pdu"])

        GIContainer pdu = pdus.get(0)

        GIParameter<Integer> pduLength = pdu.getParameter(sipDefRef["/MICROSAR/
EcuC/EcucPduCollection/Pdu/PduLength"])

        "PduLength: " + pduLength.getValueMdf().intValue()
    }
}
```

Listing 4.86: Usage of the untyped BswmdModel with SipDefRefs

See chapter 5.3.1.2 on page 265 for more details.

4.6.3.7 Switching from Domain Models to BswmdModel

You can switch from domain models to the BswmdModel, if the domain model is backed by ActiveEcuC elements. Please read the documentation of the different domain models, for whether this is possible for a certain domain model.

To switch from a domain model to the BswmdModel, you can call one of the methods for IHasModelObjects like, `bswmdModel(IHasModelObject, WrappedTypedDefRef)`. But you need a DefRef to get the type safe BswmdModel object. The domain model documents, which DefRef must be used for the certain domain model object.

```
// Domain model object of the communication domain
ICanController canDomainModel = ...

def canControllerBswmd = canDomainModel.bswmdModel(CanController.DefRef)

// Or use a closure
canDomainModel.bswmdModel(CanController.DefRef){ canControllerBswmd ->
    //Use the bswmd object
}
```

Listing 4.87: Switch from a domain model object to the corresponding BswmdModel object

4.6.4 MDF Model in AutomationInterface

Access to the MDF model is required in all areas which are not covered by the BswmdModel. This is the SystemDescription (non-Ecuc data) and details of the Ecuc model which are not covered by the BswmdModel.

The MDF model implements the raw AUTOSAR data model and is based on the AUTOSAR meta-model. For details about the MDF model, see chapter 5.1 on page 249.

For more details concerning the methods mentioned in this chapter, you should also read the JavaDoc sections in the described interfaces and classes.

4.6.4.1 Reading the MDF Model

The `mdfModel()` methods provide entry points to start navigation through the MDF model. Client code can use the `Closure` overloads to navigate into the content of the found MDF objects. Inside the called closure the related MDF object is available as closure parameter.

The following types of entry points are provided here:

- `mdfModel(TypedAsrPath)` searches an object with the specified AUTOSAR path
- `mdfModel(TypedDefRef)` searches all objects with the specified definition
- `mdfModel(Class)` searches all objects with the specified model type (meta class)
- `mdfModel(String)` searches for model elements with by different properties, see 4.6.4.2 on page 92 for details.

When a closure is being used, the object found by `mdfModel()` is provided as parameter when this closure is called:

```
code {  
    // Create a type-safe AUTOSAR path for a MIVariableDataPrototype  
    def asrPath =  
        AsrPath.create("/PortInterfaces/PiSignal_Dummy/DeSignal_Dummy",  
            MIVariableDataPrototype)  
  
    // Use the Java-Style syntax  
    def dataDefPropsMdf = mdfModel(asrPath).swDataDefProps  
  
    // Or use the Closure syntax to navigate  
  
    // Enter the MDF model tree starting at the object with this path  
    mdfModel(asrPath) {  
        // Parameter type is MIVariableDataPrototype:  
        dataPrototype ->  
  
        // Traverse down to the swDataDefProps  
        dataPrototype.swDataDefProps { MISwDataDefProps props  
            println "Do something ..."  
        }  
    }  
}
```

Listing 4.88: Navigate into an MDF object starting with an AUTOSAR path

The `mdfModel()` method itself returns the found object too. Retrieving the objects member (as property) is then possible directly using the returned object.

An alternative is using a closure to navigate into the MDF object and access its member there:

```
// Get an MDF object and get its members directly
def obj = mdfModel(asrPath)      // Type MIVariableDataPrototype
def props = obj.swDataDefProps  // Type MISwDataDefProps

// Get an MDF object and get its members using a closure
def props2
def obj2 = mdfModel(asrPath) {
    props2 = swDataDefProps
}

// The results are the same
assert obj == obj2
assert props == props2
```

Listing 4.89: Find an MDF object and retrieve some content data

Closures can be nested to navigate deeply into the MDF model tree:

```
mdfModel(asrPath) {
    int count = 0
    swDataDefProps {
        // swDataDefPropsVariant is a List<MISwDataDefPropsConditional>
        // Execute the following for ALL elements of this List
        List v = swDataDefPropsVariant {
            println "Do something ..."
            count++
        }
    }
    assert count >= 1
}
```

Listing 4.90: Navigating deeply into an MDF object with nested closures

When a member doesn't exist during navigation into a deep MDF model tree, the specified closure is not called:

```
mdfModel(asrPath) {
    int count = 0
    assert adminData == null
    adminData {
        count++
    }
    assert count == 0
}
```

Listing 4.91: Ignoring non-existing member closures

Retrieving a Child by Shortname or Definition There are multiple ways to retrieve children from an MDF model object, by the shortname or by its definition. The shortname can be used at the object with `childByName()` or at the child list with `byName()`.

childByName The `childByName(MIARObject, String, Closure)` method calls the passed Closure, if the request child exists. And returns the child `MIReferrable` below the specified object which has this relative AUTOSAR path (not starting with '/').

```

MContainer canGeneral = ...
canGeneral.childByName("CanMainFunctionRWPeriods"){ child->
    //Do something
}

```

Listing 4.92: Get a MReferrable child object by name

Lists containing Referrables

- The method `byName(String)` retrieves the child with the shortname, or `null`, if no child exists with this shortname.
- The method `byName(String, Closure)` retrieves the child with the shortname, or `null`, if no child exists with this shortname. Then the closure is executed with the child as closure parameter, if the child is not `null`. The child is finally returned.
- The method `byName(Class, String)` retrieves the child with the shortname and type, or `null`, if no child exists with this shortname.
- The method `byName(Class, String, Closure)` retrieves the child with the shortname and type, or `null`, if no child exists with this shortname. Then the closure is executed with the child as closure parameter, if the child is not `null`. The child is finally returned.
- The method `getAt(String)` all members with this relative AUTOSAR path. Groovy also allows to write `list["ShortnameToSearchFor"]`.

```

// The asrPath points to an MISenderReceiverInterface
def prototype = mdmModel(asrPath)

// byName() with shortname
def data1 = prototype.dataElement.byName("DeSignal_Dummy")
assert data1.name == "DeSignal_Dummy"

// byName() with type and shortname
def data2 = prototype.dataElement.byName(MIVariableDataPrototype, "DeSignal2")

// getAt() with shortname
def data3 = prototype.dataElement["DeSignal3"]

```

Listing 4.93: Retrieve child from list with `byName()`

Lists containing Parameters and Containers

- The method `getAt(TypedDefRef)` returns all children with the passed definition. Groovy also allows to write `list[DefRef]`.

4.6.4.2 Reading the MDF Model by String

The method `mdmModel(String)` searches for model elements by multiple ways at once. The method evaluates the specified property in the following order, it will continue, if nothing was found:

- AUTOSAR path, see `mdmModel(AsrPath)`, if the path begins with an `'/'` and the model element is no definition object (`MIParamConfMultiplicity`)
 - Example: `/ActiveEcuc/MyCan/MyContainer`

- ObjectLink, see `AsrObjectLink`, if the path begins with an `'/'` and the model element is no definition object (type `MIPParamConfMultiplicity`)
 - Example: `/ActiveEcuc/MyCan/MyContainer[0:ParameterDef]`
- Definition path, see `mdfModel(DefRef)`, if the path begins with an `'/'`
 - Example: `/MICROSAR/Can2`
- MICROSAR QUERY, if the path begins with `"msrq:"`. The defined MICROSAR QUERY filters the configuration elements by the given arbitrary filter code. The filter code must be evaluable to a `String`, `Boolean` or `Pattern`.

Examples:

- `msrq:/MICROSAR/Crc/CrcGeneral{ true }`
- `msrq:/MICROSAR/Crc/CrcGeneral{ ~"[\\w]*[1231]\\$" }`
- `msrq:/MICROSAR/Crc/CrcGeneral{ "CrcGeneral" }`
- `msrq:/MICROSAR/Crc/CrcGeneral{ it.getName() == "CrcGeneral" }`
- `msrq:/MICROSAR/Crc/CrcGeneral{ elem -> elem.getName() == "CrcGeneral" }`
- `msrq:/MICROSAR/Crc/CrcGeneral{ getName() == "CrcGeneral" }`
- `msrq:/MICROSAR/Crc/CrcGeneral{ it.getName().contains("CrcGeneral") }`
- `msrq:/[ANY]/Crc/CrcGeneral/{ true }`
- AUTOSAR path relative to the ActiveEcuc package, if it does not begin with an `'/'`
 - Example: `MyCan/MyContainer`
- Definition path as `DefRef` with wildcard `ANY` starting at the moduleConfiguration, if it does not begin with an `'/'`
 - Example: `Can/CanGeneral`
- Definition path as `DefRef` with wildcards, if it does begin with a valid wildcard like `/[ANY]`, see `EDefRefWildcard`.
 - Example: `/[ANY]/Can/CanGeneral`
- Shortname of an `MIARElement` if the path does not contain any `'/'`.
 - Example: `MyContainer`

This method does **not** limit the search to the ActiveEcuC, so it can be used to retrieve any object with the path `String`.

Remark: Even in post-build selectable variant models this method expects to find at most one object because script code will never run in an unfiltered context.

Caution: This is a potentially slow operation, you should use other `mdfModel()` methods, if possible. Because this method must traverse the whole model in some cases.

```
def moduleCfg1 = mdmModel("/ActiveEcuC/Can").single
def moduleCfg2 = mdmModel("Can").single
def moduleCfg3 = mdmModel("/[ANY]/Can").single
def parameter = mdmModel("/ActiveEcuC/MyCan/MyContainer[0:ParameterDef]").singleOrNull
```

Listing 4.94: Get elements with mdmModel(String)

The method `msrQuery(String)` searches for model elements by using an arbitrary filter code as closure. The method evaluates the specified pattern and returns the matching model elements. If nothing was found, it returns an empty list.

The input string defined as an MICROSAR QUERY, filters the configuration elements by the given arbitrary filter code. The arbitrary filter code must be defined inside of the `{ }`. The filter code must be evaluable to a `String`, `Boolean` or `Pattern`.

Examples:

- `/MICROSAR/Crc/CrcGeneral{ true }`
- `/MICROSAR/Crc/CrcGeneral{ ~"[\\w]*[1231]\\$" }`
- `/MICROSAR/Crc/CrcGeneral{ "CrcGeneral" }`
- `/MICROSAR/Crc/CrcGeneral{ it.getName() == "CrcGeneral" }`
- `/MICROSAR/Crc/CrcGeneral{ elem -> elem.getName() == "CrcGeneral" }`
- `/MICROSAR/Crc/CrcGeneral{ getName() == "CrcGeneral" }`
- `/MICROSAR/Crc/CrcGeneral{ it.getName().contains("CrcGeneral") }`
- `/[ANY]/Crc/CrcGeneral/{ true }`

4.6.4.3 Writing the MDF Model

Writing to the MDF model can be done with the same `mdmModel(AsrPath)` API, but you have to call specific methods to modify the model objects. The methods are divided in the following use cases:

- Change a simple property like `Strings`
- Change or create a single child relation (0:1)
- Create a new child for a child list (0:*)
- Update an existing child from a child list (0:*)

You have to open a transaction before you can modify the MDF model, see chapter 4.6.6 on page 108 for details about transactions.

4.6.4.4 Simple Property Changes

The properties of MDF model object simply be changed by with the setter method of the model object. Simple setter exist for example for the types:

- `String`
- `Enums`

- Integer
- Double

```
transaction{
    // The asrPath points to an MIVariableDataPrototype
    mdfModel(asrPath) { dataPrototype ->
        dataPrototype.category = "NewCategory"
    }
}
```

Listing 4.95: Changing a simple property of an MIVariableDataPrototype

4.6.4.5 Creating single Child Members (0:1)

For single child members (0:1), the automation API provides an additional method for the getter `get<Element>OrCreate()` for convenient child object creation. The methods will create the element, instead of returning `null`.

```
transaction{
    // The asrPath points to an MIVariableDataPrototype
    mdfModel(asrPath) {
        int count = 0
        assert adminData == null
        adminDataOrCreate {
            count++
        }
        assert count == 1
        assert adminData != null
    }
}
```

Listing 4.96: Creating non-existing member by navigating into its content with `OrCreate()`

If the compile time child type is not instatiatable, you have to provide the concrete type by `get<Element>OrCreate(Class childType)`.

```
transaction{
    // The asrPath points to an MIVariableDataPrototype
    mdfModel(asrPath) {
        introductionOrCreate(MIBlockLevelContent) { docuBlock ->
            assert docuBlock instanceof MIBlockLevelContent
        }
    }
}
```

Listing 4.97: Creating child member by navigating into its content with `OrCreate()` with type

4.6.4.6 Creating and adding Child List Members (0:*)

For child list members, the automation API provides many `createAndAdd()` methods for convenient child object creation. These method will always create the element, regardless if the same element (e.g. same `ShortName`) already exists.

If you want to update element see the chapter 4.6.4.7 on page 98.

```
transaction{
    // The asrPath points to an MIVariableDataPrototype
    mdfModel(asrPath) {
        assert adminData.sdg.empty

        adminData {
            sdg.createAndAdd(MISdg) {
                gid = "NewGidValue"
            }
        }

        assert adminData.sdg.first.gid == "NewGidValue"
    }
}
```

Listing 4.98: Creating new members of child lists with createAndAdd() by type

These methods are available — but be aware that not all of these methods are available for all child lists. Adding parameters, for example, is only permitted in the parameter child list of an `MIContainer` instance.

All Lists:

- The method `createAndAdd()` creates a new MDF object of the lists content type and appends it to this list. If the type is not instantiatable the method will throw a `ModelException`. The new object is finally returned.
- The method `createAndAdd(Closure)` creates a new MDF object of the lists content type and appends it to this list. If the type is not instantiatable the method will throw a `ModelException`. Then the closure is executed with the new object as closure parameter. The new object is finally returned.
- The method `createAndAdd(Class)` creates a new MDF object of the specified type and appends it to this list. The new object is finally returned.
- The method `createAndAdd(Class, Closure)` creates a new MDF object of the specified type and appends it to this list. Then the closure is executed with the new object as closure parameter. The new object is finally returned.
- The method `createAndAdd(Class, Integer)` creates a new MDF object of the specified type and inserts it to this list at the specified index position. The new object is finally returned.
- The method `createAndAdd(Class, Integer, Closure)` creates a new MDF object of the specified type and inserts it to this list at the specified index position. Then the closure is executed with the new object as closure parameter. The new object is finally returned.

Lists containing Referrables

- The method `createAndAdd(String)` creates a new child with the specified shortname and appends it to this list. The new object is finally returned. The used type is the lists content type. If the type is not instantiatable the method will throw a `ModelException`.
- The method `createAndAdd(String, Closure)` creates a new `MIReferrable` with the specified shortname and appends it to this list. Then the closure is executed with the new

object as closure parameter. The new object is finally returned. The used type is the lists content type. If the type is not instantiatable the method will throw a `ModelException`.

- The method `createAndAdd(Class, String)` creates a new `MReferrable` with the specified type and shortname and appends it to this list. The new object is finally returned.
- The method `createAndAdd(Class, String, Closure)` creates a new `MReferrable` with the specified type and shortname and appends it to this list. Then the closure is executed with the new object as closure parameter. The new object is finally returned.
- The method `createAndAdd(Class, String, Integer)` creates a new `MReferrable` with the specified type and shortname and inserts it to this list at the specified index position. The new object is finally returned.
- The method `createAndAdd(Class, String, Integer, Closure)` creates a new `MReferrable` with the specified type and shortname and inserts it to this list at the specified index position. Then the closure is executed with the new object as closure parameter. The new object is finally returned.

Lists containing Parameters and Containers

- The method `createAndAdd(TypedDefRef)` creates a new `Ecuc` object (container or parameter) with the specified definition and appends it to this list. The new object is finally returned.
- The method `createAndAdd(TypedDefRef, Closure)` creates a new `Ecuc` object (container or parameter) with the specified definition and appends it to this list. Then the closure is executed with the new object as closure parameter. The new object is finally returned.
- The method `createAndAdd(TypedDefRef, Integer)` creates a new `Ecuc` object (container or parameter) with the specified definition and inserts it to this list at the specified index position. The new object is finally returned.
- The method `createAndAdd(TypedDefRef, Integer, Closure)` creates a new `Ecuc` object (container or parameter) with the specified definition and inserts it to this list at the specified index position. Then the closure is executed with the new object as closure parameter. The new object is finally returned.
- The method `byDefOrCreate(TypedDefRef)` retrieves the child with the passed definition, if the child exists and has a definition multiplicity of 0:1 or 1:1. Otherwise a new child is created. The definition and shortname (using the definition name) are automatically set before returning the new child. So this method will always create a new child if the upper multiplicity is greater than 1.

Lists containing Containers

- The method `createAndAdd(TypedDefRef, String)` creates a new container with the specified definition and shortname and appends it to this list. The new container is finally returned.
- The method `createAndAdd(TypedDefRef, String, Closure)` creates a new container with the specified definition and shortname and appends it to this list. Then the closure is executed with the new container as closure parameter. The new container is finally returned.

- The method `createAndAdd(TypedDefRef, String, Integer)` creates a new container with the specified definition and shortname and inserts it to this list at the specified index position. The new container is finally returned.
- The method `createAndAdd(TypedDefRef, String, Integer, Closure)` creates a new container with the specified definition and shortname and inserts it to this list at the specified index position. Then the closure is executed with the new container as closure parameter. The new container is finally returned.

4.6.4.7 Updating existing Elements

For child list members, the automation API provides many `byNameOrCreate()` methods for convenient child object update and creation on demand. These method will create the element if id does not exists, or return the existing element.

```
transaction{
  // The path points to an MISenderReceiverInterface
  mdfModel(asrPath) { sendRecIf ->
    def dataList = sendRecIf.dataElement

    def dataElement = dataList.byNameOrCreate("MyDataElement")
    dataElement.name = "NewName"

    def dataElement2 = dataList.byNameOrCreate("NewName")

    assert dataElement == dataElement2
  }
}
```

Listing 4.99: Updating existing members of child lists with `byNameOrCreate()` by type

These methods are available — but be aware that not all of these methods are available for all child lists. Updating container, for example, is only permitted in the parameter child list of an `MIContainer` instance.

Lists containing Referrables

- The method `byNameOrCreate(String)` retrieves the child with the passed shortname, or creates the child, if it does not exist. The shortname is automatically set before returning the new child.
- The method `byNameOrCreate(TypedDefRef, String,Closure)` retrieves the child with the passed shortname, or creates the child, if it does not exist. The shortname is automatically set before returning the new child. Then the closure is executed with the child as closure parameter. The child is finally returned.
- The method `byNameOrCreate(Class, String)` retrieves the child with the passed type and shortname, or creates the child, if it does not exist. The shortname is automatically set before returning the new child.
- The method `byNameOrCreate(Class, String,Closure)` retrieves the child with the passed type and shortname, or creates the child, if it does not exist. The shortname is automatically set before returning the new child. Then the closure is executed with the child as closure parameter. The child is finally returned.

Lists containing Containers

- The method `byNameOrCreate(TypedDefRef, String)` retrieves the child with the passed definition and shortname, or creates the child, if it does not exist. The definition and shortname are automatically set before returning the new child.
- The method `byNameOrCreate(TypedDefRef, String, Closure)` retrieves the child with the passed definition and shortname, or creates the child, if it does not exist. The definition and shortname are automatically set before returning the new child. Then the closure is executed with the child as closure parameter. The child is finally returned.

4.6.4.8 Deleting Model Objects

The method `delete(MIObject)` deletes the specified object from the model. This method must be called inside a transaction because it changes the model content.

Special case: If this method is being called on an active module configuration, it actually calls `IOOperations.deactivateModuleConfiguration(MIModuleConfiguration)` to deactivate the module correctly.

```
// MIParameterValue param = ...

transaction {
    assert !param.isDeleted()
    param.delete()
    assert param.isDeleted()
}
```

Listing 4.100: Delete a parameter instance

The method `moRemove()` does the same as `delete()`. For details about model object deletion and access to deleted objects, read section 5.1.7.4 on page 253 ff.

IsDeleted The `isDeleted(MIObject)` method returns `true` if the specified object has been deleted (removed) from the MDF model, or is invisible in the current active `IModelView`.

```
MIObject obj = ...
if (!obj.isDeleted()) {
    work with obj ...
}
```

Listing 4.101: Check is a model instance is deleted

Note: The return value is dependent on the current active thread and the current active `IModelView` in this thread!

The method `moIsRemoved()` does the same as `isDeleted()`.

4.6.4.9 Duplicating Model Objects

The `duplicate(MIObject)` method copies (clones) a complete MDF model sub-tree and adds it as child below the same parent.

- The source object must have a parent. The clone will be added to the same MDF feature below the same parent then

- AUTOSAR UUIDs will not be cloned. The clone will contain new UUIDs to guarantee unambiguity

This method can clone any model sub-tree, also see `IOperations.deepClone(MIObject, MIObject)` for details.

Note: This operation must be executed inside of a transaction.

```
// MIContainer container = ...
transaction {
    def newCont = container.duplicate()
    // The duplicated container newCont
}
```

Listing 4.102: Duplicates a container under the same parent

4.6.4.10 Special properties and extensions

asrPath The `getAsrPath(MIReferrable)` method returns the AUTOSAR path of the specified object.

```
MIContainer canGeneral = ...
AsrPath path = canGeneral.asrPath
```

Listing 4.103: Get the AsrPath of an MIReferrable instance

See chapter 5.4.2 on page 275 for more details about AsrPaths.

asrObjectLink The `getAsrObjectLink(MIARObject)` method returns the `AsrObjectLink` of the specified object.

```
MIParameValue param = ...
AsrObjectLink link = param.asrObjectLink
```

Listing 4.104: Get the AsrObjectLink of an AUTOSAR model instance

See chapter 5.4.3 on page 276 for more details about AsrObjectLinks.

defRef The `getDefRef()` method returns the `DefRef` of the model object.

```
MIParameValue param = ...
DefRef defRef = param.defRef
```

Listing 4.105: Get the DefRef of an Ecuc model instance

The `MIParameValue.setDefRef(DefRef)` method sets the definition of this parameter to the `defRef`.

```
MIParameValue param = ...
DefRef newDefinition = ...
param.defRef = newDefinition
```

Listing 4.106: Set the DefRef of an Ecuc model instance

If the specified `DefRef` has a wildcard, the parameter must have a parent to calculate the absolute definition path - otherwise a `ModelCeHasNoParentException` will be thrown.

If it has no wildcard and no parent, the absolute definition path of the defRef will be used.

If the parameter has a parent or and parents definition does not match the defRefs parent definition, this method fails with `InconsistentParentDefinitionException`.

The `MIContainer.setDefRef(DefRef)` method sets the definition of this container to the defRef.

See chapter 5.4.4 on page 276 for more details about `DefRefs`.

ceState The `CeState` is an object which aggregates states of a related MDF object. Client code can e.g. check with the `CeState` if an `Ecuc` object has a related pre-configuration value. The `getCeState(MIObject)` method returns the `CeState` of the specified model object.

```
MIPParameterValue param = ...
IPParameterStatePublished state = param.ceState
```

Listing 4.107: Get the `CeState` of an `Ecuc` parameter instance

See chapter 5.4.5 on page 279 for more details about the `CeState`.

ceState - User-defined Flag The method `isUserDefined()` returns `true`, if the `ecuc` configuration element like parameters is flagged as user-defined.

```
MIPParameterValue param = ...
def flag = param.ceState.userDefined
```

Listing 4.108: Retrieve the user-defined flag of an `Ecuc` parameter in Groovy

The method `setUserDefined(boolean)` sets or removes the user-defined flag of a `ecuc` configuration element like parameters.

Note: This method must be executed inside a transaction because it modifies the model state.

```
MIPParameterValue param = ...
transaction {
    param.ceState.userDefined = true
}
```

Listing 4.109: Set an `Ecuc` parameter instance to user defined

EcuConfigurationAccess and EcucDefinitionAccess The Groovy automation interface also provides special access methods for `Ecuc` elements (module configurations, container and parameter) to the

- `EcuConfigurationAccess` (see 5.5.1 on page 281)
- `EcucDefinitionAccess` (see 5.5.2 on page 285)

The `getEcucDefinition()` method returns the `IEcucDefinition` of the model object.

```
MIPParameterValue param = ...
IEcucDefinition definition = param.ecucDefinition
```

Listing 4.110: Get the `IEcucDefinition` of an `Ecuc` model instance

The `getEcuConfiguration()` method returns the `IEcucHasDefinition` of the model object.

```
MIParameterValue param = ...
IEcuHasDefinition cfg = param.ecuConfiguration
```

Listing 4.111: Get the IEcuHasDefinition of an Ecuc model instance

These methods are the same as for bswmd model objects.

4.6.4.11 Reverse Reference Resolution - ReferencesPointingToMe

You can resolve all references in the MDF model in the reverse direction, so you can start at a reference target and navigate to all references which point to the reference target.

referencesPointingToMe The `getReferencesPointingToMe()` method returns all reference parameters in the active ecuc pointing to specified target (`MIReferredable`) object. It returns an empty collection if the target object is invisible or removed.

The `getReferencesPointingToMe(DefRef)` method returns all reference parameters in the active ecuc with the specified definition (`DefRef`) pointing to the specified target (`MIReferredable`) object. It returns an empty collection if the target object is invisible, removed or the specified definition is null.

```
List<MIReferenceValue> refs = container.referencesPointingToMe
//Or
DefRef refDefRef = // DefRef to reference parameter
def refByDef = container.getReferencesPointingToMe(refDefRef)
```

Listing 4.112: referencesPointingToMe sample

systemDescriptionObjectsPointingToMe The method `getSystemDescriptionObjectsPointingToMe()` returns all objects located in the system description which are parent objects of references pointing to the specified target. It returns an empty collection if the object is invisible or removed.

```
List<MIObject> references =
    systemDescElement.systemDescriptionObjectsPointingToMe
```

Listing 4.113: systemDescriptionObjectsPointingToMe sample

4.6.4.12 Derived Containers

The `MIHasContainer.getDerived()` method provides access to derived container information. The method returns a `IDerivedElementInfo` object corresponding to the model element.

The `IDerivedElementInfo` can be used to retrieve information about element or delete it:

- `getRemovedDerivedSubContainers()`: Retrieves the removed children, which could be used to restore them the children
- `isDerived()`: returns `true` if the element is derived
- `delete()`: deletes the element regardless if it is derived or not

```
container.derived.isDerived()

// Or
container.derived{
    boolean isDerivedFlag = isDerived()
    def removedList = getRemovedDerivedSubContainers()
}
```

Listing 4.114: Derived Container API access

Deletion of Derived Containers The method `delete()` deletes the `MIContainer` regardless, if it is derived or not.

This method behaves as follows:

- If the container is a derived container it calls the derived container deletion operation to delete it.
- All other containers will be deleted by means of `moRemove()`

```
transaction{
    container.derived.delete()
}
```

Listing 4.115: Delete a derived container unconditionally

4.6.4.13 AUTOSAR Root Object

The `getAUTOSAR()` method returns the AUTOSAR root object (the root object of the MDF model tree of AUTOSAR data).

```
MIAUTOSAR root = AUTOSAR
```

Listing 4.116: Get the AUTOSAR root object

4.6.4.14 ActiveEcuC

The activeEcuC access methods provide access to the module configurations of the EcuC model.

```
// Get the modules as Collection<MIModuleConfiguration>
Collection modules = activeEcuC.allModules
```

Listing 4.117: Get the active EcuC and all module configurations

```
// Iterate over all module configurations
activeEcuc {
    int count = 0
    allModules.each { moduleCfg ->
        count++
    }
    assert count > 1
}
```

Listing 4.118: Iterate over all module configurations

```
activeEcuc {
    // Parameter type is IActiveEcuc
    ecuc ->

    def defRef = DefRef.create(EDefRefWildcard.AUTOSAR, "EcuC")

    // Get the modules as Collection<MIModuleConfiguration>
    Collection foundModules = ecuc.modules(defRef)
    assert !foundModules.empty
}
```

Listing 4.119: Get module configurations by definition

4.6.4.15 DefRef based Access to Containers and Parameters

The Groovy automation interface for the MDF model provides some overloaded access methods for

- `MIModuleConfiguration.getSubContainer()`
- `MIContainer.getSubContainer()`
- `MIContainer.getParameter()`

to offer convenient filtering access to the subContainer and parameter child lists.

```
activeEcuc {
    // Parameter type is IActiveEcuc
    ecuc ->

    def module = ecuc.modules(EcuC.DefRef).first

    // Get containers as List<MIContainer>
    def containers = module.subContainer(EcucGeneral.DefRef)

    // Get parameters as List<MIParameterValue>
    def cpuType = containers.first.parameter(CPUType.DefRef)

    assert cpuType.size() == 1
}
```

Listing 4.120: Get subContainers and parameters by definition

4.6.4.16 Ecuc Parameter and Reference Value Access

The Groovy automation interface also provides special access methods for Ecuc parameter values. These methods are implemented as extensions of the Ecuc parameter and value types and can therefore be called directly at the parameter or reference instance.

Value Checks

- `hasValue(MIPParameterValue)`
returns `true` if the parameter (or reference) has a value.
- `containsBoolean(MINumericalValue)`
returns `true` if the parameter value contains a valid boolean with the same semantic as `IModelAccess.containsBoolean(MINumericalValue)`.

Call this method in advance

to guarantee that `getAsBoolean(MINumericalValueVariationPoint)` doesn't lead to errors.

- `containsInteger(MINumericalValue)`
returns `true` if the parameter value contains a valid integer with the same semantic as `IModelAccess.containsInteger(MINumericalValue)`.

Call this method in advance

to guarantee that `getAsInteger(MINumericalValueVariationPoint)` doesn't lead to errors.

- `containsDouble(MINumericalValue)`
returns `true` if the parameter value contains a valid double (AUTOSAR float) with the same semantic as `IModelAccess.containsFloat(MINumericalValue)`.

Call this method in advance

to guarantee that `getAsDouble(MINumericalValueVariationPoint)` doesn't lead to errors.

```
// MINumericalValue param = ...

if (!param.hasValue()) {
    scriptLogger.warn "The parameter has no value!"
}

if (param.containsInteger()) {
    int value = param.value.asInteger
}
```

Listing 4.121: Check parameter values

Parameters

- `getAsLong(MINumericalValueVariationPoint)` returns the value as native `long`.
Throws `NumberFormatException` if the value string doesn't represent an integer value.
Throws `ArithmeticException` if the value will not exactly fit in a `long`.
- `getAsInteger(MINumericalValueVariationPoint)` returns the value as native `int`.

Throws `NumberFormatException` if the value string doesn't represent an integer value.
 Throws `ArithmeticException` if the value will not exactly fit in an `int`.

- `getAsBigInteger(MINumericalValueVariationPoint)` returns the value as `BigInteger`.

Throws `NumberFormatException` if the value string doesn't represent an integer value.

- `getAsDouble(MINumericalValueVariationPoint)` returns the value as `Double`.

Throws `NumberFormatException` if the value string doesn't represent a float value.

- `getAsBigDecimal(MINumericalValueVariationPoint)` returns the value as `BigDecimal`.

Note: This method will possibly return `MBigDecimal.POSITIVE_INFINITY`, `MBigDecimal.NEGATIVE_INFINITY` or `MBigDecimal.NaN`.

If it is necessary to do computations with these special numbers, use `getAsDouble(MINumericalValueVariationPoint)` instead.

Throws `NumberFormatException` if the value string doesn't represent a float value.

- `getAsBoolean(MINumericalValueVariationPoint)` returns the value as `Boolean`.

Throws `NumberFormatException` if the value string doesn't represent a boolean value.

- `asCustomEnum(MITextualValue, Class)` returns the value of the enum parameter as a custom enum literal. If the `Class` `destClass` implements the `IModelEnum` interface, the literals are mapped via these information form the `IModelEnum` interface. Read the JavaDoc of `IModelEnum` for more details.

```
// MINumericalValue param = ...
// MINumericalValueVariationPoint is the type of param.value

long longValue = param.value.asLong
assert longValue == 10

int intValue = param.value.asInteger
assert intValue == 10

BigInteger bigIntValue = param.value.asBigInteger
assert bigIntValue == BigInteger.valueOf(10)

Double doubleValue = param.value.asDouble
assert Math.abs(doubleValue-10.0) <= 0.0001
```

Listing 4.122: Get integer parameter value

References

- `getAsAsrPath(MIARRef)` returns the reference value as AUTOSAR path.
- `getAsAsrPath(MIReferenceValue)` returns the reference parameters value as AUTOSAR path.
- `getRefTarget(MIReferenceValue)` returns the reference parameters target object (the object referenced by this parameter). It returns `null` if the target cannot be resolved or the reference parameter doesn't contain a value reference.

```
// MIReferenceValue refParam = ...

def asrPath1 = refParam.asAsrPath
def asrPath2 = refParam.value.asAsrPath
assert asrPath1 == asrPath2

String pathString = refParam.value.value
assert asrPath1.autosarPathString == pathString

def target1 = refParam.refTarget
def target2 = refParam.value.refTarget
assert target1 == target2
```

Listing 4.123: Get reference parameter value

4.6.5 SystemDescription Access

The systemDescription API provides methods to retrieve system description data like the path to the flat extract or the flat map instance.

It is grouped by the AUTOSAR version. So the `getAutosar4()` methods provides access to AUTOSAR 4 model elements.

The `getPaths()` provides common paths to elements like:

- FlatMap path
- FlatExtract path
- FlatCompositionType path

```
AsrPath flatExtractPath = systemDescription.paths.flatExtractPath
AsrPath flatMapPath = systemDescription.paths.flatMapPath
```

Listing 4.124: Get the FlatExtract and FlatMap paths by the SystemDescription API

```
systemDescription{
  autosar4{
    flatExtract.ifPresent{ theFlatExtract ->
      // do something with the flatMap
    }
  }
}
// Or in property style
def theFlatExtractOpt = systemDescription.autosar4.flatExtract
if(theFlatExtractOpt){
  def theFlatExtract = theFlatExtractOpt.get()
}
```

Listing 4.125: Get FlatExtract instance by the SystemDescription API

4.6.6 Transactions

Model changes must always be executed within a transaction. The automation API provides some simple means to execute transactions.

For details about transactions read 5.1.7 on page 253.

```
scriptTask("TaskName", DV_PROJECT){
    code {
        transaction{
            // Your transaction code here
        }
    }
}
```

Listing 4.126: Execute a transaction

```
scriptTask("TaskName", DV_PROJECT){
    code {
        transaction("Transaction name") {
            // The transactionName property is available inside a transaction
            String name = transactionName
        }
    }
}
```

Listing 4.127: Execute a transaction with a name

The transaction name has no additional semantic. It is only be used for logging and to improve error messages.

Nested Transactions If you open a transaction inside of a transaction the inner transaction is ignored and it is as no transaction call was done. So be aware that nested transactions are no real transaction, which leads to the fact the these nested transactions can not be undone.

If you want to know whether a transaction is already running, see the transactions API below.

4.6.6.1 Transactions API

The Transactions API with the keyword **transactions** provides access to running transactions or the transaction history.

You can use method `isTransactionRunning()` to check if a transaction is currently running. The method returns `true`, if a transaction is running in the current `Thread`.

```

scriptTask("TaskName", DV_PROJECT){
    code {
        // Switch to the transactions API
        transactions{

            //Check if a transaction is running
            assert isTransactionRunning() == false

            // Open a transaction
            transaction{
                // Now a transaction is running
                assert isTransactionRunning() == true
            }
        }
        // Or the short form
        transactions.isTransactionRunning()
    }
}

```

Listing 4.128: Check if a transaction is running

TransactionHistory The transaction history API provides some methods to handle transaction undo and redo. This way, complex model changes can be reverted quite easily.

- The `undo()` method executes an undo of the last transaction. If the last transaction frame cannot be undone or if the undo stack is empty this method returns without any changes.
- The `undoAll()` method executes undo until the transaction stack is empty or an undoable transaction frame appears on the stack.
- The `redo()` method executes an redo of the last undone transaction. If the last undone transaction frame cannot be redone or if the redo stack is empty this method returns without any changes.
- The `canUndo()` method returns `true` if the undo stack is not empty and the next undo frame can be undone. This method changes nothing but you can call it to find out if the next `undo()` call would actually undo something.
- The `canRedo()` method returns `true` if the redo stack is not empty and the next redo frame can be redone. This method changes nothing but you can call it to find out if the next `redo()` call would actually redo something.

```

scriptTask("TaskName", DV_PROJECT){
    code {
        transaction("TransactionName") {
            // Your transaction code here
        }

        transactions{
            assert transactionHistory.canUndo()

            transactionHistory.undo()

            assert !transactionHistory.canUndo()
        }
    }
}

```

Listing 4.129: Undo a transaction with the transactionHistory

```
scriptTask("TaskName", DV_PROJECT){
    code {
        transaction("TransactionName") {
            // Your transaction code here
        }

        transactions{
            transactionHistory.undo()

            assert transactionHistory.canRedo()

            transactionHistory.redo()

            assert !transactionHistory.canRedo()
        }
    }
}
```

Listing 4.130: Redo a transaction with the transactionHistory

4.6.6.2 Operations

The model operations implement convenient means to execute complex model changes like AUTOSAR module activation or cloning complete model sub-trees. The operations API is available inside of a transaction with the keyword **operation**. The class **IOperations** defines the available methods.

- The method **activateModuleConfiguration(DefRef)** activates the specified module configuration. This covers:
 - Creation of the module including the reference in the ActiveEcuC (the ECUC-VALUE-COLLECTION)
 - Creation of mandatory containers and parameters (lower multiplicity > 0)
 - Applying the recommended configuration
 - Applying the pre-configuration values

Note: If the DefRef has a wildcard, **activateModuleConfiguration(DefRef)** tries to activate the most specific module definition matching the wildcard, if unique. If it is not unique the method will throw an exception. For example the DefRef **/[ANY]/Dio** will activate the **/MICROSAR/Dio** instead of **/AUTOSAR/EcuDefs/Dio**.

```
transaction{
    // Activates the Dio module
    operations.activateModuleConfiguration(sipDefRef.Dio)
}
```

Listing 4.131: Activation of the ModuleConfiguration Dio

- The method **deactivateModuleConfiguration(MIModuleConfiguration)** deletes the specified module configuration from the model. In case of a split configuration, the related persistency location is being removed from the project settings. In XML file base configurations, the related file is being deleted during the next project save if it doesn't contain configuration objects anymore.

If the module configuration is referenced from the active-ECUC this link is being removed too.

- The method `changeBswImplementation(MIModuleConfiguration, MIBswImplementation)` changes the BSW-implementation of a module configuration including the definition of all contained containers and parameters.
- `setConfigurationVariantOfAllModuleConfigurations(EEcucConfigurationVariant)` sets the implementation configuration variant of all active `MIModuleConfiguration`. If a module configuration does not support the requested variant it is ignored.

Supported enum values are:

- `com.vector.cfg.model.access.ecuconfiguration.EEcucConfigurationVariant`
 - * `VARIANT_PRE_COMPILE`
 - * `VARIANT_LINK_TIME`
 - * `VARIANT_POST_BUILD_LOADABLE`

This is for *post-build loadable* only! See the method `setConfigurationVariant()` in class `IEcucModuleConfiguration` for details.

- The `deepClone(MIObject, MIObject)` operation copies (clones) a complete MDF model sub-tree and adds it as child below the specified parent.
 - The source object must have a parent. The clone will be added to the same MDF feature below the destination parent then
 - AUTOSAR UUIDs will not be cloned. The clone will contain new UUIDs to guarantee unambiguousness
- The method `createModelObject(Class)` creates a new element of the passed modelClass (meta class). The modelObject must be added to the whole AUTOSAR model, before finishing the transaction.
- The method `createUniqueMappedAutosarPackage()` can be used to create new MIAR-Packages in new arxml files. It creates an new instance of the specified AUTOSAR package and adds it to the model tree. All non-existing parent packages will be created too.

The new package (including new created parent packages) will be mapped uniquely to the specified location (Path and AUTOSAR version).

4.6.7 Model Synchronization

The Model synchronization provides operation to solve and synchronize common model related items. The model synchronization API is available inside of an active project with the keyword `modelSynchronization`. The class `IModelSynchronizationApi` defines the available methods.

The method `synchronize()` synchronizes the model for all registered model synchronization elements like validations and other operations. The method will open a transaction, if `isSynchronizationRequired()` returns `true`, otherwise this method does nothing.

```
// Execute the model synchronization
modelSynchronization.synchronize()

//Or more elaborated, but means the same
modelSynchronization{
    if(synchronizationRequired){
        synchronize()
    }
}
```

Listing 4.132: Model synchronization inside an open project

4.6.8 PreBuild and PostBuild Variance (Post-build selectable)

The variance access API is the entry point for convenient access to variant AUTOSAR model content. It provides means to filter variant model content and access variant specific data.

The DaVinci Configurator supports two types of variance:

- PostBuild variance (Post-build selectable)
- PreBuild variance

For details about PostBuild variance and model views read 5.2 on page 255.

4.6.8.1 Investigate Project Variance

The projects variance can be analyzed using the `variance` keyword. These methods can be called then:

- The method `getCurrentlyActiveView()` returns the currently active model view.
- The method `variantView(String)` returns the `IPredefinedVariantView` with the given name. This may be a PreBuild or PostBuild view.

```
scriptTask("TaskName", DV_PROJECT){
    code{
        // Activates the DoorLeftFront variant
        variance.variantView("DoorLeftFront").activeWith{
            // Now all MDF model accesses are executed in the variant "
            DoorLeftFront"
        }
    }
}
```

Listing 4.133: Retrieve and use a variant view by name


```

scriptTask("TaskName", DV_PROJECT){
    code{
        def activeView1 = variance.currentlyActiveView
        assert activeView1 instanceof IPostBuildInvariantValuesView

        // ... or with a closure
        variance {
            def activeView2 = currentlyActiveView
            assert activeView1 == activeView2
            assert activeView1 == invariantValuesView

            // Get number of variants
            int num = allVariantViews.size()
            assert num == 4
        }
    }
}

```

Listing 4.134: The default view is the IPostBuildInvariantValuesView

Investigate Project Variance - PostBuild

- The method `hasPostBuildVariance()` returns `true` if the active project contains post-build variants.
- The method `getPostBuildInvariantValuesView()` returns the PostBuild invariant values view. This view contains objects which are not variant (Object or parent have no VariationPoint) or the values in all variants are equal.
- The method `getPostBuildInvariantEcucDefView()` returns the PostBuild invariant Ecuc definition view. This view contains the same objects as the invariant values view but excludes all objects which, by (EcuC / BSWMD) definition, support variance. Using this view you can avoid dealing with objects which are accidentally equal by value (in your test configurations) but potentially can be different because they support variance.
- The method `getAllPostBuildVariantViews()` returns the model views of all PostBuild predefined variants defined in the evaluated variant set. It never returns `null`. If the project contains no PostBuild variants, the result will be an empty list.

The order of variant views returned is deterministic. It is the natural order of the names of the variants defined in the evaluated variant set.

- The method `getAllPostBuildVariantViewsOrInvariant()` returns the same as the method `getAllPostBuildVariantViews()` if the project contains PostBuild variants. If the project contains no PostBuild variants (see `hasPostBuildVariance()`) the method returns a list containing only the `IPostBuildInvariantValuesView`.

This helps to create code working with both variant and non-variant projects.

4.6.8.2 Variant Model Objects

The following model object extensions provide convenient means to investigate model object variance in detail.

- The method `activeWith(IModelView, Closure)` executes code under visibility of the specified model view.

- The method `isModelInvariant(MIObject)` returns `true` if the object and all its parents has no variation point conditions. If this is `true`, this model object instance is visible in all variant views.
- The method `isVisible(MIObject)` returns `true` if the object is visible in the current model view.
- The method `isVisibleInModelView(MIObject, IModelView)` returns `true` if the object is visible in the specified model view.
- The method `asViewedModelObject(MIObject)` returns a new `IViewedModelObject` instance using the currently active view.
- The method `getVariantSiblings(MIObject)` returns MDF object instances representing the same object but in all variants.

For details about the sibling semantic see 5.2.1.3 on page 257.

- The method `getVariantSiblingsWithoutMyself(MIObject)` returns the same collection as `getVariantSiblings(MIObject)` but without the specified object.

```
// IPostBuildPredefinedVariantView viewDoorLeftFront = ...
// MIParameterValue variantParameter = ...

viewDoorLeftFront.activeWith {
    assert variance.currentlyActiveView == viewDoorLeftFront

    // The parameter instance is not visible in all variants ...
    assert !variantParameter.isModelInvariant()

    // ... but all variants have a sibling with the same value
    assert variantParameter.isPostBuildValueInvariant()
}
```

Listing 4.135: Execute code in a model view

Variant Model Objects - PostBuild

- The method `isPostBuildValueInvariant(MIObject)` returns `true` if the object has the same value in all PostBuild variants. For details about invariant views see 5.2.1.4 on page 258.
- The method `isPostBuildEcucDefInvariant(MIObject)` returns `true` if the object is invariant according to its EcuC definition.
- The method `isNeverPostBuildVisible(MIObject)` returns `true` if the object is *invisible* in all variant views.
- The method `getVisiblePostBuildVariantViews(MIObject)` returns all variant views the specified object is visible in.
- The method `getVisiblePostBuildVariantViewsOrInvariant(MIObject)` For semantic details see `IModelViewManager.getVisiblePostBuildVariantViewsOrInvariant(MIObject)`.

4.6.9 Additional Model API

4.6.9.1 User Annotations

In DaVinci Configurator the user can add AUTOSAR annotations to configuration elements. You can create, modify, read and delete these annotations like in the UI editors.

All sub types of `MIHasAnnotation` elements support annotations like:

- `MIModuleConfigurations`
- `MIContainers`
- `MIParameeterValues`
- `MIIdentifiabiles`

Although annotations are stored in the data model, their `changeable` state is independent of the configuration element `changeable` state. Annotations can be added/changed/deleted on every existing configuration element with valid definition, except the project was opened in read-only mode.

The `IUserAnnotation` interface provide methods like:

- `getLabel()` - Returns the label of the annotation, like `getName()` of a container
- `setLabel()` - Changes the label
- `getText()` - Returns the text of the annotation.
- `setText()` - Changes the text
- `isChangeable()` - Returns `true`, if the annotation is changeable
- `delete()` - Deletes the annotation

Access User Annotations The `getUserAnnotations(MIARObject)` method returns the `IUserAnnotations` for the model element. The returned list provides additional methods defined in `IUserAnnotationList`.

```
// We already have the container "cont" or any other model element
def myContainer = cont

def annos = myContainer.userAnnotations // Retrieve the list of annotations
def anno = annos.byLabel("MyLabel")    // Select the annotation with "MyLabel"
def text = anno.text                   // Get the Text

// Or short
text = myContainer.userAnnotations["MyLabel"].text
```

Listing 4.136: Get a UserAnnotation of a container

Creation and Modification of User Annotations You can create new User Annotations with the methods:

- `createAndAdd(label)`
- `byLabelOrCreate(label)`

```
transaction{
    // We already have the container "cont"
    def anno = cont.userAnnotations.createAndAdd("MyAnno")
    anno.text = "My Text"
}
```

Listing 4.137: Create a new UserAnnotation

```
transaction{
    // We already have the container "cont"
    def anno = cont.userAnnotations.byLabelOrCreate("MyAnno")
    anno.text = "My Text"
}
```

Listing 4.138: Create or get the existing UserAnnotation by label name

Notes The `IUserAnnotationList` is updated, when the underlying model changes.

The `IUserAnnotationList` is read only list and does not permit any modify operations defined in `java.util.List`, but certain operations like `createAndAdd(String)` will affect the list content. If you delete a contained `IUserAnnotation` the list will not be updated.

4.7 Generation

The Automation Interface provides generation API for different generation use cases:

- Normal code generation, see 4.7.1
 - Including external generation steps
- SWC Templates and Contract Phase Headers generation, see 4.7.3 on page 124

4.7.1 Code Generation

The block **generation** encapsulates all settings and commands which are related to code generation of BSW modules:

The basic structure is the following:

```
generation{
    settings{
        // Settings like the selection of generators for execution are done
        here
        externalGenerationSteps{
            // Settings related to externalGenerationSteps can be done here
        }
    }
    // The execution of the generation or validation can be started here
}
```

Listing 4.139: Basic structure

4.7.1.1 Generation Settings

The class `IGenerationSettingsApi` encapsulates all settings which belong to a generation process.

E.g.

- Select the generators to execute
- Select the target type (Real, VTT)
- Select the external generation steps
- If the module supports multiple module configurations, select the configurations which shall be generated

The following chapters show samples for the standard use cases.

Generation with default Project Settings The following snippet executes a validation with the default project settings.

```
scriptTask("validate_with_default_settings"){
    code{
        generation{
            validate()
        }
    }
}
```

Listing 4.140: Validate with default project settings

To execute a generation with the standard project settings the following snippet can be used. The validation is executed implicitly before the generation because of AUTOSAR requirements.

```
scriptTask("generate_with_default_settings"){
    code{
        generation{
            generate()
        }
    }
}
```

Listing 4.141: Generate with standard project settings

Generation of one Module This sample selects one specific module and starts the generation. There are two ways to open an settings block:

- **settings**
 - This keyword creates empty settings. E.g. no module is selected for execution.
- **settingsFromProject**
 - This keyword takes the project settings as template. E.g. modules from the project settings are initially activated and can optionally be refined by explicit selections.

```
scriptTask("generate_one_module"){
    code{
        generation{
            settings{
                // To take the project settings as template use
                // settingsFromProject{
                selectGeneratorsByDefRef("/MICROSAR/Aaa")
                }
            generate()
        }
    }
}
```

Listing 4.142: Generate one module

Instead of selecting the generator directly by its **DefRef**, there is also the possibility to fetch the generator object and select this object for execution.

```
scriptTask("generate_one_module"){
  code{
    generation{
      settings{
        // To take the project settings as template use
        // settingsFromProject{
          def gens = generatorByDefRef ("/MICROSAR/Aaa")
          selectGenerators(gens)
        }
      }
    }
  }
}
```

Listing 4.143: Generate one module

Generation of multiple Modules To select more than one generator the following snippet can be used.

```
scriptTask("generate_two_modules"){
  code{
    generation{
      settings{
        selectGeneratorsByDefRef ("/MICROSAR/Aaa", "/MICROSAR/Bbb")
      }
    }
  }
}
```

Listing 4.144: Generate two modules

Generation of Multi Instance Modules Some module definitions have a upper multiplicity greater than one. (E.g. [0:5] or [0:*) This means it is allowed to create more than one module configuration from this module definition. If the related generator is started with the default API, all available module configurations are selected for generation. The following API can be used to generate only a subset of all related module configurations.

```

scriptTask("generate_one_module_with_two_configs"){
  code{
    generation{
      settings{
        def gen = generatorByDefRef ("/MICROSAR/MultiInstModule")
        // clear default selection
        gen.deselectAllModuleInstances()
        // Select the module configurations to generate
        gen.selectModuleInstance(AsrPath.create("/ActiveEcuC/
          MultiInstModule1"))

        // Instead of the full qualified path, the module configuration
        // short name can also be used
        gen.selectModuleInstance("MultiInstModule2")
      }
      generate()
    }
  }
}

```

Listing 4.145: Generate one module with two configurations

4.7.1.2 Generation of Generation Steps

Besides the internal generators, which are covered by the topics above, there are also generation steps which can be executed with the following API. A new block `externalGenerationSteps` within the `settings` block encapsulates all settings related to external generation scripts.

```

scriptTask("generate_ext_gen_step"){
  code{
    generation{
      settings{
        externalGenerationSteps{
          // To take the project settings as template use
          // externalGenerationStepsFromProject{}
          selectStep("ExtGen1")
          selectStep("ExtGen2")
        }
      }
      generate()
    }
  }
}

```

Listing 4.146: Execute an external generation step

Retrieval of TargetType (REAL, VTT) of Generation Steps You can query the `EEnvironmentTargetType` of the generation step. This will give you the information if the step can be executed in REAL, VTT or both modes.


```
generation.settings.externalGenerationSteps{
    def step = stepByName("ExtGen1")
    def targetType = step.generationStep.targetType

    if(targetType.isRealAvailable()){
        // Real use case
    }else if(targetType.isVttAvailable()){
        // VTT use case
    }else{
        // None selected
    }
}
```

Listing 4.147: Retrieval of the TargetType of a Generation Step

4.7.1.3 Evaluate generation or validation results

Each validation and generation process has an overall result which states if the execution has been successfully or not. Additionally to the overall state, the state of one specific generator can also be of interest. To provide a possibility to access this information all methods for **validate** and **generate** return an **IGenerationResultModel**.

```
scriptTask("generate_with_default_settings"){
    code{
        generation{
            def result = generate()
            println "Overall result : " + result.result
            println "Duration      : " + result.formattedDuration

            // Access results of each generator or generation step
            result.generationResultRoot.allGeneratorAndStepElements.each {
                println "Generator name : " + it.name
                println "Result       : " + it.currentState
            }
        }
    }
}
```

Listing 4.148: Evaluate the generation result

4.7.2 Generation Task Types

There are three types of `IScriptTaskType` for the generation process:

- Generation Step: `DV_GENERATION_STEP`
- Custom Workflow Step: `DV_CUSTOM_WORKFLOW_STEP`
- Generation Process Start: `DV_ON_GENERATION_START`
- Generation Process End: `DV_ON_GENERATION_END`

The general description of the type is in chapter 4.3.1.4 on page 33. The following code samples show the usage of these task types:

Generation Step A sample for the `DV_GENERATION_STEP` type:

```
scriptTask("GenStepTask", DV_GENERATION_STEP){
    taskDescription "Task is executed as Generation Step"

    def myArg = newUserDefinedArgument(
        "myArgument",
        String,
        "Defines a user argument for the GenerationStep")

    code{ phase, generationType, resultSink ->

        def myArgVal = myArg.value
        // The value myArgVal was passed from the generation step in the
        // project settings editor

        scriptLogger.info "MyArg is: $myArgVal"
        scriptLogger.info "GenerationType is: $generationType"

        if(phase.calculation){
            // Execute code before / after calculation

            transaction {
                // Modify the Model in the calculation phase
            }
        }

        if(phase.validation){
            // Execute code before / after validation
        }

        if(phase.generation){
            // Execute code before / after generation
        }
    }
}
```

Listing 4.149: Use a script task as generation step during generation

The *Generation Step* can also report validation results into the passed `resultSink`. See chapter 4.8.5.10 on page 137 for a sample how to create an validation-result and report it.

The `generationType` defines if the current generation is for the **REAL** or **VTT** platform.

Custom Workflow Step A sample for the DV_CUSTOM_WORKFLOW_STEP type:

```
scriptTask("GenStepTask", DV_CUSTOM_WORKFLOW_STEP){
    taskDescription "Task is executed as custom workflow step"

    def myArg = newUserDefinedArgument(
        "myArgument",
        String,
        "User argument for the step")

    code{
        def myArgVal = myArg.value
        // The value myArgVal was passed from the custom workflow step in the
        // project settings editor
        scriptLogger.info "MyArg is: $myArgVal"
    }
}
```

Listing 4.150: Use a script task as custom workflow step

Generation Process Start A sample for the DV_ON_GENERATION_START type:

```
scriptTask("GenStartTask", DV_ON_GENERATION_START){
    taskDescription "The task is automatically executed at generation start"

    code{ phasesToExecute, generators ->

        scriptLogger.info "Phases are: $phasesToExecute"
        scriptLogger.info "Generators to execute are: $generators"

        // Execute code before the generation will start
    }
}
```

Listing 4.151: Hook into the GenerationProcess at the start with script task

Generation Process End A sample for the DV_ON_GENERATION_END type:

```
scriptTask("GenEndTask", DV_ON_GENERATION_END){
    taskDescription "The task is automatically executed at generation end"

    code{ generationResult, generators ->

        scriptLogger.info "Process result was: $generationResult"
        scriptLogger.info "Executed Generators: $generators"

        // Execute code after the generation process was finished
    }
}
```

Listing 4.152: Hook into the GenerationProcess at the end with script task

4.7.3 Software Component Templates and Contract Phase Headers Generation

The Software Component Templates and Contract Phase Headers (Swct) generation automation API provides access to configure and start the Swct generation.

The block **generation.swct** encapsulates all settings and commands which are related to this use case.

The basic structure is the following:

```
generation.swct{
  settings{
    // Settings like the selection of components to generate
  }
  // The execution of the generation can be started here
  generate()
}
```

Listing 4.153: Basic Swct structure

4.7.3.1 Swct Generation Settings

The class `IGenerationSwctSettingsApi` encapsulates all settings which belong to a Swct generation process.

Examples:

- Select the software components to execute
- Retrieve the available software components

The following chapters show samples for the standard use cases.

4.7.3.2 Generation with default Project Settings

To execute the Swct generation with the standard project settings the following snippet can be used:

```
scriptTask("generate_with_default_settings"){
  code{
    generation.swct{
      generate()
    }
  }
}
```

Listing 4.154: SWC Templates and Contract Headers generation with standard project settings

4.7.3.3 Generation of all Software Components

To execute the Swct generation for all available software components the following snippet can be used:

```
scriptTask("generate_with_default_settings"){
  code{
    generation.swct{
      settings.selectAll()
      generate()
    }
  }
}
```

Listing 4.155: SWC Templates and Contract Headers generation of all components

4.7.3.4 Generation of one Software Component

This sample selects one specific software component and starts the generation. There are two ways to open an settings block:

- **settings**
 - This keyword creates empty settings. E.g. no component is selected for execution.
- **settingsFromProject**
 - This keyword takes the project settings as template. E.g. component from the project settings are initially activated and can optionally be refined by explicit selections.

```
scriptTask("generate_one_component"){
  code{
    generation.swct{
      settings{
        selectSoftwareComponent("MyApplType")
      }

      generate()
    }
  }
}
```

Listing 4.156: SWC Templates and Contract Headers generation of one selected component

Instead of selecting the software component directly by its **Name**, there is also the possibility to fetch the software component object and **select()** this object for execution.

```
scriptTask("generate_one_component"){ code{
  generation.swct{
    settings{
      def sw = softwareComponentByName("MyApplType")
      // Select the software component
      sw.select()

      // You could also retrieve information about the component
      def asrPath = sw.asrPath
      if(sw.selected){ /* Do something */ }
    }
    generate()
  }
}}
```

Listing 4.157: Swct generation get component and select component

4.7.3.5 Generation of multiple Software Components

To select more than one Software Component the following snippet can be used.

```
scriptTask("generate_one_component"){
  code{
    generation.swct{
      settings{

        // Select the tow software components
        selectSoftwareComponent("MyApplType", "MySecondApplType")
      }

      generate()
    }
  }
}
```

Listing 4.158: Swct generation of multiple components

4.7.3.6 Evaluate generation results

The same API is used as for the normal generation, see chapter 4.7.1.3 on page 121 for details.

4.8 Validation

4.8.1 Introduction

All examples in this chapter are based on the situation of the figure 4.6. The module and the validators are not from the real MICROSAR stack, but just for the examples. There is a module **Tp** that has 3 **Buffer** containers and each **Buffer** has a **Size** parameter with value=3. There is also a validator that requires the **Size** parameter to be a multiple of 4. For each **Size** parameter that violates this constraint, a validation-result with ID **Tp00012** is created.

Such a validation-result has 2 solving-actions. One that sets the **Size** to the next smaller valid value, and one that sets the **Size** to the next bigger valid value. The latter solving-action is marked as preferred-solving-action.

There is also a **Tp00011** result that stands for any other result. The examples will not touch it.

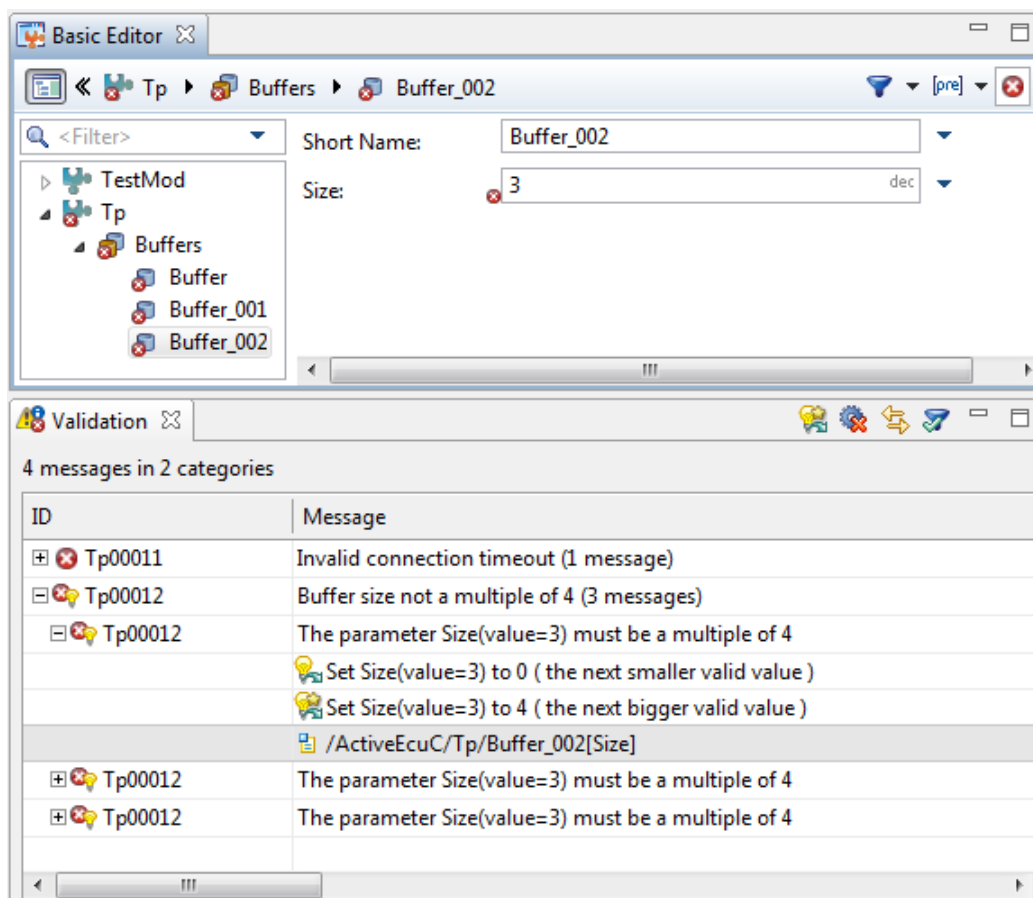


Figure 4.6: example situation with the GUI

4.8.2 Access Validation-Results

A `validation{}` block gives access to the validation API of the consistency component. That means accessing the validation-results which are shown in the GUI in the validation view, and solving them by executing solving-actions which are also shown in the GUI beneath each validation-result (with a bulb icon).

`getValidationResults()` waits for background-validation-idle and returns all validation-results

of any kind. The returned collection has no deterministic order, especially it is not the same order as in the GUI.

```
scriptTask("CheckValidationResults_filterByOriginId", DV_PROJECT){
  code{
    validation{
      // access all validation-results
      def allResults = validationResults
      assert allResults.size() > 3

      // filter based on methods of IValidationResultUI e.g. isId()
      def tp12Results = validationResults.filter{it.isId("Tp", 12)}
      assert tp12Results.size() == 3
    }

    // alternative access to validation-results without a validation block
    assert validation.validationResults.size() > 3
  }
}
```

Listing 4.159: Access all validation-results and filter them by ID

4.8.3 Model Transaction and Validation-Result Invalidation

Before we continue in this chapter with solving validation-results, the following information is import to know:

Relation to model transactions:

Solving validation-results with solving-actions always creates a transaction implicitly. An `IllegalStateException` will be thrown if this is done within an explicitly opened transaction.

Invalidation of validation-results:

Any model modification may invalidate any validation-result. In that case, the responsible validator creates a new validation-result if the inconsistency still exists. Whether this happens for a particular modification/validation-result depends on the validator implementation and is not visible to the user/client.

Trying to solve an invalidated validation-result will throw an `IllegalStateException`. Therefore it is not safe to solve a particular `ISolvingActionUI` that was fetched before the last transaction. Instead, please fetch a solving-action after the last transaction, or use the method `ISolver.solve(Closure)` which is the most preferred way of solving validation-results with solving-actions.

See chapter 4.8.4.1 on the following page for details.

4.8.4 Solve Validation-Results with Solving-Actions

A single validation-result can be solved by calling `solve()` on one of its solving-actions.


```
scriptTask("SolveSingleResultWithSolvingAction", DV_PROJECT){
  code{
    validation{
      def tp12Results = validationResults.filter{it.isId("Tp", 12)}
      assert tp12Results.size() == 3

      // Take first (any) validation-result and filter its solving-
      // actions based on methods of ISolvingActionUI
      tp12Results.first.solvingActions.filter{
        it.description.contains("next bigger valid value")

      }.single.solve() // reduce the collection to a single
        ISolvingActionUI and call solve()

      assert validationResults.filter{it.isId("Tp", 12)}.size() == 2
      // One Tp12 validation-result solved
    }
  }
}
```

Listing 4.160: Solve a single validation-result with a particular solving-action

4.8.4.1 Solver API

`getSolver()` gives access to the `ISolver` API, which has advanced methods for bulk solutions.

`ISolver.solve(Closure)` allows to solve multiple validation-results within one transaction. You should always use this method to solve multiple validation-results at once instead of calling `ISolvingActionUI.solve()` in a loop. This is very important, because solving one validation-result, may cause invalidation of another one. And calling `ISolvingActionUI.solve()` of an invalidated validation-result throws an `IllegalStateException`. Also, invalidated validation-results may get recalculated and you would miss the recalculated validation-results with the loop approach. But with `ISolver.solve(Closure)` you can solve invalidated->recalculated results as well as results which didn't exist at the time of the call (but have been caused by solving some other validation-result).

`ISolver.solve(Closure)` first waits for background-validation-idle in order to have reproducible results.

The closure may contain multiple statements like:

```
result{specify result predicate}.withAction{select solving action}
```

All statements together will be used as a mapper from any solvable validation-result to a particular solving-action. The order of these statements does not affect the solving action execution order. The statement order might only be relevant if multiple statements match on a particular result, but would select a different solving-action. In that case, the first statement that successfully selects a solving-action wins.

```
scriptTask("SolveMultipleResults", DV_PROJECT){
  code{
    validation{
      assert validationResult.size() == 4
      solver.solve{
        // Call result() and pass a closure that works as filter
        // based on methods of IValidationResultUI.
        result{
          isId("Tp", 12)
        }.withAction{
          containsString("next bigger valid value")
        }

        // On the return value, call withAction() and pass a closure that
        // selects a solving-action based on methods
        // of IValidationResultForSolvingActionSelect

        // multiple result() calls can be placed in one solve() call.
        result{isId("Com", 34)}.withAction{containsString("recalculate")}
      }

      assert validationResult.size() == 1
      // Three Tp12 and zero Com34 (didn't exist) results solved. One other
      left
    }
  }
}
```

Listing 4.161: Fast solve multiple results within one transaction

Solve all PreferredSolvingActions `ISolver.solveAllWithPreferredSolvingAction()` solves all validation-results with its preferred solving- action of each validation-result (solving-action return by `IValidationResultUI.getPreferredSolvingAction()`). Validation-results without a preferred solving-action are skipped.

This method first waits for background-validation-idle in order to have reproducible results.

```
scriptTask("SolveAllWithPreferred", DV_PROJECT){
  code{
    validation{
      assert validationResult.size() == 4

      solver.solveAllWithPreferredSolvingAction()

      assert validationResult.size() == 1

      // this would do the same
      transactions.transactionHistory.undo()
      assert validationResult.size() == 4

      solver.solve{
        result{true}.withAction{preferred}
      }

      assert validationResult.size() == 1
    }
  }
}
```

Listing 4.162: Solve all validation-results with its preferred solving-action (if available)

4.8.5 Advanced Topics

4.8.5.1 Access Validation-Results of a Model Object

You can retrieve validation-results also from any model object (MDF, Domain or BswmdModel).

`MIObject.getValidationResults()` returns the validation-results of an `MIObject`. These are those results for which `IVValidationResultUI.matchErroneousCE(MIObject)` returns true.

```
scriptTask("CheckValidationResultsOfObject", DV_PROJECT){
  code{
    // sampleDefRefs contains DefRef constants just for this example.
    // Please use the real DefRefs from your SIP

    // a Buffer container
    def buffer002 = mdfModel(AsrPath.create("/ActiveEcuC/Tp/Buffer_002"))
    // the Size parameter
    def sizeParam = buffer002.parameter(sampleDefRefs.tpBufferSizeDefRef).
      single

    // the result exists for the Size parameter, not for the Buffer
    // container
    assert sizeParam.validationResults.size() == 1
    assert buffer002.validationResults.size() == 0
  }
}
```

Listing 4.163: Access all validation-results of a particular object

`MIObject.getValidationResultsRecursive()` returns the validation-results of an `MIObject` and all its children. So this will return all results of the whole subtree, like an editor displays results at parent objects.

`IViewedModelObject.getValidationResults()` returns the validation-results for the element matching the model object and the model view, like `BswmdModel` objects.

`IViewedModelObject.getValidationResultsRecursive()` returns the validation-results of an `MIObject` for the elements like `BswmdModel` objects all its children. This will also filter for the correct `IModelView`. So this will return all results of the whole subtree, like an editor displays results at parent objects.

4.8.5.2 Access Validation-Results of a DefRef

`DefRef.getValidationResults()` returns all validation-results which match the passed definition. So every configuration element which matches the validation-result and is an instance of definition.

The used project for this call is the active project, see `ScriptApi.getActiveProject()`.

```
scriptTask("CheckValidationResultsOfDefRef", DV_PROJECT){
    code{
        // sampleDefRefs contains DefRef constants just for this example.
        // Please use the real DefRefs from your SIP

        assert sampleDefRefs.tpBufferSizeDefRef.validationResults.size() == 3
    }
}
```

Listing 4.164: Access all validation-results of a particular DefRef

4.8.5.3 Filter Validation-Results using an ID Constant

Groovy allows you to spread list elements as method arguments using the spread operator. This allows you to define constants for the `isId(String,int)` method.

```
scriptTask("FilterResultsUsingAnIdConstant2", DV_PROJECT){
    code{
        validation{
            def tp12Const = ["Tp",12]

            assert validationResult.size() > 3
            assert validationResult.filter{it.isId(*tp12Const)}.size() == 3
        }
    }
}
```

Listing 4.165: Filter validation-results using an ID constant

4.8.5.4 Identification of a Particular Solving-Action

A so called solving-action-group-ID identifies a solving-action uniquely within one validation-result. In other words, two solving-actions, which do semantically the same, from two validation-results of the same result-ID (origin + number), belong to the same solving-action-group. This semantical group may have an optional solving-action-group-ID, that can be used for solving-action identification within one validation-result.

Keep in mind that the solving-action-group-ID is only unique within one validation-result-ID, and that the group-ID assignment is optional for a validator implementation.

In order to find out the solving-action-group-IDs, press **CTRL+SHIFT+F9** with a selected validation-result to copy detailed information about that result including solving-action-group-IDs (if assigned) to the clipboard.

If group-IDs are assigned, it is much safer to use these for solving-action identification than description-text matching, because a description-text may change.

```
final int SA_GROUP_ID_TP12_NEXT_BIGGER_VALID_VALUE = 2

scriptTask("SolveMultipleResultsByGroupId", DV_PROJECT){
    code{
        validation{
            assert validationResult.size() == 4

            solver.solve{
                result{isId("Tp", 12)}
                .withAction{
                    byGroupId(SA_GROUP_ID_TP12_NEXT_BIGGER_VALID_VALUE)
                }
                // instead of .withAction{containsString("next bigger valid value")}
            }

            assert validationResult.size() == 1
            // Three Tp12 validation-results solved.
        }
    }
}
```

Listing 4.166: Fast solve multiple validation-results within one transaction using a solving-action-group-ID

4.8.5.5 Validation-Result Description as MixedText

`IVValidationResultUI.getDescription()` returns an `IMixedText` that describes the inconsistency.

`IMixedText` is a construct that represents a text, whereby parts of that text can also hold the object which they represent. This allows a consumer e.g. a GUI to make the object-parts of the text clickable and to reformat these object-parts as wanted.

Consumers which don't need these advanced features can just call `IMixedText.toString()` which returns a default format of the text.

4.8.5.6 Further `IVValidationResultUI` Methods

The following listing gives an overview of other "properties" of an `IVValidationResultUI`.

```
scriptTask("IValidationResultUIApiOverview", DV_PROJECT){
  code{
    validation{
      def r = validationResults.filter{it.isId("Tp", 12)}.first
      assert r.id.origin == "Tp"
      assert r.id.id == 12
      assert r.description.toString().contains("must be a multiple of")
      assert r.severity == EValidationSeverityType.ERROR
      assert r.solvingActions.size() == 2
      assert r.getSolvingActionByGroupId(2).description.contains("next bigger
        valid value")

      // this result has a preferred-solving-action
      assert r.preferredSolvingAction == r.getSolvingActionByGroupId(2)

      // results with lower severity than ERROR can be acknowledged in the GUI
      assert r.acknowledgement.isPresent() == false

      // if the cause was an exception, r.cause.get() returns it
      assert r.cause.isPresent() == false

      // an ERROR result gets reduced to WARNING if one of its erroneous CEs is
        user-defined (user-overridden)
      assert r.isReducedSeverity() == false

      // on-demand results are visualized with a gear-wheel icon
      assert r.isOnDemandResult() == false
    }
  }
}
```

Listing 4.167: IValidationResultUI overview

4.8.5.7 IValidationResultUI in a variant (Post-Build selectable) Project

```
scriptTask("IValidationResultUIInAVariantProject", DV_PROJECT){
  code{
    validation{
      def r = validationResults.filter{it.isId("Tp", 12)}.first
      assert r.isGeneralVariantContext() // either it is a general result
      ...
      assert r.predefinedVariantContexts.size() == 0 // or it is assigned
        to one or more (but never all) variants
      // If a validator assigns a result to all variants, it will be a
        general result at UI-side.
    }
  }
}
```

Listing 4.168: IValidationResultUI in a variant (post build selectable) project

4.8.5.8 Erroneous CEs of a Validation-Result

`IValidationResultUI.getErroneousCEs()` returns a collection of `IDescriptor`, each describing a CE that gets an error annotation in the GUI.

To check for a certain model element is affected by the result please use the methods, which return `true`, if a model is affected by the validation-result:

- `IValidationResultUI.matchErroneousCE(MIObject)`
- `IValidationResultUI.matchErroneousCE(IHasModelObject)`
- `IValidationResultUI.matchErroneousCE(MIHasDefinition, DefRef)`

```
scriptTask("IValidationResultUIErroneousCEs", DV_PROJECT){
  code{
    validation{
      // sampleDefRefs contains DefRef constants just for this example.
      // Please use the real DefRefs from your SIP

      def result = validationResults.filter{it.isId("Tp", 12)}.first

      // Retrieve the model element to check
      def modelElement // = retrieveElement ...

      // Check if the model object is affected by the validation-result
      assert result.matchErroneousCE(modelElement)
    }
  }
}
```

Listing 4.169: CE is affected by (matches) an IValidationResultUI

Advanced Descriptor Details An IDescriptor is a construct that can be used to "point to" some location in the model. A descriptor can have several kinds of aspects to describe where it points to. Aspect kinds are e.g. IMdfObjectAspect, IDefRefAspect, IMdfMetaClassAspect, IMdfFeatureAspect.

`getAspect(Class)` gets a particular aspect if available, otherwise null.

A descriptor has a parent descriptor. This allows to describe a hierarchy.

E.g. if you want to express that something with definition X is missing as a child of the existing MDF object Y. In this example you have a descriptor with an IDefRefAspect containing the definition X. This descriptor that has a parent descriptor with an IMdfObjectAspect containing the object Y.

The term descriptor refers to a descriptor together with its parent-descriptor hierarchy.

```

import com.vector.cfg.model.cedescriptor.aspect.*

scriptTask("IValidationResultUIErroneousCEs", DV_PROJECT){
  code{
    validation{
      // sampleDefRefs contains DefRef constants just for this example.
      // Please use the real DefRefs from your SIP

      def result = validationResults.filter{it.isId("Tp", 12)}.first
      def descriptor = result.erroneousCEs.single // this result in this
      // example has only a single erroneous-CE descriptor
      def defRefAspect = descriptor.getAspect(IDefRefAspect.class)
      assert defRefAspect != null; // this descriptor in this example has
      // an IDefRefAspect
      assert defRefAspect.defRef.equals(sampleDefRefs.tpBufferSizeDefRef)
      def objectAspect = descriptor.getAspect(IMdfObjectAspect.class)
      assert objectAspect != null // // this descriptor in this example
      // has an IMdfObjectAspect
      // An IMdfObjectAspect would be unavailable for a descriptor
      // describing that something is missing
      def parentObjectAspect = descriptor.parent.getAspect(
        IMdfObjectAspect.class)
      assert parentObjectAspect != null

      // Dealing with descriptors is universal, but needs more code.
      // Using these methods might fit your needs.
      assert result.matchErroneousCE(objectAspect.getObject())
      assert result.matchErroneousCE(parentObjectAspect.getObject(),
        sampleDefRefs.tpBufferSizeDefRef)
    }
  }
}

```

Listing 4.170: Advanced use case - Retrieve Erroneous CEs with descriptors of an IValidationResultUI

4.8.5.9 Examine Solving-Action Execution

The easiest and most reliable option for verifying solving-action execution is to check the presence of validation-results afterwards.

This is also the feedback strategy of the GUI. After multiple solving-actions have been solved, the GUI does not show the execution result of each individual solving-action, but just the remaining validation-results after the operation. Only if a single solving-action is to be solved, and that fails, the GUI shows the message of that failure including the reason.

The following describes further options of examination:

`ISolvingActionUI.solve()` returns an `ISolvingActionExecutionResult`. An `ISolvingActionExecutionResult` represents the result of one solving action execution. Use `isOk()` to find out if it was successful. Call `getUserMessage()` to get the failure reason.

`ISolver.solve(Closure)` returns an `ISolvingActionSummaryResult`. An `ISolvingActionSummaryResult` represents the execution of multiple results. `ISolvingActionSummaryResult.isOk()` returns true if `getExecutionResult()` is `EExecutionResult.SUCCESSFUL` or `EExecutionResult.WARNING`, this is if at least one sub-result was ok.

Call `getSubResults()` to get a list of `ISolvingActionExecutionResults`.


```

import com.vector.cfg.util.activity.execresult.EExecutionResult

scriptTask("SolvingReturnValue", DV_PROJECT){
    code{
        validation{
            assert validationResult.size() == 4
            // In this example, three validation-results have a preferred
            // solving action.
            // One of the three cannot be solved because a parameter is user-
            // defined.
            def summaryResult = solver.solveAllWithPreferredSolvingAction()
            assert validationResult.size() == 2 // Two have been solved, one
            // with a preferred solving-action is left.
            assert summaryResult.executionResult == EExecutionResult.WARNING

            // DemoAsserts is just for this example to show what kind of sub-
            // results the summaryResult contains.
            DemoAsserts.summaryResultContainsASubResultWith("OK",summaryResult)
            //two such sub-results for the validation-results with preferred-
            //solving-action that could be solved

            DemoAsserts.summaryResultContainsASubResultWith(["invalid
            modification","not changeable","Reason","is user-defined"],
            summaryResult)
            // such a sub-result for the failed preferred solving action due to
            // the user-defined parameter

            DemoAsserts.summaryResultContainsASubResultWith("Maximum solving
            attempts reached for the validation-result of the following
            solving-action",summaryResult)
            // Cfg5 takes multiple attempts to solve a result because other
            // changes may eliminate a blocking reason, but stops after an
            // execution limit is reached.
        }
    }
}

```

Listing 4.171: Examine an ISolvingActionSummaryResult

4.8.5.10 Create a Validation-Result in a Script Task

The `resultCreation` API provides methods to create new `IVValidationResults`, which could then be reported to a `IVValidationResultSink`. This can be used to report validation-results similar to a validator/generator, but from within a script task.

ValidationResultSink The `IVValidationResultSink` must be obtained by the context and is not provided by the creation API. E.g. some script tasks pass an `IVValidationResultSink` as argument (like `DV_GENERATION_STEP`).

Or you have to activate the MD license option for development during script task creation by calling the method `requiresMDDevelopmentLicense()`, then you could retrieve an `IVValidationResultSink` from the method `getResultSink()`.

Reporting ValidationResult in Task providing a ResultSink This sample applies to task types providing a `ResultSink` in the Task API, like `DV_GENERATION_STEP`.

```

scriptTask("ScriptTaskCreationResult" /* Insert with task type providing
resultSink */ ){
  code{
    validation{
      resultCreation{
        // The ValidationResultId group multiple results
        def valId = createValidationResultIdForScriptTask(
          /* ID */ 1234,
          /* Description */ "Summary of the ValidationResultId",
          /* Severity */ EValidationSeverityType.ERROR)
        // Create a new resultBuilder
        def builder = newResultBuilder(valId, "Description of the Result")

        // You can add multiple elements as error objects to mark them
        builder.addErrorObject(sipDefRef.EcucGeneral.bswmdModel().single)
        // Add more calls when needed

        // Create the result from the builder
        def valResult = builder.buildResult()

        // You need to report the result to a resultSink
        // You have to get the sink from the context, e.g. script task args
        // a sample line would be
        resultSinkForTask.reportValidationResult(valResult)
      }
    }
  }
}

```

Listing 4.172: Create a ValidationResult

Reporting ValidationResult with MD License Option for Development This sample can be used in every task types but you need a MD license option for development to retrieve the ResultSink.

```

scriptTask("ScriptTaskCreationResult", DV_PROJECT){

  // Result reporting requires an MD license for development
  requiresMDDevelopmentLicense()

  code{
    validation{
      resultCreation{
        // The ValidationResultId group multiple results
        def valId = createValidationResultIdForScriptTask(
          /* ID */ 1234,
          /* Description */ "Summary of the ValidationResultId",
          /* Severity */ EValidationSeverityType.ERROR)
        // Create a new resultBuilder
        def builder = newResultBuilder(valId, "Description of the Result")

        // Create the result from the builder
        def valResult = builder.buildResult()

        // When MD license is enabled you can access a resultSink
        resultSink.reportValidationResult(valResult)
      }
    }
  }
}

```

Listing 4.173: Report a ValidationResult when MD license option is available

4.8.5.11 Turn off auto-solving-action execution

Auto-solving-action execution is a feature to simplify configuration by automatically adjusting dependent data after a change was made by the user. This feature runs synchronous to the user change and may have impact on UI responsiveness. If UI response time is not acceptable, this should be reported to Vector.

Using `setEnabled(boolean)`, auto-solving-action execution can be disabled to find out if this is the cause and as an interim workaround.

If auto-solving-action execution is disabled, data might get out of sync after a user change, E.g. Vtt dual target sync, BSW Internal Behavior, In that case, these have to be solved manually with the corresponding validation-result's solving action.

This setting is stored as user-independent project setting.

This setting can only be changed if `isChangeable()` returns true (false e.g. due to read-only project), otherwise an `IllegalStateException` is thrown.

```
scriptTask("SolvingReturnValue", DV_PROJECT){
    code{
        validation{
            settings{
                if (autoSolvingActionExecution.changeable) {
                    autoSolvingActionExecution.enabled = false
                }
            }
        }
    }
}
```

Listing 4.174: Turn off auto solving action execution

4.9 Update Workflow

The Update Workflow derives the initial EcuC from the input files and updates the project accordingly. The Update Workflow API comprises modification of variants, modification of the input files list and the execution of an update workflow.

4.9.1 Method Overview

- **workflow**: the **workflow** closure is the central entry point for the Workflow API.
 - **update**: contains all settings for the Update Workflow and executes the update after leaving the closure block.
 - * **input**: supports the modification of the input files list and specific settings.
 - **communication**: the **communication** closure contains settings for the communication extract and communication legacy input files (like cbd, ldf or fibex). Take a look at the JavaDoc of **ICommunicationApi** for all possible settings.

4.9.2 Example: Content of Input Files has changed.

In case of a changed content of input files, the update workflow can be started with the **workflow.update(dpaProjectFilePath)** method. This will start the Update Workflow, with the input files as selected in the DaVinci Configurator GUI. The parameter **dpaProjectFilePath** accepts the same types and has the same semantic as **resolvePath** described in 4.4.3.1 on page 39.

```
scriptTask("UpdateExistingProject", DV_APPLICATION) {  
    code {  
        workflow.update pathToDpaFile  
    }  
}
```

Listing 4.175: "Update existing project"

The update workflow is started at the end of the update-closure.

4.9.3 Example: List of Input Files shall be changed

```
scriptTask("ChangeListOfComExtractsAndUpdate", DV_APPLICATION) {
  code {
    def extractPath = paths.resolvePath(extractFile)
    def diagExtractPath = paths.resolvePath(diagExtract)
    workflow.update(dpaProjectFile){
      updateSettings{
        updateMode = ECUC_ONLY
        uuidUsageInStandardConfigurationEnabled = false;
        uuidUsageInSystemDescriptionEnabled = false;
      }
      input{
        communication{
          extract{
            extractFiles{exFilePathList->
              // clear the list of communication extracts
              exFilePathList.clear()
              // adds an communication extract
              exFilePathList.add(extractPath.asPersistablePath())
            }

            // change the selection of the ecuInstance
            // Note: this closure is deferred executed.
            ecuInstanceSelection{
              return availableEcuInstances[0]
            }
          }
        }
      }
      diagnostic{
        extract{
          extractFiles{exFilePathList->
            // clear the list of communication extracts
            exFilePathList.clear()
            // adds an communication extract
            exFilePathList.add(diagExtractPath.asPersistablePath())
          }

          // change the selection of the ecuInstance
          // Note: this closure is deferred executed.
          ecuInstanceSelection{
            return availableEcuInstances[0]
          }
        }
      }
    }
  }
}
```

Listing 4.176: Change list of communication extracts and update

Note: The code in the `ecuInstanceSelection` closure is deferred executed. The access to variables, declared outside of this closure is not allowed.

This example shows the complete replacement of the current list of communication extracts with one extract and the selection of the first `ecuInstance` in the new extract. The update workflow is executed after the update closure block is left.

4.9.4 Prerequisites

The Update Workflow can't be executed while the Project to update is open. E.g. in a `IProjectRef.openProject` closure block or in a `ScriptTask` with the `DV_PROJECT` `ScriptTaskType`.

Because the update workflow has to close and open the project during update, which would cause strange behavior in your client code.

4.10 Domains

The domain APIs are specifically designed to provide high convenience support for typical domain use cases.

The domain API is the entry point for accessing the different domain interfaces. It is available in opened projects in the form of the `IDomainApi` interface.

`IDomainApi` provides methods for accessing the different domain-specific APIs. Each domain's API is available via the domain's name. For an example see the communication domain API 4.10.1.

`getDomain()` allows accessing the `IDomainApi` like a property.

```
scriptTask('taskName') {  
  code {  
    // IDomainApi is available as "domain" property  
    def domainApi = domain  
  }  
}
```

Listing 4.177: Accessing `IDomainApi` as a property

`domain(Closure)` allows accessing the `IDomainApi` in a scope-like way.

```
scriptTask('taskName') {  
  code {  
    domain {  
      // IDomainApi is available inside this Closure  
    }  
  }  
}
```

Listing 4.178: Accessing `IDomainApi` in a scope-like way

4.10.1 Communication Domain

The communication domain API is specifically designed to support communication related use cases. It is available from the `IDomainApi` 4.10 in the form of the `ICommunicationApi` interface.

`getCommunication()` allows accessing the `ICommunicationApi` like a property.

```
scriptTask('taskName') {  
  code {  
    // ICommunicationApi is available as "communication" property  
    def communication = domain.communication  
  }  
}
```

Listing 4.179: Accessing `ICommunicationApi` as a property

`communication(Closure)` allows accessing the `ICommunicationApi` in a scope-like way.

```
scriptTask('taskName') {  
  code {  
    domain.communication {  
      // ICommunicationApi is available inside this Closure  
    }  
  }  
}
```

Listing 4.180: Accessing ICommunicationApi in a scope-like way

The following use cases are supported:

Accessing Can Controllers `getCanControllers()` returns a list of all `ICanControllers` in the configuration 4.10.1.1 on the following page.

4.10.1.1 CanControllers

An `ICanController` instance represents a `CanController` `MIContainer` providing support for use cases exceeding those supported by the model API.

```
scriptTask('OptimizeAcceptanceFilters', DV_APPLICATION) {
  code {
    // replace $dpaFile with the path to your project
    def theProject = projects.openProject("$dpaFile") {
      transaction {
        domain.communication {
          // open acceptance filters of all CanControllers
          canControllers*.openAcceptanceFilters()

          // open acceptance filters of first CanController
          canControllers.first.openAcceptanceFilters()
          canControllers[0].openAcceptanceFilters() // same as above

          // open acceptance filters of second CanController
          // (if there is a second CanController)
          canControllers[1]?.openAcceptanceFilters()

          // open acceptance filters of a dedicated CanController
          canControllers.filter { it.name.contains 'CH0' }.single.
            openAcceptanceFilters()

          // accessing a dedicated CanController
          def ch0 = canControllers.filter { it.name.contains 'CH0' }.single

          // assert: ch0's first CanFilterMask value is XXXXXXXXXXXX
          assert 'XXXXXXXXXX' == ch0.canFilterMasks[0].filter

          // set CanFilterMask value to 0111111111
          ch0.canFilterMasks[0].filter = '0111111111'
          assert '0111111111' == ch0.canFilterMasks[0].filter

          // automatic acceptance filter optimization
          ch0.optimizeFilters { fullCan = true }
        }
      }
    }
    scriptLogger.info('Successfully optimized Can acceptance filters.')
  }
}
```

Listing 4.181: Optimizing Can Acceptance Filters

Opening Acceptance Filters `openAcceptanceFilters()` opens all of this `ICanController`'s acceptance filters.

Optimizing Acceptance Filters `optimizeFilters(Closure)` optimizes this `ICanController`'s acceptance filter mask configurations. The given `Closure` is delegated to the `IOptimizeAcceptanceFiltersApi` interface for parameterizing the optimization.

Using `setFullCan(boolean)` it can be specified whether the optimization shall take full can objects into account or not.

Creating new CanFilterMasks `createCanFilterMask()` creates a new `ICanFilterMask` for this `ICanController`.

Accessing a CanController's CanFilterMasks `getCanFilterMasks()` returns all of this `ICanController`'s `ICanFilterMasks`.

Accessing a CanController's MIContainer `getMdfObject()` returns the `MIContainer` represented by this `ICanController`.

4.10.1.2 CanFilterMasks

An `ICanFilterMask` instance represents a `CanFilterMask MIContainer` providing support for use cases exceeding those supported by the model API.

For example code see 4.10.1.1 on the previous page. The following use cases are supported:

Filter Types `ECanAcceptanceFilterType` lists the possible values for an `ICanFilterMask`'s filter type.

`STANDARD` results in a standard Can acceptance filter value with length 11.

`EXTENDED` results in an extended Can acceptance filter value with length 29.

`MIXED` results in a mixed Can acceptance filter value with length 29.

Accessing a CanFilterMask's Filter Type `getFilterType()` returns this `ICanFilterMask`'s filter type.

Specifying a CanFilterMask's Filter Type Using `setFilterType(ECanAcceptanceFilterType)` this `ICanFilterMask`'s filter type can be specified.

Accessing a CanFilterMask's Filter Value `getFilter()` returns this `ICanFilterMask`'s filter value. A `CanFilterMask`'s filter value is a `String` containing the characters '0', '1' and 'X' (don't care). For determining if a given Can ID passes the filter it is matched bit for bit against the `String`'s characters. The character at index 0 is matched against the most significant bit. The character at index `length() - 1` is matched against the least significant bit. The length of the `String` corresponds to the `CanFilterMask`'s filter type.

Specifying a CanFilterMask's Filter Value Using `setFilter(String)` this `ICanFilterMask`'s filter value can be specified.

Accessing a CanFilterMask's MIContainer `getMdfObject()` returns the `MIContainer` represented by this `ICanFilterMask`.

4.10.2 Diagnostics Domain

The diagnostics domain API is specifically designed to support diagnostics related use cases. It is available from the IDomainApi 4.10 on page 143 in the form of the IDiagnosticsApi interface.

getDiagnostics() allows accessing the IDiagnosticsApi like a property.

```
scriptTask('taskName') {  
  code {  
    // IDiagnosticsApi is available as "diagnostics" property  
    def diagnostics = domain.diagnostics  
  }  
}
```

Listing 4.182: Accessing IDiagnosticsApi as a property

diagnostics(Closure) allows accessing the IDiagnosticsApi in a scope-like way.

```
scriptTask('taskName') {  
  code {  
    domain.diagnostics {  
      // IDiagnosticsApi is available here  
    }  
  }  
}
```

Listing 4.183: Accessing IDiagnosticsApi in a scope-like manner

The following use cases are supported:

Dem Events The API provides access and creation of IDemEvents in the configuration. See chapter 4.10.2.1 on the next page for more details.

Check for OBD II isObd2Enabled() checks, if OBD II is available in the configuration.

Enable OBD II setObd2Enabled(boolean) enables or disables OBD II in the configuration. Note, that OBD II can only be enabled, if a valid SIP license was found.

Check for WWH-OBD isWh0bdEnabled() checks, if WWH-OBD is available in the configuration.

Enable WWH-OBD setWh0bdEnabled(boolean) enables or disables WWH-OBD in the configuration. Note, that WWH-OBD can only be enabled, if a valid SIP license was found.

4.10.2.1 DemEvents

An `IDemEvent` instance represents a diagnostic event and provides usecase centric functionalities to modify and query diagnostic events.

Accessing Dem Events `getDemEvents()` returns a list of all `IDemEvents` in the configuration.

Creating Dem Events `createDemEvent(Closure)` is used to create diagnostic events of different kinds.

The method can be configured to create different types of DTCs/Events:

1. **UDS Event:** This is the default type of event, when only an 'eventName' and a 'dtc' number is specified. A new `DemEventParameter` container with the given shortname and a new `DemDTCClass` with the given `DemUdsDTC` is created.

```
scriptTask('taskName') {
  code {
    transaction {
      domain.diagnostics {

        def udsEvent = createDemEvent {
          eventName = "NewUdsEvent"
          dtc = 0x30
        }
      }
    }
  }
}
```

Listing 4.184: Create a new UDS DTC with event

2. **OBD II Event:** If OBD II is enabled for the loaded configuration, and a 'obd2Dtc' is specified instead of a 'dtc', the method will create an OBD II relevant event. The difference is, that it will set the parameter `DemObdDTC` instead of `DemUdsDTC`. It is also possible to specify 'dtc' as well as 'obd2dtc', which will result in both DTC parameters are set.

```
scriptTask('taskName') {
  code {
    transaction {
      domain.diagnostics {
        // OBD must be enabled and legislation must be OBD2
        // Enable OBD2
        obd2Enabled = true

        def obd2Event = createDemEvent {
          eventName = 'NewOBD2Event'
          obd2Dtc = 0x40
        }

        def obd2CombinedEvent = createDemEvent {
          eventName = 'UDS_OBD2_Combined_Event'
          dtc = 0x31
          obd2Dtc = 0x41
        }
      }
    }
  }
}
```

Listing 4.185: Enable OBD II and create a new OBD related DTC with event

3. **WWH-OBD Event:** If WWH-OBD is enabled for the loaded configuration, and a 'wwhObdDtcClass' with a value other than 'NO_CLASS' is specified, the method will create a WWH-OBD relevant event. Note that WWH-OBD relevant events usually do reference the so called MIL indicator, thus this reference will be set by default in the newly created DemEventParameter.

```
scriptTask('taskName') {
    code {
        transaction {
            domain.diagnostics {
                // OBD must be enabled, and legislation must be WWH-OBD
                // The parameter '/Dem/DemGeneral/DemMILIndicatorRef' must
                // be set
                wwhObdEnabled = true

                def wwhObdEvent = createDemEvent {
                    eventName = 'WWHOBD_Event'
                    dtc = 0x50
                    // wwhObdClass != NO_CLASS indicates WWH-OBD event
                    wwhObdDtcClass = CLASS_A
                }
            }
        }
    }
}
```

Listing 4.186: Enable WWH-OBD and create a new OBD related DTC with event

4. **J1939 Event:** The last type of event is a J1939 related event, which can be created when J1939 is licensed and available for the loaded configuration. This is done in a similar way as for UDS events, but additionally specifying 'spn', 'fmi' values as well as the name of the referenced 'nodeAddress'.

```
scriptTask('taskName') {
    code {
        def nodeAddressContainer = mdfModel(AsrPath.create("/ActiveEcuC/
Dem/DemConfigSet/DemJ1939NodeAddress", MIContainer))

        transaction {
            domain.diagnostics {
                // J1939 Event creation
                // J1939 must be enabled and License must be available.
                j1939Enabled = true

                def j1939Event = createDemEvent {
                    eventName 'J1939_Event'
                    dtc 0x30
                    spn 90
                    fmi 13
                    nodeAddress nodeAddressContainer
                }
            }
        }
    }
}
```

Listing 4.187: Open a project, enable J1939 and create a new J1939 DTC with event

Important Note:

For every DTC numbers apply the rule, that if there are already DemDTCClasses with the given number, they will be used. In such a case, no new DemDTCClass container is created.

4.10.3 Mode Management Domain

The mode management domain API is specifically designed to support mode management related use cases. It is available from the IDomainApi 4.10 on page 143 in the form of the IModeManagementApi interface.

getModeManagement() allows accessing the IModeManagementApi like a property.

```
scriptTask('taskName') {  
  code {  
    // IModeManagementApi is available as "modeManagement" property  
    def modeManagement = domain.modeManagement  
  }  
}
```

Listing 4.188: Accessing IModeManagementApi as a property

modeManagement(Closure) allows accessing the IModeManagementApi in a scope-like way.

```
scriptTask('taskName') {  
  code {  
    domain.modeManagement {  
      // IModeManagementApi is available inside this Closure  
    }  
  }  
}
```

Listing 4.189: Accessing IModeManagementApi in a scope-like way

4.10.3.1 BswM Auto Configuration

The IBswMAutoConfigurationApi allows for semi-automatic creation of dedicated parts of the BswM configuration. The BswM auto configuration takes an input consisting of "features" and "parameters" to be provided via the IBswMAutoConfigurationApi. Each feature may have zero, one or more sub-features and zero, one or more parameters.

The corresponding BswM configuration content is derived based on the (de)activation of features and the values assigned to the parameters.

The available features and parameters depend strongly on the project's input data and general project setup. They can be addressed by **String** identifiers. These identifiers are best obtained from the corresponding auto configuration assistant of the BSW management editor in the Cfg5 GUI.

```

scriptTask('EcuStateHandlingAutoConfiguration', DV_PROJECT) {
  code {
    // In projects with post-build selectable variance switching to an
    // IPredefinedVariantView for performing auto configuration is mandatory
    variance.variantView('Left').activeWith {

      domain.modeManagement.bswMAutoConfig('Ecu State Handling') {
        activate '/ECU State Machine/Support ComM'
        set '/ECU State Machine/Self Run Request Timeout' to 0.2
        set '/ECU State Machine/Number of Run Request User' to 4
        overrides {
          if (addition || removal) {
            keepOverride
          } else if (BswMArgumentRef.DefRef.isDefinitionOf(element)
            && feature('/ECU State Machine/Support ComM/CAN00_f26020e5').
              enabled
            && parameter('/ECU State Machine/Number of PostRun Request
              User').value == 4) {
            discardOverride
          } else {
            keepOverride
          }
        }
      }
    }
  }
}

```

Listing 4.190: ECU State Handling Auto Configuration

Executing the BswM Auto Configuration `IModeManagementApi.bswMAutoConfig(String, Closure)` delegates the given code to the `IBswMAutoConfigurationApi` of the given BswM auto configuration domain.

Activating BswM Auto Configuration Features `activate(String)` activates the BswM auto configuration feature with the given identifier. All enabled sub-features of the specified feature are also activated. Imagine the features displayed in a tree structure (like in Cfg5 GUI) where checking a tree node automatically checks all children.

Deactivating BswM Auto Configuration Features `deactivate(String)` deactivates the BswM auto configuration feature with the given identifier. All enabled sub-features of the specified feature are also deactivated. Imagine the features displayed in a tree structure (like in Cfg5 GUI) where unchecking a tree node automatically unchecks all children.

Assigning Values to BswM Auto Configuration Parameters `set(String)` sets the parameter with the given identifier to the specified value. Supported value types are `boolean`, `BigInteger`, `BigDecimal`, `String` and `MIReferrable` (reference parameters).

Manually Adapting the BswM Auto Configuration Content The BswM auto configuration mechanism is useful for creating large parts of the BswM configuration based on certain built-in heuristics. Where these heuristics fail to fulfill detailed project specific requirements manual adaptations to the auto-generated configuration content become necessary.

Per default manual adjustments are kept in the configuration. But subsequent BswM auto configuration runs may render previously applied adjustments obsolete or dysfunctional. Using `overrides(Closure)` a callback can be registered to be called for each detected adaptation. The callback can decide for each adjustment if it is to remain in the configuration or if it is to be overwritten by the BswM auto configuration. For details on which information is provided to this callback please refer to the javadoc provided with `IBswMAutoConfigurationOverride`.

Inspecting BswM Auto Configuration Domains The `getBswMAutoConfigDomains()` method of the `IModeManagementApi` interface provides read-access to all available BswM auto configuration domains. Available features and parameters can be inspected for various properties. See javadoc of `IBswMAutoConfigurationDomain`, `IBswMAutoConfigurationFeature` and `IBswMAutoConfigurationParameter` for details.

```
domain.modeManagement {
  // In projects with post-build selectable variance switching to an
  // IPredefinedVariantView for inspecting auto configuration is mandatory
  variance.variantView('Left').activeWith {

    // get all BswM auto configuration domains
    def ecuStateHandlingDomain = bswMAutoConfigDomains.forEach {
      scriptLogger.info it.identifier
    }

    def isEnabled = bswMAutoConfigDomain 'Ecu State Handling' feature '/ECU
      State Machine/Support ComM' enabled
    def isActive = bswMAutoConfigDomain 'Ecu State Handling' feature '/ECU
      State Machine/Support ComM' activated
    if (isEnabled && isActive) {
      // activation state can be toggled at enabled features only
      bswMAutoConfig('Ecu State Handling') {
        deactivate '/ECU State Machine/Support ComM'
      }
    }

    bswMAutoConfigDomain('Ecu State Handling') {
      // this code is delegated to the 'Ecu State Handling'
      // auto configuration domain
      def p1 = parameter '/ECU State Machine/Self Run Request Timeout' value
      scriptLogger.info 'Self Run Request Timeout = ' + p1
      def p2 = parameter '/ECU State Machine/Number of Run Request User' value
      scriptLogger.info 'Number of Run Request User = ' + p2

      // get all root features
      rootFeatures.forEach { scriptLogger.info it.identifier }

      // get all sub-features of a feature
      feature '/ECU State Machine/Support ComM' subFeatures.forEach {
        scriptLogger.info it.identifier
      }

      // get all parameters of a feature
      feature '/ECU State Machine' parameters.forEach {
        scriptLogger.info it.identifier
      }
    }
  }
}
```

Listing 4.191: Inspecting Auto Configuration Elements

4.10.4 Runtime System Domain

The runtime system domain API is specifically designed to support runtime system related use cases. It is available from the `IDomainApi` (see 4.10 on page 143) in the form of the `IRuntimeSystemApi` interface.

`getRuntimeSystem()` allows accessing the `IRuntimeSystemApi` like a property.

```
scriptTask('taskName') {  
  code {  
    // IRuntimeSystemApi is available as "runtimeSystem" property  
    def runtimeSystem = domain.runtimeSystem  
  }  
}
```

Listing 4.192: Accessing `IRuntimeSystemApi` as a property

`runtimeSystem(Closure)` allows accessing the `IRuntimeSystemApi` in a scope-like way.

```
scriptTask('taskName') {  
  code {  
    domain.runtimeSystem {  
      // IRuntimeSystemApi is available inside this Closure  
    }  
  }  
}
```

Listing 4.193: Accessing `IRuntimeSystemApi` in a scope-like way

The following use cases are supported:

4.10.4.1 Component Port Connection

A component port (`IComponentPort`) represents a port prototype and its corresponding component prototype, and in case of a delegation port the corresponding top level composition type (Ecu Composition).

The connecting component ports use case allows connecting (a.k.a. mapping) different ports in a similar way the component connection assistant does.

Selecting component ports to map The entry point is to select a collection of component ports and auto-map them to the possible target component ports by applying the matching rules of the component connection assistant.

`selectComponentPorts(Closure)` allows the selection of `IComponentPorts` using predicates.

Predicates To select the component ports predicates can be provided to narrow down the component ports to be connected: this corresponds to the manual selection of certain component ports in the component connection assistant.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Component Port Predicates

- `unconnected()` matches unconnected component ports.
- `connected()` matches connected component ports.
- `completed()` matches component ports which are completed.

A delegation port is completed if and only if the port is connected and each of the port's communication elements is data mapped to a system signal or a system signal group.

An inner port is completed if the port is connected or each of the port's communication elements is data mapped to a system signal or a system signal group. This means an inner port which is connected and data mapped is also completed.

- `notCompleted()` matches component ports which are not completed.

See `completed()` for the conditions a port has to meet to be a completed port.

- `terminated()` matches terminated component ports.
- `notTerminated()` matches non-terminated component ports.
- `senderReceiver()` matches component ports whose port has a sender/receiver port interface.
- `clientServer()` matches component ports whose port has a client/server port interface.
- `modeSwitch()` matches component ports whose port has a mode-switch port interface.
- `nvData()` matches component ports whose port has a NvData port interface.
- `parameter()` matches component ports whose port has a parameter (calibration) port interface.
- `trigger()` matches component ports whose port has a trigger port interface.
- `provided()` matches provided component ports (p-port).
- `required()` matches required component ports (r-port).
- `providedRequired()` matches provided-required component ports (pr-port).
- `delegation()` matches delegation ports (ports of the Ecu composition).
- `application()` matches component ports whose port interface is an application port interface.
- `service()` matches component ports whose port interface is a service port interface.
- `applicationComponent()` matches component ports whose component type is an application component type. Application component types are all component types which are not service component types, as displayed in the ECU Software Components Editor, not `ApplicationSwComponentTypes` as defined by AUTOSAR.
- `serviceComponent()` matches component ports whose component type is a service component type.
- `parameterComponent()` matches component ports whose component type is a parameter component type.

- `nvBlockComponent()` matches component ports whose component type is a nv block component type.
- `sensorActuatorComponent()` matches component ports whose component type is a sensor actuator component type.
- `ioHwAbstractionComponent()` matches component ports whose component type is a I/O hardware abstraction component type, also called `EcuAbstractionSwComponentType`.
- `complexDeviceDriverComponent()` matches component ports whose component type is a complex device driver component type.
- `serviceProxyComponent()` matches component ports whose component type is a service proxy component type.
- `name(String)` matches component ports with the given port name.
- `name(Pattern)` matches component ports with the given port name pattern.
- `asrPath(String)` matches component ports with the given port autosar path.
- `asrPath(Pattern)` matches component ports with the given port autosar path pattern.
- `component(String)` matches component ports with the given component name.
- `component(Pattern)` matches component ports with the given component name pattern.
- `componentAsrPath(String)` matches the component ports with the given component autosar path.
- `componentAsrPath(Pattern)` matches component ports with the given component autosar path pattern.
- `componentType(String)` matches component ports whose component type's name equals the given component type name.
- `componentType(Pattern)` matches component ports whose component type's name matches the given component type name pattern.
- `componentTypeAsrPath(String)` matches the component ports whose component type's autosar path equals the given component type autosar path.
- `componentTypeAsrPath(Pattern)` matches component ports whose component type's autosar path matches the given component type autosar path pattern.
- `portInterfaceMapping(String)` matches component ports for whose port interfaces a port interface mapping with the given port interface mapping name exists.
- `portInterfaceMapping(Pattern)` matches component ports for whose port interfaces a port interface mapping with the given port interface mapping name pattern exists.
- `portInterfaceMappingAsrPath(String)` matches component ports for whose port interfaces a port interface mapping with the given port interface mapping autosar path exists.
- `portInterfaceMappingAsrPath(Pattern)` matches component ports for whose port interfaces a port interface mapping with the given port interface mapping autosar path pattern exists.
- `originComponentPortName(String)` matches component ports having an origin component port with the given `originPortName`. That means the port has an incomplete

delegation connection in the structured extract to a composition port with the given `originPortName`.

- `originComponentPortNamePattern(Pattern)` matches component ports having an origin component port with the given origin port name pattern. That means the port has an incomplete delegation connection in the structured extract to a composition port with the given origin port name pattern.
- `originComponentPortComponent(String)` matches component ports having an origin component port with the given `originComponentName`. That means the port has an incomplete delegation connection in the structured extract to a composition port whose composition owner instance has the given `originComponentName`.
- `originComponentPortComponent(Pattern)` matches component ports having an origin component port with the given origin component name pattern. That means the port has an incomplete delegation connection in the structured extract to a composition port whose composition owner instance has the given origin component name pattern.
- `hasInnerTopLevelDelegationOriginComponentPort()` matches component ports which have an inner top level origin component port. That means the port in the structured extract has an incomplete delegation connection which ends at a composition that is instantiated directly inside the top level composition (ECU Composition).
- `filterAdvanced(Closure)` matches component ports for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```
scriptTask("selectAllPorts", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def selectedPorts =
          selectComponentPorts {
            // no predicates: select ALL component ports
          } getComponentPorts()
        scriptLogger.infoFormat("Selected {0} component ports.", selectedPorts.
          size())
      }
    }
  }
}
```

Listing 4.194: Selects all component ports

```
scriptTask("selectAllUnconnectedPorts", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def selectedPorts =
          selectComponentPorts {
            unconnected() // select all unconnected component ports
          } getComponentPorts()
        scriptLogger.infoFormat("Selected {0} component ports.", selectedPorts.
          size())
      }
    }
  }
}
```

Listing 4.195: Selects all unconnected component ports

```
scriptTask("selectAllUnconnectedSRAndConnectedModePorts", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def selectedPorts =
          selectComponentPorts {
            // start with logical OR
            or {
              and { // unconnected sender/receiver ports
                unconnected()
                senderReceiver()
              }
              and { // connected modeSwitch ports
                connected()
                modeSwitch()
              }
            }
          } getComponentPorts()
        scriptLogger.infoFormat("Selected {0} component ports.", selectedPorts.
          size())
      }
    }
  }
}
```

Listing 4.196: Select all unconnected sender/receiver or connected mode-switch component ports

```

scriptTask("selectNotCompletedPorts", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def selectedPorts =
          selectComponentPorts {
            // this predicate filters for ports
            // which needs to be connected and/or a data mapping
            notCompleted()
          } getComponentPorts()
        scriptLogger.infoFormat("Selected {0} component ports.", selectedPorts.
          size())
      }
    }
  }
}

```

Listing 4.197: Selects not completed component ports

```

scriptTask ("selectComponentPortsUsingOriginContextPredicates", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {

        // we want to use information from the structured extract to
        // select flat extract ports

        def selectedComponentPorts = selectComponentPorts {
          // use component port related predicates
          senderReceiver()
          required()

          // combine them with origin context related predicates
          // but remember that we are still selecting flat extract
          // ports here
          // we only use the origin context ports as additional
          // criteria

          // we want only ports for which the connection ends at the
          // highest composition level inside the top level
          // composition
          // of the structured extract
          hasInnerTopLevelDelegationOriginComponentPort()

          // and only ports whose origin context has a special name
          // pattern for their composition owner instance
          originComponentPortComponent(~"Origin.*")
        }.getComponentPorts()

        scriptLogger.infoFormat("Selected {0} component ports using
          their origin context as additional selection criteria.",
          selectedComponentPorts.size())
      }
    }
  }
}

```

Listing 4.198: Use origin context predicates for selecting component ports

Auto-Mapping The use case of auto-mapping component ports is based on the selection of component ports: it offers the methods to auto-map.

`autoMap()` tries to auto-map the selection of component ports according the component connection assistant default rules.

Examples for `autoMap()`

```
scriptTask("automapAll", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def mappedConnectors =
          selectComponentPorts {
            // no predicates: select ALL component ports
          } autoMap()
        scriptLogger.infoFormat("Created {0} mappings.", mappedConnectors.size
          ())
      }
    }
  }
}
```

Listing 4.199: Tries to auto-map all ports

```
scriptTask("automapAllUnconnected", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def mappedConnectors =
          selectComponentPorts {
            unconnected() // select all unconnected component ports
          } autoMap()
        scriptLogger.infoFormat("Created {0} mappings.", mappedConnectors.size
          ())
      }
    }
  }
}
```

Listing 4.200: Tries to auto-map all unconnected component ports

```

scriptTask("autoMapUnconnectedSRCS", DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def mappedConnectors =
                    selectComponentPorts {
                        // select all unconnected client/server and unconnected
                        // sender/receiver ports
                        unconnected()
                        or {
                            clientServer()
                            senderReceiver()
                        }
                    } autoMap()
                scriptLogger.infoFormat("Created {0} mappings.",mappedConnectors.size())
            }
        }
    }
}

```

Listing 4.201: Tries to auto-map all unconnected sender/receiver and client/server ports

```

import com.vector.cfg.model.sysdesc.api.port.IComponentPort

scriptTask("autoMapAdvancedfilter", DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def mappedConnectors =
                    selectComponentPorts {
                        // select component port by own custom filter predicate
                        filterAdvanced {IComponentPort port ->
                            "MyUUID".equals(port.getMdfPort().getUuid2())
                        }
                    } autoMap()
                scriptLogger.infoFormat("Created {0} mappings.",mappedConnectors.size())
            }
        }
    }
}

```

Listing 4.202: Tries to auto-map port determined by advanced filter

`autoMapTo(Closure)` tries to auto-map the selection of component ports according the component connection assistant rules but offers more control for the auto-mapping: Inside the closure additional predicates for narrowing down the target component ports can be defined and code to evaluate and change the auto-mapper results can be provided.

Narrowing down the target component ports may be useful to gain better matches for the auto-mapper: In case several target component ports match equally, no auto-mapping is performed. So reducing the target component ports may improve the results of the auto-mapping.

The component port selection will produce trace, info and warning logs. To see them, activate the 'com.vector.cfg.dom.runtimesys.groovy.api.IComponentPortSelection' logger with the appropriate log level.

Control the auto-mapping in autoMapTo(Closure)

`selectTargetPorts(Closure)` allows to define predicates to narrow down the target ports for

the auto-mapping. The predicates are used to filter the possible target component ports which were computed from the source component port selection.

```
scriptTask("autoMapUnconnectedToComponentPrototype", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def mappedConnectors =
          selectComponentPorts {
            unconnected() // select all unconnected ports
          } autoMapTo {
            selectTargetPorts {
              component "App1" // and auto-map them to all ports of
                              component "App1"
            }
          }
        scriptLogger.infoFormat("Created {0} mappings.",mappedConnectors.size())
      }
    }
  }
}
```

Listing 4.203: Tries to auto map all unconnected ports to the ports of one component prototype

`evaluateMatches(Closure)` allows to evaluate and change the results of the auto-mapping. It corresponds to the confirm page of the component connection assistant.

For each source component port the provided closure is called: Parameters are the source component port, the optional matched target component port (or null), and a list of all potential target component ports (respecting the `selectTargetPorts(Closure)` predicates). The return value must be a list of target component ports.

```
import com.vector.cfg.dom.runtimesys.api.assistant.connection.
    ISourceComponentPort
import com.vector.cfg.dom.runtimesys.api.assistant.connection.
    ITargetComponentPort

scriptTask("automapAllUnconnectedAndEvaluateMatches", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def mappedConnectors =
          selectComponentPorts {
            unconnected()
          } autoMapTo {
            evaluateMatches {
              ISourceComponentPort sourcePort,
              ITargetComponentPort optionalMatchedTargetPort,
              List<ITargetComponentPort> potentialTargetPorts ->
              if (sourcePort.getPortName().equals("MyExceptionalPort")
                ) {
                // example for excluding a port from auto-mapping
                // by having a close look
                // sourcePort.getMdfPort()....
                return null
              }
              // default: do not change the auto-matched port
              [optionalMatchedTargetPort]
            }
          }
      }
      scriptLogger.infoFormat("Created {0} mappings.",mappedConnectors.size())
    }
  }
}
```

Listing 4.204: Tries to auto-map all unconnected ports and evaluate matches

```

import com.vector.cfg.dom.runtimesys.api.assistant.connection.
    ISourceComponentPort
import com.vector.cfg.dom.runtimesys.api.assistant.connection.
    ITargetComponentPort

scriptTask("anotherExampleForUsingEvaluateMatches", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def mappedConnectors =
          selectComponentPorts {
            unconnected()
          } autoMapTo {
            evaluateMatches {
              ISourceComponentPort sourcePort,
              ITargetComponentPort optionalMatchedTargetPort,
              List<ITargetComponentPort> potentialTargetPorts ->

              // iterate over potential target ports to find the
              // correct target

              // like in java you can use a for loop
              for (ITargetComponentPort targetCP :
                potentialTargetPorts) {
                if (targetCP.getPortName().startsWith("MyPort_")
                ) {
                  return [targetCP]
                }
              }

              // or you can use a stream
              def myTargets = potentialTargetPorts.findAll {
                it.getPortName().startsWith("OtherPort_")
              }
              return myTargets
            }
          }
      }
      scriptLogger.infoFormat("Created {0} mappings.",mappedConnectors.
        size())
    }
  }
}

```

Listing 4.205: Another example for using evaluate matches

```

import com.vector.cfg.dom.runtimesys.api.assistant.connection.
    ISourceComponentPort
import com.vector.cfg.dom.runtimesys.api.assistant.connection.
    ITargetComponentPort

scriptTask("automap1ToN", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def mappedConnectors =
          selectComponentPorts {
            // select single delegation port
            delegation()
            name "rDelegationSRPort1"
          } autoMapTo {
            selectTargetPorts {
              // select a collection of target ports (names start with
              "rSRPort")
              name ~"rSRPort.*"
            }
            evaluateMatches {
              ISourceComponentPort sourcePort,
              ITargetComponentPort optionalMatchedTargetPort,
              List<ITargetComponentPort> potentialTargetPorts ->
              // return all potentialTargetPorts for 1:n
              connections, not only the one matched best
              potentialTargetPorts
            }
          }
        scriptLogger.infoFormat("Created {0} mappings.",mappedConnectors.size())
      }
    }
  }
}

```

Listing 4.206: Auto-map a component port and realize 1:n connection by using evaluate matches

`forceConnectionWhen1To1()` allows to force a mapping even the usual auto-mapping rules will not match. Precondition is that the collections of source component ports and target component ports only contain one component port each. Otherwise no mapping is done.

```

scriptTask("autoMapTwoNonMatchingPorts", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def mappedConnectors =
          selectComponentPorts {
            // select a single source component port
            name "prNVPort1"
            component "NvApp1"
          } autoMapTo {
            selectTargetPorts {
              // select a single target component port
              name "rSRPort2"
              component "App2"
            }
            // force the connection even names do not match at all
            forceConnectionWhen1To1()
          }
        scriptLogger.infoFormat("Created {0} mappings.",mappedConnectors.size())
      }
    }
  }
}

```

Listing 4.207: Create mapping between two ports which names do not match.

`useOriginContextForMatch()` uses another algorithm to match the component ports.

The standard algorithm matches only the names of the ports (delegation port of flat extract or port of a SWC of the flat extract).

This option uses also the origin context's name for the name matching.

Incomplete Connections:

Below we will talk about complete and incomplete connections. A connection is complete if the port of a SWC is connected to another SWC port or to a delegation port of the top level ECU composition. A connection is incomplete if a SWC port is connected to a delegation port of a composition which is not the top level ECU composition and the connection stops at this port (the delegation port is unconnected on the other side).

Origin Context:

Origin contexts of an inner port are delegation ports of the structured extract which are connected to this port and are the outermost ports of an incomplete connection. Delegation ports of the flat extract cannot have any origin contexts.

Example:

We want to map the port 'pData' of 'App1' of the flat extract. The corresponding component in the structured extract is instantiated inside the composition 'Comp1'. 'pData' is connected to the port 'pOriginContext' of 'Comp1'. 'pOriginContext' has no further ports connected to it.

When not using `useOriginContextForMatch()` option, only 'pData' would be used for the port name matching.

When using the `useOriginContextForMatch()` option, not only (but also) the name 'pData' is used for the port name matching, but also the origin context 'pOriginContext'.

```

scriptTask("mapUsingOriginContext", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def createdConnections = selectComponentPorts {
          component("App1OriginContextMatch")
          name("A")
        } autoMapTo {
          // this option will not only match the name of the port 'A'
          // but also the delegation ports' names of incomplete connections
          // of the structured extract
          useOriginContextForMatch()
        }
      }
      scriptLogger.infoFormat("Created '{0}' connections.",
        createdConnections.size())
    }
  }
}
}

```

Listing 4.208: Use the origin context for the port name matching

Simple API for connection between two ports This API covers the use case when the names of the components and ports, which should be connected, are known. The entry point is the selection of exactly one component port.

`componentPort(String, String)` allows to select an `IComponentPort` and to do further operations on it, e.g. connecting the port to another port.

`ISelectedComponentPort` represents a selection of exactly one `IComponentPort` and provides further actions on it.

`connectTo(String, String, Optional)` creates an `IConnector` between the `IComponentPort` which is represented by this `ISelectedComponentPort` and the `IComponentPort` which is retrieved by the given component and port name. It is possible to connect the component port to a delegation port by using 'COMPOSITIONTYPE' as componentName.

The API provides only the very basic checks.

- Direction of the ports is checked. E.g. it is not allowed to connect two PPorts within an AssemblySwConnector.
- Connecting incompatible types of port interfaces is not allowed. E.g. it is not allowed to connect a mode switch with a sender receiver port.
- Connecting two delegation ports is not allowed.
- The port interface mapping has to reference the port interfaces of the selected component ports.
- Connecting a terminated port is not allowed. Please remove the port terminator first. Use `ISelectedComponentPort.removePortTerminator()`.
- Creating redundant connections is not allowed. The ports cannot be connected by a second connector.

Examples

```
import java.util.Optional

scriptTask ("assemblyConnectionExample", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {

                // enter component and port name of a component port and the
                // component port to connect it to
                // optionally you can add a port interface mapping
                def createdConnector = componentPort("App1", "pDataSend").
                    connectTo("App2", "rSRPort2", Optional.empty())

                scriptLogger.infoFormat("Created a connection between '{0}' and
                    '{1}'.",
                    createdConnector.getProvidedPort().getName(),
                    createdConnector.getRequiredPort().getName())

            }
        }
    }
}
```

Listing 4.209: Example how to create a simple assembly connection

```
import java.util.Optional

scriptTask ("delegationConnectionExample", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                // to select a delegation port the name of the ECU Composition
                // is used as component name
                def createdConnector = componentPort("COMPOSITIONTYPE", "
                    rDelegationSRPort1").connectTo("App2", "rSRPort2", Optional.
                    empty())

                // the provided and required port getter work also for
                // delegation connections
                // you can find more info in the java doc of IConnector
                scriptLogger.infoFormat("Created a connection between '{0}' and
                    '{1}'.",
                    createdConnector.getProvidedPort().getName(),
                    createdConnector.getRequiredPort().getName())

            }
        }
    }
}
```

Listing 4.210: Example how to create a simple delegation connection

```

import java.util.Optional

scriptTask ("delegationConnectionExample", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def portInterfaceMappingPath = "/ComponentTypes/
                DataTypeMappingSets/PortInterfaceMappingSet1/Mapping1"

                // to add a port interface mapping to the connection, use an
                optional with the AUTOSAR path to the port interface mapping
                def createdConnector = componentPort("COMPOSITIONTYPE", "
                pDelegationSRPort2").connectTo("App1", "pSRPort1", Optional.
                of(portInterfaceMappingPath))

                scriptLogger.infoFormat("Created a connection between '{0}' and
                '{1}'.",
                createdConnector.getProvidedPort().getName(),
                createdConnector.getRequiredPort().getName())
            }
        }
    }
}

```

Listing 4.211: Create connector with port interface mapping

Terminating Component Ports Port Terminators can be used to acknowledge the fact, that the port is not connected yet. This will prevent validation rules to produce validation results reporting these ports as unconnected or missing data mappings for these ports.

`terminate()` terminates all selected `IComponentPorts`. If one of the selected ports is already terminated or connected to another component port, the port will be ignored.

The termination of component ports disables the validation of these ports. In other words, these ports are acknowledged as not connected yet. This should give a better overview of the open ports, which still have to be connected or need a data mapping.

`removePortTerminators()` removes the port terminators of all selected component ports. If one of the selected component ports is not terminated the method will ignore that port.

See `terminate()` for more information about the purpose of terminating ports.

It is also possible to create and remove port terminators via the simple API starting with the selection of one component port (`componentPort(String, String)`).

`terminate()` terminates the selected `IComponentPort` if it is not already terminated or connected to another component port. You can use `IComponentPort.isTerminated()` to check if a port is terminated and `IComponentPort.isConnected()` if a port is connected to other ports.

The termination of component ports disables the validation of these ports. In other words, these ports are acknowledged as not connected yet. This should give a better overview of the open ports, which still have to be connected or need a data mapping.

`removePortTerminator()` removes the port terminator of the selected component port.

See `terminate()` for more information about the purpose of terminating ports.

Examples


```

import com.vector.cfg.model.sysdesc.api.port.IComponentPort

scriptTask("terminatePort", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // the statements below will return us a collection with all component
        // ports which will be terminated
        def terminatedPorts =
          selectComponentPorts {
            delegation()
            name("pDelegationCSPort1")

            // use terminate() to terminate all selected component ports
            // if a selected port is already terminated or connected, it will
            // not be terminated (again)
          } terminate()

        // this result may contain less ports than the actual selected ports,
        // if some of the selected ports were connected or terminated
        for (final IComponentPort terminatedPort : terminatedPorts) {
          scriptLogger.infoFormat("Terminated component port '{0}'.",
            terminatedPort.getName())
        }
      }
    }
  }
}

```

Listing 4.212: Terminate port using the component port selection API

```

import com.vector.cfg.model.sysdesc.api.port.IComponentPort

scriptTask("removePortTerminator", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // the statements below will return us a collection with all component
        // ports for which a port terminator was removed
        def removedPortTerminators =
          selectComponentPorts {
            // filter for all terminated delegation ports
            delegation()
            // there are predicates to filter for terminated() and
            // notTerminated() ports
            terminated()

            // if a port is not terminated it will be skipped
          } removePortTerminators()

        // the result may contain less component ports than the selection,
        // if some of the ports were not terminated
        for (final IComponentPort componentPort : removedPortTerminators) {
          scriptLogger.infoFormat("Removed port terminator of component port
            '{0}'.", componentPort.getName())
        }
      }
    }
  }
}

```

Listing 4.213: Remove port terminator using the component port selection API

```
scriptTask("createPortTerminator", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // select the component port via the simple API and call terminate()
        // this API is more strict and throws an exception if the selected port
        // cannot be terminated
        def terminatedPort = componentPort("COMPOSITIONTYPE", "
          rDelegationSRPort1").terminate()

        scriptLogger.infoFormat("Terminated component port '{0}'.",
          terminatedPort.getName())
      }
    }
  }
}
```

Listing 4.214: Create a port terminator using the simple API

```
scriptTask("removePortTerminator", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // select the component port via the simple API and call terminate()
        // this API is more strict and throws an exception if the selected port
        // has no port terminator to remove
        def removedTerminatorPort = componentPort("App1_1", "pSRPort1").
          removePortTerminator()

        scriptLogger.infoFormat("Terminated component port '{0}'.",
          removedTerminatorPort.getName())
      }
    }
  }
}
```

Listing 4.215: Remove a port terminator using the simple API

4.10.4.2 Data Mapping

The data mapping use case allows to connect signal instances and data elements / operations / triggers in a similar way the data mapping assistant does.

Communication Element A data element, an operation or a trigger to be data-mapped is represented by an `ICommunicationElement`. A data element is represented by the subtype `IDataCommunicationElement`, an operation is represented by the subtype `IOperationCommunicationElement` and a trigger is represented by the subtype `ITriggerCommunicationElement`. A communication element contains the full context information (component prototype, port prototype, data type hierarchy) necessary for data mapping.

Signal Instance The system signals and system signal groups to be data-mapped are represented by a signal instance (`IAbstractSignalInstance`). `ISignalInstance` represents a system signal, `ISignalGroupInstance` represents a system signal group. 'Signal instance' means that the system signal or system signal group is at least referenced by one `ISignal` or `ISignalGroup`.

System signals or system signal groups which are not referenced by an ISignal or ISignalGroup are not represented as signal instance and so are not available for data mapping.

The entry point for data mapping is either to select a collection of signal instances and auto-map them to the possible target communication elements or vice versa by applying the matching rules of the data mapping assistant.

Mapping signal instances `selectSignalInstances(Closure)` allows the selection of `IAbstractSignalInstances` using predicates.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Signal Instance Predicates

- `unmapped()` matches signal instances which are not data-mapped.
- `mapped()` matches signal instances which are data-mapped.
- `signalGroup()` matches signal instances which are a signal group instance.
- `groupSignal()` matches signal instances which are a group signal.
- `transformed()` matches signal instances which are transformation signals.
- `tx()` matches signal instances whose direction is compatible to `EDirection.Tx`.
- `rx()` matches signal instances whose direction is compatible to `EDirection.Rx`.
- `name(String)` matches signal instances with the given name.
- `name(Pattern)` matches signal instances with the given name pattern.
- `asrPath(String)` matches signal instances with the given autosar path.
- `asrPath(Pattern)` matches signal instances with the given autosar path pattern.
- `iSignal(String)` matches signal instances which are referenced at least by one ISignal/ISignalGroup with the given name.
- `iSignal(Pattern)` matches signal instances which are referenced at least by one ISignal/ISignalGroup with the given name pattern.
- `iSignalAsrPath(String)` matches signal instances which are referenced at least by one ISignal/ISignalGroup with the given autosar path.
- `iSignalAsrPath(Pattern)` matches signal instances which are referenced at least by one ISignal/ISignalGroup with the given autosar path pattern.
- `physicalChannel(String)` matches signal instances which are referenced by at least an ISignal/ISignalGroup for which an ISignalTriggering exists for a PhysicalChannel with the given name.
- `physicalChannel(Pattern)` matches signal instances which are referenced by at least an ISignal/ISignalGroup for which an ISignalTriggering exists for a PhysicalChannel with the given name pattern.
- `physicalChannelAsrPath(String)` matches signal instances which are referenced by at least an ISignal/ISignalGroup for which an ISignalTriggering exists for a PhysicalChannel with the given autosar path.

- `physicalChannelAsrPath(Pattern)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` for which an `ISignalTriggering` exists for a `PhysicalChannel` with the given autosar path pattern.
- `communicationCluster(String)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `PhysicalChannel` of a `CommunicationCluster` with the given name.
- `communicationCluster(Pattern)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `PhysicalChannel` of a `CommunicationCluster` with the given name pattern.
- `communicationClusterAsrPath(String)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `PhysicalChannel` of a `CommunicationCluster` with the given autosar path.
- `communicationClusterAsrPath(Pattern)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `PhysicalChannel` of a `CommunicationCluster` with the given autosar path pattern.
- `pdu(String)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` for which an `ISignalToIPduMapping` exists for a `Pdu` with the given name.
- `pdu(Pattern)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` for which an `ISignalToIPduMapping` exists for a `Pdu` with the given name pattern.
- `pduAsrPath(String)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` for which an `ISignalToIPduMapping` exists for a `Pdu` with the given autosar path.
- `pduAsrPath(Pattern)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` for which an `ISignalToIPduMapping` exists for a `Pdu` with the given autosar path pattern.
- `frame(String)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `Pdu` for that a `PduToFrameMapping` exists for a `Frame` with the given name.
- `frame(Pattern)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `Pdu` for that a `PduToFrameMapping` exists for a `Frame` with the given name pattern.
- `frameAsrPath(String)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `Pdu` for that a `PduToFrameMapping` exists for a `Frame` with the given autosar path.
- `frameAsrPath(Pattern)` matches signal instances which are referenced by at least an `ISignal/ISignalGroup` which is sent via a `Pdu` for that a `PduToFrameMapping` exists for a `Frame` with the given autosar path pattern.
- `filterAdvanced(Closure)` matches signal instances for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```
scriptTask("SelectAllUnmappedSignalInstances", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def signalInstances =
          selectSignalInstances {
            unmapped() // select all signal instances which are not yet
                      data mapped
          } getSignalInstances()
        scriptLogger.infoFormat("Selected {0} signal instances.",
                               signalInstances.size())
      }
    }
  }
}
```

Listing 4.216: Select all unmapped signal instances

```
scriptTask("SelectAllUnmappedRxOrTransformedSignalInstances", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def signalInstances =
          selectSignalInstances {
            // the signal instances should not be data-mapped yet
            unmapped()
            or { // and should either be a rx signal or a transformation
              signal
              rx()
              transformed()
            }
          } getSignalInstances()
        scriptLogger.infoFormat("Selected {0} signal instances.",
                               signalInstances.size())
      }
    }
  }
}
```

Listing 4.217: Select all unmapped rx or transformed signal instances

```

import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance
scriptTask("SelectSignalInstancesUsingAdvancedFilter", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def signalInstances =
          selectSignalInstances {
            filterAdvanced { IAbstractSignalInstance signalInstance ->
              // implement own custom filter
              def mdfoObject = signalInstance.getMdfObject()
              // work on directly on autosar model level ...
              // select signal instance only which has admin data
              def select = false
              mdfoObject.adminData {
                select = true
              }
              select
            }
          } getSignalInstances()
        scriptLogger.infoFormat("Selected {0} signal instances.",
          signalInstances.size())
      }
    }
  }
}

```

Listing 4.218: Select signal instances using an advanced filter

Auto-Mapping The use case of auto-mapping signal instances is based on the selection of signal instances: it offers the methods to auto-map.

`autoMap()` tries to auto-map the selection of `IAbstractSignalInstances` (`ISignalInstance` or `ISignalGroupInstance`) according the data mapping assistant default rules. Therefore the selection of possible target communication elements is computed and tried to match to the selected signal instances.

Examples for `autoMap()`

```

scriptTask("autoDatamapAllUnmappedSignalInstances", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def dataMappings =
          selectSignalInstances {
            unmapped()
          } autoMap()
        scriptLogger.infoFormat("Created {0} data mappings.",
          dataMappings.size())
      }
    }
  }
}

```

Listing 4.219: Auto data map all unmapped signal instances

`autoMapTo(Closure)` tries to auto-map the selection of signal instances according the data mapping assistant rules but offers more control for the auto-mapping: Inside the closure additional predicates for narrowing down the target communication elements can be defined and code to evaluate and change the auto-mapper results can be provided.

`autoMapTo(Closure)` will produce trace, info and warning logs. To see them, activate the `'com.vector.cfg.dom.runtimesys.groovy.api.ISignalInstanceSelection'` logger with the appropriate log level.

Control the auto-mapping in `autoMapTo(Closure)`

`selectTargetCommunicationElements(Closure)` allows to define predicates to narrow down the target communication elements for the auto-mapping. The predicates are used to filter the possible target communication elements which were computed from the signal instance selection.

`evaluateMatches(Closure)` allows to evaluate and change the results of the auto-mapping. It corresponds to the confirm page of the data mapping assistant.

For each signal instance the provided closure is called: Parameters are the signal instance, the optional matched target communication element (or null), and a list of all potential target communication elements (respecting the `selectTargetCommunicationElements(Closure)` predicates). The return value must be a communication element or null.

```
import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance
import com.vector.cfg.model.sysdesc.api.com.ICommunicationElement

scriptTask("autoDatamapAllUnmappedSignalInstancesAndEvaluate", DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def dataMappings =
                    selectSignalInstances {
                        unmapped()
                    } autoMapTo {
                        selectTargetCommunicationElements {
                            unmapped()
                        }
                        evaluateMatches {
                            IAbstractSignalInstance signal,
                            ICommunicationElement optionalMatchedComElement,
                            List<ICommunicationElement> potentialComElements
                            ->
                                // evaluate
                                optionalMatchedComElement
                        }
                    }
                scriptLogger.infoFormat("Created {0} data mappings.",
                    dataMappings.size())
            }
        }
    }
}
```

Listing 4.220: Auto data map all unmapped signal instances to unmapped communication elements and evaluate

Nested Array of Primitives `expandNestedArraysOfPrimitive(boolean)` allows to control the expansion of nested arrays of primitive globally. Per default, arrays are fully expanded (allowing to data map each array element). By setting the value to `'false'`, all nested arrays of primitive are not expanded and can be directly data-mapped to a signal.

```

import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance
import com.vector.cfg.model.sysdesc.api.com.ICommunicationElement

scriptTask("autoDatamapAllSignalInstancesAndDoNotExpandNestedArrayElements",
    DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def dataMappings =
                    selectSignalInstances {
                        } autoMapTo {
                            // do not expand nested array elements
                            expandNestedArraysOfPrimitive false
                            evaluateMatches {
                                IAbstractSignalInstance signal,
                                ICommunicationElement optionalMatchedComElement,
                                List<ICommunicationElement> potentialComElements ->
                                    // perform manual mapping to a signal group
                                    if (signal.getName().equals("elemB_c255f5e38fd8b21d")) {
                                        for (final ICommunicationElement comElement :
                                            potentialComElements) {
                                            if (comElement.getFullyQualifiedName().equals("App2.
                                                rSRPort1.Element_2")) {
                                                return comElement
                                            }
                                        }
                                    }
                                    // now check: for the group signal the the record element
                                    representing an array is not expanded
                                    if (signal.getName().equals("fieldA_fd3783e235e88d3")) {
                                        // group signal
                                        for (final ICommunicationElement comElement :
                                            potentialComElements) {
                                            if (comElement.getFullyQualifiedName().equals("App2.
                                                rSRPort1.Element_2.RecordElement")) {
                                                // do some direct mapping here
                                            }
                                        }
                                    }
                                    optionalMatchedComElement
                                }
                            }
                        }
                    scriptLogger.infoFormat("Created {0} data mappings.",dataMappings.size
                        ())
                }
            }
        }
    }
}

```

Listing 4.221: Auto data map all signal instances and do not expand nested array elements

`expandNestedArraysOfPrimitive(String,boolean)` allows to control the expansion of nested arrays of primitive for single nested arrays. Per default, the `expandNestedArraysOfPrimitive(boolean)` applies. For the given fully qualified communication element name, the global setting can be overridden.


```

import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance
import com.vector.cfg.model.sysdesc.api.com.ICommunicationElement

scriptTask("autoDatamapAllSignalInstancesAndDoExpandSpecificNestedArrayElement"
, DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def dataMappings =
          selectSignalInstances {
            } autoMapTo {
              // do not expand nested array elements
              expandNestedArraysOfPrimitive false
              expandNestedArraysOfPrimitive( "App2.rSRPort1.Element_2.
                RecordElement",true)
            evaluateMatches {
              IAbstractSignalInstance signal,
              ICommunicationElement optionalMatchedComElement,
              List<ICommunicationElement> potentialComElements ->
              // perform manual mapping to a signal group
              if (signal.getName().equals("elemB_c255f5e38fd8b21d")) {
                for (final ICommunicationElement comElement :
                  potentialComElements) {
                  if (comElement.getFullyQualifiedName().equals("App2.
                    rSRPort1.Element_2.RecordElement")) {
                    return comElement
                  }
                }
              }
              // now check: for the group signal the the record element
              // representing an array is expanded:
              // the single array elements can be mapped
              if (signal.getName().equals("fieldA_f1d3783e235e88d3")) {
                // group signal
                for (final ICommunicationElement comElement :
                  potentialComElements) {
                  if (comElement.getFullyQualifiedName().equals("App2.
                    rSRPort1.Element_2.RecordElement[0]")) {
                    // do some direct mapping to array element here
                  }
                }
              }
              optionalMatchedComElement
            }
          }
        scriptLogger.infoFormat("Created {0} data mappings.",dataMappings.size
        ())
      }
    }
  }
}

```

Listing 4.222: Auto data map all signal instances and expand specific nested array element

Mapping communication elements `selectCommunicationElements(Closure)` allows the selection of `ICommunicationElements` using predicates.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Communication Element Predicates

- `unconnected()` matches communication elements whose component port is unconnected.
- `connected()` matches communication elements whose component port is connected.
- `senderReceiver()` matches communication elements whose port has a sender/receiver port interface.
- `clientServer()` matches communication elements whose port has a client/server port interface.
- `trigger()` matches communication elements whose port has a trigger port interface.
- `provided()` matches communication elements whose port is a provided port (p-port).
- `required()` matches communication elements whose port is a required port (r-port).
- `delegation()` matches communication elements whose port is delegation port.
- `unmapped()` matches communication elements whose are not data-mapped.
- `mapped()` matches communication elements whose are data-mapped.
- `ownerPortTerminated()` matches communication elements whose component port is terminated.
- `ownerPortNotTerminated()` matches communication elements whose component port is not terminated.
- `name(String)` matches communication elements with the given data element or operation name.
- `name(Pattern)` matches communication elements with the given data element or operation name pattern.
- `asrPath(String)` matches communication elements with the given data element or operation autosar path.
- `asrPath(Pattern)` matches communication elements with the given data element or operation autosar path pattern.
- `component(String)` matches communication elements with the given component name.
- `component(Pattern)` matches communication elements with the given component name pattern.
- `componentAsrPath(String)` matches communication elements with the given component name autosar path.
- `componentAsrPath(Pattern)` matches communication elements with the given component name autosar path pattern.
- `port(String)` matches communication elements with the given component port name.
- `port(Pattern)` matches communication elements with the given component port name pattern.
- `portAsrPath(String)` matches communication elements with the given component port autosar path.
- `portAsrPath(Pattern)` matches communication elements with the given component port autosar path pattern.

- `filterAdvanced(Closure)` Add a custom predicated which matches communication elements for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```
scriptTask("SelectAllUnmappedDelPortComElements", DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def comElements =
                    selectCommunicationElements {
                        // select all unmapped delegation communication elements
                        delegation()
                        unmapped()
                    } getCommunicationElements()
                scriptLogger.infoFormat("Selected {0} communication elements.",
                    comElements.size())
            }
        }
    }
}
```

Listing 4.223: Select all unmapped delegation port communication elements

```
import com.vector.cfg.model.sysdesc.api.com.ICommunicationElement
import com.vector.cfg.model.sysdesc.api.com.IDataCommunicationElement
scriptTask("SelectComElementsUsingAdvancedFilter", DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def comElements =
                    selectCommunicationElements {
                        // advanced filter:
                        // only select communication elements
                        // which represent data elements of a specific data type
                        filterAdvanced { ICommunicationElement comElement ->
                            if (comElement instanceof IDataCommunicationElement) {
                                def mdmDataElement = comElement.
                                    getDataElementOrOperationMdmObject()
                                // check directly on autosar model level
                                return mdmDataElement.type.refTarget.name.equals("
                                    myCustomDataType")
                            }
                            false
                        }
                    } getCommunicationElements()
                scriptLogger.infoFormat("Selected {0} communication elements.",
                    comElements.size())
            }
        }
    }
}
```

Listing 4.224: Select communication elements using an advanced filter

`autoMap()` tries to auto-map the selection of `ICommunicationElements` (`IDataCommunicationElement`

or `IOperationCommunicationElement`) according the data mapping assistant default rules. Therefore the selection of possible target signal instances is computed and tried to match to the selected communication elements.

Examples for `autoMap()`

```
scriptTask("autoDatamapAllUnmappedSRDelPortComElements", DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def dataMappings =
                    selectCommunicationElements {
                        // select all unmapped sender/receiver delegation ports
                        delegation()
                        unmapped()
                        senderReceiver();
                    } autoMap()
                scriptLogger.infoFormat("Created {0} data mappings.", dataMappings.size())
            }
        }
    }
}
```

Listing 4.225: Auto data map all unmapped sender/receiver delegation port communication elements

`autoMapTo(Closure)` tries to auto-map the selection of communication elements according the data mapping assistant rules but offers more control for the auto-mapping: Inside the closure additional predicates for narrowing down the target signal instances can be defined and code to evaluate and change the auto-mapper results can be provided.

`autoMapTo(Closure)` will produce trace, info and warning logs. To see them, activate the `'com.vector.cfg.dom.runtimesys.groovy.api.ICommunicationElementSelection'` logger with the appropriate log level.

Control the auto-mapping in `autoMapTo(Closure)`

`selectTargetSignalInstances(Closure)` allows to define predicates to narrow down the target signal instances for the auto-mapping. The predicates are used to filter the possible target signal instances which were computed from the communication element selection.

`evaluateMatches(Closure)` allows to evaluate and change the results of the auto-mapping. It corresponds to the confirm page of the data mapping assistant.

For each communication element the provided closure is called: Parameters are the communication element, the optional matched target signal instance (or null), and a list of all potential target signal instances (respecting the `selectTargetSignalInstances(Closure)` predicates). The return value must be a signal instance or null.

```

import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance
import com.vector.cfg.model.sysdesc.api.com.ICommunicationElement

scriptTask("autoDatamapAllUnmappedComElementsAndEvaluate", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def dataMappings =
          selectCommunicationElements {
            unmapped() // only unmapped communication elements
          } autoMapTo {
            selectTargetSignalInstances {
              // only map to unmapped rx signal instances
              unmapped()
              rx()
            }
            evaluateMatches {
              ICommunicationElement communicationElement,
              IAbstractSignalInstance optionalMatchedSignalInstance,
              List<IAbstractSignalInstance> potentialSignalinstances ->
              // evaluate the match here
              if (optionalMatchedSignalInstance != null) {
                def mdfSystemSignal =
                  optionalMatchedSignalInstance.getMdfObject()
                ;
                // check more specific ...
              }
              optionalMatchedSignalInstance
            }
          }
      }
      scriptLogger.infoFormat("Created {0} data mappings.",dataMappings.size
        ())
    }
  }
}

```

Listing 4.226: Auto data map all unmapped communication elements to unmapped rx signal instances and evaluate

Nested Array of Primitives `expandNestedArraysOfPrimitive(boolean)` allows to control the expansion of nested arrays of primitive globally. Per default, arrays are fully expanded (allowing to data map each array element). By setting the value to 'false', all nested arrays of primitive are not expanded and can be directly data-mapped to a signal.

```

import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance
import com.vector.cfg.model.sysdesc.api.com.ISignalGroupInstance
import com.vector.cfg.model.sysdesc.api.com.ICommunicationElement

scriptTask("autoDatamapDoNotExpandNestedArrayElements", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def dataMappings =
          selectCommunicationElements {
            } autoMapTo {
              expandNestedArraysOfPrimitive false // do not expand nested arrays
              of primitive
            evaluateMatches {
              ICommunicationElement communicationElement,
              IAbstractSignalInstance optionalMatchedSignalInstance,
              List<IAbstractSignalInstance> potentialSignalInstances ->
              if ("App2.rSRPort1.Element_2".equals(communicationElement.
                getFullyQualifiedName())) {
                // manual matching: map to first signal group
                for (IAbstractSignalInstance potentialSignal:
                  potentialSignalInstances) {
                  if (potentialSignal instanceof ISignalGroupInstance
                    ) {
                    return potentialSignal
                  }
                }
              }
              if ("App2.rSRPort1.Element_2.RecordElement".equals(
                communicationElement.getFullyQualifiedName())) {
                // now the RecordElement which represents an array is
                // directly offered to map
                // ....
              }
              optionalMatchedSignalInstance
            }
          }
        scriptLogger.infoFormat("Created {0} data mappings.",dataMappings.size
          ())
      }
    }
  }
}

```

Listing 4.227: Autodatamap and do not expand nested array elements

`expandNestedArraysOfPrimitive(String,boolean)` allows to control the expansion of nested arrays of primitive for single nested arrays. Per default, the `expandNestedArraysOfPrimitive(boolean)` applies. For the given fully qualified communication element name, the global setting can be overridden.

The fully qualified communication element name is e.g. determinable when using the data mapping assistant, performing an arbitrary signal group mapping of the root data element, and using the right-mouse menu its 'Copy fully qualified name' action on the nested array element.

```

import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance
import com.vector.cfg.model.sysdesc.api.com.ISignalGroupInstance
import com.vector.cfg.model.sysdesc.api.com.ICommunicationElement

scriptTask("autoDatamapDoExpandSpecificNestedArrayElement", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def dataMappings =
          selectCommunicationElements {
            } autoMapTo {
              // do not generally expand nested arrays of primitive
              expandNestedArraysOfPrimitive false
              // but expand the following specific record element
              expandNestedArraysOfPrimitive("App2.rSRPort1.Element_2.
                RecordElement",true)
            evaluateMatches {
              ICommunicationElement communicationElement,
              IAbstractSignalInstance optionalMatchedSignalInstance,
              List<IAbstractSignalInstance> potentialSignalInstances ->
              if ("App2.rSRPort1.Element_2".equals(
                communicationElement.getFullyQualifiedName())) {
                // manual matching: map to first signal group
                for (IAbstractSignalInstance potentialSignal:
                  potentialSignalInstances) {
                  if (potentialSignal instanceof
                    ISignalGroupInstance) {
                    return potentialSignal
                  }
                }
              }
              if ("App2.rSRPort1.Element_2.RecordElement[0]".equals(
                communicationElement.getFullyQualifiedName())) {
                // the RecordElement (representing an array of
                // primitive) is expanded to map the single array
                // elements
                // ....
              }
              optionalMatchedSignalInstance
            }
          }
        scriptLogger.infoFormat("Created {0} data mappings.",dataMappings.size
          ())
      }
    }
  }
}

```

Listing 4.228: Autodatamap and do expand a specific nested array element

Simple API for data mapping This API covers the use case when the names of the communication elements, which should be data mapped, are known, as well as the AUTOSAR paths to the signal groups and signals. The entry point is the selection of a communication element and potentially also its child communication elements by using the fully qualified names.

`communicationElement(String...)` allows to select an `ICommunicationElement` and to do further operations on it, e.g. performing a data mapping. For complex communication elements also the children can be selected. In such case the first `communicationElementName` has to be the name of the root element.

`ISelectedCommunicationElement` represents a selection of exactly one `ICommunicationElement` and provides further actions on it. For complex communication elements, also a subset of the child elements is represented.

`mapTo(String...)` creates an `IDataMapping` for the `ICommunicationElement` which is represented by this `ISelectedCommunicationElement`. The mapped signal is the given `abstractSignalInstance`.

In case of a complex mapping first the system signal group has to be referenced. The child mappings are created considering the given order or in other words, the first communication element is mapped to the first signal, the second element to the second signal and so on.

For a client server to signal mapping, select the operation communication element and enter the paths to two serialized signals. Which signal is the call and which one the return signal is determined by the direction of the signals.

Hint: Use 'ECU Composition' or 'COMPOSITIONTYPE' as component name to select communication elements of delegation ports.

There are a few checks also for the simple API.

- Before creating the data mapping check if an equal mapping already exists. Do not create redundant mappings.
- Check that the amount of the selected communication elements is equal to the amount of the selected signals. For the client server use case there will be one communication element for the call direction and one for the return direction.
- Checks that the direction of the signal and communication element are compatible. Checks also the type compatibility of signal (group) and communication element.
An operation communication element can only be mapped to a serialized signal.
Records can only be mapped to serialized signals or signal groups.
Unions can only be mapped to serialized signals.
Arrays with complex array element can only be mapped to serialized signals or signal groups.
Trigger communication elements cannot be mapped to signal groups.
- For the client server data mappings, check that exactly two signals are selected and that both signals are serialized signals.
- Checks for complex mappings, that the first abstract signal instance is a signal group and the other instances are group signals of this signal group.
- Check that the selected communication elements are suitable for data mapping. That means they should belong to a sender receiver, client server or a trigger port, which is not a service port and not a PRPort.
- Check the hierarchy of the selected communication elements for complex mappings. First selected element should be the root element and all further selected elements children of the root element.
- Check for the client server use case, that exactly one communication element is selected and the according communication element for the return signal mapping can be found. The communication element has to be an operation communication element.

- Check for a complex mapping that the first selected communication element is really a complex root element.

Examples

```
scriptTask ("createSimpleMapping", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        // specify path to the system signal
        def signalPath = "/VectorAutosarExplorerGeneratedObjects/
          SYSTEM_SIGNALS/Element_1_b16df82332bcf915"

        // enter the fully qualified communication element name
        // that means ComponentName.PortName.DataElementName
        def communicationElementName = "App1.pDataSend.Element"

        def createdMapping = communicationElement(
          communicationElementName).mapTo(signalPath)

        scriptLogger.infoFormat("Mapped '{0}' to '{1}'.",
          createdMapping.getMappedCommunicationElement().
            getFullyQualifiedName(),
          createdMapping.getMappedSystemSignal().getAutosarPath())
      }
    }
  }
}
```

Listing 4.229: Create sender receiver to signal mapping

```
scriptTask ("mapDelegationPort", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def signalPath = "/VectorAutosarExplorerGeneratedObjects/
          SYSTEM_SIGNALS/Element_1_b16df82332bcf915"

        // for delegation ports use 'ECU Composition' or '
          COMPOSITIONTYPE' instead of the component name
        def communicationElementName = "ECU Composition.
          pDelegationSRPort2.Element"

        def createdMapping = communicationElement(
          communicationElementName).mapTo(signalPath)

        scriptLogger.infoFormat("Mapped '{0}' to '{1}'.",
          createdMapping.getMappedCommunicationElement().
            getFullyQualifiedName(),
          createdMapping.getMappedSystemSignal().getAutosarPath())
      }
    }
  }
}
```

Listing 4.230: Create data mapping for delegation port

```
scriptTask ("createClientServerMapping", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def callSignalPath = "/VectorAutosarExplorerGeneratedObjects/
          SYSTEM_SIGNALS/rSRPort2_d4aecc362f1feef3"
        def returnSignalPath = "/VectorAutosarExplorerGeneratedObjects/
          SYSTEM_SIGNALS/pSRPort3_2264a06bc04fc81d"

        // if an operation communication element is selected, a client
        // server to signal mapping will be created
        // the assignment of call and return signal role is depending
        // on the direction of the signal
        def communicationElementName = "ECU Composition.
          pDelegationCSPort1.Operation"

        def createdMapping = communicationElement(
          communicationElementName).mapTo(callSignalPath,
          returnSignalPath)

        scriptLogger.infoFormat("Mapped '{0}' to '{1}' as call signal
          and '{2}' as return signal.",
          createdMapping.getMappedCommunicationElement().
            getFullyQualifiedName(),
          createdMapping.getMappedSystemSignal().getAutosarPath(),
          createdMapping.getMappedReturnSignal().getAutosarPath())
      }
    }
  }
}
```

Listing 4.231: Create client server to signal mapping

```

import com.vector.cfg.model.sysdesc.api.com.ISenderReceiverDataMapping

scriptTask ("mapRecordToSignalGroup", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                // specify the path to the signal group
                def signalGroup = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNAL_GROUPS/Element_2_de8db6949370c6b4"

                // specify the paths to the group signals of the signal group
                def groupSignal1 = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNALS/ay1_48523fe229ba8c99"
                def groupSignal2 = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNALS/ay2_071a3305d39fcca4"
                def groupSignal3 = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNALS/ay3_84eba37e401eacd1"

                // the name of the root element
                def record = "ECU Composition.pDelegationSRPort1.Element_2"

                // the names of the child elements
                def recordElement1 = "ECU Composition.pDelegationSRPort1.
                Element_2.RecordElement"
                def recordElement2 = "ECU Composition.pDelegationSRPort1.
                Element_2.RecordElement_1"
                def recordElement3 = "ECU Composition.pDelegationSRPort1.
                Element_2.RecordElement_2"

                // create the mapping, first argument should be the root
                // element, followed by the leaf elements for the child
                // mappings
                // for the signals, first argument should be the signal group,
                // followed by the group signals

                // the mapping will be done using the given order
                // e.g. the first element (record) will be mapped to the signal
                // group (signalGroup),
                // the last record element (recordElement3) will be mapped to
                // the last group signal (groupSignal3)
                def createdMapping = communicationElement(record,
                recordElement1, recordElement2, recordElement3)
                .mapTo(signalGroup, groupSignal1, groupSignal2,
                groupSignal3)

                scriptLogger.infoFormat("Mapped '{0}' to '{1}'.",
                createdMapping.getMappedCommunicationElement().
                getFullyQualifiedName(),
                createdMapping.getMappedSystemSignal().getAutosarPath())

                // print info for the child mappings
                for (final ISenderReceiverDataMapping childMapping :
                createdMapping.getChildDataMappings()) {
                    scriptLogger.infoFormat("Mapped '{0}' to '{1}'.",
                    childMapping.getMappedCommunicationElement().
                    getFullyQualifiedName(),
                    childMapping.getMappedSystemSignal().getAutosarPath())
                }
            }
        }
    }
}

```

Listing 4.232: Map record to signal group

```

import com.vector.cfg.model.sysdesc.api.com.ISenderReceiverDataMapping

scriptTask ("mapArrayToSignalGroup", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                // specify the path to the signal group
                def signalGroup = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNAL_GROUPS/Element_2_de8db6949370c6b4"

                // specify the paths to the group signals of the signal group
                def groupSignal1 = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNALS/ay1_48523fe229ba8c99"
                def groupSignal2 = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNALS/ay2_071a3305d39fcca4"
                def groupSignal3 = "/VectorAutosarExplorerGeneratedObjects/
                SYSTEM_SIGNALS/ay3_84eba37e401eacd1"

                // the name of the root element
                def array = "ECU Composition.pDelegationSRPort2.Element_1"

                // select the element of the array using the position index of
                // the element
                def arrayElement1 = "ECU Composition.pDelegationSRPort2.
                Element_1[0]"
                def arrayElement2 = "ECU Composition.pDelegationSRPort2.
                Element_1[1]"
                def arrayElement3 = "ECU Composition.pDelegationSRPort2.
                Element_1[2]"

                def createdMapping = communicationElement(array, arrayElement1,
                arrayElement2, arrayElement3)
                .mapTo(signalGroup, groupSignal1, groupSignal2,
                groupSignal3)

                scriptLogger.infoFormat("Mapped '{0}' to '{1}'.",
                createdMapping.getMappedCommunicationElement().
                getFullyQualifiedName(),
                createdMapping.getMappedSystemSignal().getAutosarPath())

                // print info for the child mappings
                for (final ISenderReceiverDataMapping childMapping :
                createdMapping.getChildDataMappings()) {
                    scriptLogger.infoFormat("Mapped '{0}' to '{1}'.",
                    childMapping.getMappedCommunicationElement().
                    getFullyQualifiedName(),
                    childMapping.getMappedSystemSignal().getAutosarPath())
                }
            }
        }
    }
}

```

Listing 4.233: Map array to signal group

Terminating Component Ports of Communication Elements Port Terminators can be used to acknowledge the fact, that the port is not connected yet. This will prevent validation rules to produce validation results reporting these ports as unconnected or missing data mappings for these ports.

`terminateOwnerPorts()` terminates the `IComponentPorts` of all selected `ICommunicationElements`. If one of the selected ports is already terminated or connected to another component port, the port will be ignored.

The termination of component ports disables the validation of these ports. In other words, these ports are acknowledged as not connected yet. This should give a better overview of the open ports, which still have to be connected or need a data mapping.

`removePortTerminatorsForOwnerPorts()` removes the port terminators of the `IComponentPorts` of all selected `ICommunicationElements`.

See `terminateOwnerPorts()` for more information about the purpose of terminating ports.

Examples

```
import com.vector.cfg.model.sysdesc.api.port.IComponentPort

scriptTask("terminatePort", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // the the statements below will return us a collection with all
        // component ports which will be terminated
        def terminatedPorts =
          selectCommunicationElements {
            // also for the communication elements there are predicates to
            // filter for terminated owner ports
            ownerPortNotTerminated()
            port("pSRPort1")

            // this call will terminate the component port owner of each
            // selected communication element
          } terminateOwnerPorts()

        // if multiple communication elements has the same component port owner
        // the component port will be terminated and returned only once
        for (final IComponentPort terminatedPort : terminatedPorts) {
          scriptLogger.infoFormat("Terminated component port '{0}'.",
            terminatedPort.getName())
        }
      }
    }
  }
}
```

Listing 4.234: Terminate port using the communication element selection API

```

import com.vector.cfg.model.sysdesc.api.port.IComponentPort

scriptTask("removePortTerminator", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // the statements below will return us a collection with all component
        // ports for which a port terminator was removed
        def removedPortTerminators =
          selectCommunicationElements {
            component("App1_1")
            port("pSRPort1")

            // if a port is not terminated it will be skipped
          } removePortTerminatorsForOwnerPorts()

        for (final IComponentPort componentPort : removedPortTerminators) {
          scriptLogger.infoFormat("Removed port terminator of component port
                                  '{0}'.", componentPort.getName())
        }
      }
    }
  }
}

```

Listing 4.235: Remove port terminator using the communication element selection API

4.10.4.3 Create Component Prototypes

In the create component prototypes use case, components can be instantiated after a component type was selected.

Selecting component types to instantiate The entry point is to select a collection of component types and create prototypes for them.

`selectComponentTypes(Closure)` allows the selection of `IComponentTypes` using predicates.

Predicates To select the component types predicates can be provided to narrow down the types that should be instantiated.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Component Type Predicates

- `name(String)` matches component types with the given component type name.
- `name(Pattern)` matches component types with the given component type name pattern.
- `asrPath(String)` matches component types with the given component type autosar path.
- `asrPath(Pattern)` matches component types with the given component type autosar path pattern.

- `component(String)` matches component types for which a component prototype with the given component name exists.
- `component(Pattern)` matches component types for which a component prototype with the given component name pattern exists.
- `application()` matches component types which are application component types. Application component types are all component types which are not service component types, as displayed in the ECU Software Components Editor, not `ApplicationSwComponentTypes` as defined by AUTOSAR.
- `service()` matches component types which are service component types.
- `parameter()` matches component types which are parameter (calibration) component types.
- `nvBlock()` matches component types which are nv block component types.
- `sensorActuator()` matches component types which are sensor actuator component types.
- `ioHwAbstraction()` matches component types which are I/O hardware abstraction component types, also called `EcuAbstractionSwComponentType`.
- `complexDeviceDriver()` matches component types which are complex device driver component types.
- `serviceProxy()` matches component types which are service proxy component types.
- `instantiated()` matches component types that are already instantiated. In other words matches if a component prototype of that component type already exists.
- `supportsMultipleInstantiation()` matches component types which support multiple instantiation.
- `filterAdvanced(Closure)` matches component types for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```
scriptTask ("selectComponentTypeByName", DV_PROJECT ){
    code {
        domain.runtimeSystem {
            def selectedComponentTypes = selectComponentTypes {
                name "App1"
            }.getComponentTypes()

            scriptLogger.infoFormat("Selected '{0}' component types.",
                selectedComponentTypes.size())
        }
    }
}
```

Listing 4.236: Select component type by name

```
scriptTask ("selectNotInstantiatedComponentTypes", DV_PROJECT ){
    code {
        domain.runtimeSystem {
            def selectedComponentTypes = selectComponentTypes {
                not {
                    instantiated()
                }
            }.getComponentTypes()

            scriptLogger.infoFormat("Selected '{0}' component types.",
                selectedComponentTypes.size())
        }
    }
}
```

Listing 4.237: Select not instantiated component types

Instantiate Components The use case of instantiating components is based on the selection of component types.

`createPrototype()` creates a `SwComponentPrototype` in the `FlatExtract` for each selected component type. The names of the created `SwComponentPrototypes` are derived from the selected component types.

Examples for `createPrototype()`

```
scriptTask ("createComponentPrototypesForNotInstantiatedTypes", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def createdComponents = selectComponentTypes {
                    not {
                        instantiated()
                    }
                }.createPrototype()

                scriptLogger.infoFormat("Created '{0}' component prototypes.",
                    createdComponents.size())
            }
        }
    }
}
```

Listing 4.238: Create component prototypes for not instantiated types

Specify the component prototype instantiation in `createPrototypeWith(Closure)`

`IComponentPrototypeCreator` provides an Api to control some aspects, e.g. the naming, of newly created components.

- `name(Closure)` computes a name for the component prototypes that should be created for, by the `IComponentTypeSelection` provided, component types.
- `count(int)` defines how many component prototypes should be created for each selected component type. The default is 1.

Examples for customizing the instantiation


```

import com.vector.cfg.model.sysdesc.api.component.IComponentType

scriptTask ("specifyNameOfCreatedComponent", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def createdComponents = selectComponentTypes {
          application()
        }.createPrototypeWith {
          name {
            // define the naming of new created prototypes
            IComponentType type -> type.getName() + "_postfix"
          }
        }

        scriptLogger.infoFormat("Created '{0}' component prototypes.",
          createdComponents.size())
      }
    }
  }
}

```

Listing 4.239: Specify name of created component

```

import com.vector.cfg.model.sysdesc.api.component.IComponentType

scriptTask ("specifyNameOfCreatedComponent", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def createdComponents = selectComponentTypes {
          name ~"App.*"
        }.createPrototypeWith {
          name {
            // you can still define a naming pattern
            IComponentType type -> type.getName() + "_CP"
          }

          // and at the same time define how many prototypes should
          // be created for each component type
          count(3)
        }

        scriptLogger.infoFormat("Created '{0}' component prototypes.",
          createdComponents.size())
      }
    }
  }
}

```

Listing 4.240: Create more than 1 component prototype

4.10.4.4 Bridge between MDF and model abstractions

The Runtime System Domain uses model abstractions to simplify the structure of the AUTOSAR model.

`IModelAbstraction` is the common super interface for all model abstractions (as e.g. `Object` for all java classes). It defines common functionality which all model abstractions provide for

generic handling of model abstractions.

On MDF level the base interface for AUTOSAR model objects is the `MIOObject`.

It is possible to switch between model abstractions and MDF objects. This might be helpful for advanced script tasks that extend the current scope of the model abstractions.

`getModelAbstractionsForMdfObjects(Collection)` is a method for an arbitrary access to all model abstractions which correspond to the given collection of MDF objects.

`getMdfObject()` is a bridge from the `IModelAbstraction` to the underlying MDF object. For compound model abstractions, the main object will be returned, e.g. returns the port for a component port.

Example for navigating between MDF model and model abstractions

```

import com.vector.cfg.model.access.IReferrableAccess
import java.util.Collections
import com.vector.cfg.model.abstraction.api.IModelAbstraction
import com.vector.cfg.model.sysdesc.api.com.IAbstractSignalInstance

scriptTask ("switchBetweenMdfAndModelAbstraction", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {

                // -----
                // get a model abstraction object for your MDF object
                // -----
                def referrableAccess = ScriptApi.activeProject.getInstance(
                    IReferrableAccess)

                // get some MDF objects by e.g. using the referrable access
                def mdfSystemSignal = referrableAccess.getReferrableByPath("/
                    VectorAutosarExplorerGeneratedObjects/SYSTEM_SIGNALS/
                    Element_1_b16df82332bcf915")

                def mdfObjects = Collections.singletonList(mdfSystemSignal)

                // get the model abstractions for the MDF objects
                def modelAbstractions = getModelAbstractionsForMdfObjects(
                    mdfObjects)

                // for the system signal an IAbstractSignalInstance is returned
                // , if it is referenced by at least one ISignal
                // so there will be exactly one model abstraction in the
                // collection in this example
                def signalInstanceModelAbstraction
                for (IModelAbstraction modelAbstraction : modelAbstractions) {
                    if (modelAbstraction instanceof IAbstractSignalInstance) {
                        signalInstanceModelAbstraction = modelAbstraction
                    }
                }

                if (signalInstanceModelAbstraction == null) {
                    scriptLogger.infoFormat("System Signal '{0}' is not
                        referenced by any ISignals",
                        mdfSystemSignal.getName())
                }

                // -----
                // get a MDF object for your model abstraction object
                // -----
                def mdfObject = signalInstanceModelAbstraction.getMdfObject()
                // now the system signal can be used on MDF level

            }
        }
    }
}

```

Listing 4.241: Switch between MDF and model abstraction example

4.10.4.5 Task Mapping

The task mapping use case allows to map events (also called triggers) to tasks.

Events An event `IEvent` (called `AbstractEvent` in AUTOSAR) represents a `RTEEvent` or a `BswEvent`. Events are raised on different conditions and are used to implement application or basic software in AUTOSAR. (Sometimes they are also called triggers.)

Executable Entities An executable entity (`IExecutableEntity`) represents a `RunnableEntity` or a `BswSchedulableEntity`. Both are abstractions of executable code in AUTOSAR. (Sometimes they are also called functions.)

Task Mappings A task mapping (`ITaskMapping`) represents an `IEvent` (also called trigger) that is mapped to a task in the context of a component prototype or a module configuration. It corresponds to the task mapping container in the RTE configuration.

The entry point for the task mapping is either to select events (triggers) or executable entities (functions). After that a task can be selected and the task mappings customized.

Selecting and task mapping events `selectEvents(Closure)` allows the selection of `IEvents` using predicates.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Event Predicates

- `name(String)` matches events (triggers) with the given event name.
- `name(Pattern)` matches events (triggers) with the given event name pattern.
- `asrPath(String)` matches events (triggers) with the given event autosar path.
- `asrPath(Pattern)` matches events (triggers) with the given event autosar path pattern.
- `component(String)` matches events (triggers) which belong to components with the given component name.
- `component(Pattern)` matches events (triggers) which belong to components which matches the given component name pattern.
- `componentType(String)` matches events (triggers) which are part of the internal behavior of component types with the given component type name.
- `componentType(Pattern)` matches events (triggers) which are part of the internal behavior of component types which matches the given component type name pattern.
- `componentTypeAsrPath(String)` matches events (triggers) which are part of the internal behavior of component types with the given component type autosar path.
- `componentTypeAsrPath(Pattern)` matches events (triggers) which are part of the internal behavior of component types whose autosar path matches the given component type autosar path pattern.
- `moduleConfiguration(String)` matches events (triggers) which belong to module configurations with the given module configuration name.
- `moduleConfiguration(Pattern)` matches events (triggers) which belong to module configurations which matches the given module configuration name pattern.

- `moduleConfigurationAsrPath(String)` matches events (triggers) which belong to module configurations with the given module configuration autosar path.
- `moduleConfigurationAsrPath(Pattern)` matches events (triggers) which belong to module configurations whose autosar path matches the given module configuration autosar path pattern.
- `task(String)` matches events (triggers) which are mapped to a task with the given task name.
- `task(Pattern)` matches events (triggers) which are mapped to a task whose name matches the given task name pattern.
- `bswEvent()` matches events (triggers) which are bsw events.
- `rteEvent()` matches events (triggers) which are rte events.
- `unmapped()` matches unmapped events (triggers). In case of multi instantiated components/modules matches if unmapped at least in one context. Use `fullyUnmapped()` to determine whether an event is unmapped in all contexts.
- `fullyUnmapped()` matches events (triggers) which are not mapped in any context. If no multi instantiation is used, the result is the same as for `unmapped()`.
- `mapped()` matches mapped events (triggers). In case of multi instantiated components/modules matches if mapped at least in one context. Use `fullyMapped()` to determine whether an event is mapped in all contexts.
- `fullyMapped()` matches events (triggers) which are mapped in every context. If no multi instantiation is used, the result is the same as for `mapped()`.
- `timing()` matches events which are timing events (triggers).
- `timing(BigDecimal)` matches events (triggers) which are timing events with the given period (seconds).
- `init()` matches events (triggers) which are init events.
- `dataReception()` matches events (triggers) which are data received events.
- `dataReceptionError()` matches events (triggers) which are data receive error events.
- `dataSendCompletion()` matches events (triggers) which are data send completed events.
- `operationInvoked()` matches events (triggers) which are operation invoked events.
- `operationInvoked(String)` matches operation invoked events (triggers) which are invoked by an operation with the given operationName.
- `serverCallReturns()` matches events (triggers) which are asynchronous server call returns events.
- `modeSwitch()` matches events (triggers) which are mode switch events.
- `modeEntry()` matches events (triggers) which are mode switch events with activation kind ON-ENTRY.
- `modeExit()` matches events (triggers) which are mode switch events with activation kind ON-EXIT.
- `modeTransition()` matches events (triggers) which are mode switch events with activation kind ON-TRANSITION.

- `modeSwitchedAck()` matches events (triggers) which are mode switched acknowledgement events.
- `externalTrigger()` matches events (triggers) which are external trigger occurred events.
- `internalTrigger()` matches events (triggers) which are internal trigger occurred events.
- `background()` matches events (triggers) which are background events.
- `mandatory()` matches events (triggers) which must be mapped. (The mapping of operation invoked events is optional, so this predicate filters all operation invoked events.)
- `filterAdvanced(Closure)` matches events (triggers) for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```
scriptTask ("selectEvents", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def selectedEvents = selectEvents {
                    // select all unmapped events of component 'App1'
                    unmapped()
                    component("App1")
                }.getEvents()

                scriptLogger.infoFormat("Selected '{0}' events.",
                    selectedEvents.size())
            }
        }
    }
}
```

Listing 4.242: Select events example

Selecting and task mapping executable entities `selectExecutableEntities(Closure)` allows the selection of `IExecutableEntity`s using predicates.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Executable Entity Predicates

- `symbol(String)` matches runnable entities with the given symbol and bsw schedulable entities whose corresponding bsw module entry short name matches the given symbol.
- `symbol(Pattern)` matches runnable entities whose symbol matches the given symbol pattern and bsw schedulable entities whose corresponding bsw module entry short name matches the given symbol pattern.
- `name(String)` matches executable entities (functions) with the given name.
- `name(Pattern)` matches executable entities (functions) with the given name pattern.

- `asrPath(String)` matches executable entities (functions) with the given autosar path.
- `asrPath(Pattern)` matches executable entities (functions) with the given autosar path pattern.
- `component(String)` matches executable entities (functions) which belong to components with the given component name.
- `component(Pattern)` matches executable entities (functions) which belong to components which matches the given component name pattern.
- `componentType(String)` matches executable entities (functions) which are part of the internal behavior of component types with the given component type name.
- `componentType(Pattern)` matches executable entities (functions) which are part of the internal behavior of component types which matches the given component type name pattern.
- `componentTypeAsrPath(String)` matches executable entities (functions) which are part of the internal behavior of component types with the given component type autosar path.
- `componentTypeAsrPath(Pattern)` matches executable entities (functions) which are part of the internal behavior of component types whose autosar path matches the given component type autosar path pattern.
- `moduleConfiguration(String)` matches executable entities (functions) which belong to module configurations with the given module configuration name.
- `moduleConfiguration(Pattern)` matches executable entities (functions) which belong to module configurations which matches the given module configuration name pattern.
- `moduleConfigurationAsrPath(String)` matches executable entities (functions) which belong to module configurations with the given module configuration autosar path.
- `moduleConfigurationAsrPath(Pattern)` matches executable entities (functions) which belong to module configurations whose autosar path matches the given module configuration autosar path pattern.
- `task(String)` matches executable entities (functions) which have at least one event (trigger) that is mapped to a task with the given task name.
- `task(Pattern)` matches executable entities (functions) which have at least one event (trigger) that is mapped to a task whose name matches the given task name pattern.
- `bswSchedulableEntity()` matches executable entities (functions) which are bsw schedulable entities.
- `runnableEntity()` matches executable entities (functions) which are runnable entities.
- `unmapped()` matches executable entities (functions) with at least one unmapped event (trigger).
- `fullyUnmapped()` matches executable entities (functions) with all of its events (triggers) being not mapped in any context to a task.
- `mapped()` matches executable entities (functions) with at least one mapped event (trigger).
- `fullyMapped()` matches executable entities (functions) with all of its events (triggers) being mapped in each context to a task.

- `filterAdvanced(Closure)` matches executable entities (functions) for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```
scriptTask ("selectExecutableEntities", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def selectedExecutables = selectExecutableEntities {
                    // select all runnables with symbol 'MySymbol'
                    symbol("MySymbol")
                    runnableEntity()
                }.getExecutableEntities()

                scriptLogger.infoFormat("Selected '{0}' executable entities.",
                    selectedExecutables.size())
            }
        }
    }
}
```

Listing 4.243: Select executable entities example

Mapping to a task The task mapping is based on the selection of events (triggers) or executable entities (functions).

Event selection `mapToTask(Closure)` tries to perform a task mapping for the selection of events (triggers). Inside the closure the task mapping can be controlled, e.g. selecting the task to which the events should be mapped to and order the event's positions. Does not consider events (triggers) which do not reference an executable entity (function).

ExecutableEntity selection `mapToTask(Closure)` tries to perform a task mapping for the selection of executable entities (functions). Inside the closure the task mapping can be controlled, e.g. selecting the task to which the events (triggers) of the selected executable entities should be mapped to and order the event's positions.

Select a task Exactly one task has to be selected to perform a task mapping.

`selectTask(Closure)` allows to define predicates to select a task for the task mapping.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Task Predicates

- `name(String)` matches tasks with the given task name.
- `name(Pattern)` matches tasks with the given task name pattern.

- `core(String)` matches tasks running on a core with the given name / number (whether a core name or a core number is used, depends on the OS, if core number is used the String to be matched is 'Core<number>', e.g. 'Core1').
- `core(Pattern)` matches tasks running on a core with the given name pattern / number pattern (whether a core name or a core number is used, depends on the OS, if core number is used the String to be matched is 'Core<number>', e.g. 'Core1').
- `application(String)` matches tasks which belong to an application with the given name.
- `application(Pattern)` matches tasks which belong to an application whose name matches the given name pattern.
- `numberOfTaskMappings(int)` matches tasks which already have the given number of task mappings. The predicate can also be used to search for empty tasks with '0' as argument.
- `priority(BigInteger)` matches tasks with the given priority value.
- `filterAdvanced(Closure)` matches tasks for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Additional comfort functions The API provides some comfort functions listed below.

Combine via symbol `combineViaSymbol(boolean)` determines whether the BswModuleEntities and the RunnableEntities should be combined using their symbol. That means they will be mapped to the same position on the same task. It is enough to select only the RunnableEntity or only the BswModuleEntity, when using this option both will be mapped. The default is true.

The condition is that the symbol of a RunnableEntity and the BswModuleEntry short name of a BswModuleEntity are equal.

Map events of a runnable entity together `mapAllEventsOfRunnableEntity(boolean, boolean)` is a possibility to map all events of a RunnableEntity to the same position on a task. In case of the selection of events, the task mapping will be extended, by all events (triggers) of runnable entities (functions) for which at least one event (trigger) is selected.

With help of the two boolean arguments, the behavior of ignoring already mapped events and ignoring events whose mapping is optional can be controlled.

Specify an order The order of the task mappings can be specified with the help of an internal structural element, the so called position in task entry.

An `IPositionInTaskEntry` represents a position in task for the task mapping. The entry is able to combine several events that are mapped to one position (e.g. needed when mapping a main function of a service component and its corresponding schedulable entity).

`order(Closure)` allows to evaluate and change the order of the task mappings.

It provides a possibility to order the already existing task mappings of the selected task and the new task mappings that should be created.

Order task mappings by defining successor mappings If you do not care about the absolute position value of the task mappings, but want to define an order, there is an option to specify successor relationships between the selected task mappings.

`defineSuccessors(Closure)` allows to specify the order of the selected task mappings by defining successor relationships between the task mappings.

First you have to specify one task mapping as the starting point.

`forTaskMapping(Closure)` allows to select a starting task mapping for which successors can be defined.

After that you can define a direct successor or a (logical) successor for the previously selected task mapping.

`successor(Closure)` allows to select a successor for the previously selected task mapping of the sequence. The sequence can be continued by another `successor(Closure)` or `directSuccessor(Closure)` call. To start a new sequence call `ITaskMappingSuccessorDefinition.forTaskMapping(Closure)`.

`directSuccessor(Closure)` allows to select a direct successor for the previously selected task mapping of the sequence. The sequence can be continued by another `successor(Closure)` or `directSuccessor(Closure)` call. To start a new sequence call `ITaskMappingSuccessorDefinition.forTaskMapping(Closure)`.

Within these calls you can select task mappings using task mapping predicates (see 4.10.4.5). If the task mappings cannot be ordered to match the defined rules (for example if cycles were defined), an exception is thrown.

Set Activation Offset It is possible to set the value of the activation offset for the events/executable entities which will be newly mapped.

`setActivationOffset(BigDecimal)` allows to set the activation offset at the created task mappings. The offset will be set for all created task mappings to the given `offsetInSeconds` value.

Filter Task Mappings `filterTaskMappings(Closure)` allows to filter the task mappings that should be created. This might be especially helpful to narrow down the task mappings after selecting events or executable entities when using multi instantiation (e.g. to filter the task mappings for only one instance of a multi instantiated component prototype).

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Task Mapping Predicates

- `component(String)` matches task mappings whose event is part of the internal behavior of a component with the given component name.
- `component(Pattern)` matches task mappings whose event is part of the internal behavior of a component with the given component name pattern.
- `moduleConfiguration(String)` matches task mappings whose event is part of the internal behavior of a module configuration with the given module configuration name.

- `moduleConfiguration(Pattern)` matches task mappings whose event is part of the internal behavior of a module configuration with the given module configuration name pattern.
- `moduleConfigurationAsrPath(String)` matches task mappings whose event is part of the internal behavior of a module configuration with the given module configuration autosar path.
- `moduleConfigurationAsrPath(Pattern)` matches task mappings whose event is part of the internal behavior of a module configuration with the given module configuration autosar path pattern.
- `unmapped()` matches task mappings which are not mapped to a task.
- `mapped()` matches task mappings which are mapped to a task.
- `task(String)` matches task mappings which are mapped to a task with the given task name.
- `task(Pattern)` matches task mappings which are mapped to a task whose name matches the given task name pattern.
- `componentType(String)` matches task mappings which belongs to component types with the given component type name.
- `componentType(Pattern)` matches task mappings which belongs to component types matching the given component type name pattern.
- `componentTypeAsrPath(String)` matches task mappings which belongs to component types with the given component type autosar path.
- `componentTypeAsrPath(Pattern)` matches task mappings which belongs to component types matching the given component type autosar path pattern.
- `event(String)` matches task mappings for events with the given event name.
- `event(Pattern)` matches task mappings for events matching the given event name pattern.
- `eventAsrPath(String)` matches task mappings for events with the given event autosar path.
- `eventAsrPath(Pattern)` matches task mappings for events matching the given event autosar path pattern.
- `bswEvent()` matches task mappings for bsw events.
- `rteEvent()` matches task mappings for rte events.
- `timing()` matches task mappings for timing events.
- `timing(BigDecimal)` matches task mappings for timing events with the given period (seconds).
- `init()` matches task mappings for init events.
- `dataReception()` matches task mappings for data received events.
- `dataReceptionError()` matches task mappings for data receive error events.
- `dataSendCompletion()` matches task mappings for data send completed events.
- `operationInvoked()` matches task mappings for operation invoked events.

- `operationInvoked(String)` matches task mappings for operation invoked events which are invoked by an operation with the given `operationName`.
- `serverCallReturns()` matches task mappings for events which are asynchronous server call returns events.
- `modeSwitch()` matches task mappings for mode switch events.
- `modeEntry()` matches task mappings for mode switch events with activation kind `ON-ENTRY`.
- `modeExit()` matches task mappings for mode switch events with activation kind `ON-EXIT`.
- `modeTransition()` matches task mappings for mode switch events with activation kind `ON-TRANSITION`.
- `modeSwitchedAck()` matches task mappings for mode switched acknowledgement events.
- `externalTrigger()` matches task mappings for external trigger occurred events.
- `internalTrigger()` matches task mappings for internal trigger occurred events.
- `background()` matches task mappings for background events.
- `mandatory()` matches task mappings for events which must be mapped. (The mapping of operation invoked events is optional, so this predicate filters all operation invoked events.)
- `symbol(String)` matches task mappings for runnable entities with the given symbol and bsw schedulable entities whose corresponding bsw module entry short name matches the given symbol.
- `symbol(Pattern)` matches task mappings runnable entities whose symbol matches the given symbol pattern and bsw schedulable entities whose corresponding bsw module entry short name matches the given symbol pattern.
- `executableEntity(String)` matches task mappings for executable entities (functions) with the given name.
- `executableEntity(Pattern)` matches task mappings for executable entities (functions) with the given name pattern.
- `executableEntityAsrPath(String)` matches task mappings for executable entities (functions) with the given autosar path.
- `executableEntityAsrPath(Pattern)` matches task mappings for executable entities (functions) with the given autosar path pattern.

Apply execution order constraints An `ExecutionOrderConstraint` restricts the execution order of a set of `ExecutableEntities`. Therefore successor and direct successor relationships can be defined for executable entities (functions), but also for events (triggers).

`selectExecutionOrderConstraints(Closure)` allows to define predicates to select execution order constraints that should be applied.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Execution Order Constraint Predicates

- `name(String)` matches execution order constraints with the given execution order constraint name.
- `name(Pattern)` matches execution order constraints with the given execution order constraint name pattern.
- `filterAdvanced(Closure)` matches execution order constraints for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Check current task mapping The event and the executable entity selections offer getters to retrieve task mappings. Therefore first the given predicate is evaluated to identify which events are selected, then all task mappings which references the selected events are collected.

`getTaskMappings()` retrieves all `ITaskMappings` for the selected events (see `getEvents()`).

Note:

1. In case of multi instantiation of component prototypes, the different instances share the same events, since the event is part of the internal behavior of the component type. Therefore if the event is selected, `getTaskMappings()` will always return the task mappings for all component prototypes.
2. Since this method can be run outside of a transaction, there might be selected events for which no task mapping container does exist yet. The container cannot be created by calling `getTaskMappings()`, so no task mapping can be returned. This happens if the system description is not synchronized, after changes in the structured extract were done (see Automation Interface Documentation, chapter about Model Synchronization for examples how to synchronize).

`getTaskMappings()` retrieves all `ITaskMappings` for the selected executable entities (see `getExecutableEntities()`).

Example

```

import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask("checkTaskMapping", DV_PROJECT){
  code {

    // because we use only a getter method and no transaction below,
    // make sure that your system description is synchronized,
    // otherwise task mapping container may be missing or obsolete.
    // since Cfg 5.18 this call is enough to make sure your task mapping
    // containers are up to date
    modelSynchronization.synchronize()

    domain.runtimeSystem {
      def taskName = "OsTask"

      def taskMappings = selectEvents {
        task(taskName)
      } getTaskMappings()

      // be careful in case of multi-instantiated component prototypes,
      // since events and executable entities are part of the internal
      // behavior of the component type,
      // you will receive always the task mappings for all instances here
      // (even if the task mappings of the other component prototype
      // instances are not mapped to "OsTask")

      // print info to the console with owner of the task mapping and the
      // mapped task
      for (final ITaskMapping taskMapping : taskMappings) {
        scriptLogger.infoFormat("TaskMapping of '{1}' for event '{0}' is
          mapped to '{2}'".",
          taskMapping.getEvent().getName(),
          taskMapping.getOwnerDescription(),
          taskMapping.getMappedTask() == null ? "no task" : taskMapping.
            getMappedTask().getName())
      }
    }
  }
}

```

Listing 4.244: Check which events are currently mapped to OsTask

Keep existing task mappings on current position `queue()` is an option that allows to keep the task mappings which are already mapped to the selected task on the current position. The new task mappings will be placed in the defined order into existing gaps. That means they are mapped to the lowest free position.

Example: The selected task 'Task1' has already a TaskMappingA at position 1 and a TaskMappingB at position 3. The task mappings TaskMappingC, TaskMappingD and TaskMappingE (in that order) should be mapped to the same task using the `queue()` option. The new task mappings will be assigned in the defined order to the next free position on 'Task1'.

So the result will be:

```

0 -> TaskMappingC (new1)
1 -> TaskMappingA (old)
2 -> TaskMappingD (new2)
3 -> TaskMappingB (old)

```

4 -> TaskMappingE (new3)

If the options `mapAllEventsOfRunnableEntity(boolean, boolean)` or `combineViaSymbol(boolean)` needs to combine an existing mapping with other mappings, the combined task mapping is seen as a new mapping. Its position will be assigned according to the rules of a new mapping explained above. The old mapping which was not combined will be removed. In other words combined task mappings are preferred over single task mappings.

Examples for mapToTask(Closure)

```
import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask ("doTaskMappingOfApp1", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def taskMappings = selectEvents {
                    // select all events of component App1
                    component("App1")
                } mapToTask {
                    selectTask {
                        // select a task
                        name("OsTask")
                    }
                }

                scriptLogger.infoFormat("Created '{0}' task mappings.",
                    taskMappings.size())

                // let's print more information to check the created task
                mappings
                for (ITaskMapping taskMapping : taskMappings) {
                    scriptLogger.infoFormat("Mapped '{0}' triggered by '{1}' to
                        position '{2}' on task '{3}'.",
                        taskMapping.getExecutableEntity().getName(),
                        taskMapping.getEvent().getName(),
                        taskMapping.getPositionInTask(),
                        taskMapping.getMappedTask().getName())
                }
            }
        }
    }
}
```

Listing 4.245: Perform task mapping example

```
scriptTask ("combineViaSymbol", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectEvents {
          component("Service1")
          timing()
        } mapToTask {
          selectTask {
            name("OtherName")
          }
          // the default is true
          // call this if you do not want to combine runnables and
          // bsw module entities via their symbol
          combineViaSymbol(false)
        }
      }
      scriptLogger.infoFormat("Created '{0}' task mappings.",
        taskMappings.size())
    }
  }
}
```

Listing 4.246: Do not combine runnable and bsw module entity via symbol

```
scriptTask ("mapAllEventsOfRunnable", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectEvents {
          name("background_event")
          component("App1_1")
        } mapToTask {
          selectTask {
            name("OsTask")
          }
          // decide whether to consider only unmapped events
          // and whether to consider only events whose mapping is
          // mandatory
          mapAllEventsOfRunnableEntity(true, false)
        }
      }
      scriptLogger.infoFormat("Created '{0}' task mappings.",
        taskMappings.size())
    }
  }
}
```

Listing 4.247: Map all events of a runnable together


```

import com.vector.cfg.model.sysdesc.api.taskmapping.IPositionInTaskEntry

scriptTask ("orderTaskMappings", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectEvents {
          component("App1")
        } mapToTask {
          selectTask {
            name("OtherName")
          }
          order {
            List<IPositionInTaskEntry> entries ->

            int mappedIndex = 0
            int index = 10

            for (IPositionInTaskEntry entry : entries) {
              // identify by executable entity name
              if (entry.getTriggeredExecutableEntity().equals("
                DataSendComp")) {
                entry.setPosition(9)
                continue;
              }

              // already mapped on task
              def alreadyMapped = entry.getAssociatedTaskMappings
                ().find {
                  taskMapping -> taskMapping.getMappedTask() !=
                    null
                }
              if (alreadyMapped != null) {
                entry.setPosition(mappedIndex)
                mappedIndex++
                continue;
              }

              // newly mapped
              entry.setPosition(index)
              index++
            }
          }
        }
      }

      scriptLogger.infoFormat("Created '{0}' task mappings.",
        taskMappings.size())
    }
  }
}

```

Listing 4.248: Manually order the task mappings

```

import com.vector.cfg.model.sysdesc.api.taskmapping.IPositionInTaskEntry

scriptTask ("orderTaskMappingsOfOsTask", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def taskMappings = selectEvents {
                    task("OsTask")
                } mapToTask {
                    filterTaskMappings {
                        task("OsTask")
                    }
                    selectTask {
                        name("OsTask")
                    }
                }
                order {
                    List<IPositionInTaskEntry> entries ->

                    // in this example runnables of App1, App2 and App3 (
                    // with only 1 task mapping) are mapped on OsTask
                    // sort the runnables by owner
                    int runnablesOfApp1 = 0
                    int runnablesOfApp2 = 0
                    for (IPositionInTaskEntry entry : entries) {
                        if (entry.getOwner().equals("Component App1")) {
                            runnablesOfApp1++;
                        }
                        if (entry.getOwner().equals("Component App2")) {
                            runnablesOfApp2++;
                        }
                    }

                    // we sort in this example first runnables of 'App1'
                    // followed by the runnabels of 'App2'
                    // and last but not least the runnable of 'App3'
                    int maxIndex = entries.size() - 1
                    int indexForApp1 = 0
                    int indexForApp2 = runnablesOfApp1

                    for (IPositionInTaskEntry entry : entries) {
                        // the runnable of App3 should be mapped to the
                        // last position on OsTask
                        if (entry.getOwner().equals("Component App3")) {
                            entry.setPosition(maxIndex);
                        }
                        if (entry.getOwner().equals("Component App1")) {
                            entry.setPosition(indexForApp1);
                            indexForApp1++
                        }
                        if (entry.getOwner().equals("Component App2")) {
                            entry.setPosition(indexForApp2);
                            indexForApp2++
                        }
                    }
                }
            }
        }
        scriptLogger.infoFormat("Created '{0}' task mappings.",
            taskMappings.size())
    }
}
}

```

Listing 4.249: Order task mappings on OsTask

```
import com.vector.cfg.model.sysdesc.api.eoc.IExecutionOrderConstraint

scriptTask ("applyEOC", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def selectedConstraints
                def taskMappings = selectExecutableEntities {
                    component("App1_1")
                } mapToTask {
                    selectTask {
                        name("OsTask")
                    }

                    // select execution order constraints that should be
                    // applied
                    selectExecutionOrderConstraints {
                        name("App1ExecutionOrderConstraint")
                        selectedConstraints =
                            getSelectedExecutionOrderConstraints()
                    }
                }

                scriptLogger.infoFormat("Created '{0}' task mappings.",
                    taskMappings.size())

                for (IExecutionOrderConstraint eoc : selectedConstraints) {
                    scriptLogger.infoFormat("Applied execution order constraint
                        '{0}'.",
                        eoc.getName())
                }
            }
        }
    }
}
```

Listing 4.250: Use execution order constraints for the task mapping

```
scriptTask ("firstTaskMappings", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectExecutableEntities {
          componentType("App1")
        } mapToTask {
          selectTask {
            name("OsTask")
          }

          // in this example two components ('App1' and 'App1_1') are
          // of component type 'App1'
          // do the task mapping only for 'App1_1'
          filterTaskMappings {
            component("App1_1")
          }
        }

        scriptLogger.infoFormat("Created '{0}' task mappings.",
                                taskMappings.size())
      }
    }
  }
}
```

Listing 4.251: Filter task mappings

```
scriptTask ("queueExample", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectExecutableEntities {
          componentType("App1")
        } mapToTask {
          selectTask {
            name("OsTask")
          }

          // this option will consider the existing mappings on the
          // task
          // if an existing task mapping is not combined for another
          // new incoming mapping, it will remain on its current
          // position
          queue()
        }

        // if the existing task mapping was combined for another new
        // incoming mapping, it is considered as a new mapping and will
        // appear in the taskMappings below
        scriptLogger.infoFormat("Created '{0}' task mappings.",
                                taskMappings.size())
      }
    }
  }
}
```

Listing 4.252: Use the queue option example

```
import com.vector.cfg.model.sysdesc.api.taskmapping.IEvent
import com.vector.cfg.model.mdf.ar4x.swcomponenttemplate.swcinternalbehavior.
    rtevents.MIDataReceivedEvent

scriptTask ("advancedFilterForEvents", DV_PROJECT ){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectEvents {
          // use advanced filter if you cannot find a suitable
          predicate
          filterAdvanced { IEvent event ->
            // use the mdm model if the IEvent does not offer
            required methods
            def mdmEvent = event.getMdmObject()

            // for example, filter for data received events
            with special criteria
            if (mdmEvent instanceof MIDataReceivedEvent) {
              // filter here for the special criteria
              return true
            }

            // do not select other events
            return false
          }
        } mapToTask {
          selectTask {
            name("OtherName")
          }
        }

        scriptLogger.infoFormat("Created '{0}' task mappings.",
            taskMappings.size())
      }
    }
  }
}
```

Listing 4.253: Advanced Filter for Events

```

import com.vector.cfg.model.sysdesc.api.taskmapping.IPositionInTaskEntry
import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask ("orderTaskMappingsSimple", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {
                def taskMappings = selectEvents {
                    component("App1")
                } mapToTask {
                    selectTask {
                        name("OsTask")
                    }
                    order {
                        List<IPositionInTaskEntry> entries ->

                        for (IPositionInTaskEntry entry : entries) {
                            // identify by executable entity name and set the
                            // position
                            if (entry.getTriggeredExecutableEntity().equals("
                                DataSendComp")) {
                                // Runnable 'DataSendComp' will be mapped
                                // to position 0 on task 'OsTask'
                                entry.setPosition(0)
                                continue
                            } else if (entry.getTriggeredExecutableEntity().
                                equals("Runnable1")) {
                                    entry.setPosition(1)
                                    continue
                                } else if (entry.getTriggeredExecutableEntity().
                                    equals("Runnable2")) {
                                        entry.setPosition(2)
                                        continue
                                    }
                                }
                            }
                        }
                    }
                }

                // print info to the console which runnable was mapped to which
                // position
                for (final ITaskMapping taskMapping : taskMappings) {
                    scriptLogger.infoFormat("Mapped runnable {0} to position
                        {1}.",
                        taskMapping.getExecutableEntity().getName(),
                        taskMapping.getPositionInTask())
                }
            }
        }
    }
}

```

Listing 4.254: Simple example of ordering the task mappings

```
import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask("mapAndSetActivationOffset", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectEvents {
          // define predicates to select your event
          component("App1")
          init()
        } mapToTask {
          // map the event to task 'OsTask'
          selectTask {
            name("OsTask")
          }
          // set the activation offset parameter value
          // for the task mapping to 10 ms
          setActivationOffset(0.01)
        }

        // print info to the console which runnable was mapped and the
        // activation offset
        for (final ITaskMapping taskMapping : taskMappings) {
          scriptLogger.infoFormat("Mapped runnable {0} to position {1}
            with activation offset {2}.",
            taskMapping.getExecutableEntity().getName(),
            taskMapping.getPositionInTask(),
            taskMapping.getActivationOffset())
        }
      }
    }
  }
}
```

Listing 4.255: Set the activation offset while mapping to a task

```

import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask ("defineSuccessorsSimple", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {

                // you can use both the event selection or the executable
                // entity selection API here
                def taskMappings = selectEvents {
                    component("App1")
                } mapToTask {
                    selectTask {
                        name("OsTask")
                    }
                    defineSuccessors {
                        forTaskMapping {
                            // define task mapping predicates to select the
                            // start of your sequence
                            // here we really use the predicates for task
                            // mappings, not for events nor executable entities
                            // but the task mapping selection offers us a lot
                            // of predicates
                            // it allow us to filter e.g. for the events which
                            // the task mappings reference or the executable
                            // entity which is triggered by the referenced
                            // event
                            executableEntity "Runnable1"
                        } successor {
                            // now define predicates to select successors for
                            // Runnable1
                            executableEntity "Runnable2"
                        } successor {
                            // we can continue by defining the successors for
                            // Runnable2 now
                            externalTrigger()
                        }
                    }
                }

                // so the result on OsTask will be Runnable1 -> Runnable2 ->
                // all runnables triggered by external trigger events

                scriptLogger.infoFormat("Created '{0}' task mappings.",
                    taskMappings.size())

                for (final ITaskMapping taskMapping : taskMappings) {
                    scriptLogger.infoFormat("Mapped runnable {0} to position
                        {1}.",
                        taskMapping.getExecutableEntity().getName(),
                        taskMapping.getPositionInTask())
                }
            }
        }
    }
}

```

Listing 4.256: Order the task mappings by defining successor relationships


```

import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask ("successorForGroup", DV_PROJECT ){
    code {
        transaction {
            domain.runtimeSystem {

                def taskMappings = selectExecutableEntities {
                    runnableEntity()
                } mapToTask {
                    selectTask {
                        name("OsTask")
                    }
                    defineSuccessors {
                        // you do NOT have to narrow the selection down to one
                        // task mapping
                        // we want to order the task mappings by their SWC
                        // owner in this example

                        // we want the runnables of App1 be executed before the
                        // runnables of App2 and App3
                        // but we do not care about any order for the runnables
                        // of App2 and App3 or want define them later

                        // execute runnables of App1 before runnables of App2
                        forTaskMapping {
                            component "App1"
                        } successor {
                            component "App2"
                        }

                        // you can define multiple sequences for the same task
                        // mappings
                        // execute runnables of App1 before runnables of App3
                        forTaskMapping {
                            component "App1"
                        } successor {
                            component "App3"
                        }
                    }
                }
            }
        }

        // the script will map the runnables to OsTask and guarantees
        // that the runnables of App1 are mapped before the runnables
        // of App2 and App3

        scriptLogger.infoFormat("Created '{0}' task mappings.",
                                taskMappings.size())

        for (final ITaskMapping taskMapping : taskMappings) {
            scriptLogger.infoFormat("Mapped runnable {0} to position
                                   {1}.",
                                   taskMapping.getExecutableEntity().getName(),
                                   taskMapping.getPositionInTask())
        }
    }
}

```

Listing 4.257: Order groups by using successor calls

Set Activation Offset It is also possible to set the activation offset parameter value of a task mapping using the event or the executable entity selection without mapping the events/executable entities to a task. You can use this option for example if you just want to set the activation offset and do not care whether the event/executable is already mapped to a task or not.

`setActivationOffset(BigDecimal)` sets the activation offset at the task mapping containers for the selected events. If the symbol of a schedulable entity matches a runnable name, the activation offset will be set for both, even if only one of them is selected. (Matching works as for `ITaskMapper.combineViaSymbol(boolean)`.)

`setActivationOffset(BigDecimal)` sets the activation offset at the task mapping containers for the selected executable entities.

Examples

```
import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask("setActivationOffset", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def taskMappings = selectEvents {
          // define predicates to select your event
          component("App1")
          timing()

          // set the activation offset parameter value
          // for the task mapping to 10 ms
        }.setActivationOffset(0.01)

        // print info to the console with the runnable name which is
        // triggered by the event
        // and the activation offset of the task mapping
        for (final ITaskMapping taskMapping : taskMappings) {
          scriptLogger.infoFormat("TaskMapping of runnable {0} has the
            activation offset {1}.",
            taskMapping.getExecutableEntity().getName(),
            taskMapping.getActivationOffset())
        }
      }
    }
  }
}
```

Listing 4.258: Set the activation offset using the event selection

```

import com.vector.cfg.model.sysdesc.api.taskmapping.ITaskMapping

scriptTask("setActivationOffset", DV_PROJECT){
    code {
        transaction {
            domain.runtimeSystem {
                def taskMappings = selectExecutableEntities {
                    // define predicates to select your runnable
                    component("App1")
                    name("Runnable1")

                    // set the activation offset parameter value
                    // for the task mapping to 100 ms
                }.setActivationOffset(0.1)

                // print info to the console with runnable name and the activation
                offset
                for (final ITaskMapping taskMapping : taskMappings) {
                    scriptLogger.infoFormat("TaskMapping of runnable {0} has the
                        activation offset {1}.",
                        taskMapping.getExecutableEntity().getName(),
                        taskMapping.getActivationOffset())
                }
            }
        }
    }
}

```

Listing 4.259: Set the activation offset using the executable entity selection

4.10.4.6 Create Delegation Ports

The automation interface offers a possibility to create delegation ports at the ECU Composition of the FlatExtract. Therefore a port interface needs to be selected and a direction specified.

Selecting port interfaces to instantiate The entry point is to select a collection of port interfaces. After that the naming, direction, etc. can be specified and the port prototypes created.

`selectPortInterfaces(Closure)` allows the selection of `IPortInterfaces` using predicates.

Predicates To select the port interfaces predicates can be provided to narrow down the interfaces for which a delegation port should be created.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Port Interface Predicates

- `name(String)` matches port interfaces with the given port interface name.
- `name(Pattern)` matches port interfaces with the given port interface name pattern.
- `asrPath(String)` matches port interfaces with the given port interface autosar path.

- `asrPath(Pattern)` matches port interfaces with the given port interface autosar path pattern.
- `service()` matches port interfaces which are service interfaces.
- `application()` matches port interfaces which are application interfaces.
- `senderReceiver()` matches port interfaces which are sender receiver interfaces.
- `clientServer()` matches port interfaces which are client server interfaces.
- `modeSwitch()` matches port interfaces which are mode switch interfaces.
- `nvData()` matches port interfaces which are NvData interfaces.
- `trigger()` matches port interfaces which are trigger interfaces.
- `parameter()` matches port interfaces which are parameter interfaces.
- `componentType(String)` first matches all component types with the given component type name, then retrieves all port interfaces of the component type's port prototypes.
- `componentType(Pattern)` first matches all component types with the given component type name pattern, then retrieves all port interfaces of the component type's port prototypes.
- `componentTypeAsrPath(String)` first matches all component types with the given component type asr path, then retrieves all port interfaces of the component type's port prototypes.
- `componentTypeAsrPath(Pattern)` first matches all component types with the given component type asr path pattern, then retrieves all port interfaces of the component type's port prototypes.
- `component(String)` first matches all components with the given component name, then retrieves all port interfaces of the component's ports.
- `component(Pattern)` first matches all components with the given component name pattern, then retrieves all port interfaces of the component's ports.
- `componentPort(String)` first matches all `IComponentPorts` with the given name, then retrieves all port interfaces of the component ports.
- `componentPort(Pattern)` first matches all `IComponentPorts` with the given name pattern, then retrieves all port interfaces of the component ports.
- `filterAdvanced(Closure)` matches port interfaces for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```

scriptTask("selectPortInterfacesByName", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def selectedPortInterfaces =
          selectPortInterfaces {
            // selects all sender receiver application port interfaces with
            // the name 'MyPortInterface'
            senderReceiver()
            application()
            name "MyPortInterface"

            // getPortInterfaces() will filter all port interfaces for the
            // given predicates
            // so in our example we will receive
            // all sender receiver application port interfaces with the short
            // name 'MyPortInterface'
          } getPortInterfaces()
        scriptLogger.infoFormat("Selected {0} port interfaces.",
          selectedPortInterfaces.size())
      }
    }
  }
}

```

Listing 4.260: Select PortInterface by name and type

```

scriptTask("selectPortInterfacesByComponentPorts", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def selectedPortInterfaces =
          selectPortInterfaces {
            // selects the port interface of the port 'pCSPort1' of
            // component 'App1'
            componentPort "App1.pCSPort1"
          } getPortInterfaces()
        scriptLogger.infoFormat("Selected {0} port interfaces.",
          selectedPortInterfaces.size())
      }
    }
  }
}

```

Listing 4.261: Select PortInterfaces by component ports

Instantiate delegation port prototypes The use case of instantiating delegation port prototypes is based on the selection of port interfaces.

`createPrototype(Closure)` creates a `PortPrototype` on the ecu composition of the `FlatExtract` for each selected port interface. If the naming is not specified, the names of the created delegation ports are derived from the selected port interfaces. The direction of the ports has to be specified.

Specify the delegation port prototype instantiation

`IDelegationPortCreator` provides an Api to control some aspects, e.g. the naming or the direction, of newly created delegation ports.

- `name(Closure)` computes a name for the delegation port prototypes that should be created for port interfaces, which are provided by the `IPortInterfaceSelection`.
- `direction(EDirection)` defines the direction of the port prototype that should be created. `EDirection.Tx` will create provided ports, `EDirection.Rx` will create required ports. Delegation provided-required ports are not supported.
- `count(int)` defines how many delegation port prototypes should be created for each selected port interface. The default is 1.

Examples

```
import com.vector.cfg.model.sysdesc.api.com.EDirection

scriptTask("createDelegationPortSimple", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def createdComponentPorts =
          selectPortInterfaces {
            // select all client server application port interfaces of
            // component 'App3'
            componentType "App3"
            clientServer()
            application()
          } createPrototype {
            // EDirection.Tx to create a PPort and EDirection.Rx to create
            // a RPort
            direction(EDirection.Tx)
            // if no name is specified, the name of the port interface will
            // be taken for the port
          }
        scriptLogger.infoFormat("Created {0} delegation ports.",
          createdComponentPorts.size())
      }
    }
  }
}
```

Listing 4.262: Create delegation port simple

```
import com.vector.cfg.model.sysdesc.api.com.EDirection
import com.vector.cfg.model.sysdesc.api.port.IPortInterface

scriptTask("createDelegationPortCustomized", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def createdComponentPorts =
          selectPortInterfaces {
            // select the port interface of 'App1.ppFirst' and the port
            // interface named 'Second'
            or {
              componentPort "App1.ppFirst"
              name "Second"
            }
          } createPrototype {
            name {
              // specify the naming of the new ports
              IPortInterface portInterface -> "pp" + portInterface.
                getName() + "_new"
            }
            // EDirection.Rx is leading to the creation of required ports
            direction(EDirection.Rx)
            // for each selected port interface two delegation ports will
            // be created
            count(2)
          }
        scriptLogger.infoFormat("Created {0} delegation ports.",
          createdComponentPorts.size())
      }
    }
  }
}
```

Listing 4.263: Create delegation port customized

```

import com.vector.cfg.model.sysdesc.api.com.EDirection
import com.vector.cfg.model.sysdesc.api.port.IPortInterface

scriptTask("createDelegationPortWithNameOfOtherPort", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // in this example we want to create a delegation port
        // for a port of component 'App1'
        // and name the delegation port as the port of 'App1'

        // select ports using the component port selection API
        def selectedComponentPorts = selectComponentPorts {
          unconnected()
          senderReceiver()
          component("App1")
        } getComponentPorts()

        // get the first port
        // we are sure that the first port is the correct one in this
        // example, to keep the example simple
        def myPort = selectedComponentPorts.get(0)

        // now create a new delegation port
        // use port interface and name of the port you have just selected
        def componentPorts = selectPortInterfaces {
          // use the port interface's path of your selected port
          asrPath(myPort.getPortInterface().getAutosarPath())
        } createPrototype {
          name {
            // just ignore the port interface parameter when naming the
            // new port
            // you do not have to use it
            // instead use the name of our existing port
            myPort.getPortName()
          }
          direction(EDirection.Tx)
        }
        // since the short names of the ports will be equal now
        // we can for example connect them easier
        // because we make sure the name matching algorithm
        // finds the port pair which should be connected

        scriptLogger.infoFormat("Created {0} component ports.",
                                componentPorts.size())
      }
    }
  }
}

```

Listing 4.264: Create delegation port with name of other port

4.10.4.7 Retrieving short name paths and fully qualified names

The runtime system automation API requires/allows to use short name paths and fully qualified names to select elements. This chapter describes how these can be retrieved.

In general you can find a 'Copy' -> 'Copy Short Name Path' command in the context menu for most elements.

Path of Port Interface Mapping If you have already connected two ports and use a port interface mapping for the connection, you can search for your connector in the ECU Software Components Editor. You can find it in the Application Ports grid or the Service Mappings grid under the ECU Composition node or under the Application or Service Ports node of your application or service component.

'Copy' -> 'Copy Short Name Path' in the context menu available in the Port Interface Mapping column for a given connection copies the short name path of the connection's port interface mapping to the clip board.

If you have no connection yet which uses the port interface mapping, search for the port interface mapping in another way. Expand the Port Interface Mapping Sets node of the ECU Software Components Editor and the node of the set which contains your mapping. Now you can do the 'Copy' -> 'Copy Short Name Path' command in the context menu of the tree node which belongs to the port interface mapping you were looking for.

Paths of System Signals and System Signal Groups If you have already used your signal / signal group for a data mapping, you can find the data mapping in the Data Mapping or the Application Ports grid under the ECU Composition node. Once you found your mapping you can retrieve the short name path of the signal / signal group via the 'Copy' -> 'Copy Short Name Path' context menu on the cell of the Signal column in the Data Mapping grid or the Mapped Signal column of the Application Ports grid.

Fully Qualified Name of Communication Elements Communication elements are used for data mappings. Their fully qualified name is build out of three parts (in general, children of complex communication elements might have more). The name of the component, the name of the port and the name of the data element/operation/trigger itself. In case of a delegation port you can use 'ECU Composition' or 'COMPOSITIONTYPE' as component name.

Examples

Communication element of non-delegation port:
'ComponentName.PortName.DataElementName'

Communication element of delegation port:
'ECU Composition.DelegationPortName.DataElementName'

Complex communication element (record element of a record):
'ComponentName.PortName.RecordName.RecordElement1Name'

Complex communication element (array element at certain index):
'ComponentName.PortName.ArrayName[0]'

Open the data mapping assistant. You can find it in the navigation view under Runtime System -> Add Data Mapping or as hyperlink above grids which shows data mappings. Select the direction 'Find matching signals for the communication elements' on the first page and after that your communication elements on the second page. Now on the third page (Confirm page) you can open a context menu on the cell in the Communication Element column of your communication element and select copy fully qualified name. The name will be copied into the

clip board. If you need the name of a child communication element which is not shown yet, you might have map the parent to a signal group first.

You can also just use the examples above and replace the names with the names of your component, port and communication element.

4.10.4.8 Origin Context

According to AUTOSAR the flat extract is created out of the structured extract. During the flattening process, the inner compositions and their ports are lost. However sometimes the information about this objects is helpful to perform actions on the flat extract, such as for example connecting ports or doing the data mapping. We call the objects of the structured extract, which are related to the flat extract objects, origin contexts.

The component port selection provides an option to use the origin context's names as additional mapping criteria. This was already introduced above (see 4.10.4.1 on page 165).

Origin Component Port There is an own model element for the component ports of the structured extract. A component port (see also `IComponentPort`) represents a port prototype and its corresponding component prototype. The `IOriginComponentPort` represents a port in context of a component prototype for the upstream model (structured extract).

Further we want to clarify some of the terminology which is used in context of the origin component port. The term delegation port is pretty clear for the flat extract, since there are no other compositions beside the top level composition. However it is possible to instantiate also compositions inside the top level composition and inside other compositions in the structured extract. We call all ports whose owner is a composition, delegation ports.

Another term used here is the inner top level. Since a project can have only one top level composition, the first hierarchy level defining the rough structure of the software components is directly inside the top level composition. So everything directly inside the top level composition is called the inner top level.

For example if a composition 'MyComposition' is instantiated directly in the top level composition and has a port named 'SendData', so we call the origin component port 'MyComposition.SendData' an inner top level delegation port. Let's assume the composition named 'OtherComposition' has a port named 'ReceiveData' and is instantiated in 'MyComposition'. The origin component port 'OtherComposition.ReceiveData' is not an inner top level delegation port, since we use this term only for the hierarchy level inside the top level composition.

Select Origin Component Ports When a port is connected to an inner composition port in the structured extract, there is no connector for this connection in the flat extract. Especially for this cases the automation interface provides an origin component port selection.

`selectOriginComponentPorts(Closure)` allows the selection of `IOriginComponentPorts` using predicates. The origin component ports which are selected here, are ends of incomplete delegation connections in the structured extract.

Predicates To select the origin component ports, predicates are provided to narrow down the selection.

Per default the predicates are combined via logical AND. To realize other combinations, use the 'or', 'not' and 'and' predicates.

Origin Component Port Predicates

- `name(String)` matches origin component ports with the given port name.
- `name(Pattern)` matches origin component ports with the given port name pattern.
- `asrPath(String)` matches origin component ports with the given port autosar path.
- `asrPath(Pattern)` matches origin component ports with the given port autosar path pattern.
- `component(String)` matches origin component ports with the given component name.
- `component(Pattern)` matches origin component ports with the given component name pattern.
- `componentAsrPath(String)` matches the origin component ports with the given component autosar path.
- `componentAsrPath(Pattern)` matches origin component ports with the given component autosar path pattern.
- `componentType(String)` matches origin component ports whose component type's name equals the given component type name.
- `componentType(Pattern)` matches origin component ports whose component type's name matches the given component type name pattern.
- `componentTypeAsrPath(String)` matches origin component ports whose component type's autosar path equals the given component type autosar path.
- `componentTypeAsrPath(Pattern)` matches origin component ports whose component type's autosar path matches the given component type autosar path pattern.
- `provided()` matches provided origin component ports (p-port).
- `required()` matches required origin component ports (r-port).
- `providedRequired()` matches provided-required origin component ports (pr-port).
- `innerTopLevelDelegation()` matches origin component ports on the highest hierarchy level. In other words the component of the matched ports is instantiated directly inside the top level composition (ECU Composition).
- `ofFlatExtractPort()` retrieves the origin component ports of the given flatComponent-Port.
- `senderReceiver()` matches origin component ports whose port has a sender/receiver port interface.
- `clientServer()` matches origin component ports whose port has a client/server port interface.
- `trigger()` matches origin component ports whose port has a trigger port interface.
- `filterAdvanced(Closure)` matches origin component ports for which the given closure results to true.
- `and(Closure)` combines the predicates inside the closure with a logical AND.
- `or(Closure)` combines the predicates inside the closure with a logical OR.
- `not(Closure)` negates the combination of predicates inside the closure.

Examples

```
scriptTask("selectOriginComponentPorts", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        def selectedOriginPorts = selectOriginComponentPorts {
          innerTopLevelDelegation()
          provided()
        } getOriginComponentPorts()

        scriptLogger.infoFormat("Selected '{0}' origin component ports.",
                                selectedOriginPorts.size())
      }
    }
  }
}
```

Listing 4.265: Select ends of incomplete connections

```
scriptTask("originPortsForFlatExtractPort", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {
        // first we need to find our flat extract port
        // we will use the component port selection for this example
        def componentPort = selectComponentPorts {
          name "pDataSend"
          component "Appl"
        } getComponentPorts().iterator().next()

        def selectedOriginPorts = selectOriginComponentPorts {
          ofFlatExtractPort(componentPort)
        } getOriginComponentPorts()

        scriptLogger.infoFormat("Selected '{0}' origin component ports for {1}.",
                                selectedOriginPorts.size(),
                                componentPort.getName())
      }
    }
  }
}
```

Listing 4.266: Select the ends of incomplete connections for a specific flat extract component port

Create Delegation Ports Using Origin Context We have already learned how to create new delegation ports in the flat extract using the port interface selection (see 4.10.4.6 on page 219). Sometimes a delegation connection was not completed in the structured extract and is not flattened out. To complete this connection in the flat extract we need a new delegation port and want to use exactly the same port interfaces as in the structured extract. For this use case there is a shortcut directly at the origin component port selection, that simplifies the transition from origin port to its port interface.

`createFlatExtractDelegationPorts(Closure)` creates a `PortPrototype` on the `ecu` composition of the `FlatExtract` for each selected origin component port using their port interfaces. If the naming is not specified, the names of the created delegation ports are derived from the port

interfaces. The direction of the ports has to be specified.

Examples

```
import com.vector.cfg.model.sysdesc.api.com.EDirection

scriptTask("createPortFromOriginContext", DV_PROJECT){
  code {
    transaction {
      domain.runtimeSystem {

        // in this example we create a delegation port which is missing in the
        // flat extract
        // the port interface for our new port is provided by an origin context
        // port

        def selectedOriginPorts
        def createdDelegationPorts = selectOriginComponentPorts {
          provided()
          name "OriginContext"

          // remember the selected ports to print better info later
          selectedOriginPorts = getSelectedOriginComponentPorts()

        }.createFlatExtractDelegationPorts {
          // this call retrieves the port interfaces of the selected origin
          // component ports
          // and creates for each origin component port a delegation port in
          // the flat extract

          // specify the name and direction of the new port
          name {
            // optionally you could use the port interface as help for
            // specifying the name here
            // IPortInterface portInterfaceOfOriginPort -> ...
            "PortWithInterfaceOfOriginContext"
          }
          // it is difficult to determine the correct direction here
          // so it might be a good idea to run the script for p and r ports
          // separately
          direction(EDirection.Tx)
        }

        for (int i = 0; i < selectedOriginPorts.size(); i++) {
          scriptLogger.infoFormat("Created new delegation port {0} for origin
            port {1}.",
            createdDelegationPorts.get(i).getName(),
            selectedOriginPorts.get(i).getName())
        }
      }
    }
  }
}
```

Listing 4.267: Create a delegation port using the port interface of an origin context port

4.11 Persistency

The persistency API provides methods which allow to import and export model data from and to files. The files are normally in the AUTOSAR .arxml format.

4.11.1 Model Export

The modelExporty allows to export MDF model data into .arxml files.

To access the export functionality use one of the getModelExport() or modelExport(Closure) methods.

```
// You can access the API in every active project
def exportApi = persistency.modelExport

//Or you use a closure
persistency.modelExport {
}
```

Listing 4.268: Accessing the model export persistency API

4.11.1.1 Export ActiveEcuc

The method exportActiveEcucToFile(Object) exports the whole ActiveEcuC configuration into a single file of type Path specified by the user.

```
scriptTask('taskName') {
    code {
        def destinationFile // Define the file to export into...
        persistency.modelExport.exportActiveEcucToFile(destinationFile)
    }
}
```

Listing 4.269: Export the ActiveEcuc to a file

The method exportActiveEcuc(Object) exports the whole ActiveEcuC configuration into a single file of type Path.

```
scriptTask('taskName') {
    code {
        def tempExportFolder = paths.resolveTempPath(".")
        def resultFile = persistency.modelExport.exportActiveEcuc(
            tempExportFolder)
    }
}
```

Listing 4.270: Export the ActiveEcuc into a folder

4.11.1.2 Export PostBuild Variants (Post-build selectable)

The method exportPostBuildVariants(Object) exports the PostBuild variants info. This will export the ActiveEcuc and miscellaneous data. The ActiveEcuC is exported into one file (even for split DPA-projects) per variant into <project-name>.<variant-name>.ecuc.arxml.

Miscellaneous data is exported into one file per variant. The files contain all data of the project except:

- ModuleConfigurations, ModuleDefinitions
- BswImplementations, EcuConfigurations
- Variant information like EvaluatedVariantSet

The created files are `<project-name>.<variant-name>.misc.arxml`.

The method returns a `List<Path>` of exported files.

```
scriptTask('taskName') {
    code {
        persistency.modelExport {
            def tempExportFolder = paths.resolveTempPath(".")
            def fileList = exportPostBuildVariants(tempExportFolder)
        }
    }
}
```

Listing 4.271: Export a PostBuild project into files per predefined variant

4.11.1.3 Export PreBuild Variants

The method `exportPreBuildVariants(Object)` exports the PreBuild variants info. This will export the ActiveEcuC and miscellaneous data. The ActiveEcuC is exported into one file (even for split DPA-projects) per variant into `<project-name>.<variant-name>.ecuc.arxml`.

Miscellaneous data is exported into one file per variant. The files contain all data of the project except:

- ModuleConfigurations, ModuleDefinitions
- BswImplementations, EcuConfigurations

The created files are `<project-name>.<variant-name>.misc.arxml`.

The method returns a `List<Path>` of exported files.

```
scriptTask('taskName') {
    code {
        persistency.modelExport {
            def tempExportFolder = paths.resolveTempPath(".")
            def fileList = exportPreBuildVariants(tempExportFolder);
        }
    }
}
```

Listing 4.272: Export a PreBuild project into files per predefined variant

4.11.1.4 Advanced Exports

The advanced export use case provides access to multiple `IModelExporter` for special export use cases like export the system description for the RTE.

Normally you would retrieve an `IModelExporter` by its ID via `getExporter(String)`. On this exporter you can call:

- `IModelExporter.export(Object)` to export the model
- `IModelExporter.exportAsPostBuildVariants(Object)` to export the model divided into files per PostBuild predefined variant.

You can retrieve a list of supported exporters from `getAvailableExporter()`. The list can differ from data loaded in your project.

```
scriptTask('taskName') {
  code {
    def tempExportFolder = paths.resolveTempPath(".")

    // Export with an exporter in one line
    persistency.modelExport["activeEcuc"].export(tempExportFolder)
  }
}
```

Listing 4.273: Export the project with an exporter into a folder

```
scriptTask('taskName') {
  code {
    def tempExportFolder = paths.resolveTempPath(".")

    def fileList
    //Switch to the persistency export API
    persistency.modelExport{
      // The getAvailableExporter() returns all exporters in the system
      def exporterList = getAvailableExporter()

      // Select an exporter by its ID
      def exporterOpt = getExporter("activeEcuc")

      exporterOpt.ifPresent { exporter ->
        // Export into folder, when exporter exists
        fileList = exporter.export(tempExportFolder)
      }
    }
  }
}
```

Listing 4.274: Export the project with an exporter and checks

Export an Model Tree The method `exportModelTreeToFile(Object, MIObject)` exports the specified model object and the subtree into a single file of type `Path` specified by the user.


```
scriptTask('taskName') {
  code {
    def destinationFile // Define the file to export into...
    MIARPackage autosarPkg = mdfModel(AsrPath.create("/MICROSAR"))

    persistency.modelExport{
      exportModelTreeToFile(destinationFile, autosarPkg)
    }
  }
}
```

Listing 4.275: Export an AUTOSAR package into a file

The method `exportModelTree(Object, MIObject)` exports the specified model object and the subtree into a single file of type `Path`.

```
scriptTask('taskName') {
  code {
    def exportFolder = paths.resolveTempPath(".")
    MIARPackage autosarPkg = mdfModel(AsrPath.create("/MICROSAR"))

    def resultFile = persistency.modelExport.exportModelTree(exportFolder,
      autosarPkg)
  }
}
```

Listing 4.276: Export an AUTOSAR package into a folder

Export an Model Tree including all referenced Elements You could also export model trees including all referenced elements with the exporter `modelTreeClosure`:

```
scriptTask('taskName') {
  code {
    def exportFolder = paths.resolveTempPath(".")
    MIARPackage microsarPkg = mdfModel(AsrPath.create("/MICROSAR"))
    MIARPackage autosarPkg = mdfModel(AsrPath.create("/AUTOSAR"))

    persistency.modelExport["modelTreeClosure"].export(exportFolder,
      autosarPkg, microsarPkg)
  }
}
```

Listing 4.277: Exports two elements and all references elements

Usage of Exporter Arguments You can use `withExporterArgs(Map, Closure)` to specify exporter arguments like in the command line with `-exporterArgs` argument. The key is the exporter ID, the value are the arguments to the exporter. See command line help for details.

```
persistence.modelExport{
    // Specify the arguments with exporterId: "arguments"
    withExporterArgs(modelTree: "--element /MICROSAR"){
        // Call any export code with the active arguments.
        getExporter("modelTree").get().exportToFile(destinationFile)
    }
}
```

Listing 4.278: Use exporter arguments like in the commandline

4.11.2 Model Import

To access the import functionality use one of the `getModelImport()` or `modelImport(Closure)` methods.

```
// You can access the API in every active project
def importApi = persistence.modelImport

//Or you use a closure
persistence.modelImport {
}
```

Listing 4.279: Accessing the model import persistency API

4.11.2.1 Module Configuration Import

To access the module import functionality use one of the `importModuleConfigurations(List)` methods.

```
// You can access the API inside the closure

persistence.modelImport {
    importModuleConfigurations(importFile)
}
```

Listing 4.280: Accessing the import module configuration persistency API

The method `importModuleConfigurations(Path, Closure)` imports `MIModuleConfiguration` from the specified `.arxml` file into the current `ActiveEcuC`. The `Closure` can be used to specify the import mode and filter if necessary.

The method `importModuleConfigurations(Path)` imports `MIModuleConfiguration` from the specified `.arxml` file into the current `ActiveEcuC`.

The method `importModuleConfigurations(List)` imports `MIModuleConfiguration` from the specified `.arxml` files into the current `ActiveEcuC`.

The method `importModuleConfigurations(List, Closure)` imports `MIModuleConfiguration` from the specified `.arxml` files into the current `ActiveEcuC`. The `Closure` can be used to specify the import mode and filter if necessary.

Note: If a module configuration is contained in several files a `PersistenceImportException` is thrown.

4.11.2.2 Specify import mode and module filter

To specify an import mode use the method `addToModel(Closure)` to add the imported modules to the `ActiveEcuC` or use the method `replaceInModel(Closure)` (*this is the default mode*) to replace already existing module configurations with the imported one.

To specify a filter for the module configurations to import use one of the methods:

- `module(DefRef)` Use a single `DefRef`
- `module(List)` Use a list of `AsrPath`, `DefRef` or `Definition Refs` as `String`
- `module(AsrPath)` Use a single `AsrPath`
- `module(String)` Use a single `Definition Ref` as `String`

```
// You can access the API inside the closure

def importFile = paths.resolvePath("./ImportFile.arxml")

persistency.modelImport {

    importModuleConfigurations(importFile) {

        addToModel(){

            // Use 'addToModel()' to add the imported module configuration to the
            // current ActiveEcuC. If a module configuration with the same name
            // already exists, the module configuration is ignored.

            module("/MICROSAR/LinIf")    // -> DefRef as String
            def linNmAsrPath = AsrPath.create("/ActiveEcuC/LinNm")
            module(linNmAsrPath) // -> Autosar path as AsrPath instance

        }

        replaceInModel(){

            // Use 'replaceInModel()' to replace already existing module
            // configurations in the current ActiveEcuC.

            List<String> modulesToImport = Arrays.asList("/MICROSAR/LinSM")

            module(modulesToImport)

        }

    }

}
```

Listing 4.281: Specify the module configuration import mode and filter

4.12 Utilities

4.12.1 Constraints

Constraints provides general purpose constraints for checking given parameter values throughout the automation interface. These constraints are referenced from the AutomationInterface documentation wherever they apply. The AutomationInterface takes a fail fast approach verifying provided parameter values as early as possible and throwing appropriate exceptions if values violate the corresponding constraints.

The following constraints are provided:

IS_NOT_NULL Ensures that the given **Object** is not **null**.

IS_NON_EMPTY_STRING Ensures that the given **String** is not empty.

IS_VALID_FILE_NAME Ensures that the given **String** can be used as a file name.

IS_VALID_PROJECT_NAME Ensures that the given **String** can be used as a name for a project. A valid project name starts with a letter [a-zA-Z] contains otherwise only characters matching [a-zA-Z0-9_] and is at most 128 characters long.

IS_NON_EMPTY_ITERABLE Ensures that the given **Iterable** is not empty.

IS_VALID_AUTOSAR_SHORT_NAME Ensures that the given **String** conforms to the syntactical requirements for AUTOSAR short names.

IS_VALID_AUTOSAR_SHORT_NAME_PATH Ensures that the given **String** conforms to the syntactical requirements for AUTOSAR short name paths.

IS_WRITABLE Ensures that the file or folder represented by the given **Path** exists and can be written to.

IS_READABLE Ensures that the file or folder represented by the given **Path** exists and can be read.

IS_EXISTING_FOLDER Ensures that the given **Path** points to an existing folder.

IS_EXISTING_FILE Ensures that the given **Path** points to an existing file.

IS_CREATABLE_FOLDER Ensures that the given **Path** either points to an existing folder which can be written to or points to a location at which a corresponding folder could be created.

IS_DCF_FILE Ensures that the given `Path` points to a DaVinci Developer workspace file (.dcf file).

IS_DPA_FILE Ensures that the given `Path` points to a DaVinci project file (.dpa file).

IS_ARXML_FILE Ensures that the given `Path` points to an .arxml file.

IS_SYSTEM_DESCRIPTION_FILE Ensures that the given `Path` points to a system description input file (.arxml, .dbc, .ldf, .xml or .vsde file).

4.12.2 Converters

General purpose converters (`java.util.Functions`) for performing value conversions throughout the automation interface are provided. These converters are referenced from the AutomationInterface documentation wherever they apply. The AutomationInterface is typed strongly. In some cases, however, e.g. when specifying file locations, it is desirable to allow for a range of possibly parameter types. This is achieved by accepting parameters of type `Object` and converting the given parameters to the desired type.

The following converters are provided:

ScriptConverters.TO_PATH Attempts to convert arbitrary `Objects` to `Paths` using `IAutomationPathsApi.resolvePath(Object)` 4.4.3.2 on page 39.

ScriptConverters.TO_SCRIPT_PATH Attempts to convert arbitrary `Objects` to `Paths` using `IAutomationPathsApi.resolveScriptPath(Object)` 4.4.3.3 on page 40.

ScriptConverters.TO_VERSION Attempts to convert arbitrary `Objects` to `IVersions`. The following conversions are implemented:

- For `null` or `IVersion` arguments the given argument is returned. No conversion is applied.
- `Strings` are converted using `Version.valueOf(String)`.
- `Numbers` are converted by converting the `int` obtained from `Number.intValue()` using `Version.valueOf(int)`.
- All other `Objects` are converted by converting the `String` obtained from `Object.toString()`.

ScriptConverters.TO_BIG_INTEGER Attempts to convert arbitrary `Objects` to `BigIntegers`. The following conversions are implemented:

- For `null` or `BigInteger` arguments the given argument is returned. No conversion is applied.
- `Integers`, `Longs`, `Shorts` and `Bytes` are converted using `BigInteger.valueOf(long)`.
- All other types of objects are interpreted as `Strings` (`Object.toString()`) and passed to `BigInteger(BigInteger(String))`.

ScriptConverters.TO_BIG_DECIMAL Attempts to convert arbitrary Objects to BigDecimals. The following conversions are implemented:

- For `null` or `BigDecimal` arguments the given argument is returned. No conversion is applied.
- Floats and Doubles, are converted using `BigDecimal.valueOf(double)`.
- Integers, Longs, Shorts and Bytes are converted using `BigDecimal.valueOf(long)`.
- All other types of objects are interpreted as Strings (`Object.toString()`) and passed to `BigDecimal.BigDecimal(String)`.

ModelConverters.TO_MDF Attempts to convert arbitrary Objects to MDFObjects. The following conversions are implemented:

- For `null` or `MDFObject` arguments the given argument is returned. No conversion is applied.
- `IHasModelObjects` are converted using their `getMdfModelElement()` method.
- `IViewedModelObjects` are converted using their `getMdfObject()` method.
- For all other Objects `ClassCastExceptions` are thrown.

For thrown Exceptions see the used functions described above.

4.13 Advanced Topics

This chapter contains advanced use cases and classes for special tasks. For a normal script these items are not relevant.

4.13.1 Java Development

It is also possible to write automation scripts in plain Java code, but this is not recommended. There are some items in the API, which need a different usage in Java code.

This chapter describes the differences in the Automation API when used from Java code.

4.13.1.1 Script Task Creation in Java Code

Java code could not use the Groovy syntax to provide script tasks. So another way is needed for this. The `IScriptFactory` interface provides the entry point that Java code could provide script tasks. The `createScript(IScriptCreationApi)` method is called when the script is loaded.

This interface is **not** necessary for Groovy clients.

```
public class MyScriptFactoryAsJavaCode implements IScriptFactory {
    @Override
    public void createScript(IScriptCreationApi creation) {
        creation.scriptTask("TaskFromFactory", IScriptTaskTypeApi.
            DV_APPLICATION,
            (taskBuilder) -> {
                taskBuilder.code(
                    (scriptExecutionContext, taskArgs) -> {
                        // Your script task code here
                        return null;
                    });
            });
        creation.scriptTask("Task2", IScriptTaskTypeApi.DV_PROJECT,
            (taskBuilder) -> {
                taskBuilder.code(
                    (scriptExecutionContext, taskArgs) -> {
                        // Your script task code for Task2 here
                        return null;
                    });
            });
    }
}
```

Listing 4.282: Java code usage of the `IScriptFactory` to contribute script tasks

You should try to use Groovy when possible, because it is more concise than the Java code, without any difference at script task creation and execution.

4.13.1.2 Java Code accessing Groovy API

Most of the Automation API is usable from both languages Java and Groovy, but some methods are written for Groovy clients. To use it from Java you have to write some glue code.

Differences are:

- Accessing Properties
- Using API entry points.
- Creating Closures

Accessing Properties Properties are not supported by Java so you have to use the getter/setter methods instead.

API Entry Points Most of the Automation API is added to the object by so called DynamicObjects. This is not available in Java, so you have to call `IScriptExecutionContext.getInstance(Class)` instead. So if you want to access The `IWorkflowApi` you have to write:

```
//Java code:
IScriptExecutionContext scriptCtx = ...;
IWorkflowApi workflow = scriptCtx.getInstance(IWorkflowApiEntryPoint.class).
    getWorkflow()

//Instead of Groovy code:
workflow{
}
```

Listing 4.283: Accessing WorkflowAPI in Java code

Creating Closure instances from Java lambdas The class `Closures` provides API to create Closure instances from Java `FunctionalInterfaces`.

The `from()` methods could be used to call Groovy API from Java classes, which only accepts Closure instances.

Sample:

```
Closure<?> c = Closures.from((param) -> {
    // Java lambda
});
```

Listing 4.284: Java Closure creation sample

Creating Closure Instances from Java Methods You could also create arbitrary Closures from any Java method with the class `MethodClosure`. This is describe in:

http://melix.github.io/blog/2010/04/19/coding_a_groovy_closure_in.html¹

4.13.1.3 Java Code in dvgroovy Scripts

It is not possible to write Java classes when using the `.dvgroovy` script file. You have to create an automation script project, see chapter 7 on page 293.

¹Last accessed 2016-05-24

4.13.2 Unit testing API

The Automation Interface provides an connector to execute unit tests as script task. This is helpful, if you want to write tests for:

- Generators (see chapter 4.14 on page 244 for details)
- Validations
- Workflow rules
- ...

Normally a script task executes it's code block, but the unit test task will execute all contained unit tests instead.

4.13.2.1 JUnit4 Integration

The AutomationInterface can execute JUnit 4 test cases and test suites.

Execution of JUnit Test Classes A simple unit test class will look like:

```
import org.junit.Test;

public class ScriptJUnitTest {

    @Test
    public void testYourLogic() {
        // Write your test code here
    }
}
```

Listing 4.285: Run all JUnit tests from one class

You can access the Automation API with the `ScriptApi` class. See chapter 4.4.8 on page 49 for details.

Execution of multiple Tests with JUnit Suite To execute multiple tests you have to group the tests into a test suite.

```
import org.junit.runner.RunWith;
import org.junit.runners.Suite;
import org.junit.runners.Suite.SuiteClasses;

@RunWith(Suite.class)
@SuiteClasses({
    // Two test classes
    ScriptJUnitTest.class,
    ScriptSpockTest.class,

    // Another JUnit suite
    InnerSuiteScriptJUnitTests.class,
})
public class AllMyScriptJUnitTests {
}
```

Listing 4.286: Run all JUnit tests using a Suite

You can also group test suites in test suites and so on.

4.13.2.2 Execution of Spock Tests

The AutomationInterface can also execute Spock tests. See:

- Homepage: <https://github.com/spockframework/spock>²
- Documentation: <http://spockframework.org/spock/docs/1.1/index.html>³

It is also possible to group multiple Spock test into a JUnit Test Suite.

Usage sample:

```
import spock.lang.Specification

class ScriptSpockTest extends Specification {

    def "Simple Spock test"(){
        when:
            //Add your test logic here
            def myExpectedString = "Expected"

        then:
            myExpectedString == "Expected"
    }
}
```

Listing 4.287: Run unit test with the Spock framework

You can access the Automation API with the `ScriptApi` class. See chapter 4.4.8 on page 49 for details.

You have to add a Spock dependency in your `build.gradle` file:

```
dependencies {
    compileOnly("org.spockframework:spock-core:1.1-groovy-2.4"){
        exclude group: 'org.codehaus.groovy', module: 'groovy-all'
    }
}
```

Listing 4.288: Additional Spock dependency in Gradle

Note: after the change you have to call Gradle to update the IntelliJ IDEA project.

```
gradlew idea
```

4.13.2.3 Registration of Unit Tests in Scripts

A test or the root suite class has to be registered in a script to be executable. The first argument is the `taskName` for the UnitTests the second is the class of the tests.

```
// You can add a unit test inside a script
unitTestTask("MyUnitTest", AllMyScriptJUnitTests.class)
```

Listing 4.289: Add a UnitTest task with name MyUnitTest

²Last accessed 2018-04-04

³Last accessed 2018-04-04

It is also possible to reference the test/suite class directly as a script inside of a script project. So you don't have to create a script as a wrapper.

```
project.ext.automationClasses = [  
    "sample.MyScript",  
    "sample.MyUnitTestSuite", // This is a test suite  
    // Add here your test or suite class with full qualified name  
]
```

Listing 4.290: The projectConfig.gradle file content for unit tests

4.13.2.4 Model TestInfrastructure

The `ITransactionUndoAllRule` class provides a `JUnit TestRule`, which will undo all transaction after the `JUnit` test was executed. This can be used as a `ClassRule` or `Rule` to undo only for the whole test class or for each test case. This could also be used with `Spock`.

```
public class TransactionUndoAllRuleTest {  
    @Rule  
    public ITransactionUndoAllRule rule = ITransactionUndoAllRule.  
        forActiveProject();  
  
    @Test  
    public void testcase() {  
        //After this test case all transactions are reverted by the  
        TransactionUndoAllRule  
    }  
}
```

Listing 4.291: Usage of the `ITransactionUndoAllRule` in a `JUnit` test

4.13.2.5 Automation Project TestInfrastructure

The `IProjectLoadRule` class provides a `JUnit TestRule`, which will load the passed `IProjectRef` before test execution and close it afterwards. This can be used as a `ClassRule` or `Rule` and it could also be used with `Spock`.

```
public class ProjectLoadRuleTest {  
    @ClassRule  
    static IProjectLoadRule rule = IProjectLoadRule.forProject(ScriptApi.  
        scriptCode.projects.parameterizeProjectLoad{  
            dpaFile "YourProject.dpa"  
        })  
  
    @Test  
    public void testcase() {  
        //In this test the project was loaded and will be closed after the test  
    }  
}
```

Listing 4.292: Usage of the `IProjectLoadRule` in a `JUnit` test

For details about the how to load a project, see chapter 4.5.5 on page 69. Or if you want to load only an `.arxml` file, see chapter 4.5.8 on page 73.

4.14 Generator Testing

You can test Generators with an Automation Interface ScriptProject. There are two categories of generator tests, which can be performed:

- Black-box tests
- White-box tests

Both test categories are achieved by unit tests written in the ScriptProject, see chapter 4.13.2 on page 241 for how to write unit tests with the Automation Interface.

Black-box tests The Black-box tests test the functionality without knowing the internal structure of the generator. You can achieve this by using the Code Generation (see chapter 4.7.1 on page 117)) and verify that the generated code is correct in your unit test.

4.14.1 White-box tests

The white-box tests test the functionality with knowledge about the internal structure of the generator. This allows you to test single classes and internal algorithms especially error cases of the generator.

You need the license option .MD for the white-box tests development and execution.

This is not available for script files, you need a script project.

Technical description: It will allow you to access and use all classes of the Generator including package-private classes and methods. The generator is loaded into your script during unit test execution.

4.14.1.1 Step-by-step

You need to do the following steps:

1. Add the generator to your script project as compile dependency, see 4.14.1.2
2. Create your unit tests for your generator, see 4.13.2 on page 241
 - If you need a GeneratorPackage, see 4.14.1.3 on the next page
 - If you use transactions, see 4.13.2.4 on the preceding page
 - If you want to load projects, see 4.13.2.5 on the previous page
3. Execute your tests inside of a running DaVinci Configurator

4.14.1.2 Compilation

To enable the access to the generator classes you have to specify the generator under test in your `build.gradle` file of your script project.

The `generatorTests` allows to configure generators under test. You can add multiple generators with `generator(<PATH-TO-GENERATOR>)`.

```
dvCfgAutomation {
    generatorTests{
        generator("<PATH-TO-GENERATOR>")
    }
}
```

Listing 4.293: DaVinci Configurator build Gradle DSL API - generatorTests

The specified generators are automatically added as compile dependency to your script project.

Note: You have to update the IntelliJ IDEA project, see 7.9.3.2 on page 301.

If you want to access GenDevKit classes or you reference GenDevKit classes indirectly, you have to specify a GenDevKit version:

```
dvCfgAutomation {
    generatorTests{
        generator("<PATH-TO-GENERATOR>")
        genDevKit("<VERSION>") //E.g. 21.00.10
    }
}
```

Listing 4.294: DaVinci Configurator build Gradle DSL API - generatorTests - genDevKit

The `genDevKit` method accepts the version as `String` or as path to the GenDevKit folder.

4.14.1.3 GeneratorTestingApi

The `IGeneratorTestingApi` provides methods to test code with white box tests which require a real `IGeneratorPackage` or an `IGeneratorResultSink` etc. of the generator under test.

You can use the `IGeneratorTestingApi` with the call: `ScriptApi.scriptCode.genTesting`

The `createGenerator(Class)` method creates an `IGeneratorTestingAccess` for the passed class of the `IGeneratorPackage` under test. The method will use the currently active project for the generator. This will always create a new generator instance.

You can specify the used project with the method `createDeployablePackage(IProjectContext, Class)`.

The `withGenerator(Class, Closure)` method creates an `IGeneratorTestingAccess` and automatically activates it inside of the `Closure` code block.

IGeneratorTestingAccess The `IGeneratorTestingAccess` holds one created `IGeneratorPackage` under test and provides the following accessors:

- `getGeneratorPackage()`
- `getGenerationProcessor()`
- `getResultSink()`

The `IGeneratorPackage` needs to be activated before it is used in the test case. The best way to do it is with an `JUnit TestRule`, see listing below. You could also use the `with(Closure)` method. Or you do it manually with `activate()` and `deactivate()`, but you have to use a `try/finally` construct.

Examples The following sample use the API to execute a Spock test:

```
class SpockGeneratorTest extends Specification {
    @ClassRule
    @Shared
    IGeneratorTestingAccess<TestGeneratorPackage> genUnderTest = ScriptApi.
        scriptCode.
    //We test the TestGeneratorPackage class
    genTesting.createGenerator(TestGeneratorPackage)

    def "GeneratorName" (){
        when:
        def gen = genUnderTest.generatorPackage

        then:
        gen.getGeneratorName() == "TestGenerator"
    }
}
```

Listing 4.295: Spock test using a GeneratorPackage

The following sample use the API to execute a JUnit test:

```
public class JunitGeneratorTest {
    @ClassRule
    public static IGeneratorTestingAccess<TestGeneratorPackage> genUnderTest =
        ScriptApi.scriptCode.
    //We test the TestGeneratorPackage class
    genTesting.createGenerator(TestGeneratorPackage)

    @Test
    public void testGeneratorName(){
        def gen = genUnderTest.generatorPackage
        assert gen.getGeneratorName() == "TestGenerator"
    }
}
```

Listing 4.296: JUnit test using a GeneratorPackage

4.14.1.4 Test OuputFile Generation

You can also test the generation of `IOutputFile` classes with the `IGeneratorTestingApi`.

Examples The following sample use the API to execute a Spock test:

```
def "Content of TestOutputFile" (){
    when: "Generate the output file"
    def gen = genUnderTest.generatorPackage

    def dataRep = new TestDataRep(gen)
    def content = new TestOutputFile(gen, dataRep).generateFileContent()

    then:
    content == "TestFileContent" + NL
}
```

Listing 4.297: Spock test case which generates an OutputFile and verifies the content

The following sample use the API to execute a JUnit test:

```
@Test
public void testContentOfTestOutputFile(){
    def gen = genUnderTest.generatorPackage

    def dataRep = new TestDataRep(gen)
    def content = new TestOutputFile(gen, dataRep).generateFileContent()

    assert content == "TestFileContent" + NL
}
```

Listing 4.298: JUnit test case which generates an OutputFile and verifies the content

4.14.1.5 Test GeneratorResults and ValidationResults

The `IGeneratorTestingAccess` provides a special `IGenTestingGeneratorResultSink` for testing purpose. You can retrieve it with `IGeneratorTestingAccess.getResultSink()`. The `IGenTestingGeneratorResultSink` can be used to call code under test which requires an `IGeneratorResultSink`.

The `IGenTestingGeneratorResultSink` provides access to assert that a certain code has created the expected `IValidationResult` objects. You can use the access API for `IValidation-ResultUI` objects provided by the validation , see chapter 4.8.2 on page 127 for details.

Examples The following sample use the result sink to execute a Spock test:

```
def "DataRep creates Error ValidationResult" (){
    when: "Execute the code under test"
    def gen = genUnderTest.generatorPackage
    def dataRep = new TestDataRep(gen)
    dataRep.createData()

    then: "Retrieve the validation result created by the code under test"
    def results = genUnderTest.resultSink.
        validationResults.filter{ it.isId("TestGen", 123) }

    results.size() == 1
    results.first.description.toString() == "DescriptionText"
}
```

Listing 4.299: Spock test case which verifies a ValidationResult

The following sample use the result sink to execute a JUnit test:

```
@Test
public void dataRepCreatesErrorValidationResult(){
    def gen = genUnderTest.generatorPackage
    //Execute the code under test
    def dataRep = new TestDataRep(gen)
    dataRep.createData()

    //Retrieve the validation result created by the code under test
    def results = genUnderTest.resultSink.
        validationResults.filter{ it.isId("TestGen", 123) }

    assert results.size() == 1
    assert results.first.description.toString() == "DescriptionText"
}
```

Listing 4.300: JUnit test case which verifies a ValidationResult

5 Data models in detail

This chapter describes several details and concepts of the involved data models. Be aware that the information here is focused on the Java API. In most cases it is more convenient using the Groovy APIs described in 4.6 on page 75. So, whenever possible use the Groovy API and read this chapter only to get background information when required.

5.1 MDF model - the raw AUTOSAR data

The MDF model is being used to store the AUTOSAR model loaded from several ARXML files. It consists of Java interfaces and classes which are generated from the AUTOSAR meta-model.

5.1.1 Naming

The MDF interfaces have the prefix `MI` followed by the AUTOSAR meta-model name of the class they represent. For example, the MDF interface related to the meta-model class `ARPackage` (AUTOSAR package in the top-level structure of the meta-model) is `MIARPackage`.

5.1.2 The models inheritance hierarchy

The MDF model therefore implements (nearly) the same inheritance hierarchy and associations as defined by the AUTOSAR model. These interfaces provide access to the data stored in the model.

See figure 5.1 on the next page shows the (simplified) inheritance hierarchy of the ECUC container type `MIContainer`. What we can see in this example:

- A container is an `MIIdentifiable` which again is a `MIReferrable`. The `MIReferrable` is the type which holds the shortname (`getName()`). All types which inherit from the `MIReferrable` have a shortname (`MIARPackage`, `MIModuleConfiguration`, ...)
- A container is also a `MIHasContainer`. This is an artificial base class (not part of the AUTOSAR meta-model) which provides all features of types which have sub-containers. The `MIModuleConfiguration` therefore has the same base type
- A container also inherits from `MIHasDefinition`. This is an artificial base class (not part of the AUTOSAR meta-model) which provides all features of types which have an AUTOSAR definition. The `MIModuleConfiguration` and `MIPParameterValue` therefore has the same base type
- All `MIIdentifiables` can hold `ADMIN-DATA` and `ANNOTATIONS`
- All MDF objects in the AUTOSAR model tree inherit from `MIObject` which is again an `MIObject`

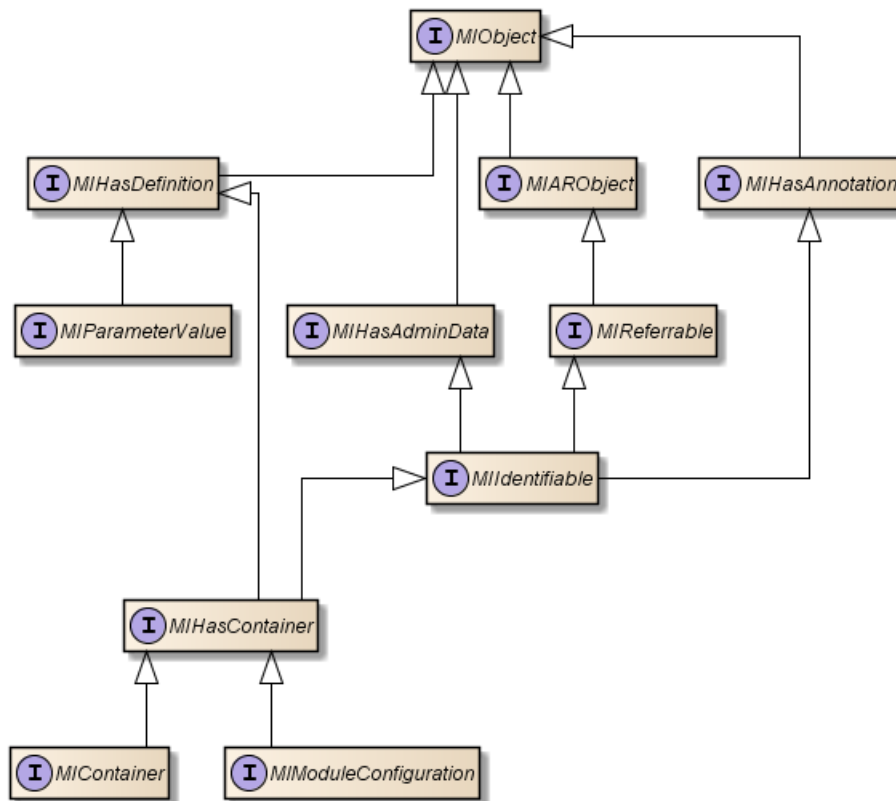


Figure 5.1: ECUC container type inheritance

5.1.2.1 MIObject and MDFObject

The `MIObject` is the base interface for all AUTOSAR model objects in the DaVinci Configurator data model. It extends `MDFObject` which is the base interface of all model objects. Your client code shall always use `MIObject`, when AUTOSAR model objects are used, instead of `MDFObject`.

The figure 5.2 on the following page describes the class hierarchy of the `MIObject`.

5.1.3 The models containment tree

The root node of the AUTOSAR model is `MIAUTOSAR`. Starting at this object the complete model tree can be traversed. `MIAUTOSAR.getSubPackage()` for example returns a list of `MIARPackage` objects which again have child objects and so on.

Figure 5.3 on the next page shows a simple example of an MDF object containment hierarchy. This example contains two AUTOSAR packages with module configurations below.

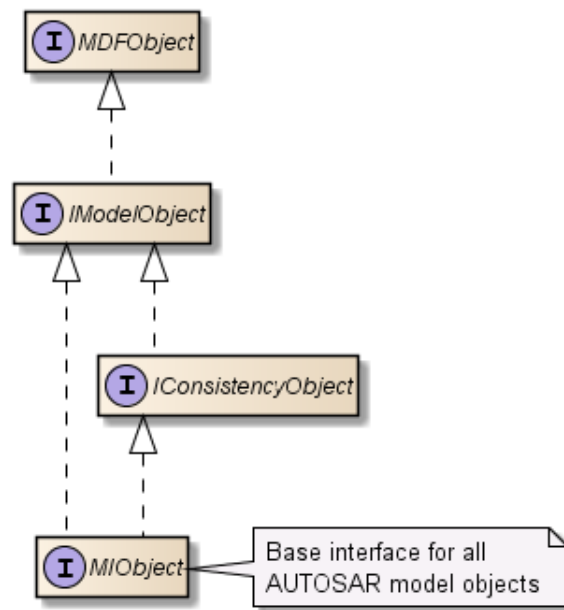


Figure 5.2: MIObjekt class hierarchy and base interfaces

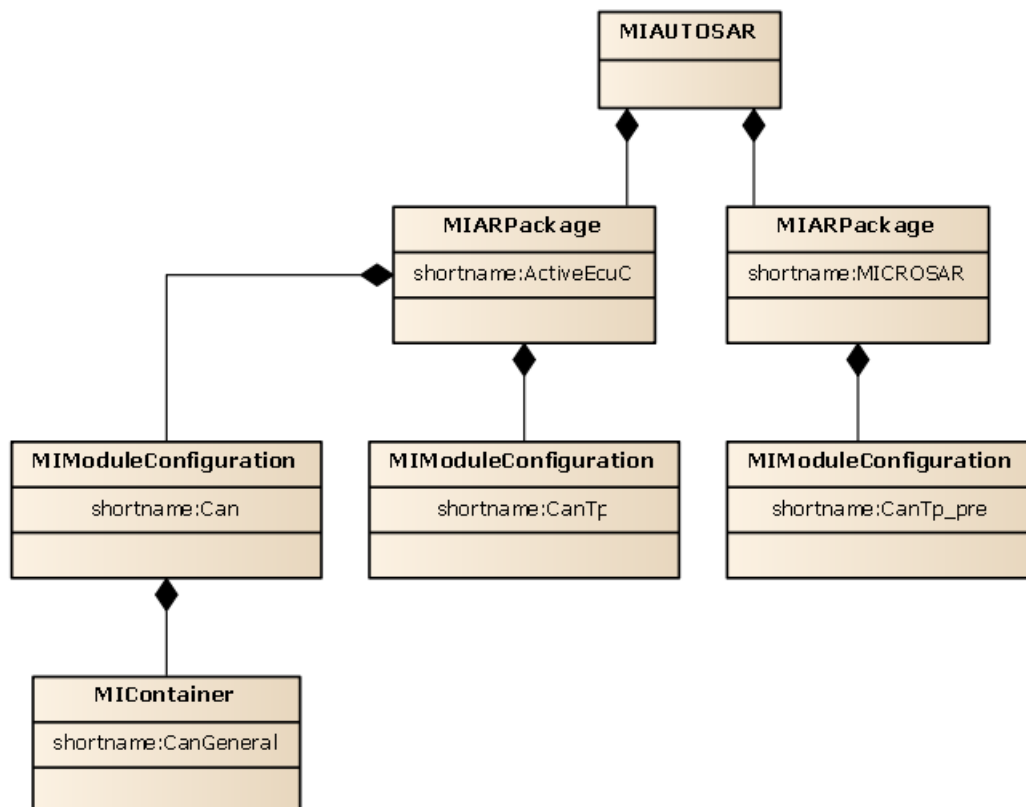


Figure 5.3: Autosar package containment

In general, objects which have child objects provide methods to retrieve them.

- `MIAUTOSAR.getSubPackage()` for example returns a list of child packages
- `MIContainer.getSubContainer()` returns the list of sub-containers and `MIContainer.getParameter()` all parameter-values and reference-values of a container

5.1.4 The ECUC model

The interfaces and classes which represent the ECUC model don't exactly follow the AUTOSAR meta-model naming. because they are designed to store AUTOSAR 3 and AUTOSAR 4 models as well.

Affected interfaces are:

- `MIModuleConfiguration` and its child objects (containers, parameters, ...)
- `MIModuleDef` and its child objects (containers definitions, parameter definitions, ...)

The ECUC model also unifies the handling of parameter- and reference-values. Both, parameter-values and reference-values of a container, are represented as `MIParameterValue` in the MDF model.

5.1.5 Order of child objects

Child object lists in the MDF model have the same order as the data specified in the ARXML files. So, loading model objects from AXRML doesn't change the order.

5.1.6 AUTOSAR references

All AUTOSAR reference objects in the MDF model have the base interface `MIARRef`.

Figure 5.4 shows this type hierarchy for the definition reference of an ECUC container.

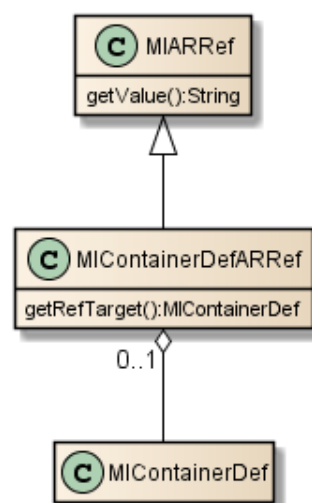


Figure 5.4: The ECUC container definition reference

In ARXML, such a reference can be specified as:

```
<DEFINITION-REF DEST="ECUC-PARAM-CONF-CONTAINER-DEF">  
  /MICROSAR/Com/ComGeneral  
</DEFINITION-REF>
```

- `MIARRef.getValue()` returns the AUTOSAR path of the object, the reference points to (as specified in the ARXML file). In the example above `"/MICROSAR/Com/ComGeneral"` would be this value
- `MIContainerDefARRef.getRefTarget()` on the other hand returns the referenced MDF object if it exists. This method is located in a specific, typesafe (according to the type it points to) reference interface which extends `MIARRef`. So, if an object with the AUTOSAR path `"/MICROSAR/Com/ComGeneral"` exists in the model, this method will return it

5.1.7 Model changes

5.1.7.1 Transactions

The MDF model provides model change transactions for grouping several model changes into one atomic change.

A solving action, for example, is being executed within a transaction for being able to change model content. Validation and generator developers don't need to care for transactions. The tools framework mechanisms guarantee that their code is being executed in a transaction were required.

The tool guarantees that model changes cannot be executed outside of transactions. So, for example, during validation of model content the model cannot be changed. A model change here would lead to a runtime exception.

5.1.7.2 Undo/redo

On basis of model change transactions, MDF provides means to undo and redo all changes made within one transaction. The tools GUI allows the user to execute undo/redo on this granularity.

5.1.7.3 Event handling

MDF also supports model change events. All changes made in the model are reported by this asynchronous event mechanism. Validations, for example, detect this way which areas of the model need to be re-validated. The GUI listens to events to update its editors and views when model content changes.

5.1.7.4 Deleting model objects

Model objects must be deleted by a special service API. In Java code that's:
`IModelOperationsPublished.deleteFromModel(MDFObject).`

Deleting an object means:

- All associations of the object are deleted. The connection to its parent object, for example, is being deleted which means that the object is not a member of the model tree anymore

- The object itself is being deleted. In fact, it is not really deleted (and garbage collected) as a Java object but only marked as removed. Undo of the transaction, which deleted this object, removes this marker and restores the deleted associations

5.1.7.5 Access to deleted objects

All subsequent access to content of deleted objects throws a runtime exception. Reading the shortname of an `MIContainer`, for example.

5.1.7.6 Set-methods

Model interfaces provide get-methods to read model content. MDF also offers set-methods for fields and child objects with multiplicity `0..1` or `1..1`.

These set-methods can be used to change model content.

- `MIARRef.getValue()` for example returns a references AUTOSAR path
- `MIARRef.setValue(String newValue)` sets a new path

5.1.7.7 Changing child list content

MDF doesn't offer set-methods for fields and child objects with multiplicity `0..*` or `1..*`. `MIContainer.getSubContainer()`, for example, returns the list of sub-containers but there is no `MIContainer.setSubContainer()` method to change the sub-containers.

Changing child lists means changing the list itself.

- To add a new object to a child list, client code must use the lists `add()` method. `MIContainer.getSubContainer().add(container)`, for example, adds a container as additional sub-container. This added object is being appended at the end of the list
- Removing child list objects is a side-effect of deleting this object. The delete operation removes it from the list automatically

5.1.7.8 Change restrictions

The tools transaction handling implements some model consistency checks to avoid model changes which shall be avoided. Such changes are, for example:

- Creating duplicate shortnames below one parent object (e.g. two sub-containers with the same shortname)
- Changing or deleting pre-configured parameters

When client code tries to change the model this way, the related model change transaction is being canceled and the model changes are reverted (unconditional undo of the transaction). A special case here are solving actions. When a solving action inconsistently changes the model, only the changes made by this solving action are reverted (partial transaction undo of one solving action execution).

5.2 Post-build selectable

5.2.1 Model views

5.2.1.1 What model views are

After project load, the MDF model contains all objects found in the ARXML files. Variation points are just data structures in the model without any special meaning in MDF.

If you want to deal with variants you must use model views. A model view filters access to the MDF model based on the variant definition and the variation points.

There is one model view per variant. If you use this variants model view, the MDF model filters exactly what this variant contains. All other objects become invisible. When you retrieve parameters of a container for example, you'll see only parameters contained in your selected variant.

```
final boolean isVisible = ModelAccessUtil.isVisible(t.paramVariantA);
```

Listing 5.1: Check object visibility

5.2.1.2 The IModelViewManager project service

The `IModelViewManager` handles model visibility in general. It provides the following means:

- Get all available variants
- Execute code with visibility of a specific predefined variant only. This means your code sees all objects contained in the specified variant. All objects which are not contained in this variant will be invisible
- Execute code with visibility of invariant data only (see `IInvariantView`).
- Execute code with unfiltered model visibility. This means that your code sees all objects unconditionally. If the project contains variant data, you see all variants together

It additionally provides detailed visibility information for single model objects:

- Get all variants, a specific object is visible in
- Find out if an object is visible in a specific variant

```
final List<IPostBuildPredefinedVariantView> variants = viewMgr.  
    getAllPostBuildVariantViews();
```

Listing 5.2: Get all available variants

```
try (final IModelViewExecutionContext context = viewMgr.executeWithModelView(t.  
    variantViewA)) {  
    assertIsVisible(t.paramInvariant);  
    assertIsVisible(t.paramVariantA);  
    assertNotVisible(t.paramVariantB);  
}  
  
try (final IModelViewExecutionContext context = viewMgr.executeWithModelView(t.  
    variantViewB)) {  
    assertIsVisible(t.paramInvariant);  
    assertNotVisible(t.paramVariantA);  
}
```

```
        assertIsVisible(t.paramVariantB);
    }

    try (final IModelViewExecutionContext context = viewMgr.executeUnfiltered()) {
        assertIsVisible(t.paramInvariant);
        assertIsVisible(t.paramVariantA);
        assertIsVisible(t.paramVariantB);
    }
```

Listing 5.3: Execute code with variant visibility

Important remark: It is essential that the `execute...()` methods are used exactly as implemented in the listing above. The `try (...) {...}` construct is a new Java 7 feature which guarantees that resources are closed whenever (and how ever) the try block is being left. For details read:

<http://docs.oracle.com/javase/tutorial/essential/exceptions/tryResourceClose.html>


```

Collection<IPostBuildPredefinedVariantView> visibleVariants = viewMgr.
    getVisiblePostBuildVariantViews(t.paramInvariant);
assertThat(visibleVariants.size(), equalTo(2));
assertThat(visibleVariants, containsInAnyOrder(t.variantViewA, t.variantViewB))
    ;

visibleVariants = viewMgr.getVisiblePostBuildVariantViews(t.paramVariantA);
assertThat(visibleVariants.size(), equalTo(1));
assertThat(visibleVariants, containsInAnyOrder(t.variantViewA));

```

Listing 5.4: Get all variants, a specific object is visible in

5.2.1.3 Variant siblings

Variant siblings of an MDF object are MDF object instances which represent the same object but in other variants.

The method `IModelVarianceAccessPublished.getPostBuildVariantSiblings()` provides access to these sibling objects:

This method returns MDF object instances representing the same object but in all variants. The collection returned contains the object itself including all siblings from other PostBuild variants.

The calculation of siblings depends on the object-type as follows:

- **Ecuc Module Configuration:**

Since module configurations are never variant, this method always returns a collection which contains the specified object only

- **Ecuc Container:**

For siblings of a container all of the following conditions apply:

- They have the same AUTOSAR path
- They have the same definition path (containers with the same AUTOSAR path but different definitions may occur in variant models - but they are not variant siblings because they differ in type)

- **Ecuc Parameter:**

For siblings of a parameter all of the following conditions apply:

- The parent containers have the same AUTOSAR path
- The parameter siblings have the same definition path

The parameter values are **not** relevant so parameter siblings may have different values. Multi-instance parameters are special. In this case the method returns all multi-instance siblings of all variants.

- **System description object:**

For siblings of `MISReferrables` all of the following conditions apply:

- They have the same meta-class
- They have the same AUTOSAR path

For siblings of non-`MISReferrables` all of the following conditions apply:

- Their nearest `MISReferrable`-parents are either the same object or variant siblings

- Their containment feature paths below these nearest `MIReferrable`-parents is equal

Special use cases: When the specified object is not a member of the model tree (the object itself or one of its parents has no parent), it also has no siblings. In this case this method returns a collection containing the specified object only.

Remark concerning visibility: This method returns all siblings independent of the currently visible objects. This means that the returned collection probably contains objects which are not visible by the caller! It also means that the specified object itself doesn't need to be visible for the caller.

5.2.1.4 The Invariant model views

There are use cases which require to see the invariant model content only. One example are generators for modules which don't support variance at all.

There are two different invariant views currently defined:

- **Value based invariance** (values *are equal* in all variants):
The `IPostBuildInvariantValuesView` contains objects where all variant siblings have the same value and exist in all variants. One of the siblings is contained
- **Definition based invariance** (values which *shall be equal* in all variants):
The `IPostBuildInvariantEcucDefView` contains objects which are not allowed to be variant according to the BSWMD rules. One of the siblings is contained

All Invariant views derive from the same interface `IInvariantView`, so if you want to use an invariant view and not specifying the exact view, you could use the `IInvariantView` interface. The figure 5.5 describes the hierarchy.

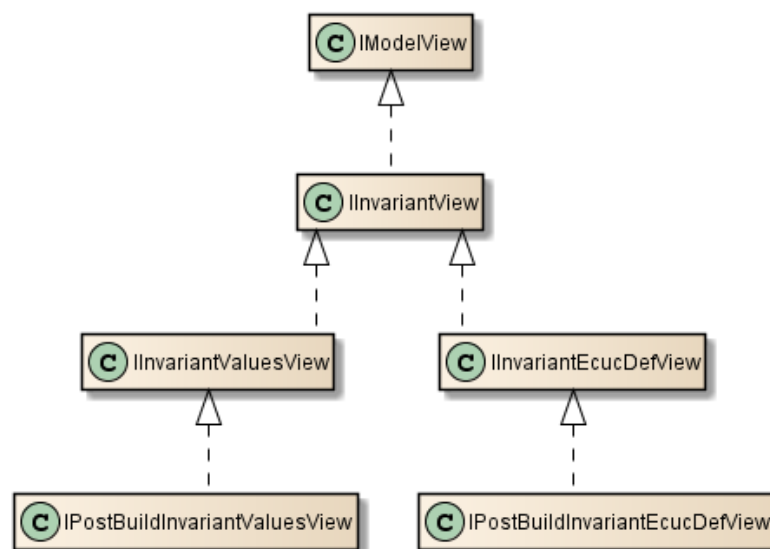


Figure 5.5: Invariant views hierarchy

The PostBuild InvariantValues model view The `IPostBuildInvariantValuesView` contains only elements which have **one** of the following properties:

- The element and no parent has any `MIVariationPoint` with a post-build condition

- All variant siblings have the same value and exist in all variants. Then one of the siblings is contained in the `IPostBuildInvariantValuesView`

So the semantic of the `InvariantValues` model view is that all values are equal in all variants.

You could retrieve an instance of `IPostBuildInvariantValuesView` by calling `IModelViewManager.getInvariantValuesView()`.

```
IModelViewManager viewMgr = ...;
IPostBuildInvariantValuesView invariantView = viewMgr.
    getPostBuildInvariantValuesView();
// Use the invariantView like any other model view
```

Listing 5.5: Retrieving an `InvariantValues` model view

Example The figure 5.6 describes an example for a module with containers and the visibility in the `IPostBuildInvariantValuesView`.

- Container A is invisible because it is contained in variant 1 only
- Container B and C are visible because they are contained in all variants
- Parameter a is visible because it is contained in all variants with the same value
- Parameter b is invisible: It is contained in all variants but with different values
- Parameter c is invisible because it is contained in variant 3 only

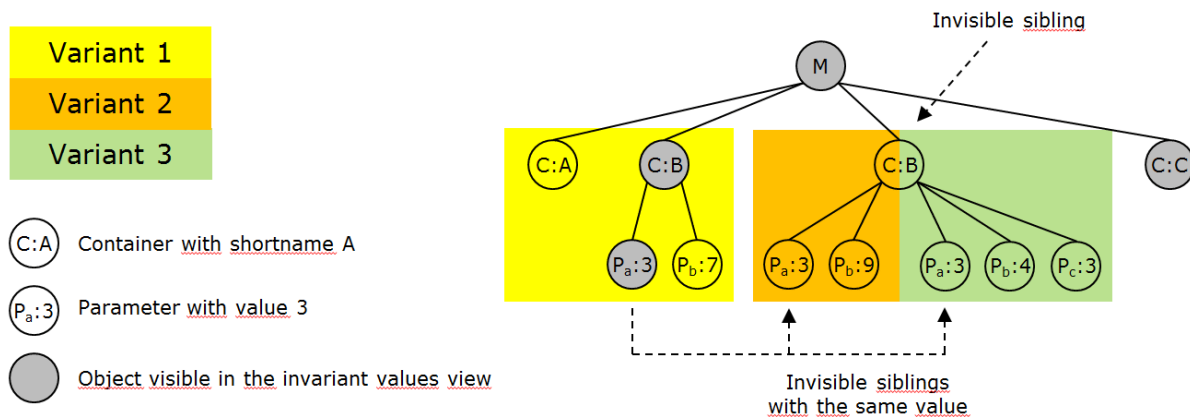


Figure 5.6: Example of a model structure and the visibility of the `IInvariantValuesView`

Specification See also the specification for details of the `IPostBuildInvariantValuesView`.

The PostBuild Invariant EcuC definition model view The `IPostBuildInvariantEcucDefView` contains the same objects as the invariant values view but additionally excludes all objects which, by (EcuC / BSWMD) definition, support variance. Using this view you can avoid dealing with objects which are accidentally equal by value (in your test configurations) but potentially can be different because they support variance.

More exact the `IPostBuildInvariantEcucDefView` will additionally exclude elements which have the following properties:

- If the parent module configuration specifies VARIANT-POST-BUILD-SELECTABLE as implementation configuration variant
 - All objects (`MContainer`, `MINumericalValue`, ...) are *excluded*, which **support** variance according to their EcuC definition. (potentially variant objects)
- If the parent module configuration doesn't specify VARIANT-POST-BUILD-SELECTABLE as implementation configuration variant. All contained objects **do not** support variance, so the view actually shows the same objects as the `IPostBuildInvariantValuesView`.

The implementation configuration variant in fact overwrites the objects definition for elements in the `ModuleConfiguration`.

Reasons to Use the view The `EcucDef` view guarantees that you don't access potentially variant data without using variant specific model views. So it allows you to improve code quality in your generator.

When your test configuration for example contains equal values for a parameter which is potentially variant you will see this parameter in the invariant values view but not in the `EcucDef` view. Consequences if you access data in other module configurations: When the BSWMD file of this other module is being changed, e.g. a parameter now supports variance, objects can become invisible due to this change. You are forced to adapt your code then.

Usage You could retrieve an instance of `IPostBuildInvariantEcucDefView` by calling `IModelViewManager.getInvariantEcucDefView()`. And then use it as any other `IModelView`.

```
IModelViewManager viewMgr = ...;
IInvariantEcucDefView invariantView = viewMgr.getInvariantEcucDefView();
// Use the invariantView like any other model view
```

Listing 5.6: Retrieving an `InvariantEcucDefView` model view

Specification See also the specification for details of the `IPostBuildInvariantEcucDefView`.

5.2.1.5 Accessing invisible objects

When you switch to a model view, objects which are not contained in the related variant become invisible. This means that access to their content leads to an `InvisibleVariantObjectFeatureException`.

To simplify handling of invisible objects, some model services provide model access even for invisible objects in variant projects. The affected classes and interfaces are:

- `ModelUtil`
- `ModelAccessUtil`
- `IReferrableAccess`
- `IModelAccess`
- `IModelCompareService`
- `AsrPath`

- DefRef
- IEcucDefinitionAccess (all methods which deal with configuration side objects)

Only a subset of the methods in these services work with invisible objects (read the methods JavaDoc for details). The general policy to select exactly these methods was:

- Support access to type and object identity of MDF objects (definition and AUTOSAR path)
- Parameter value or other content related information must still be retrieved in a context the object is visible in
- Also not contained are methods which change model content. E.g. deleting invisible objects, set parameter values, ...

5.2.1.6 IViewedModelObject

The `IViewedModelObject` is a container for one `MIObjekt` and an `IModelView` that was used when viewing the `MIObjekt`.

The interface provides getter for the `MIObjekt`, and the `IModelView` which was active during creation of the `IViewedModelObject`. So the `IViewedModelObject` represents a tuple of `MIObjekt` and `IModelView`.

This could be used to preserve the state/tuple of a `MIObjekt` and `IModelView`, for later retrieval.

Examples:

- BswmdModel objects
- Elements for validation results, retrieved in a certain view
- Model Query API like `ModelTraverser`, to preserve `IModelView` information

Notes:

A `IViewedModelObject` is immutable and will not update any state. Especially not when the visibility of the `getMdfObject()`, is changed after the construction of the `IViewedModelObject`.

It is not guaranteed, that the `MIObjekt` is visible in the creation `IModelView`, after the model is changed. It is also possible to create an `IViewedModelObject` of a `MIObjekt` and a `IModelView`, where the `MIObjekt` is invisible.

The method `getCreationModelView()` returns the `IModelView` of the `IViewedModelObject`, which was active when the model object was viewed `IViewedModelObject`.

5.2.2 Variant specific model changes

The CFG5 data model provides an execution context which guarantees that only the selected variant is being modified. Objects which are visible in more than one variant are cloned automatically. The clones and the object which is being modified (or their parents) automatically get a variation point with the required post-build conditions.

The following picture shows how this execution context works:
See figure 5.7 on the next page.

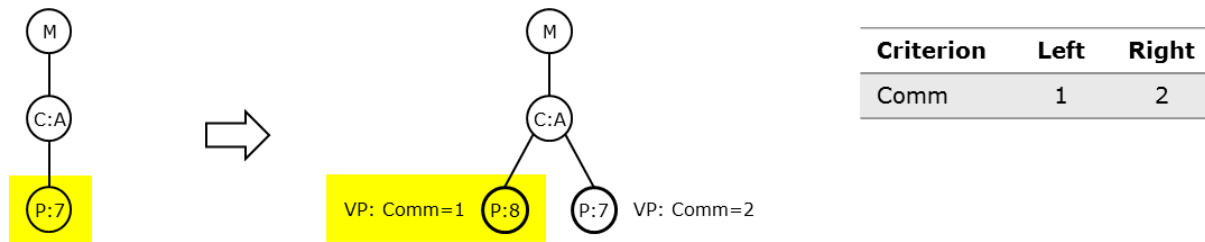


Figure 5.7: Variant specific change of a parameter value

- Before modifying the parameter, this instance is invariant. The same MDF instance is visible in all variants
- When the client code changes the parameter value, the model automatically clones the parameter first
- Only the parameter instance which is visible in the currently active view is being modified. The content of other variants stays untouched

Remark: This change mode is implicitly turned off when executing code in the `IInvariant-View` or in an unfiltered context.

```
try (final IModelViewExecutionContext viewContext = viewMgr.
    executeWithModelView(variantView)) {
    try (final IModelViewExecutionContext modeContext = viewMgr.
        executeWithVariantSpecificModelChanges()) {
        ma.setAsString(parameter, "Vector-Informatik");
    }
}
```

Listing 5.7: Execute code with variant specific changes

5.2.3 Variant common model changes

The CFG5 data model provides an execution context which guarantees that model objects are modified in all variants.

The behavior of this mode depends on the mode flag parameter as follows:

- **mode == ALL** : All parameters and containers are affected
- **mode == DEFINITION_BASED** : Only those parameters and containers are affected which do not support variance (according to their definition in the BSWMD file and the implementation configuration variant of their module configuration)
- **mode == OFF** : Doesn't turn on this change mode (this value is used internally only)

Remark: This method doesn't allow to reduce the scope of this change mode. So if ALL is already set, this method doesn't permit to use DEFINITION_BASED (or OFF) to reduce the effective amount of objects. ALL will be still active then.

The following picture shows how this execution context works:
See figure 5.8 on the following page.

- We start with a variant model which contains one parameter in two instances - one per variant - with the values 3 and 7
- When the client code sets the parameter value in variant 1 to 4, the model automatically modifies the variant sibling in variant 2

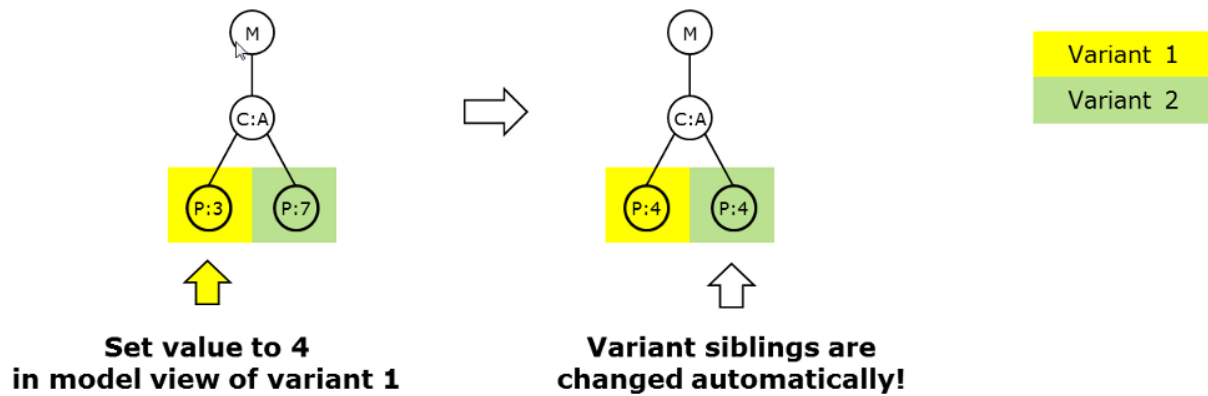


Figure 5.8: Variant common change of a parameter value

- As a result, the parameter has the same value in all variants

This change mode works with parameters and containers. The following operations are supported:

- **Container/parameter creation:** The created object afterwards exists in all variants the related parent exists in. Already existing objects are not modified. Missing objects are created
- **Container/parameter deletion:** The deleted object afterwards is being removed from all variants the related parent exists in. So actually all variant siblings are deleted
- **Parameter value change:** The parameter exists and has the same value in all variants the parent container exists in. If a parameter instance is missing in a variant, it is being created

Special behavior for multi-instance parameters:

- This mode guarantees that a set of multi-instance parameters is equal in all variants
- Only the values of multi-instance parameters are relevant. Their order can be different in different variants
- Beside the values, this change mode guarantees that all variants contain the same number of parameter instances. So, when a multi-instance set is being modified in a variant view, this change mode creates or deletes objects in other variants to guarantee an equal number of instances in all variant sibling sets

Remark: This change mode is implicitly turned on with the mode flag ALL when code is being executed in the `IInvariantView`. It is being ignored implicitly when executing code in an unfiltered context.

5.3 BswmdModel details

5.3.1 BswmdModel - DefinitionModel

The `BswmdModel` provides a type safe and easy access to data of BSW modules (Ecu configuration elements).

Example:

- Access a single parameter /MICROSAR/ComM/ComMGeneral/ComMUseRte
You can to write: `comM.getComMGeneral().getComMUseRte()`
- Access containers[0:~] /MICROSAR/ComM/ComMChannel
You can to write:

```
for (ComMChannel channel : comM.getComMChannel()){
    int value = channel.getComMChannelId().getValue();
}
```

The DaVinci Configurator internal Model (MDF model) has 1:1 relationship to your Bswmd-Model. The BswmdModel will retrieve all data from the underlying MDF model.

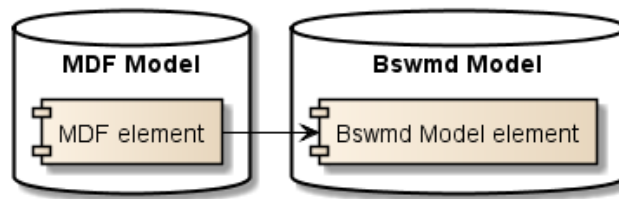


Figure 5.9: The relationship between the MDF model and the BswmdModel

DefinitionModel The DefinitionModel is the base implementation of every BswmdModel. Every BswmdModel class is a subclass of the DefinitionModel where the classes begin with GI, like GIContainer.

5.3.1.1 Types of DefinitionModels

There are two types of DefinitionModels:

1. **BswmdModel** (formally known as DefinitionTyped BswmdModel)
2. **DefRef API** (formally known as Untyped BswmdModel)

The **BswmdModel** consists of generated classes for the module definition elements like **ModuleDefinitions**, **Containers**, **Parameters** in bswmd files. The generated class contains getter methods for each child element. So you can access every child by the corresponding getter method with compile time safety of the sub type.

The **BswmdModel** derives from the **DefinitionModel DefRef API**, so the **BswmdModel** contains all functionalities of the **DefRef API**.

The **DefRef API** of the DefinitionModel provides an generic access to the Ecu configuration structure via **DefRefs**. There are **NO** generated classes for the Definition structure. The **DefRef API** uses the base classes of the DefinitionModel to provide this **DefRef** based access. Every interface in the DefinitionModel starts with an **GI**. The Ecu Configuration elements have corresponding base interfaces for each element:

- ModuleConfiguration - **GIModuleConfiguration**
- Container - **GIContainer**
- ChoiceContainer - **GIChoiceContainer**
- Parameter - **GIPParameter<?>**

- Integer Parameter - `GIParameter<BigInteger>`
- Boolean Parameter - `GIParameter<Boolean>`
- Float Parameter - `GIParameter<BigDecimal>`
- String Parameter - `GIParameter<String>`
- Reference - `GIReference<?>`
 - Container Reference - `GIReferenceToContainer`
 - Foreign Reference- `GIReference<Class>`

So there are different classes for the different model types, e.g. all MDF classes start with MI, the Untyped start with GI and DefinitionTyped classes are generated. The table 5.1 contrasts the different model types and their corresponding classes.

AUTOSAR type	MDFModel	“Untyped” BswmdModel	“DefinitionTyped”
ModuleConfiguration	MIConfiguration	GIConfiguration	CanIf (generated)
Container	MIContainer	GIContainer	CanIfPrivateCfg (generated)
String Parameter	MITextualValue	GIParameter<String>	GString
Integer Parameter	MINumericalValue	GIParameter<BigInteger>	GInteger
Reference to Container	MIReferenceValue	GIReferenceToContainer	CanIfCtrlDrvInitHohConfigRef (generated)
Enum Parameter	MITextualValue	GIParameter<String>	CanIfDispatchBusOffUL (generated)

Table 5.1: Different Class types in different models

Note: The GString in the table is not the Groovy GString class. It is `com.vector.cfg.gen.core.bswmdmodel.param.GString`.

5.3.1.2 DefRef Getter methods of Untyped Model

The DefRef API classes have no getter methods for the specific child types, but the children could be retrieve via the generic getter methods like:

- `GIContainer.getSubContainers()`
- `GIContainer.getParameters()`
- `GIContainer.getParameters(TypedDefRef)`
- `GIContainer.getParameter(TypedDefRef)`
- `GIContainer.getReferencesToContainer(TypedDefRef)`
- `GIConfiguration.getSubContainer(TypedDefRef)`
- `GIParameter.getValueMdf()`

Additionally there are methods to retrieve other referenced elements, like parent of reference reverse lookup:

- `GIContainer.getParent()`
- `GIContainer.getParent(DefRef)`
- `GIContainer.getReferencesPointingToMe()`
- `GIContainer.getReferencesPointingToMe(DefRef)`

The following listing describe the usage of the untyped bswmd method in both models:

```
// Get the container from external method getCanIfInitConfigBswmd() ...
final GIContainer canIfInit = getCanIfInitConfigBswmd();

// Gets all subcontainers from a container CanIfRxPduConfig from the canIfInit
// instance
final List<GIContainer> subContainers = canIfInit.getSubContainers(
    CanIfRxPduConfig.DEFREF.castToTypedDefRef());
if (subContainers.isEmpty()) {
    // ERROR Handling
}
final GIContainer cont = subContainers.get(0);

// Gets exactly one CanIfCanRxPduHrhRef reference from the cont instance
final GIReference<MIContainer> child = cont.getReference(CanIfCanRxPduHrhRef.
    DEFREF.castToTypedDefRef());
```

Listing 5.8: Sample code to access element in an Untyped model with DefRefs

```
final GIReferenceToContainer ref = getCanIfCanRxPduHrhRefBswmd();

final GIContainer target = ref.getRefTarget();
```

Listing 5.9: Resolves a Reference target of an Reference Parameter

```
final GIParameter<BigInteger> param = getCanIfInitConfigBswmd().getParameter(
    CanIfInitConfiguration.CANIF_NUMBER_OF_CAN_TXPDU_IDS_DEFREF);

final BigInteger value = param.getValueMdf();
```

Listing 5.10: The value of a GIParameter

The figure 5.10 on the following page shows the available **DefRef** navigation methods for the Untyped model. There are more methods to navigate with the DefRef API through the a DefinitionModel, please look into the Javadoc documentation of the GI... classes for more functionality.

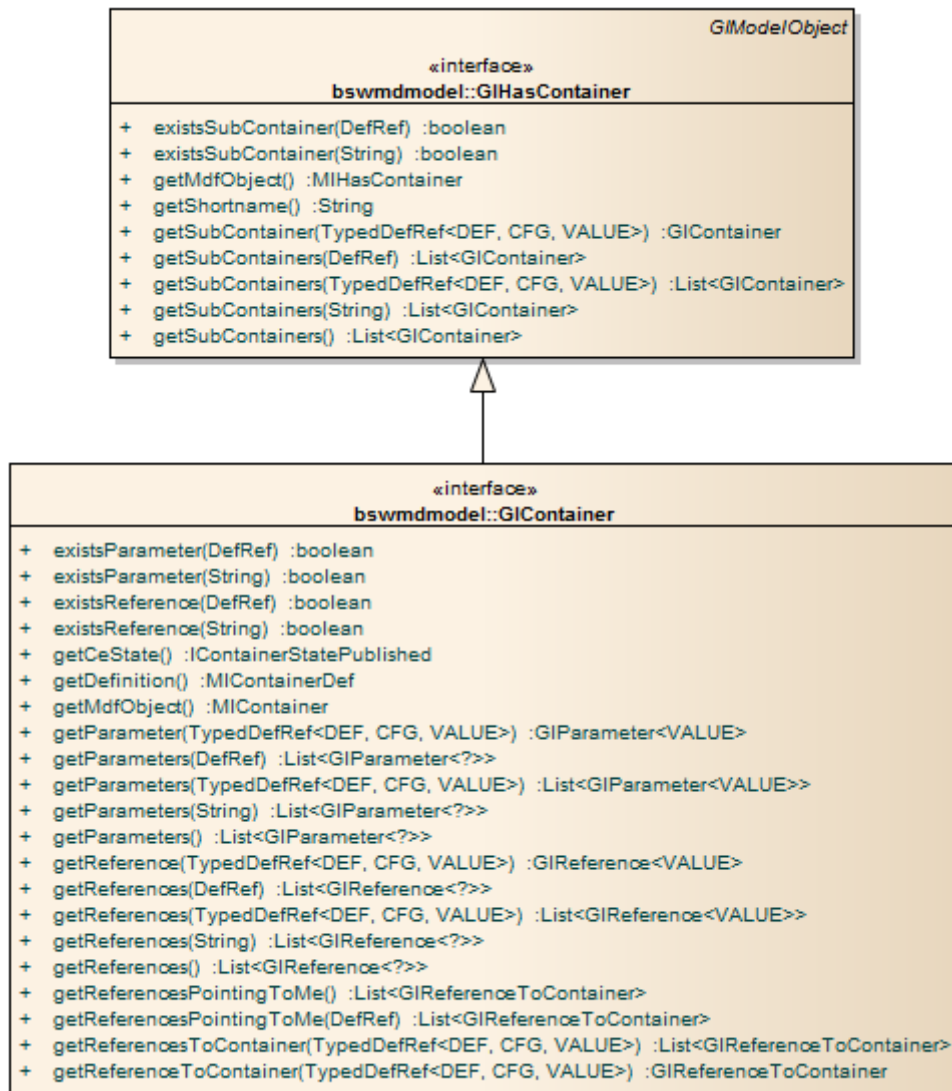


Figure 5.10: SubContainer DefRef navigation methods

5.3.1.3 References

All references in the BswmdModel are subtypes of **GIReference**. The generated model contains generated DefinitionTyped classes for references to container, for the other references their are only Untyped classes like **GInstanceReference**.

A **GIReference** has the method **getRefTargetMdf()**, this will always return the target in the MDF model as **MIReferrable**. For non **GIReferenceToContainer** this is the normal way to resolve references, but for reference to container you should always try to use the method **getRefTarget()**, which will not leave the BswmdModel.

Note: Try to use **getRefTarget()** as much as possible.

References to container The following references are references to container (References pointing to container) and are subtypes of the **GIReferenceToContainer**.

- Normal Reference

- SymbolicNameReference
- ChoiceReference

References have the method `getRefTarget()`, which returns the target as `BswmdModel` object. If the type of the target is known at model generation time, the return type will be the generated type, otherwise the return type is `GIContainer`.

Note: It is always allowed to call `getRefTarget()`, also for references pointing to external types.

There is the other method `getPossibleRefTargets()`, which returns all possible target container as list. If the type of the targets is known at model generation time, the list type will be the generated type, e.G. `List<CanGeneral>`. Otherwise the return type is `List<GIContainer>`.

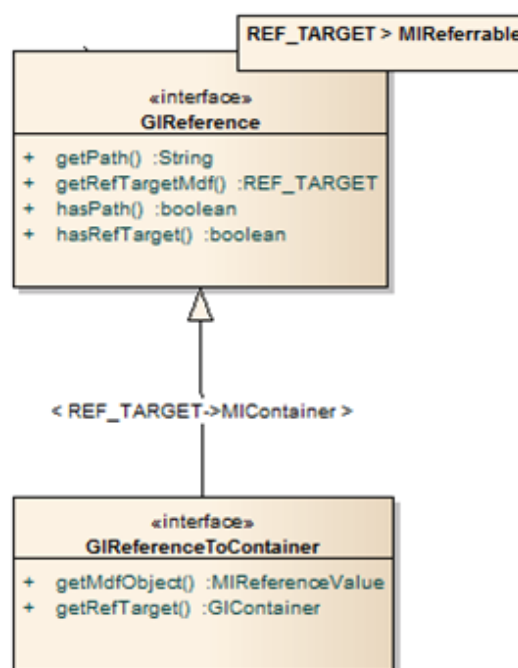


Figure 5.11: Untyped reference interfaces in the BswmdModel

SymbolicNameReferences SymbolicNameReferences have the same methods as **GIReferenceToContainer** and the additional methods `getRefTargetParameterMdf()`, which returns the target parameter as `MIObject`. The method `getRefTargetParameter()` return a `BswmdModelParameter` object, if the type is known at model generation time, the type will be the generated type. Otherwise the return type is `GIParameter`.

Note: It is always allowed to call `getRefTargetParameter()`, also for references pointing to external types.

5.3.1.4 Post-build selectable with BswmdModel

The BswmdModel supports the Post-build selectable use case, in respect that you do not have to switch nor cache the corresponding `IModelView`. The BswmdModel objects cache the so called Creation ModelView and switch transparently to that view when accessing the Model. So you don't have to switch to the correct view on access. See figure 5.12 on the next page.

You only have to ensure, that the requested `IModelView` is active or passed as parameter, when you create an instance at the `GIModelFactory`. Note: A lazy created object will inherit the view of the existing element.

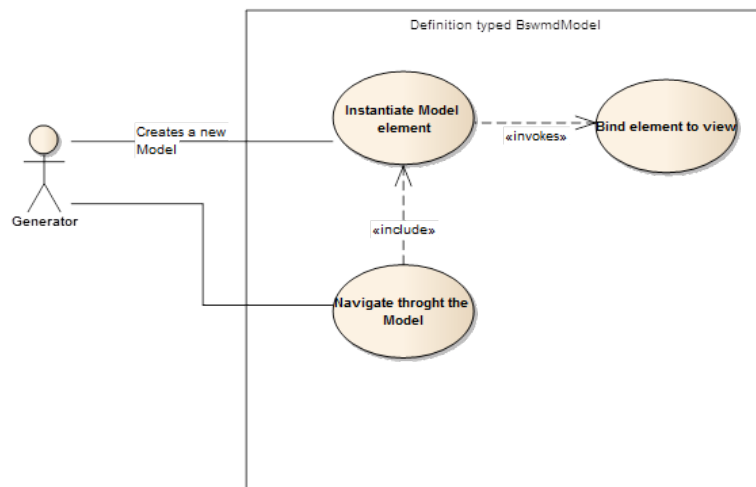


Figure 5.12: Creating a BswmdModel in the Post-build selectable use case

5.3.1.5 Creation ModelView of the BswmdModel

Every `GIModelObject` (`BswmdModel` object) has a creation `IModelView`. This is the `IModelView`, which was active or passed during creation of the `BswmdModel`. At every method call to the `BswmdModel`, the model will switch to this view.

Using the creation ModelView of the BswmdModel The method `getCreationModelView()` returns the `IModelView` of this `GIModelObject`, which was active during the creation of this `BswmdModel`.

The method `executeWithCreationModelView()` executes the code under visibility of the `getCreationModelView()` of this `GIModelObject`.

The returned `IModelViewExecutionContext` must be used within a Java "try-with-resources" feature. It makes sure, that the old view is restored when the try is completed.

```

GIModelObject myModelObject = ...;

try (final IModelViewExecutionContext context = myModelObject.
    executeWithCreationModelView()) {
    // do some operations
    ...
}
    
```

Listing 5.11: Java: Execute code with creation `IModelView` of `BswmdModel` object

The method `executeWithCreationModelView(Runnable)` executes the `Runnable` code under visibility of the `getCreationModelView()` of this `GIModelObject`.

```
GIModelObject myModelObject = ...;

myModelObject.executeWithCreationModelView()->{
    // do some operations
};
```

Listing 5.12: Java: Execute code with creation IModelView of BswmdModel object via runnable

The method `executeWithCreationModelView()` executes the `Supplier` code under visibility of the `getCreationModelView()` of this `GIModelObject`. You could use this method, if you want to return an object from this operation.

```
GIModelObject myModelObject = ...;

ReturnType returnVal = myModelObject.executeWithCreationModelView()->{
    // do some operations
    return theValue;
};
```

Listing 5.13: Java: Execute code with creation IModelView of BswmdModel object

5.3.1.6 Lazy Instantiating

The `BswmdModel` is instantiated lazily; this means when you create a `ModuleConfiguration` object only one object for the module configuration is created.

When you call a `getXXX()` method on the configuration it will create the requested sub element, if it exists. So you can start at any point in the model (e.g. a `Subcontainer`) and the model is build successively, by your calls.

It is also allowed to call a `getParent()` on a `Subcontainer`, if the parent was not created yet. The technique could be used in validations, when the creation of the full `BswmdModel` is too expensive. Then you can create only the needed container; by an MDF model object.

5.3.1.7 Optional Elements

All elements (`Container`, `Parameter` ...) are considered as optional if they have a multiplicity of 0:1. The `BswmdModel` provide a special handling of optional elements. This shall support you to recognize optional element during development (in the most cases some kind of special handling is needed). An optional Element has other access methods as a required Element: The method `getXXX()` will not return the element, it will return a `GIOptional<Element>` object instead. You can ask the `GIOptional` object if the element exists (`optElement.exists()`). Then you can call `optElement.get()` to retrieve the real object.

You also have the choice to use the method `existsXXX()`. This method is equivalent to `getXXX().exists()`. The difference is that you get a compile error, if you try to use the optional element without any check. When you are sure that the element must exist you can directly call `getXXXUnsafe()`. Note: If you use any of the get methods (`optElement.get()` or `getXXXUnsafe()`) and the element does not exist the normal `BswmdModelException` is thrown.

5.3.1.8 Class and Interface Structure of the BswmdModel

The upper part of the figure 5.13 on the following page shows the Untyped API (GI... interfaces). The bottom left part is an example of `DefinitionTyped` (generated) class for the `CanIf` module.

The bottom right part are the classes used by the DefinitionTyped model, but are not visible in the Untyped model.

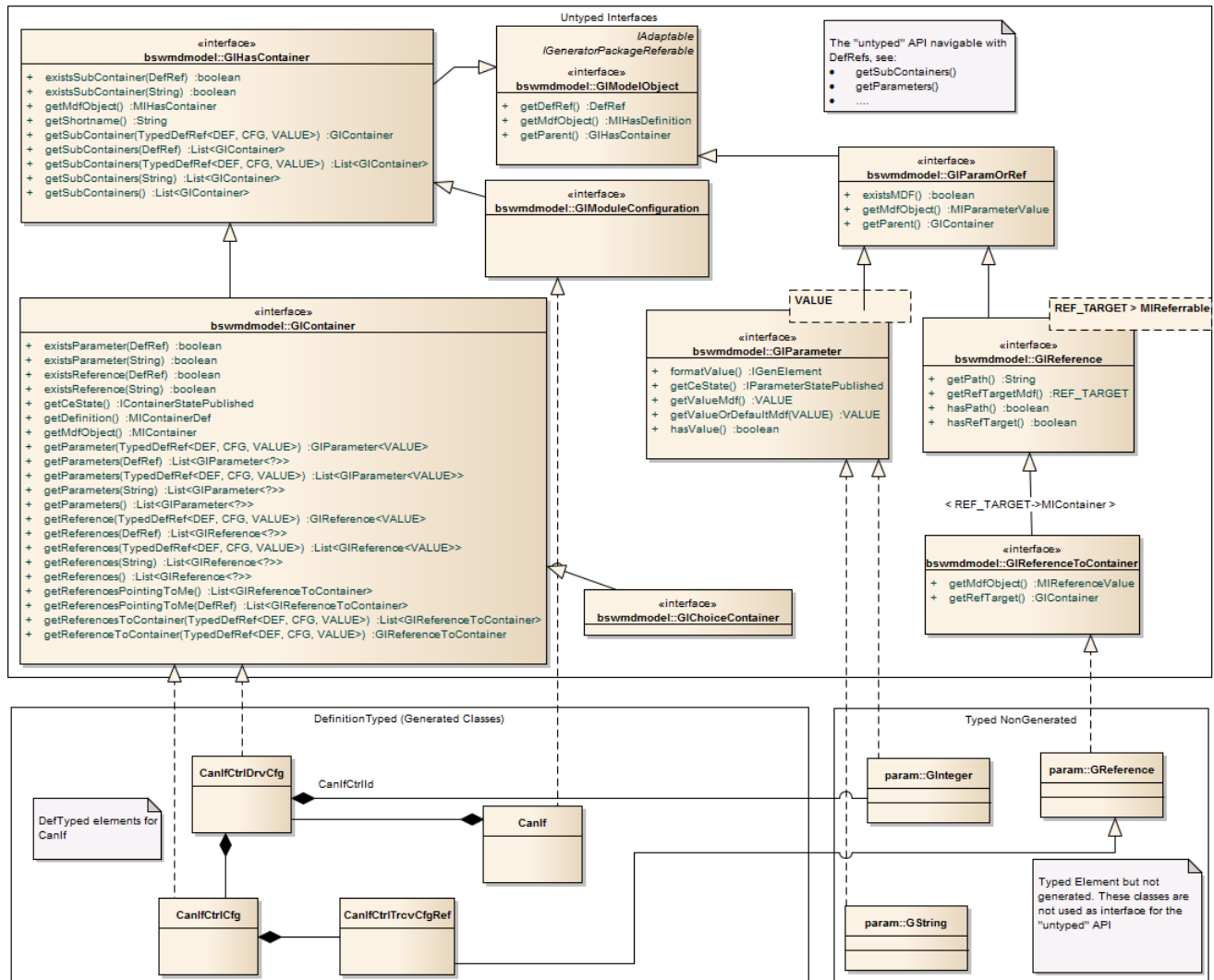


Figure 5.13: Class and Interface Structure of the BswmdModel

5.3.1.9 BswmdModel write access

The BswmdModel supports a write access for ecu configuration elements. This means new elements can be created and existing elements can be modified and deleted by the BswmdModel.

NOTE: The model is in read-only state by default, so no objects could be created. For this reason all calls to an API which creates or deletes elements has to be executed within a transaction. See *ModelDocumentation* chapter "Model changes" for more details.

Optional and required Elements (0:1/1:1 Multiplicity) For optional or required elements, the following additional methods are generated, if BswmdModelWriteAccess is enabled:

- `get...OrNull()`: Returns the requested element or null if it is missing.

- `get...OrCreate()`: Returns the existing requested element or implicitly creates a new one if it is missing.

E.g. `EcucGeneral`:

```
Ecuc ecuc = getEcucModuleConfig();

//Gets the EcucGeneral container or null if it is missing.
EcucGeneral ecucGeneralOrNull = ecuc.getEcucGeneralOrNull();

//Gets the existing EcucGeneral container or creates a new one if it is
missing.
EcucGeneral ecucGeneralOrCreate = ecuc.getEcucGeneralOrCreate();
```

Listing 5.14: Additional write API methods for `EcucGeneral`

Multiple elements (Upper Multiplicity > 1) For each multiple element, the return type for these elements is changed from `List<>` to `GIPList<>` for parameter and `GICList<>` for container, if `BswmdModelWriteAccess` is enabled. These new interfaces provide methods which allow creating and adding new children for the corresponding elements:

- `createAndAdd()`: Creates a new child element, appends it to the list and returns the new element.
- `createAndAdd(int index)`: Creates a new child element, inserts it to the list at the specified index position and returns the new element.
- For `GICList<>` only:
 - `createAndAdd(String shortName)`: Creates a new child element with the specified `shortName`, appends it to the list and returns the new element.
 - `createAndAdd(String shortName, int index)`: Creates a new child element with the specified `shortName`, inserts it to the list at the specified index position and returns the new element.
 - `byName(String shortName)`: Gets the container by specified `shortName` or throws an exception if it is missing.
 - `byNameOrNull(String shortName)`: Gets the container by specified `shortName` or null if it is missing.
 - `byNameOrCreate(String shortName)`: Gets the container by specified `shortName` or implicitly creates a new one if it is missing.
 - `exists(String shortname)`: Returns `true` if the container exists, otherwise `false`.

E.g. `EcucCoreDefinition`:


```

Ecuc ecuc = getEcucModuleConfig();

//Gets the EcucCoreDefinition list (create EcucHardware container if it is
missing)
GICList<EcucCoreDefinition> ecucCores = ecuc.getEcucHardwareOrCreate().
    getEcucCoreDefinition();

//Adds two EcucCores
EcucCoreDefinition core0 = ecucCores.createAndAdd("EcucCore0");
EcucCoreDefinition core1 = ecucCores.createAndAdd("EcucCore1");

if(ecucCores.exists("EcucCore0")) {
    //Sets EcucCoreId from EcucCore0 to 0
    ecucCores.byName("EcucCore0").getEcucCoreId().setValue(0);
}

//Creates a new EcucCore by method byNameOrCreate
EcucCoreDefinition core2 = ecucCores.byNameOrCreate("EcucCore2");

...

```

Listing 5.15: EcucCoreDefinition as GICList<EcucCoreDefinition>

Other write API

- **Deleting model objects:** It is also possible to delete objects from the model.
 - `moRemove`: Deletes the specified object from the model.
 - `moIsRemoved`: Returns `true`, if the object was removed from repository, or is invisible in the current active `IModelView`.

```

//Deletes the container 'EcucGeneral' from the model.
ecucGeneral.moRemove();

//Deletes the parameter 'EcuCSafeBswChecks' from the model.
ecucGeneral.getEcuCSafeBswChecks.moRemove();

//Deletes the child container 'EcucCoreDefinition' with shortname 'EcucCore0'
from the model.
ecucCores.byName("EcucCore0").moRemove();

// Checks if the container 'EcucGeneral' was removed from repository, or is
invisible in the current active `IModelView`.
if(ecucGeneral.moIsRemoved()) {
    ...
}

```

Listing 5.16: Deleting model objects

- **Duplication of containers:** The method `duplicate()` copies a container with all its children and appends it to the same parent.

```
//Duplicates the container 'EcucGeneral'
EcucGeneral duplicatedEcucGeneral = ecucGeneral.duplicate();

//Duplicates the child container 'EcucCoreDefinition' with shortname '
  EcucCore0'
EcucCoreDefinition duplicatedEcucCore0 = ecucCores.byName("EcucCore0").
  duplicate();
```

Listing 5.17: Duplication of containers

- **Parameter values:** The method `setValue(VALUE)` sets the value of a parameter. This method checks if the specified parameters configuration object is available and sets the new value. If the parameter object is missing it is implicitly created in the model.

```
//Sets the value of the parameter 'EcuCSafeBswChecks' to 'true'
ecucGeneral.getEcuCSafeBswChecks.setValue(true);
```

Listing 5.18: Set parameter values with the BswmdModel Write API

- **Reference targets:** The method `setRefTarget(REF_TARGET)` sets the target of a reference. This method sets the specified target object as reference target of the specified reference parameter. If the reference parameter object is missing it is implicitly created in the model.

```
//Gets the container 'OsCounter' with shortname 'SystemTimer'
OsCounter osCounterTarget = os.getOsCounters.byName("SystemTimer");

//Sets the reference target of the parameter 'CanCounterRef'
can.getCanGeneral().getCanCounterRef().setRefTarget(osCounterTarget);
```

Listing 5.19: Set reference targets with the BswmdModel Write API

5.3.2 BswmdModel generation

The BswmdModel for the automation interface is generated automatically by the DaVinciConfigurator.

5.3.2.1 DerivativeMapping

If the SIP contains one or more modules with a DerivativeMapping, the BswmdModel classes for these modules can only be generated for one certain derivative. By default, the first derivative is selected, sorted by UUID.

If a other derivative shall be selected for BswmdModel generation a `Settings.xml` file can be defined in the SIP at `<SIP-ROOT-PATH>/DaVinciConfigurator/Generators`.

Sample file:

```
<Settings>
  <Settings Name="com.vector.cfg.gen.bswmdmodelgenerator.
    BswmdAutomationModelSettings">
    <!--Selects the derivative with the name or UUID specified by
      Value-->
    <Setting Name="SelectedDerivative" Value="SPX546B"/>
  </Settings>
</Settings>
```

Listing 5.20: Settings.xml sample for DerivativeMapping

5.4 Model Utility Classes

5.4.1 AutosarUtil

The class `AutosarUtil` is a static utility class. Its methods are not directly related to the MDF model but are useful when client code deals with AUTOSAR paths and shortnames on string basis.

Some of these methods are

- `isValidShortname(String)`: Checks if this shortname is valid according the rules, the AUTOSAR standard defines (character set for example)
- `getLastShortname(String)`: Returns the last shortname of the specified AUTOSAR path
- `getFirstShortname(String)`: Returns the first shortname of the specified AUTOSAR path
- `getAllShortnames(String)`: Returns all shortnames of the specified AUTOSAR path

5.4.2 AsrPath

The `AsrPath` class represents an AUTOSAR path without a connection to any model.

`AsrPaths` are constant; their values cannot be changed after they are created. This class is immutable!

5.4.3 AsrObjectLink

This class implements an immutable identifier for AUTOSAR objects.

An `AsrObjectLink` can be created for each object in the MDF AUTOSAR model tree. The main use case of object links is to identify an object unambiguously at a specific point in time for logging reasons. Additionally and under specific conditions it is also possible to find the related MDF object using its `AsrObjectLink` instance. But this search-by-link cannot be guaranteed after model changes (details and restrictions below).

5.4.3.1 Restrictions of object links

- They are immutable and will therefore become invalid when the model changes
- So they don't guarantee that the related MDF object can be retrieved after the model has been changed. Search-by-link may even find another object or throw an exception in this case

5.4.4 DefRefs

The `DefRef` class represents an AUTOSAR definition reference (e.g. `/MICROSAR/CanIf`) without a connection to any model. A `DefRef` replaces the `String` which represents a definition reference. You shall always use a `DefRef` instance, when you want to reference something by its definition.

The class abstracts the behavior of definition references in the AUTOSAR model (e.g. AUTOSAR 3 and AUTOSAR 4 handling).

`DefRefs` are constant; their values can not be changed after they are created. All `DefRef` classes are immutable.

A `DefRef` represents the definition reference as two parts:

- Package part - e.g. `/MICROSAR`
- Definition without the package part - e.g. `CanIf/CanIfGeneral`

This is used to navigate through the AUTOSAR model with refinements and wildcards. So you have to create a `DefRef` with the two parts separated.

The figure 5.14 on the next page shows the structure of the `DefRef` class and its sub classes.

Creation You can create a `DefRef` object with following public static methods (partial):

- `DefRef.create(DefRef, String)` - Parent `DefRef`, Child name
- `DefRef.create(IDefRefWildcard, String)` - Wildcard, Definition without package
- `DefRef.create(MIHasDefinition)` - Model object
- `DefRef.create(MIHasDefinition, String)` - Parent object, Child name
- `DefRef.create(MIParamConfMultiplicity)` - Definition object
- `DefRef.create(String, String)` - Package part, Definition without package

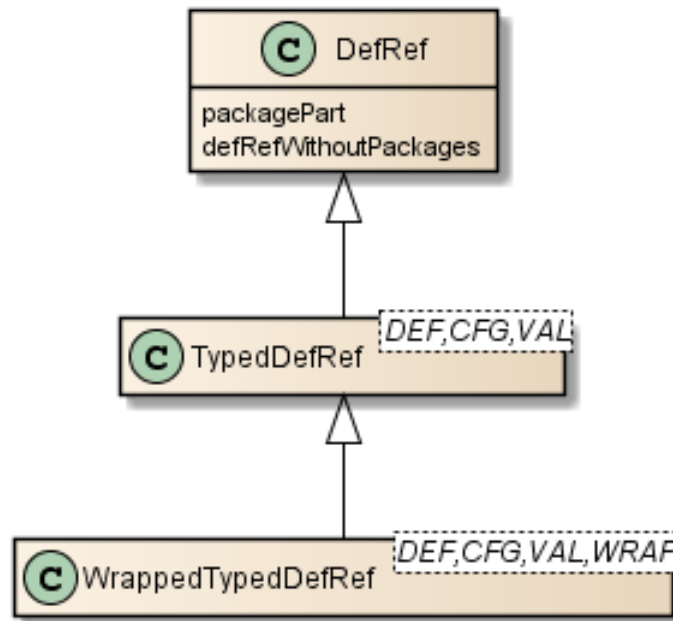


Figure 5.14: DefRef class structure

Wildcards DefRef instances can also have a wildcard instead of a package String (IDefRefWildcard). The wildcard is used to match on multiple packages. See chapter 5.4.4.2 on the following page for details.

Useful Methods This section describes some useful methods (Please look at the javadoc of the DefRef class for a full documentation):

- `defRef.isDefinitionOf(MIHasDefinition)` - Checks the definition of the configuration element and returns true if the element has the definition. The "defRef" object is e.g. from the Constants class.
 - Note: The method `isDefinitionOf()` returns **false**, if the element is removed or invisible.
- `defRef.asDefinitionOf(MIHasDefinition, Class)` - Checks the definition of the configuration element and returns the element casted to the configuration subtype, or null.
 - Note: The method `asDefinitionOf()` returns **null**, if the element is removed or invisible.

```

MIObject yourObject = ...;
DefRef yourDefRef = ...;

if(yourDefRef.isDefinitionOf(yourObject){
    //It is the correct instance
    //Do something
}

//Or with an integrated cast in the TypedDefRef case
final MIContainer container = yourDefRef.asDefinitionOf(yourObject);
if(container != null){
    //Do something
}
  
```

Listing 5.21: DefRef isDefinitionOf methods

5.4.4.1 TypedDefRefs

The `TypedDefRef` class represents an AUTOSAR definition reference with the type of the AUTOSAR (MDF) model. So every `TypedDefRef` knows which Definition, Configuration and Value element is correct for the Definition path.

The `DEF_TYPE`, `CONFIG_TYPE` and `VALUE_TYPE` are Java generics and are used many APIs to return the specific type of a request.

In addition the most `TypedDefRefs` also provide additional `TypeInfo` data, like the Multiplicity of the element. See `TypeInfo` javadoc for more details.

5.4.4.2 DefRef Wildcards

The `DefRef` class supports so called wildcards, which could be used to match on multiple packages at once, like the `/[MICROSAR]` wildcard matches on any `DefRef` package starting with `/MICROSAR`. E.g. `/MICROSAR`, `/MICROSAR/S12x`,

Every wildcard is of type `IDefRefWildcard`. An `IDefRefWildcard` instance could be passed to the `DefRef.create(IDefRefWildcard, String)` method to create a `DefRef` with wildcard information.

Predefined DefRef Wildcards The class `EDefRefWildcard` contains the predefined `IDefRefWildcards` for the `DefRef` class. These `IDefRefWildcards` could be used to create `DefRefs`, without creating your own wildcard for the standard use cases

The `DefRef.create(String, String)` method will parse the first `String` to find a wildcard matching the `EDefRefWildcards`.

Predefined wildcards: The class `EDefRefWildcard` defines the following wildcards, with the specified semantic:

- `EDefRefWildcard.ANY/[ANY]`: Matches on any package path. It is equal to any package and any packages refines from `ANY` wildcard.
- `EDefRefWildcard.AUTOSAR/[AUTOSAR]`: Matches on the AUTOSAR3 and AUTOSAR4 packages (see `DefRef` class). It is equal to the AUTOSAR packages, but not to refined packages e.g. `/MICROSAR`. Any packages which refined from AUTOSAR also refines from AUTOSAR wildcard.
- `EDefRefWildcard.NOT_AUTOSAR_STMD/[!AUTOSAR_STMD]`: Matches on any package except the AUTOSAR packages. It is equal to any package, except AUTOSAR packages. Any package refines from `NOT_AUTOSAR_STMD` wildcard, except AUTOSAR packages.
- `EDefRefWildcard.MICROSAR/[MICROSAR]`: Matches on any package stating with `/MICROSAR` (also `/MICROSAR/S12x`). It is equal to any package stating with `/MICROSAR`. Any package starting with `/MICROSAR` refines from `MICROSAR` wildcard.
- `EDefRefWildcard.NOT_MICROSAR/[!MICROSAR]`: Matches on any package path not starting with `/MICROSAR`. It is equal to any package not starting with `/MICROSAR`. Any package, which does not start with `/MICROSAR`, refines from `NOT_MICROSAR` wildcard. Also the AUTOSAR packages refine from `NOT_MICROSAR` wildcard.

Creation of the DefRef with Wildcard The elements of `EDefRefWildcard` could be passed to the `DefRef` constructor:

```
DefRef myDefRef = DefRef.create(EDefRefWildcard.MICROSAR, "CanIf");
```

Listing 5.22: Creation of `DefRef` with wildcard from `EDefRefWildcard`

Custom DefRef Wildcards You could create your own wildcard by implementing the interface `IDefRefWildcard`. Please choose a good name for your wildcard, because this could be displayed to the user, e.g. in Validation results. The `matches(DefRef)` method shall return true, if the passed `DefRef` matches the wildcard constraints.

Every wildcard string shall have the notation `/[NameOfWildcard]`.

E.g. `/[MICROSAR]`, `/[!MICROSAR]`.

5.4.5 CeState

The `CeState` is an object which allows to retrieve different states of a configuration entity.

The most important APIs for generator and script code are:

- `IParameterStatePublished`
- `IContainerStatePublished`

5.4.5.1 Getting a CeState object

The BSWMD models implement methods to get the `CeState` for a specific CE as the following listing shows (the types `GIPParameter` and `GIContainer` are interface base types in the BSWMD models):

```
GIPParameter parameter = ...;
IParameterStatePublished parameterState = parameter.getCeState();

GIContainer container = ...;
IContainerStatePublished containerState = container.getCeState();
```

Listing 5.23: Getting `CeState` objects using the BSWMD model

5.4.5.2 IParameterStatePublished

The `IParameterStatePublished` specifies a type-safe published API for parameter states. It mainly covers the following state information

- Does this parameter have a pre-configuration value? What is this value? The same information is being provided for recommended and initial (derived) values
- Is this parameter user-defined?
- Is value change or deletion allowed in the current configuration phase (post-build loadable use case)?
- What is the configuration class of this parameter

The figure 5.15 shows the inheritance hierarchy of the `IPParameterStatePublished` class and its sub classes.

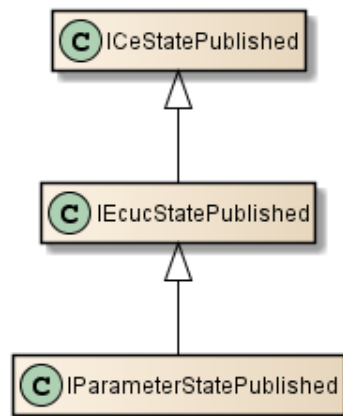


Figure 5.15: `IPParameterStatePublished` class structure

Parameters have different types of state information:

- **Simple state retrieval**
Example: The method `isUserDefined()` returns true when the parameter has a user-defined flag.
- **States and values** (pre-configuration, recommended configuration and initial (derived) values)
Example: The method `hasPreConfigurationValue()` returns true when the parameter has a pre-configured value. `getPreConfigurationValue()` returns this value.
- **States and reasons**
Example: The method `isDeletionAllowedAccordingToCurrentConfigurationPhase()` returns true if the parameter can be deleted in the current configuration phase (post-build loadable projects only). `getNotDeletionAllowedAccordingToCurrentConfigurationPhaseReasons()` returns the reasons if deletion is not allowed.

5.4.5.3 `IContainerStatePublished`

The `IContainerStatePublished` specifies a type-safe published API for container states. It mainly covers the following state information

- Does this container have a pre-configuration container (includes access to this container)? The same information is being provided for recommended and initial (derived) values
- Is change or deletion allowed in the current configuration phase (post-build loadable use case)?
- In which configuration phase has this container been created in (post-build loadable use case)?
- What is the configuration class of this container

The figure 5.16 on the following page shows the inheritance hierarchy of the `IContainerStatePublished` class and its sub classes.

This API provides state information similar to `IPParameterStatePublished`. Some of the states are container-specific, of course. `getCreationPhase()`, for example, which returns the phase a

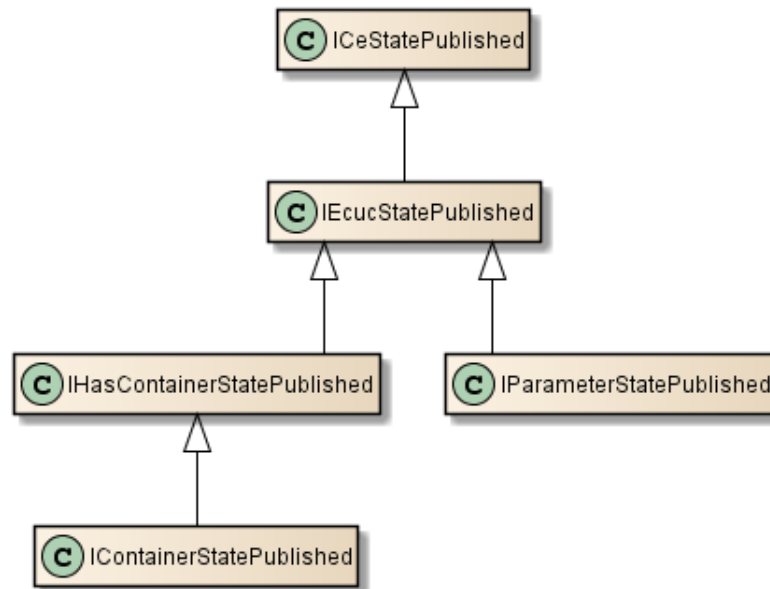


Figure 5.16: IContainerStatePublished class structure

container in a post-build loadable configuration has been created in.

5.5 Model Services

5.5.1 EcucDefinitionAccess

The `IEcucDefinitionAccess` provides convenient and typesafe access to definition objects (module, container, parameter and reference definitions). The contained `def()` methods take MDF definition objects and return wrappers which can be used to retrieve specific characteristics of definitions.

Example:

```

IEcucDefinitionAccess eda;
MIIntegerParamDef intParamDef;

// Get the integer definition wrapper
IEcucIntegerDefinition def = eda.def(intParamDef);

// Get the (optional) default value
Optional<BigInteger> defaultOpt = def.getDefault();
boolean hasDefault = defaultOpt.isPresent();
    BigInteger defaultValue = defaultOpt.get();

// Get the multiplicity
IEcucDefMultiplicity multiplicity = def.getMultiplicity();
BigInteger lower = multiplicity.getLower();
BigInteger upper = multiplicity.getUpper();
  
```

Listing 5.24: Integer parameter definition access examples

5.5.1.1 Post-build loadable

EcucModuleDefinition `IEcucModuleDefinition` is the interface of the module definition wrapper. It provides the following method(s):

`getSupportedConfigurationVariants()`

The `getSupportedConfigurationVariants()` method returns a collection of supported configuration variants. Never returns `null` but an empty collection if no supported config variants are specified.

The returned collection never contains the following literals:

- `EEcucConfigurationVariant.PRECONFIGURED_CONFIGURATION`
- `EEcucConfigurationVariant.RECOMMENDED_CONFIGURATION`

This method is for post-build loadable only!

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the module definitions used the following valid values:

- `VARIANT-PRE-COMPILE`
- `VARIANT-LINK-TIME`
- `VARIANT-POST-BUILD-LOADABLE`
- `VARIANT-POST-BUILD-SELECTABLE`

`VARIANT-POST-BUILD` was invalid! With AUTOSAR 4.2.1 and later, the following values are valid (because the loadable and selectable specifications have been separated):

- `VARIANT-PRE-COMPILE`
- `VARIANT-LINK-TIME`
- `VARIANT-POST-BUILD`

`VARIANT-POST-BUILD-LOADABLE` and `VARIANT-POST-BUILD-SELECTABLE` are invalid!

This method takes the AUTOSAR version into account and returns the post-build loadable relevant specification only.

EcucContainerDefinition `IEcucContainerDefinition` is the interface of the container definition wrapper. It provides the following method(s):

`getMultiplicityConfigurationClass()`

The `getMultiplicityConfigurationClass(EEcucConfigurationVariant)` method returns the multiplicity configuration class for the specified module implementation variant. The returned value defines in which configuration phase the number of container instances latest may change if the module implements the specified variant.

Supported values for the variant are

- `EEcucConfigurationVariant.VARIANT_PRE_COMPILE`
- `EEcucConfigurationVariant.VARIANT_LINK_TIME`
- `EEcucConfigurationVariant.VARIANT_POST_BUILD_LOADABLE`

Other values lead to an `IllegalArgumentException`.

This method doesn't take the multiplicity into account. It only investigates the multiplicity configuration class as specified in the related container definition. So it still may return `EEcucConfigurationClass.POST_BUILD` even if the multiplicity is 1:1 for example. The post-build loadable use case differs here from post-build selectable (see `supportsVariantMultiplicity()`) because the changeability in the post-build phase is being inherited from parent objects. So, if you want to find out if a container actually permits changes in the post-build phase, you should use `IContainerStatePublished`.

This method is for post-build loadable only!

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the container definitions contained the `postBuildChangeable` flag to define post-build loadable support. This method internally investigates the `postBuildChangeable` flag in this case but the `multiplicityConfigClass` table for AUTOSAR 4.2.1 and newer versions.

EcucCommonAttributes `IEcucCommonAttributes` is the base interface of all parameter and reference definition wrappers. It provides the following method(s):

`getMultiplicityConfigurationClass()`

The `getMultiplicityConfigurationClass(EEcucConfigurationVariant)` method returns the multiplicity configuration class for the specified module implementation variant. The returned value defines in which configuration phase the number of parameter instances latest may change if the module implements the specified variant.

Supported values for the variant are

- `EEcucConfigurationVariant.VARIANT_PRE_COMPILE`
- `EEcucConfigurationVariant.VARIANT_LINK_TIME`
- `EEcucConfigurationVariant.VARIANT_POST_BUILD_LOADABLE`

Other values lead to an `IllegalArgumentException`.

This method doesn't take the multiplicity into account. It only investigates the multiplicity configuration class as specified in the related parameter definition. So it still may return `EEcucConfigurationClass.POST_BUILD` even if the multiplicity is 1:1 for example. The post-build loadable use case differs here from post-build selectable (see `supportsVariantMultiplicity()`) because the changeability in the post-build phase is being inherited from parent objects. So, if you want to find out if a parameter actually permits changes in the post-build phase, you should use `IParameterStatePublished`.

This method is for post-build loadable only!

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the parameter definitions contain the `implementationConfigClass` table to define post-build loadable support. This method internally investigates the `implementationConfigClass` in this case but the `multiplicityConfigClass` table for AUTOSAR 4.2.1 and newer versions.

`getValueConfigurationClass()`

The `getValueConfigurationClass(EEcucConfigurationVariant)` method returns the value configuration class for the specified module implementation variant. The returned value defines in which configuration phase the value of parameter instances latest may change if the module implements the specified variant.

Supported values for the variant are

- `EEcucConfigurationVariant.VARIANT_PRE_COMPILE`
- `EEcucConfigurationVariant.VARIANT_LINK_TIME`
- `EEcucConfigurationVariant.VARIANT_POST_BUILD_LOADABLE`

Other values lead to an `IllegalArgumentException`.

This method never returns `EEcucConfigurationClass.LINK`.

This method is for post-build loadable only!

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the parameter definitions contain the `implementationConfigClass` table to define post-build loadable support. This method internally investigates the `implementationConfigClass` in this case but the `valueConfigClass` table for AUTOSAR 4.2.1 and newer versions.

5.5.1.2 Post-build selectable

EcucModuleDefinition `IEcucModuleDefinition` is the interface of the module definition wrapper. It provides the following method(s):

`supportsPostBuildVariance()`

The `supportsPostBuildVariance()` method returns `true` if this module configuration supports post-build selectable.

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the module definitions supported `SupportedConfigurationVariants` defined both, post-build loadable and selectable support. With AUTOSAR 4.2.1 the `supportedSupportedConfigurationVariants` specifies post-build loadable only and this method returns the value of the new `postBuildVariantSupport` flag.

EcucCommonAttributes `IEcucContainerDefinition` is the interface of the container definition wrapper. It provides the following method(s):

`supportsVariantMultiplicity()`

The `supportsVariantMultiplicity()` method returns `true` if this container type supports variant multiplicity. If `true` is returned this means that different variants may contain different number of instances of this container type.

This method takes the multiplicity into account. So, if the container definition specifies the multiplicity with `lower == upper`, it always returns `false`. Concerning post-build selectable it never makes sense to permit variance if lower and upper multiplicity are equal.

This method is for post-build selectable only!

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the container definitions contained the `postBuildChangeable` flag to define post-build loadable support. This method internally investigates the `postBuildChangeable` flag in this case but the `postBuildVariantMultiplicity` flag for AUTOSAR 4.2.1 and newer versions.

`supportsVariantShortname()`

The `supportsVariantShortname()` method returns `true` if one of the following conditions apply.

- `supportsVariantMultiplicity()` returns `true`
- The ADMIN-DATA flag `postBuildSelectableChangeable` is `true`

The use case for this specification are 1:1 containers. When this method returns `true`, 1:1 containers may have different shortnames in different variants. This is a Vector specific semantic which is not provided by AUTOSAR.

EcucCommonAttributes `IEcucCommonAttributes` is the base interface of all parameter and reference definition wrappers. It provides the following method(s):

supportsVariantMultiplicity()

The `supportsVariantMultiplicity()` method returns `true` if this parameter type supports variant multiplicity. If `true` is returned this means that different variants may contain different number of instances of this parameter type.

This method takes the multiplicity into account. So, if the parameter definition specifies the multiplicity with `lower == upper`, it always returns `false`. Concerning post-build selectable it never makes sense to permit variance if lower and upper multiplicity are equal.

This method is for post-build selectable only!

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the parameter definitions contain the `implementationConfigClass` table to define post-build selectable support. This method internally investigates the `implementationConfigClass` in this case but the `post-BuildVariantMultiplicity` flag for AUTOSAR 4.2.1 and newer versions.

supportsVariantValue()

The `supportsVariantValue()` method returns `true` if this parameter type supports a variant value. If `true` is returned this means that different variants may contain different values in instances of this parameter type.

This method is for post-build selectable only!

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the parameter definitions contain the `implementationConfigClass` table to define post-build selectable support. This method internally investigates the `implementationConfigClass` in this case but the `post-BuildVariantValue` flag for AUTOSAR 4.2.1 and newer versions.

5.5.2 EcuConfigurationAccess

The `IEcuConfigurationAccess` provides convenient and typesafe access to configuration objects (modules, containers, parameters and references). The contained `cfg()` methods take MDF (ECU configuration) objects and return wrappers which can be used to retrieve specific characteristics of the configuration content.

Example:

```

IEcuConfigurationAccess eca;
MINumericalValue intParam;

// Get the parameter wrapper
IEcucNumericalParameter numCfg = eca.cfg(intParam);

// Check if this is an integer parameter
if (numCfg instanceof IEcuIntegerParameter) {
    IEcuIntegerParameter intCfg = (IEcuIntegerParameter) numCfg;

    // Get the parameter value
    boolean hasValue = intCfg.hasValue();
    BigInteger value = intCfg.getValue();

    // Get the related definition wrapper
    IEcuIntegerDefinition def = intCfg.getEcuDefinition();
}

```

Listing 5.25: Integer parameter configuration access examples

5.5.2.1 Post-build loadable

EcucModuleConfiguration `IEcuModuleConfiguration` is the base interface of all module configuration wrappers. It provides the following method(s):

`getConfigurationVariant()`

The `getConfigurationVariant()` method returns the modules configuration variant.

This method never returns `null`. If the module has no value specified, this method returns a default value as follows:

- `EEcucConfigurationVariant.VARIANT_PRE_COMPILE`, if it is contained in the supported config variants of the related module definition
- otherwise `EEcucConfigurationVariant.VARIANT_LINK_TIME`, if it is contained in the supported config variants of the related module definition
- otherwise `EEcucConfigurationVariant.VARIANT_POST_BUILD_LOADABLE`, if it is contained in the supported config variants of the related module definition
- otherwise `EEcucConfigurationVariant.VARIANT_PRE_COMPILE`, even if not contained in the supported config variants of the related module definition or if the definition is not available

Remark about AUTOSAR versions: Prior to AUTOSAR 4.2.1 the module configurations implementation config variant defined if this module implements post-build loadable and/or selectable. With AUTOSAR 4.2.1 the implementation config variant defines only if the module implements post-build loadable. The post-build selectable aspect has been separated from this definition. This method handles the loadable semantic, independent of the AUTOSAR version.

This is for post-build loadable only!

`setConfigurationVariant()`

The `setConfigurationVariant(EEcucConfigurationVariant)` method sets the specified implementation configuration variant.

This is for post-build loadable only!

Supported values are

- `EEcucConfigurationVariant.VARIANT_PRE_COMPILE`
- `EEcucConfigurationVariant.VARIANT_LINK_TIME`
- `EEcucConfigurationVariant.VARIANT_POST_BUILD_LOADABLE`

Remarks concerning AUTOSAR versions:

- If the modules definition has schema version 4.2.1 or higher, the specified value is being written directly to the model
- If the modules definition has a schema version lower than 4.2.1, the modules implementation configuration variant in the MDF model encodes both, post-build loadable and post-build selectable. The following behavior is being implemented in this case:

Current model value	Parameter	Result in the model
PRE_COMPILE	PRE_COMPILE	PRE_COMPILE
	LINK_TIME	LINK_TIME
	POST_BUILD_LOADABLE	POST_BUILD_LOADABLE
LINK_TIME	PRE_COMPILE	PRE_COMPILE
	LINK_TIME	LINK_TIME
	POST_BUILD_LOADABLE	POST_BUILD_LOADABLE
POST_BUILD_LOADABLE	PRE_COMPILE	PRE_COMPILE
	LINK_TIME	LINK_TIME
	POST_BUILD_LOADABLE	POST_BUILD_LOADABLE
POST_BUILD_SELECTABLE	PRE_COMPILE	POST_BUILD_SELECTABLE
	LINK_TIME	POST_BUILD_SELECTABLE
	POST_BUILD_LOADABLE	POST_BUILD
POST_BUILD	PRE_COMPILE	POST_BUILD_SELECTABLE
	LINK_TIME	POST_BUILD_SELECTABLE
	POST_BUILD_LOADABLE	POST_BUILD

EcucContainer `IEcucContainer` is the base interface of all container wrappers. It provides the following method(s):

getEffectiveMultiplicityConfigurationClass()

The `getEffectiveMultiplicityConfigurationClass()` method walks up the model tree to find the related module configuration. Then it uses the module implementation configuration variant to return the selected configuration class as specified in the container definition.

This method never returns `null`. In case the detection of the configuration class fails (e.g. if the related module configuration cannot be detected), this method returns `EEcucConfigurationClass.PRE_COMPILE` by default. It also never returns `EEcucConfigurationClass.LINK`.

This method is for post-build loadable only!

getEffectiveMultiplicityConfigurationClassDefRef()

The `getEffectiveMultiplicityConfigurationClass(DefRef)` method walks up the model tree to find the related module configuration. Then it uses the module implementation configuration variant to return the selected configuration class of the specified parameter definition.

This method never returns `null`. In case the detection of the configuration class fails (e.g. if the related module configuration cannot be detected), this method returns `EEcucConfigurationClass.PRE_COMPILE` by default. It also never returns `EEcucConfigurationClass.LINK`.

This method is for post-build loadable only!

getEffectiveValueConfigurationClass()

The `getEffectiveValueConfigurationClass(DefRef)` method walks up the model tree to

find the related module configuration. Then it uses the module implementation configuration variant to return the selected configuration class of the specified parameter definition.

This method never returns `null`. In case the detection of the configuration class fails (e.g. if the related module configuration cannot be detected), this method returns `EEcucConfigurationClass.PRE_COMPILE` by default. It also never returns `EEcucConfigurationClass.LINK`.

This method is for post-build loadable only!

EcucParameter **IEcucParameter** is the base interface of all parameter and reference wrappers. It provides the following method(s):

getEffectiveMultiplicityConfigurationClass()

The `getEffectiveMultiplicityConfigurationClass()` method walks up the model tree to find the related module configuration. Then it uses the module implementation configuration variant to return the selected configuration class as specified in the parameter definition.

This method never returns `null`. In case the detection of the configuration class fails (e.g. if the related module configuration cannot be detected), this method returns `EEcucConfigurationClass.PRE_COMPILE` by default.

This is for post-build loadable only!

getEffectiveValueConfigurationClass()

The `getEffectiveValueConfigurationClass()` method walks up the model tree to find the related module configuration. Then it uses the module implementation configuration variant to return the selected configuration class as specified in the parameter definition.

This method never returns `null`. In case the detection of the configuration class fails (e.g. if the related module configuration cannot be detected), this method returns `EEcucConfigurationClass.PRE_COMPILE` by default.

This is for post-build loadable only!

5.5.2.2 Post-build selectable

EcucModuleConfiguration **IEcucModuleConfiguration** is the base interface of all module configuration wrappers. It provides the following method(s):

supportsPostBuildVariance()

The `supportsPostBuildVariance()` method returns `true` if this module configuration supports post-build selectable.

This is for post-build selectable only!

What this method actually does:

- It checks if the related definition specifies post-build selectable as supported
- It checks if the module configuration implements post-build variance. That's `true` in the following cases
 - If the modules definition has schema version 4.2.1 or higher: Check if the modules ADMIN-DATA flag "postBuildVariantSupport" is `true` (false is default if this flag is missing)

- If the modules definition has a schema version lower than 4.2.1: Check if the modules implementation configuration variant contains one of the following values `VARIANT_POST_BUILD_SELECTABLE` or `VARIANT_POST_BUILD`

It returns `true` if both conditions are `true`.

setPostBuildVarianceSupport()

The `setPostBuildVarianceSupport(boolean)` method sets the post-build support flag in the module configuration.

This is for post-build selectable only!

Remarks concerning AUTOSAR versions:

- If the modules definition has schema version 4.2.1 or higher, this method sets the modules ADMIN-DATA flag "postBuildVariantSupport" to the specified value.
- If the modules definition has a schema version lower than 4.2.1, the modules implementation configuration variant in the MDF model encodes both, post-build loadable and post-build selectable. The following behavior is being implemented in this case:

Current model value	Parameter	Result in the model
PRE_COMPILE	true	POST_BUILD_SELECTABLE
	false	PRE_COMPILE
LINK_TIME	true	POST_BUILD_SELECTABLE
	false	LINK_TIME
POST_BUILD_LOADABLE	true	POST_BUILD
	false	POST_BUILD_LOADABLE
POST_BUILD_SELECTABLE	true	POST_BUILD_SELECTABLE
	false	PRE_COMPILE
POST_BUILD	true	POST_BUILD
	false	POST_BUILD_LOADABLE

EcucContainer `IEcucContainer` is the base interface of all container wrappers. It provides the following method(s):

supportsVariantMultiplicity()

The `supportsVariantMultiplicity()` method returns `true` if the related module configuration supports variance and this containers definition support variant multiplicity. If `true` is returned this means that different variants may contain different number of instances of this container.

If the container has no definition, this method returns `false`.

This method is for post-build selectable only!

EcucParameter `IEcucParameter` is the base interface of all parameter and reference wrappers. It provides the following method(s):

supportsVariantMultiplicity()

The `supportsVariantMultiplicity()` method returns `true` if the related module configuration supports variance and this parameters definition support variant multiplicity. If `true` is returned this means that different variants may contain different number of instances of this parameter.

If the parameter has no definition, this method returns `false`.

This is for post-build selectable only!

supportsVariantValue()

The **supportsVariantValue()** method returns **true** if the related module configuration supports variance and this parameters definition support variant values. If **true** is returned this means that different variants may contain different values in instances of this parameter.

If the parameter has no definition, this method returns **false**.

This is for post-build selectable only!

6 AutomationInterface Content

6.1 Introduction

This chapter describes the content of the DaVinci Configurator AutomationInterface.

6.2 Folder Structure

The AutomationInterface consists of the following files and folders:

- **BswmdModel:** contains the generated BswmdModel that is automatically created by the DaVinci Configurator during startup
- **Core**
 - **AutomationInterface**
 - * **__doc** (find more details to its content in chapter 6.3)
 - **DVCfg_AutomationInterfaceDocumentation.pdf:** this document
 - **javadoc:** Javadoc HTML pages
 - **templates:** script file and script project templates for a simple start of script development
 - * **buildLibs:** AutomationInterface Gradle Plugin to provide the build logic to build script projects, see also 7.9 on page 299
 - * **libs:** compile bindings to Groovy and to the DaVinci Configurator AutomationInterface, used by IntelliJ IDEA and Gradle
 - * **licenses:** the licenses of the used open source libraries

6.3 Script Development Help

The help for the AutomationInterface script development is distributed among the following sources:

- DVCfg_AutomationInterfaceDocumentation.pdf (this document)
- Javadoc HTML Pages
- Script Templates

6.3.1 AutomationInterfaceDocumentation PDF

You find this document as described in chapter 6.2. It provides a good overview of architecture, available APIs and gives an introduction of how to get started in script development. The focus of the document is to provide an overview and not to be complete in API description. To get a complete and detailed description of APIs and methods use the Javadoc HTML Pages as described in 6.3.2 on the following page.

6.3.2 Javadoc HTML Pages

You find this documentation as described in chapter 6.2 on the previous page. Open the file `index.html` to access the complete DaVinci Configurator AutomationInterface API reference. It contains descriptions of all classes and methods that are part of the AutomationInterface.

The Javadoc is also accessible at your source code in the IDE for script development.

6.3.3 Script Templates

You find the Script Templates as described in chapter 6.2 on the preceding page. You may copy them for a quick startup in script development.

6.4 Libs and BuildLibs

The AutomationInterface contains libraries to build projects, see **buildLibs** in 6.2 on the previous page . And it contains other libraries which are described in **libs** in 6.2 on the preceding page.

7 Automation Script Project

7.1 Introduction

An automation script project is a normal Java/Groovy development project, where the built artifact is a single `.jar` file. The jar file is created by the build system, see chapter 7.9 on page 299.

It is the recommended way to develop scripts, containing more tasks or multiple classes.

The project provides IDE support for:

- Code completion
- Syntax highlighting
- API Documentation
- Debug support
- Build support

The recommended IDE is IntelliJ IDEA.

7.2 Automation Script Project Creation

To create a new script project please follow the instructions in chapter 2.4 on page 14.

7.3 Project File Content

An automation project will at least contain the following files and folders:

- Folders
 - `.gradle` - Gradle temp folder - **DO NOT** commit it into a version control system
 - `build` - Gradle build folder - **DO NOT** commit it into a version control system
 - `gradle` - Gradle bootstrap folder - Please commit it into your version control system
 - `src` - Source folder containing your Groovy, Java sources and resource files
- Files
 - Gradle files - see 7.9.2 on page 299 for details
 - * `gradlew.bat`
 - * `build.gradle`
 - * `settings.gradle`
 - * `projectConfig.gradle`
 - * `dvCfgAutomationBootstrap.gradle`

- IntelliJ Project files (optional) - **DO NOT** commit it into a version control system
 - * `ProjectName.iws`
 - * `ProjectName.iml`
 - * `ProjectName.ipr`

The IntelliJ Project files (`*.iws`, `*.iml`, `*.ipr`) can be recreated with the command in the windows command shell (`cmd.exe`): `gradlew idea`

7.4 Deployment of the Jar File

To deploy your automation script project you only need to deploy the built jar file located in `<ProjectDir>/build/libs/<ProjectName>-<Version>.jar`. All other files in your automation script project are **not required** for the script **execution**.

So if you want to use your script project in an DaVinci Configurator project, copy the jar file into the DaVinci Configurator project and add the folder containing the jar file in the Script Locations view with the Project scope.

7.5 IntelliJ IDEA Usage

7.5.1 Supported versions

The supported IntelliJ IDEA versions are:

- 2016.3
- 2017.2
- 2017.3
- 2018.1
- 2018.2

Please use one of the versions above. With other versions, there could be problems with the editing, code completion and so on. The support for the IntelliJ IDEA versions prior to 2016.3 was removed. Please update your version.

The free **Community edition** is **fully sufficient**, but you could also use the *Ultimate edition*.

7.5.2 Building Projects

Project Build The standard way to build projects is to choose the option `<ProjectName>[build]` in the Run Menu in the toolbar and to press the Run Button beneath that menu.

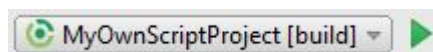


Figure 7.1: Project Build

Project Continuous Build A further option is provided for the case you prefer an automatic project building each time you save your implementation. If you choose the menu option `<ProjectName> continuous [build]` in the toolbar the Run Button has to be pressed only one time to start the continuous building. Hence forward each saving of your implementation triggers an automatic building of the script project.

But be aware that the continuous build option is available for .java and .groovy files only. In case of changes in e.g. .gradle files you still have to press the Run Button in order to build the project.

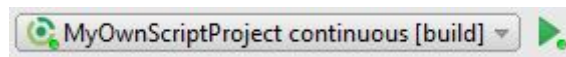


Figure 7.2: Project Continuous Build

The Continuous Build process can be stopped with the Stop Button in the Run View.



Figure 7.3: Stop Continuous Build

If you want to exit the IntelliJ IDEA while the Continuous Build process is still running, you will be asked to disconnect from it. Having disconnected you are allowed to exit the IDE.

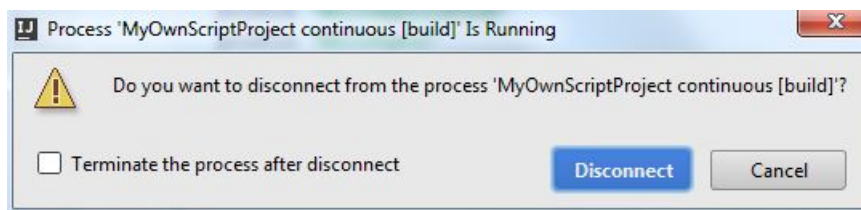


Figure 7.4: Disconnect from Continuous Build Process

7.5.3 Debugging with IntelliJ

Be aware that only script projects and not script files are debuggable.

To enable debugging you must start DaVinci Configurator application with the `enableDebugger` option as described in 7.8 on page 298.

In the IntelliJ IDEA choose the option `<ProjectName> [debug]` in the Run Menu located in the toolbar. Pressing the Debug Button starts a debug session.

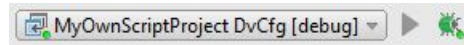


Figure 7.5: Project Debug

Set your breakpoints in IntelliJ IDEA and execute the task. To stop the debug session press the Stop Button in the Debugger View.



Figure 7.6: Stop Debug Session

If you want to exit the IntelliJ IDEA while the Debug process is still running, you will be asked to disconnect from it. Having disconnected you are allowed to exit the IDE.

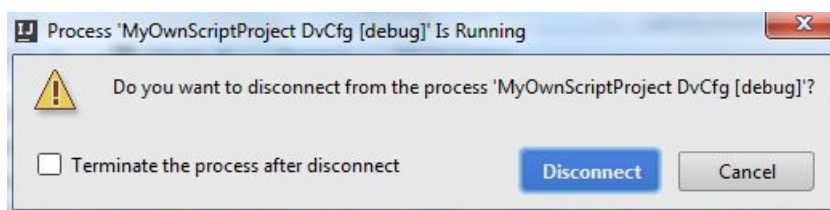


Figure 7.7: Disconnect from Debug Process

7.5.4 Troubleshooting

Code completion, Compilation If the code completion or compilation does not work, please verify that the Java JDK settings in the IntelliJ IDEA are correct. You have to set the Project JDK and the Gradle JDK setting. See 2.4.3 on page 17.

Gradle build, build button If the Gradle build does nothing after start or the build button is grayed, please verify that the Java JDK settings in the IntelliJ IDEA are correct. You have to set the Gradle JDK setting. See 2.4.3 on page 17.

If the build button is marked with an error, please make sure that the Gradle plugin inside of IntelliJ IDEA is installed. Open File->Settings...->Plugins and select the Gradle plugin.

IntelliJ Build You shall not use the IntelliJ menu "Build" or the context menu entries "Make Project", "Make Module", "Rebuild Project" or "Compile". The project shall be build with Gradle not with IntelliJ IDEA. So you have to select one of the Run Configuration (Run menu) to build the project as described in chapter 7.5 on page 294.

Groovy SDK not configured If you get the message 'Groovy SDK is not configured for ...' in IntelliJ IDEA you probably have to migrate your project as described in chapter 7.7 on page 298.

Debugging - DaVinci Configurator does not start If the DaVinciCfg.exe does not start when the `enableDebugger` option is passed, please check if the default port (8000) is free, or choose another free port by appending the port number to the `enableDebugger` option.

Compile errors - Could not find com.vector.cfg:DVCfgAutomationInterface If you get compile errors inside of the IntelliJ IDEA, after updating the DaVinci Configurator or moving projects.

Please execute the **Project Migration to newer DaVinci Configurator Version** step, see 7.7 on the next page.

Download of Gradle Distribution Error If you get an error when you start the gradlew like:

```
Downloading
http://vistrfcgci1.vi.vector.int/buildcomponents/Gradle/distributions/gradle-4.0.1-bin.zip

Exception in thread "main" java.io.FileNotFoundException:
http://vistrfcgci1.vi.vector.int/buildcomponents/Gradle/distributions/gradle-4.0.1-bin.zip
at sun.net.www.protocol.http.HttpURLConnection.getInputStream0(HttpURLConnection.java:1836)
```

The problem is you can't connect to the server, where the Gradle installation is located¹. To change the location, you have to open the file <YourProject>/gradle/wrapper/gradle-wrapper.properties and change the line `distributionUrl=`.

You have multiple options for the content of the `distributionUrl`:

- Change the URL to the Gradle default (needs internet access):
 - `https://services.gradle.org/distributions/gradle-4.0.1-bin.zip`
- Change the URL to a Server location of your choice. E.g inside your company.
- Download Gradle manually and change the URL to a local file system location like:
 - `file:/D:/YourFolder/gradle-4.0.1-bin.zip`

Caution: You have to escape a `:` with `\:` so an HTTP address would start with `http\://` and the local filesystem would start with `file\:/`.

So the default line in the file 'gradle-wrapper.properties' for the default Gradle server would be: `distributionUrl=https\://services.gradle.org/distributions/gradle-4.0.1-bin.zip`

7.6 Project Usage in different DaVinci Configurator Versions

You can execute the script tasks of a script project in different versions of the DaVinci Configurator as long as the following conditions are met:

- You compile your script project against the oldest DaVinci Configurator version to use
 - E.g. You want to use Cfg5.15 and Cfg5.16, you have to compile your script project with Cfg5.15.
- The DaVinci Configurator version span must not contain a breaking change. These changes are documented in the chapter 8 on page 305. Normally the versions have **NO** breaking changes! The default text is something like:

¹ The vector internal server `http://vistrfcgci1.vi.vector.int` is not accessible from outside of the vector network and shall only be used by internal projects. If you have a project with the internal server and your are not inside the network, please change it to another location.

"The Cfg5.16 automation interface is compatible to the Cfg5.15. So a script written with Cfg5.15 will also run in the Cfg5.16 version."

- If you use the BswmdModel, you have to use a compatible SIP
 - E.g. the used BSW module definitions (bswmd files) must have compatible names and multiplicities.

7.7 Project Migration to newer DaVinci Configurator Version / SIP

If you update your DaVinci Configurator version in your SIP or copy the project into another SIP, you should execute the IntelliJ IDEA task of Gradle to update the compile dependencies.

Steps to execute:

1. Close IntelliJ IDEA.
2. Update the DaVinci Configurator in your SIP / Change the path to the DaVinci Configurator in the file `projectConfig.gradle`
3. Update the IntelliJ IDEA project, see 7.9.3.2 on page 301

This will update the compile time dependencies of your Automation Script Project according to the new DaVinci Configurator version.

After this, please read the Changes (see chapter 8 on page 305) in the new release and update your script, if something of interest has changed.

7.8 Debugging Script Project

Be aware that only script projects and not script files are debuggable.

To debug a script project, any java debugger could be used. Simply add the `enableDebugger` parameter to the commandline of the DaVinci Configurator and attach your debugger.

```
DVCfgCmd -s MyApplScriptTask --enableDebugger
```

You could attach a debugger at port 8000 (default). If the DaVinci Configurator does not start with the option, please see 7.5.4 on page 296.

Different Debug Port

```
DVCfgCmd -s MyApplScriptTask --enableDebugger <YOUR-PORT> --waitForDebugger
```

Example:

```
DVCfgCmd -s MyApplScriptTask --enableDebugger 12345 --waitForDebugger
```

You could attach a debugger at port 12345 (select any free port) and the `DVCfgCmd` process will wait until the debugger is attached. You could also use these commandline parameters with the `DaVinciCFG.exe` to debug a script project with the DaVinci Configurator UI.

7.9 Build System

The build system uses Gradle² to build a single Jar file. It also setups the dependencies to the DaVinci Configurator and create the IntelliJ IDEA project.

To setup the Gradle installation, see chapter 2.4.4 on page 18.

7.9.1 Jar Creation and Output Location

The call to `gradlew build` in the root directory of your automation script project will create the jar file. The jar file is then located in:

- `<ProjectRoot>\build\libs\<ProjectName>-<ProjectVersion>.jar`

7.9.2 Gradle File Structure

The default automation project contains the following Gradle build files:

- `gradlew.bat`
 - Gradle batch file to start Gradle (Gradle Wrapper³)
- `build.gradle`
 - General build file - You can modify it to adapt the build to your needs
- `settings.gradle`
 - General build project settings - See Gradle documentation⁴
- `projectConfig.gradle`
 - Contains automation project specific settings - You can modify it to adapt the build to your needs
- `dvCfgAutomationBootstrap.gradle`
 - This is the internal bootstrap file. **DO NOT** change the file content.

7.9.2.1 projectConfig.gradle File settings

The file contains three essential parts of the build:

- Names of the scripts to load (`automationClasses`)
- The path to the DaVinci Configurator installation (`dvCfgInstallation`)
- Project version (`version`)

²<http://gradle.org/> [2017-07-18]

³https://docs.gradle.org/current/userguide/gradle_wrapper.html [2017-07-18]

⁴<https://docs.gradle.org/current/dsl/org.gradle.api.initialization.Settings.html> [2017-07-18]

automationClasses You have to add your classes to the list of `automationClasses` to make them loadable.

The syntax of `automationClasses` is a list of `Strings`, of all classes as full qualified Class names.

Syntax: `"javaPkg.subPkg.ClassName"`

```
// The property project.ext.automationClasses defines the classes to load
project.ext.automationClasses = [
    "sample.MyScript",
    "otherPkg.MyOtherScript",
    "javapkg.ClassName"
]
```

Listing 7.1: The `automationClasses` list in `projectConfig.gradle`

dvCfgInstallation The `dvCfgInstallation` defines the path to the DaVinci Configurator installation in your SIP. The installation is needed to retrieve the build dependencies and the generated model.

You **can** change the path to any location containing the correct version of the DaVinci Configurator.

```
// Please specify the path to your DaVinci Configurator installation
project.ext.dvCfgInstallation = new File("<PATH-TO-DaVinciConfiguratorFolder>")
```

Listing 7.2: The `dvCfgInstallation` in `projectConfig.gradle`

You could also evaluate `SystemEnv` variables, other project properties or Gradle settings to define the path dependent of the development machine, instead of encoding an absolute path. This will help, when the project is committed to a version control system. But this is project dependent and out of scope of the provided template project.

```
// Use a System environment variable as path to the DaVinci Configurator
project.ext.dvCfgInstallation = new File(System.getenv('YOUR_ENV_VARIABLE'))
```

Listing 7.3: The `dvCfgInstallation` with an `System env` in `projectConfig.gradle`

version The `project.version` defines the version of your Automation project, e.g. defines the version suffix of the jar file.

7.9.3 Advanced Build Topics

7.9.3.1 Usage of external Libraries (Jars) in the AutomationProject

You could reference external libraries (Jar files) in your `AutomationProject`. But you have to configure the libraries in the Gradle build files. **DO NOT** add a dependency in IntelliJ, this will not work.

The easiest and preferred way is the use a library from any Maven repository like `MavenCentral` or `JCenter`. This will also handle versions, and transitive dependencies automatically.

Otherwise you could download the jar file and place it in your project⁵, but this is **NOT** recommended.

The referenced libraries will be automatically bundled into your Automation project, see chapter 7.9.3.5 on page 303 `includeDependenciesIntoJar` for details.

How to add a Library? We assume we have a jar from a Maven repository like Apache Commons IO (the identifier would be `'commons-io:commons-io:2.5'`, See MavenCentral).

- Open your `build.gradle`
- Add the code for the dependency

```
dependencies {  
    // Change the identifier to your library to use  
    compile 'commons-io:commons-io:2.5'  
    // You could add multiple libraries with additional compile lines  
}
```

- Optional: if you are behind a proxy or firewall:
 - You must either set proxy options for gradle ⁶
 - **Preferred way:** use a Maven repository inside your network: To set a repository, add before the dependencies block:

```
repositories {  
    // URL to your repository. The URL below is the Vector internal network  
    // server.  
    // Please change the URL to your server  
    maven { url 'http://vistrfcgci1.vi.vector.int/artifactory/all' }  
    // Or reference MavenCentral server  
    mavenCentral()  
}
```

- Update the IntelliJ IDEA project, see 7.9.3.2

Now your project has access to the specified library.

7.9.3.2 Update IntelliJ IDEA project

If you have changed dependencies or versions of any library, you have to update your IDEA project. The best way to do this is to select the Gradle auto-import feature in the IntelliJ IDEA, see figure 7.8 on the next page.

⁵See Gradle online documentation, how to add local jar files to the build dependencies

⁶Gradle and Java online documentation for details how to set proxy settings

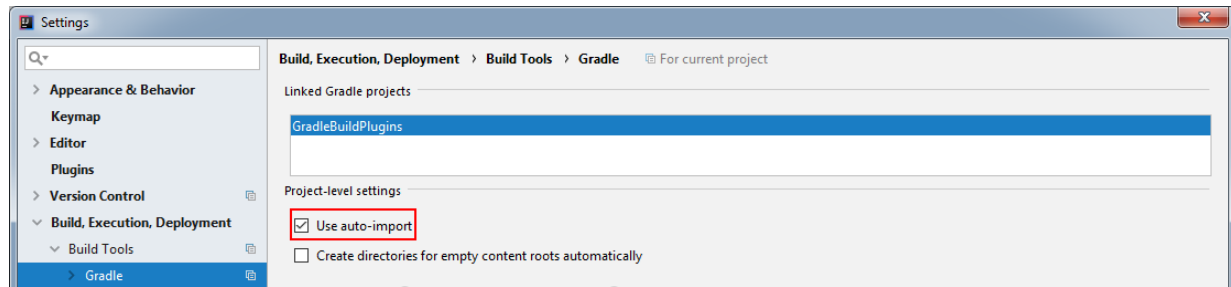


Figure 7.8: Activate the auto-import

Or you can manually execute the following steps:

1. Close IntelliJ IDEA.
2. Open a command shell (`cmd.exe`) at your project folder
 - Folder containing the `gradlew.bat`
3. Type `gradlew idea` and press enter
4. Wait until the task has finished
5. Open IntelliJ IDEA

7.9.3.3 Static Compilation of Groovy Code

The `AutomationInterface` contains a Groovy compiler extension. This allows you to use Automation API in static compiled Groovy code.

You have to mark your classes or methods with:

```
@CompileStatic(extensions = 'com.vector.cfg.groovy.extensions.
AutomationTypeChecking')
def myMethod(){
}

@CompileStatic(extensions = 'com.vector.cfg.groovy.extensions.
AutomationTypeChecking')
class MyClass{
}
```

Listing 7.4: @CompileStatic with Automation API

The same applies, if you want to use the `@TypeChecked` annotation:

```
@TypeChecked(extensions = 'com.vector.cfg.groovy.extensions.
AutomationTypeChecking')
def myMethod(){
}
```

Listing 7.5: @TypeChecked with Automation API

7.9.3.4 Gradle Maven publishing of an AutomationProject

The Gradle `dvCfgAutomation` automatically adds a Gradle `MavenPublication` instance for all signed Jar files. The publication is named `signedJar`, so the `publish` and `publishToMavenLocal` will publish the signed Jar files.

7.9.3.5 Gradle `dvCfgAutomation` API Reference

The DaVinci Configurator build system provides a Gradle DSL API to set properties of the build. The entry point is the keyword `dvCfgAutomation`

```
dvCfgAutomation {  
    classes project.ext.automationClasses  
}
```

Listing 7.6: DaVinci Configurator build Gradle DSL API

The following methods are defined inside of the `dvCfgAutomation` block:

- `classes` (Type `List<String>`) - Defines the automation classes to load
- `useBswmdModel` (Type `boolean`) - Enables or disables the usage of the `BswmdModel` inside of the script project.
- `useJarSignerDaemon` (Type `boolean`) - Enables or disables the usage of the Jar Signer Daemon process.
- `includeDependenciesIntoJar` (Type `boolean`) - Enables or disables the inclusion of dependencies during build

useBswmdModel The `useBswmdModel` enables or disables the usage of the `BswmdModel` inside of the project. This is helpful, if you want to create a project, which shall run with **different SIPs**. This prevent the inclusion of the `BswmdModel`. The default is `true` (Use the `BswmdModel`) if nothing is specified.

```
dvCfgAutomation {  
    useBswmdModel false  
}
```

Listing 7.7: DaVinci Configurator build Gradle DSL API - `useBswmdModel`

useJarSignerDaemon The `useJarSignerDaemon` enables or disables the usage of the Jar Signer Daemon process. The process is spawned when a jar file shall be signed. This will speedup the build process especially when the project is built often. The daemon is closed automatically, when not used in a certain time span.

The default of `useJarSignerDaemon` is `true`.

The Gradle task `stopJarSignerDaemon` will stop any running Signer daemon.

```
dvCfgAutomation {  
    useJarSignerDaemon true  
}
```

Listing 7.8: DaVinci Configurator build Gradle DSL API - `useJarSignerDaemon`

includeDependenciesIntoJar The `includeDependenciesIntoJar` enables or disables bundling of gradle runtime dependencies (e.g. referenced jar files) into the resulting project jar. If `includeDependenciesIntoJar` is enabled the project jar file will contain all jar dependencies under the folder `jars` inside of the jar file.

The default of `includeDependenciesIntoJar` is `true`.

```
dvCfgAutomation {  
    includeDependenciesIntoJar false  
}
```

Listing 7.9: DaVinci Configurator build Gradle DSL API - `includeDependenciesIntoJar`

generatorTests The `generatorTests` allows to configure generator tests, see chapter 4.14.1.2 on page 244 for details.

8 AutomationInterface Changes between Versions

This chapter describes the supported functionality of different versions and all API changes between different MICROSAR releases.

8.1 Currently Supported Features

The table below contains a list of functionalities of the DaVinci Configurator Automation Interface.

Legend: A functionality is available if the **Since** column contains the DaVinci Configurator version (see Since). Otherwise the functionality is not yet available.

Component	Functionality	Since
Scripts	Loading, Execution, Script-Projects	5.13
	User defined Script Task Arguments in UI and Cmd	5.14 SP1
	Stateful Script Tasks	5.14
Project	Open, modify, save and close project	5.13
	Accessing the active UI project	5.13
	Create a new project	5.13
	Accessing/Modifying the project settings target	5.18
	Open ARXML files as Project without DPA	5.14
	Switch configuration phase (Post-build loadable)	
Model	Access to the whole AUTOSAR model (EcuC and System-Desc)	5.13
	Transaction support (Undo, Redo)	5.13
	Type save access to ECU model using definitions provided by the generated BswmdModel	5.13
	Post-build selectable support	5.13
	Access of variants, Access/Modification of variant data	5.13
	Post-build loadable support	5.13
	CE-States: UserDefined, Changeable, Deletable	5.13
	Consideration of pre-configuration status	5.13
	Access and modification of User Annotations at the configuration element	5.15
	Information and deletion of derived containers	5.16
Generation	Generate code for specific modules	5.13
	Generate code for predefined code generation sequence	5.13
	Execute external generation steps	5.13
	Custom workflow execution	
	Modify code generation sequence to enable/disable specific modules or generation steps	5.13
	SWC Templates and Contract Headers Generation	5.15
	Add a ScriptTask as external generation step	5.13
	Add a ScriptTask as custom workflow step	5.14
Validation	Access to project validation result	5.13
	Access to validation results of specific model elements	5.13

	Solve validation results (by group, by id, by solving action type (preferred solving action))	5.13
Update Workflow	Updating a project	5.13
	Input file access and modification (non-variant)	5.13
	Input file access and modification (variant)	
	Configuration of system description merge	
	Access to update report	
	Script execution after successful update workflow	5.18
	Access to the FilePreProcessing result file within the update workflow	5.18
	Access to every Autosar input file except of ProjectStandardConfiguration within the FilePreProcessing of the update workflow	5.18
Reporting	Create predefined project reports	
	Create report based on specific CE set	
Reporting	Create Ecu Configuration report	5.18
Diff and Merge	Diff and Merge a Project (ActiveEcuC)	
	Diff and Merge a Project (SystemDescription)	
	Access to diff report	
Persistency	Export of configuration artefacts	5.14
	Export of ActiveEcuC	5.14
	Export of Post-build selectable Variants per Variant	5.14
	Export of AUTOSAR model trees	5.15
	Export of Module Configurations	
	Import of configuration artefacts (Please inform Vector, if you need an import)	
	Import of Module Configurations	5.17
Testing	Unit test execution with Junit	5.13
	Unit test execution with Spock	5.13
	Generator Black-box tests	5.13
	Generator White-box tests	5.18
Domains		
Base	Nothing planned	
Communication	Access and modification of Can controller configuration	5.13
	Access and modification of Can filter masks	5.13
	Access and modification of CanBusTimings registers	
	Access and modification of FullCan flag of PDUs	
	PDU and Channel abstraction	
Diagnostic	Access and modification of Diagnostic Data Identifier	
	Access and modification of Diagnostic Event Data	5.14
	Access and modification of Diagnostic Events	5.14
	Setup of event memory blocks	
	Access and modification of Production error handling	
I/O	Nothing planned	
Memory	Memory Domain Model Partitions, Memory blocks	
	FeeOptimization	
Mode Management	BSW Management	5.15

	API to provide the auto configuration (e.g. ECU state, module initialization, communication control, ...)	5.15
	API to configure logical expressions	
	API for custom configuration	
	Watchdogs: Access to the watchdogs settings and supervised entities	
	Initialization: Auto initialization and reset, Access to driver init lists	
Runtime System	Component Port Connection	5.14
	Data Mapping	5.14
	Task Mapping	5.16
	Component prototype creation	5.16
Communication Control	Nothing planned	

8.2 Changes in MICROSAR AR4-R21 - Cfg5.18

8.2.1 General

The Cfg5.18 (AR4-R21) automation interface is compatible to the Cfg5.17. So a script written with Cfg5.17 will also run in the Cfg5.18 version.

8.2.2 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 298.

8.2.2.1 Groovy

The used Groovy version was updated from 2.4.12 to 2.5.0, please see Groovy website for details. The new Groovy version does not have the groovy-all dependency anymore. If you use an extension API from Groovy you have to add the dependency manually in your `build.gradle` file.

Example:

```
compileOnly group: 'org.codehaus.groovy', name: 'groovy-xml', version: '2.5.0',  
            classifier: 'indy'
```

Listing 8.1: Additional Groovy XML dependency

If you use the Spock framework in your automation project, you should change the dependency in your `build.gradle` as described in chapter 4.13.2.2 on page 242.

8.2.2.2 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2018.2 was added to the supported versions. See 7.5.1 on page 294 for details.

The support for the IntelliJ IDEA versions prior to 2016.3 was removed. Please update your version.

8.2.2.3 BuildSystem

Gradle Build DAVID00138752: Gradle Maven Publishing added, see chapter 7.9.3.4 on page 303 for details.

8.2.3 Unit testing API

Spock-core Spock-core version was updated to version 1.1. Please change the dependency in your `build.gradle` file, if you use it. See chapter 4.13.2.2 on page 242 for details.

8.2.4 Model TestInfrastructure

New class `ITransactionUndoAllRule` added which provides a `JUnit` rule to undo all transaction executed in a `JUnit` or `Spock` test case. See chapter 4.13.2.4 on page 243 for details.

8.2.5 Automation Project TestInfrastructure

New class `IProjectLoadRule` added which provides a `JUnit` rule to load Projects before test execution in a `JUnit` or `Spock` test case. See chapter 4.13.2.5 on page 243 for details.

8.2.6 Generator Testing

New API added to test generators with white-box `JUnit` or `Spock` tests. See chapter 4.14 on page 244 for details.

8.2.7 Workflow

New workflow hook: On successful update workflow

- full access to the project after successful update workflow

New workflow hook: On FilePreProcessing result

- access to the result file created in the update workflow by the FilePreProcessing

New workflow hook: On FilePreProcessing input file

- access to every Autosar input file except of ProjectStandardConfiguration files within the FilePreProcessing of the update workflow

8.2.8 Project Settings

Project Settings API added, see chapter 4.5.3 on page 59 for details.

8.2.9 Runtime System Domain

8.2.9.1 Component Port Connection

- It is possible to use the origin context of a port as additional mapping criteria. Origin contexts are the ends of all incomplete connections in the structured extract for a corresponding port. See 4.10.4.1 on page 165.

8.2.9.2 Task Mapping

- The event and the executable entity selection offer now a `getTaskMapping` method, which can be used for example to check the current task mapping for a task, without opening a transaction and without modifying any mappings. To make sure that the task mappings are up to date, the system description should be synchronized (see chapter about Model Synchronization). See 4.10.4.5 on page 205.

- A new way to specify the order by defining successor relationships between the task mappings was added. See 4.10.4.5 on page 202. The examples can be found at 4.10.4.5 on page 215.
- To make it easier to define successors a lot of new task mapping predicates were added. It is now possible to filter task mappings for attributes of their referenced events or the executable entities which they trigger. You might have a look at 4.10.4.5 on page 202.

8.2.9.3 Origin Component Port

- Introduced a new model element called IOriginComponentPort which is an abstraction of a component port from the structured extract. The purpose of this abstraction is to provide some data from the structured extract as additional information for the existing selection APIs. See 4.10.4.8 on page 226.

8.2.9.4 Origin Context Selection

- A selection for ports of the structured extract (origin component ports) is introduced to the automation interface. The origin component ports can be used as additional information for the other APIs. For example the port interface of an origin context port can be used to create a new delegation port in flat extract. See 4.10.4.8 on page 226.
- A getter for origin component ports at the IComponentPort is now available (IComponentPort.getOriginComponentPorts).
- The selection API also offers a shortcut to create new delegation ports in the flat extract for the selected origin component ports. See 4.10.4.8 on page 228.

8.2.9.5 Component Port Selection

- Added additional predicates to use the origin context component ports as additional selection criteria. See 4.10.4.1 on page 155.

8.3 Changes in MICROSAR AR4-R20 - Cfg5.17

8.3.1 General

The Cfg5.17 (AR4-R20) automation interface is compatible to the Cfg5.16. So a script written with Cfg5.16 will also run in the Cfg5.17 version.

8.3.2 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 298.

8.3.2.1 BuildSystem

Gradle Build DAVID00136153: Fixed issue where `includeDependenciesIntoJar = true` was not working. Now the jar dependencies are again included in the built script project.

8.3.2.2 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2017.3 was added to the supported versions. See 7.5.1 on page 294 for details.

8.3.3 Persistency

8.3.3.1 Model Module Import

The methods added to import module configurations from a given file into the current project:

- `IPersistencyModelImportApi.importModuleConfigurations(Path, Closure<?>)`
- `IPersistencyModelImportApi.importModuleConfigurations(List<Path>, Closure<?>)`
- `IPersistencyModelImportApi.importModuleConfigurations(Path)`
- `IPersistencyModelImportApi.importModuleConfigurations(List<Path>)` The methods added to specify an import mode and filter for the module import:
- `IImportModuleConfigurationApi.replaceInModel(IModuleApi, Closure<?>)`
- `IImportModuleConfigurationApi.addToModel(IModuleApi, Closure<?>)`
- `IModuleApi.module(DefRef)`
- `IModuleApi.module(List<?>)`
- `IModuleApi.module(AsrPath)`
- `IModuleApi.module(String)`

8.3.3.2 Model Export

Support for `-exporterArgs` added, same as in the new command line feature.

8.3.4 BswmdModel

8.3.4.1 SIP DefRefs

The `IBswmdModelDefRefsApi` now provides new methods to check, if a module or any other definition exists in the loaded SIP:

- `IBswmdModelDefRefsApi.hasDefRef(String)` - returns `true`, if the passed definition exists.

8.3.5 Runtime System Domain

8.3.5.1 Component Port Selection

- Added predicates to the component port selector to filter component ports which are completed. See 4.10.4.1 on page 154.
- Added predicates to the component port selector to filter component ports which are terminated. See 4.10.4.1 on page 154.
- The component port offers now a getter method for the port interface of the port.

8.3.5.2 Communication Element Selection

- Added predicates to the communication element selector to filter for communication elements whose owner component ports are terminated. See 4.10.4.2 on page 178.

8.3.5.3 Create Delegation Ports

Delegation port prototypes can be created via `AutomationAPI` on the ECU Composition of the flat extract. Therefore a port interface selection with some predicates was added. See 4.10.4.6 on page 221.

8.3.5.4 Task Mapping

- A new 'queue' option was added which allows to keep the existing task mappings on the task at their current position. See 4.10.4.5 on page 206.
- Added new predicates to the event selection to filter for mode switch events by their mode activation kind (e.g. on mode entry or on mode exit) and published according method at the `IEvent` interface. See 4.10.4.5 on page 197.
- Setting the activation offset at the task mapping container is now possible using the event or the executable entity selection. See 4.10.4.5 on page 218 and 4.10.4.5 on page 202.

8.3.5.5 Simple API for connection between ports

Added a simple API to connect ports by using only the component and port names and setting an optional port interface mapping reference. See 4.10.4.1 on page 166.

8.3.5.6 Simple API for data mapping

Added another simple API to map communication elements to signals (and signal groups). The API requires the fully qualified names of the communication elements and the AUTOSAR paths to the signals and signal groups. See 4.10.4.2 on page 183.

8.3.5.7 Port Terminators

Added port terminators to the automation interface. Port terminators prevent open (unconnected and/or without data mapping) ports to produce validation messages. Ports can be terminated via the selection of component ports (also simple API) as well as the selection of communication elements (no simple API). See 4.10.4.1 on page 168 and 4.10.4.2 on page 188.

8.3.5.8 Data Mapping

Published an interface for `TriggerToSignalMappings`, which can be used for example to filter the new created mappings for `TriggerToSignalMappings`.

8.3.5.9 Service Proxy Components

Added predicates to filter component ports and component types for `ServiceProxyComponentTypes`. See 4.10.4.1 on page 155 and 4.10.4.3 on page 191.

8.3.5.10 Retrieve Short Name Paths and Fully Qualified Names

Added a chapter with examples on how to retrieve short name paths of port interface mappings, signals and signal groups and the fully qualified names of communication elements. See 4.10.4.7 on page 224.

8.3.5.11 More Examples

Added a few more examples to the documentation.

- How to select component ports which are missing a data mapping or connection.
- How to use the advanced filter for events when performing task mappings.
- Another example of ordering task mappings.
- Create a delegation port based on another port with using its name and port interface.

8.4 Changes in MICROSAR AR4-R19 - Cfg5.16

8.4.1 General

The Cfg5.16 (AR4-R19) automation interface is compatible to the Cfg5.15. So a script written with Cfg5.15 will also run in the Cfg5.16 version.

8.4.2 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 298.

8.4.2.1 Groovy

The used Groovy version was updated from 2.4.7 to 2.4.12, please see Groovy website for details.

8.4.2.2 BuildSystem

Gradle Build The Gradle will now mark the Script inside of the DaVinci Configurator with an error, if there were any problems with the last Gradle execution. This shall help the script developers to find quickly the cause of the issue.

Gradle version The used Gradle version was updated from 3.0 to 4.0.1, please see Gradle website for details. Your automation script project must now use the Gradle version 4.0.1. Please install the new Gradle version, if you manually installed the old version.

The dependency configuration `compileDvCfg` was removed, please use the configuration `compileOnly` instead.

8.4.2.3 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2017.2 was added to the supported versions. See 7.5.1 on page 294 for details.

8.4.3 ScriptAccess

New API added to retrieve the loaded scripts and call other script task inside of a script task. See 4.4.11 on page 56 for details.

8.4.4 UserInteraction - Progress Indication

The UserInteraction has now a new API to indicate progress to the User, by updating the text and the progress bar. Some long running operations like:

- Project Load
- Project Creation

- Transactions
- Update Workflow

now report the progress. See section 4.4.5.2 on page 44 for details.

8.4.5 Project Handling

Advanced API to open a Project added, which is not automatically closed, see section 4.5.5.2 on page 70 for details.

8.4.6 Model Automation API

8.4.6.1 Derived Containers

New API added to retrieve information about derived containers and delete derived containers, see chapter 4.6.4.12 on page 102 for details.

8.4.6.2 Variance API

Old Variance API deprecated and replaced by new names with PostBuild:

- `getAllVariantViews() => getAllPostBuildVariantViews()`
- `getInvariantValuesView() => getPostBuildInvariantValuesView()`
- `getInvariantEcucDefView() => getPostBuildInvariantEcucDefView()`
- `getAllVariantViewsOrInvariant() => getAllPostBuildVariantViewsOrInvariant()`
- `isValueInvariant() => isPostBuildValueInvariant()`
- etc.

8.4.6.3 CE State

The methods `ICeStatePublished.isChangeable()` and `ICeStatePublished.isDeletable()` are now part of the published API.

8.4.6.4 MDF Modification API

New method added `IMdfFeatureListHasDefinitionExtensions.byDefOrCreate(TypedDefRef<?, R, ?>)` which allows to update or create 0:1 or 1:1 parameter and container in a convenient manner.

8.4.7 Persistency

8.4.7.1 Model Export

The methods added to export models into a specified file instead of a folder:

- `IPersistencyModelExportApi.exportModelTreeToFile(Object, MIObject, MIObject...)`

- `IPersistencyModelExportApi.exportActiveEcucToFile(Object)`
- `IPersistencyModelExportApi.IModelExporter.exportToFile(Object, Object...)`

PreBuild Export API The methods added to export PreBuild variant info into a folder:

- `IPersistencyModelExportApi.exportPreBuildVariants(Object)`
- `IModelExporter.exportAsPreBuildVariants(Object folder, Object... args)`

8.4.8 Generation

8.4.8.1 Generation Steps

Now the `IGenerationStep` class has a getter for the `TargetType` (`EEnvironmentTargetType`). See chapter 4.7.1.2 on page 120 for details.

8.4.9 Runtime System Domain

8.4.9.1 Component Port Selection

Automation API supports now trigger interfaces and trigger to signal mappings. See 4.10.4.1 on page 154 and 4.10.4.2 on page 178.

Added predicates to the component port selector to filter component ports for attributes of their component types. See 4.10.4.1 on page 154.

8.4.9.2 Signal Instance Selection

It is now possible to filter `SystemSignals` with new predicates for `PhysicalChannels`, `CommunicationClusters`, `Pdus` and `Frames`. See 4.10.4.2 on page 171.

8.4.9.3 Bridge between mdf and model abstractions

Introduced a bridge to navigate between mdf model objects and model abstraction objects of the runtime system domain. See 4.10.4.4 on page 194.

8.4.9.4 Create Component Prototypes

Component prototypes can be created via `AutomationAPI`. Therefore a component type selection with some predicates was added. See 4.10.4.3 on page 192.

8.4.9.5 Task Mapping

The task mapping can be done using the `AutomationAPI` now. Two entry points were added. An event selection and an executable entity selection. After that it is possible to select a task and to customize the task mapping by e.g. map all events of a runnable to the same position or applying an execution order constraint. See 4.10.4.5 on page 200.

8.5 Changes in MICROSAR AR4-R18 - Cfg5.15

8.5.1 General

The Cfg5.15 (AR4-R18) automation interface is mostly compatible to the Cfg5.14. So a script written with Cfg5.14 will also run in the Cfg5.15 version.

8.5.2 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 298.

8.5.2.1 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2016.3 was added to the supported versions. See 7.5.1 on page 294 for details.

8.5.2.2 BuildSystem

Groovy - Static compilation The AutomationInterface Groovy compiler extension added. This allows you to use Automation API in static compiled Groovy code. See 7.9.3.3 on page 302.

includeDependenciesIntoJar The `includeDependenciesIntoJar` Gradle build setting added. See 7.9.3.5 on page 303 for details. The Gradle build will now automatically include jar dependencies into your project jar.

8.5.3 Script Execution

8.5.3.1 User defined arguments

The ScriptTask user defined arguments now support validators to validate the input before executing the task, like checking if the file exists. This provides fast user feedback. See 4.4.9.1 on page 51 for details.

8.5.4 Project Handling

New API added to create empty raw AUTOSAR model projects, see chapter 4.5.8.1 on page 74 for details.

8.5.5 Project Creation vVIRTUALtarget settings

New API added to customize vVIRTUALtarget project and executable settings for project creation. See chapter 4.5.4.7 on page 67 for details.

8.5.6 Model changes

These changes could break your existing client code, if you have used these interfaces or methods.

- Some interfaces have been renamed or moved:
 - Interface `MIMcFunctionDataRefSet` moved
 - * from package `com.vector.cfg.model.mdf.ar4x.commonstructure.measurementcalibrationsupport`
to package `com.vector.cfg.model.mdf.ar4x.commonstructure.measurementcalibrationsupport.rptsupport`
 - Interface `MIMcFunctionDataRefSetConditional` moved
 - * from package `com.vector.cfg.model.mdf.ar4x.commonstructure.measurementcalibrationsupport`
to package `com.vector.cfg.model.mdf.ar4x.commonstructure.measurementcalibrationsupport.rptsupport`
 - Interface `MIMcFunctionDataRefSetContent` moved
 - * from package `com.vector.cfg.model.mdf.ar4x.commonstructure.measurementcalibrationsupport`
to package `com.vector.cfg.model.mdf.ar4x.commonstructure.measurementcalibrationsupport.rptsupport`
 - Interface `MIFt` moved
 - * from package `com.vector.cfg.model.mdf.model.autosar.commonpatterns.textmodel.languagedatamodel.specializedloverviewparagraph`
to package `com.vector.cfg.model.mdf.model.autosar.commonpatterns.textmodel.singlelanguagedata.specializedsloverviewparagraph`
 - Interface `MIFt` moved
 - * from package `com.vector.cfg.model.mdf.model.autosar.commonpatterns.textmodel.languagedatamodel.specializedlparagraph`
to package `com.vector.cfg.model.mdf.model.autosar.commonpatterns.textmodel.singlelanguagedata.specializedslparagraph`
- Some methods have been changed or removed:
 - Interface `com.vector.cfg.model.mdf.ar4x.diagnosticservice.databyidentifier.MIDiagnosticDataByIdentifier`
 - * `MIDiagnosticDataIdentifierARRef getDataIdentifier()`
changed to
`MIDiagnosticAbstractDataIdentifierARRef getDataIdentifier()`
 - * `void setDataIdentifier(MIDiagnosticDataIdentifierARRef)`
changed to
`void setDataIdentifier(MIDiagnosticAbstractDataIdentifierARRef)`
 - Some `...Owner()` methods were removed. The usage of these methods is not recommended. Instead use the `MIObject.miImmediateComposite()` method.

8.5.7 Model Automation API

8.5.7.1 IVarianceApi

New method `IVarianceApi.getAllVariantViewsOrInvariant()` added.

8.5.7.2 Access methods

New access methods for the `EcuConfigurationAccess` and `EcucDefinitionAccess` added. See chapter 4.6.4.10 on page 101 for details.

New MDF access method added `mdfModel(String)`. This method tries to resolve a model element by testing multiple ways. See chapter 4.6.4.2 on page 92 details.

8.5.7.3 Reverse Reference Resolution - ReferencesPointingToMe

New methods to query references starting from reference targets added. See chapter 4.6.4.11 on page 102 for details.

8.5.7.4 Operations

New method `setConfigurationVariantOfAllModuleConfigurations()` added to `IOperations` class. See chapter 4.6.6.2 on page 110 for details.

New method `createUniqueMappedAutosarPackage()` added to `IOperations` class. See chapter 4.6.6.2 on page 110 for details.

8.5.7.5 User Annotations

New API to access and modify User Annotations was added. See chapter 4.6.9.1 on page 115 for details.

8.5.7.6 Variance

New method `variance.variantView(String name)` added to retrieve a variant view by name.

8.5.7.7 Model Synchronization

New API added to execution the new Model Synchronization operation. See chapter 4.6.7 on page 111 for details.

8.5.8 Persistency

New Persistency model exporter added `exportModelTree()`. See chapter 4.11 on page 230 for details.

8.5.9 Workflow

New workflow API added to configure settings with `updateSettings{}`:

- Select the update mode (`ECUC_ONLY`, `ECUC_AND_DEVELOPER_WORKSPACE`)
- Parameter `uuidUsageInStandardConfigurationEnabled`
- Parameter `uuidUsageInSystemDescriptionEnabled`

8.5.10 Validation

8.5.10.1 Validation-Result Access Methods

New two new methods added to retrieve validation by model object in a recursive manner like the editors.

- `MIObject.getValidationResultsRecursive()`
- `IViewedModelObject.getValidationResultsRecursive()`

8.5.11 Generation

8.5.11.1 SWC Templates and Contract Headers Generation

The SWC Templates and Contract Headers Generation (Swct) automation API was added, see chapter 4.7.3 on page 124 for details.

8.5.12 BswmdModel

8.5.12.1 BswmdModel Groovy

Two new methods added to access the `BswmdModel` by MDF model objects in a generic way, without knowing a `DefRef`. This is handy, if you want traverse an unknown Ecu configuration structure.

- `GIContainer bswmdModel(MIContainer)`
- `GIModuleConfiguration bswmdModel(MIModuleConfiguration)` Both methods return the base bswmd model types for the corresponding MDF model objects.

New methods added to access `BswmdModel` elements by path and or by Type:

- `List bswmdModel(Class)`
- `List bswmdModel(Class, Closure)`
- `List bswmdModel(Class, String)`
- `List bswmdModel(Class, String, Closure)`

8.5.12.2 DerivativeMapping

Until R17 modules with DerivativeMapping were ignored from the DaVinciConfigurator and no BswmdModel classes were generated for these modules. Just the corresponding AsrXxx (e.g. AsrOs) model classes were included in the BswmdModel. Now the BswmdModel classes for these modules are generated for one certain derivative.

By default, the first derivative is selected, sorted by UUID. The AsrXxx usages have to be replaced by the actual module in the scripts. See 5.3.2.1 on page 275 for more details.

8.5.13 Mode Management Domain

Introduced BswM auto configuration API for automatically creating dedicated parts of the BswM configuration. See chapter 4.10.3.1 on page 150 for details.

8.5.14 Runtime System Domain

8.5.14.1 Data Mapping

'autoMapTo' allows control now about the handling of nested arrays of primitive. See 4.10.4.2 on page 175 and 4.10.4.2 on page 181.

8.6 Changes in MICROSAR AR4-R17 - Cfg5.14

8.6.1 General

This is the **first** stable version of the DaVinci Configurator AutomationInterface.

8.6.2 Script Execution

8.6.2.1 Stateful Script Tasks

A new API was added to support cache and retrieve data over multiple script task executions. See 4.4.10 on page 54 for more details.

8.6.3 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 298.

8.6.3.1 Groovy

The used Groovy version was updated from 2.4.5 to 2.4.7, please see Groovy website for details.

8.6.3.2 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2016.2 was added to the supported versions. See 7.5.1 on page 294 for details.

8.6.3.3 BuildSystem

Gradle The used default Gradle version was updated from 2.13 to 3.0, please see Gradle website for details.

useJarSignDaemon The useJarSignDaemon Gradle build setting added. See 7.9.3.5 on page 303 for details.

8.6.4 Converter Refactoring

The converters previously provided by `com.vector.cfg.automation.api.Converters` have been moved to the new `com.vector.cfg.automation.scripting.api.ScriptConverters` and `com.vector.cfg.model.groovy.api.ModelConverters`.

8.6.5 UserInteraction

UserInteraction API added to show messages to the user, see 4.4.5.1 on page 43.

8.6.6 Project Load

8.6.6.1 AUTOSAR Arxml Files

New API added to open AUTOSAR `arxml` files as a temporary project. See chapter 4.5.8 on page 73 for details.

8.6.7 Model

Script Tasks Types The existing script task type `DV_MODULE_ACTIVATION` renamed to the new name `DV_ON_MODULE_ACTIVATION`.

A new `DV_ON_MODULE_DEACTIVATION` task type added, which is execution when a module configuration is deleted.

8.6.7.1 Transactions

A new `ITransactionsApi` added which provide access to the `transactionHistory` and API to retrieve information of running transactions. A new method `transactions.isTransactionRunning()` added.

The `ITransactionHistoryApi` was moved to the new `ITransactionsApi`. The access to the history is now `transactions.transactionHistory{}`.

Operations The new operations added:

- `deactivateModuleConfiguration()` to delete a module configuration
- `activateModuleConfiguration(DefRef, String shortName)` to activate a module configuration with the specified short name
- `createModelObject(Class<T>)` to create arbitrary MDF model objects
- `parameter.setUserDefined(boolean)` method added to set and reset the user defined flag

8.6.7.2 MDF Model Read and Write

The whole MDF model API was changed from the old `mdfRead()` and `mdfWrite()` to one method `mdfModel()` with explicit write/create methods. You have to change all your `mdfRead()` and `mdfWrite()` calls to `mdfModel()`. And every `mdfWrite()` closure the implicit creation to explicit create calls.

This was necessary due to the fact that the old implicit API leads to surprising results, when methods are called, which use the read API, but called in a write context. So the method would yield different results, when called in different contexts.

The new MDF model API will never create any elements implicitly. Now there are explicit create methods, like in the `BswmdModel`:

- For 0:1 elements: `get<Element>OrCreate()` method
- For 0:* elements: `list.createAndAdd()` and `byNameOrCreate()` methods

The write context is not needed anymore, but you have to open a `transaction()` before calling any write API.

See the chapter 4.6.4.1 on page 90 for the read API and 4.6.4.3 on page 94 for the write API.

8.6.7.3 SystemDescription Access

The SystemDescription Access API added to retrieve paths to elements like flat map, flat extract and the corresponding model elements. See chapter 4.6.5 on page 107 for details.

8.6.7.4 ActiveEcuc

The class `IActiveEcuc` was renamed to `IActiveEcucApi` to reflect that it is not the active ecuc element, but the API of the active ecuc.

8.6.8 Persistency

New Persistency API added to import and export model data. See chapter 4.11 on page 230 for details.

8.6.9 Generation

The generation script tasks `DV_GENERATION_ON_START` and `DV_GENERATION_ON_END` renamed to `DV_ON_GENERATION_START` and `DV_ON_GENERATION_END`.

The new script task type `DV_CUSTOM_WORKFLOW_STEP` added to execute tasks in the custom workflow. See 4.3.1.4 on page 33 for details.

The return type of validation and generation methods has changed to `IGenerationResultModel`. This type provides more detailed information about the executed steps.

8.6.10 BswmdModel

8.6.10.1 Writing with BswmdModel

The `BswmdModel` supports now a write access for ecuc configuration elements. This means new elements can be created and existing elements can be modified and deleted by the `BswmdModel`. See 5.3.1.9 on page 271 for more details.

8.6.11 BswmdModel Groovy

bswmdModelRead The `BswmdModel` access was changed from the old `bswmdModelRead()` to the new `bswmdModel()` method. This was done to support the new write access.

Domain Object Navigation The `BswmdModel` API now support the navigation from domain model to the `BswmdModel`. See 4.6.3.7 on page 89.

8.6.12 Diagnostics Domain

Introduced new API which allows creation and querying of diagnostic events. Also OBD and J1939 state of the configuration can be queried.

8.6.13 Communication Domain

Communication Domain API moved from
`com.vector.cfg.dom.com.model.groovy` into
`com.vector.cfg.dom.com.groovy.api`.

Can Controller classes moved from
`com.vector.cfg.dom.com.model.groovy.can` into
`com.vector.cfg.dom.com.groovy.can`.

8.6.14 Runtime System Domain

Runtime System API `IRuntimeSystemApi` now provides functionality to map ports and system signals.

Entry points are the `selectComponentPorts`, `selectSignalInstances` and `selectCommunicationElements` methods.

8.7 Changes in MICROSAR AR4-R16 - Cfg5.13

8.7.1 General

This is the **first** version of the DaVinci Configurator AutomationInterface.

8.7.2 API Stability

The API is not stable yet and could still be changed in later releases. So it could be necessary to migrate your code when you update to later versions of the DaVinci Configurator.

8.7.3 Beta Status

Some features of the AutomationInterface are have beta status. This will change for later versions of the AutomationInterface. Which means that some features:

- Are not fully tested
- Missing documentation
- Missing functionality

9 Appendix

Nomenclature

AI Automation Interface

AUTOSAR AUTomotive Open System ARchitecture

CE Configuration Entity (typically a container or parameter)

Cfg DaVinci Configurator

Cfg5 DaVinci Configurator

DV DaVinci

IDE Integrated Development Environment

JAR Java Archive

JDK Java Development Kit

JRE Java Runtime Environment

MDF Meta-Data-Framework

MSN ModuleShortName

Figures

2.1	Script Samples location	13
2.2	Script Locations View	13
2.3	Script Tasks View	13
2.4	Create New Script Project... Button	14
2.5	Project Settings	15
2.6	Project Build	16
2.7	Project SDK Setting	17
2.8	Gradle JVM Setting	18
3.1	DaVinci Configurator components and interaction with scripts	19
3.2	Structure of scripts and script tasks	21
4.1	The API overview and containment structure	26
4.2	IScriptTaskType interfaces	31
4.3	Script Task Execution Sequence	38
4.4	ScriptingException and sub types	46
4.5	Search for active project in getActiveProject()	58
4.6	example situation with the GUI	127
5.1	ECUC container type inheritance	250
5.2	MIOBJECT class hierarchy and base interfaces	251
5.3	Autosar package containment	251
5.4	The ECUC container definition reference	252
5.5	Invariant views hierarchy	258
5.6	Example of a model structure and the visibility of the IInvariantValuesView	259
5.7	Variant specific change of a parameter value	262
5.8	Variant common change of a parameter value	263
5.9	The relationship between the MDF model and the BswmdModel	264
5.10	SubContainer DefRef navigation methods	267
5.11	Untyped reference interfaces in the BswmdModel	268
5.12	Creating a BswmdModel in the Post-build selectable use case	269
5.13	Class and Interface Structure of the BswmdModel	271
5.14	DefRef class structure	277
5.15	IParameterStatePublished class structure	280
5.16	IContainerStatePublished class structure	281
7.1	Project Build	294
7.2	Project Continuous Build	295
7.3	Stop Continuous Build	295
7.4	Disconnect from Continuous Build Process	295
7.5	Project Debug	296
7.6	Stop Debug Session	296
7.7	Disconnect from Debug Process	296
7.8	Activate the auto-import	302

Tables

5.1	Different Class types in different models	265
-----	---	-----

Listings

3.1	Static field memory leak	24
3.2	Memory leak with closure variable	25
4.1	Task creation with default type	27
4.2	Task creation with TaskType Application	28
4.3	Task creation with TaskType Project	28
4.4	Define two tasks is one script	28
4.5	Script creation with IDE support	28
4.6	Task with isExecutableIf	29
4.7	Script with description	29
4.8	Task with description	30
4.9	Task with description and help text	30
4.10	Access automation API in Groovy clients by the IScriptExecutionContext	36
4.11	Access to automation API in Java clients by the IScriptExecutionContext	37
4.12	Script task code block arguments	37
4.13	Resolves a path with the resolvePath() method	39
4.14	Resolves a path with the resolvePath() method	40
4.15	Resolves a path with the resolveScriptPath() method	40
4.16	Resolves a path with the resolveProjectPath() method	41
4.17	Resolves a path with the resolveSipPath() method	41
4.18	Resolves a path with the resolveTempPath() method	41
4.19	Get the project output folder path	42
4.20	Get the SIP folder path	42
4.21	Usage of the script logger	43
4.22	Usage of the script logger with message formatting	43
4.23	Usage of the script logger with Groovy GString message formatting	43
4.24	UserInteraction from a script	44
4.25	Display progress to the user	44
4.26	Display progress to the user nested	45
4.27	Display progress to the user with progress bar work	45
4.28	Stop script task execution by throwing an ScriptClientExecutionException	46
4.29	Changing the return code of the console application by throwing an ScriptClientExecutionException	47
4.30	Using your own defined method	48
4.31	Using your own defined class	48
4.32	Using your own defined method with a daVinci block	48
4.33	ScriptApi.scriptCode{} usage in own method	49
4.34	ScriptApi.scriptCode() usage in own method	49
4.35	ScriptApi.activeProject{} usage in own method	50
4.36	ScriptApi.activeProject() usage in own method	50
4.37	Script task UserDefined argument with no value	50
4.38	Define and use script task user defined arguments from commandline	51
4.39	Script task UserDefined argument with default value	51
4.40	Script task UserDefined argument with multiple values	51
4.41	Script task UserDefined argument with predefined validator	52
4.42	Script task UserDefined argument with own validator	52
4.43	executionData - Cache and retrieve data during one script task execution	54

4.44	sessionData - Cache and retrieve data over multiple script task executions	54
4.45	sessionData and executionData syntax samples	55
4.46	Call another script task from a script task	56
4.47	Call another script task with arguments	56
4.48	Accessing IProjectHandlingApi as a property	57
4.49	Accessing IProjectHandlingApi in a scope-like way	57
4.50	Switch the active project	58
4.51	Accessing the active IProject	59
4.52	Access and modify Project Settings - Variant 1	60
4.53	Access and modify Project Settings - Variant 2	60
4.54	Creating a new project (mandatory parameters only)	61
4.55	Creating a new project (with some optional parameters)	62
4.56	Creating a new project with custom VTT settings	68
4.57	Opening a project from .dpa file	69
4.58	Parameterizing the project open procedure	69
4.59	Create Ecu Configuration Report with default settings	71
4.60	Create Ecu Configuration Report	71
4.61	Opening, modifying and saving a project	72
4.62	Opening Arxml files as project	73
4.63	Create an empty AUTOSAR model	74
4.64	Read with BswmdModel objects starting with a module DefRef (no type declaration)	76
4.65	Read with BswmdModel objects starting with a module class (strong typing)	76
4.66	Read with BswmdModel objects with closure argument	77
4.67	Read with BswmdModel object for an MDF model object	77
4.68	Read with BswmdModel objects with the untyped model (DefRefAPI)	78
4.69	Write with BswmdModel required/optional objects	79
4.70	Write with BswmdModel multiple objects	80
4.71	Write with BswmdModel - Duplicate a container	80
4.72	Write with BswmdModel - Delete elements	81
4.73	Read system description starting with an AUTOSAR path in closure	82
4.74	Read system description starting with an AUTOSAR path in property style	83
4.75	Changing a simple property of an MIVariableDataPrototype	83
4.76	Creating non-existing member by navigating into its content with OrCreate()	83
4.77	Creating new members of child lists with createAndAdd() by type	84
4.78	Updating existing members of child lists with byNameOrCreate() by type	84
4.79	BswmdModel usage with import	85
4.80	Read with BswmdModel the EcuC module configuration	86
4.81	Read with BswmdModel the EcuC module configuration with DefRef	86
4.82	Write with BswmdModel the EcucGeneral container	86
4.83	Usage of the sipDefRef API to retrieve DefRefs in script files	87
4.84	Check if a definition exists in the SIP	87
4.85	Usage of generated DefRefs form the bswmd model	88
4.86	Usage of the untyped BswmdModel with SipDefRefs	89
4.87	Switch from a domain model object to the corresponding BswmdModel object	89
4.88	Navigate into an MDF object starting with an AUTOSAR path	90
4.89	Find an MDF object and retrieve some content data	91
4.90	Navigating deeply into an MDF object with nested closures	91
4.91	Ignoring non-existing member closures	91
4.92	Get a MIReferrable child object by name	92
4.93	Retrieve child from list with byName()	92

4.94	Get elements with <code>mdfModel(String)</code>	94
4.95	Changing a simple property of an <code>MIVariableDataPrototype</code>	95
4.96	Creating non-existing member by navigating into its content with <code>OrCreate()</code> . .	95
4.97	Creating child member by navigating into its content with <code>OrCreate()</code> with type	95
4.98	Creating new members of child lists with <code>createAndAdd()</code> by type	96
4.99	Updating existing members of child lists with <code>byNameOrCreate()</code> by type	98
4.100	Delete a parameter instance	99
4.101	Check is a model instance is deleted	99
4.102	Duplicates a container under the same parent	100
4.103	Get the <code>AsrPath</code> of an <code>MIReferrable</code> instance	100
4.104	Get the <code>AsrObjectLink</code> of an AUTOSAR model instance	100
4.105	Get the <code>DefRef</code> of an <code>Ecuc</code> model instance	100
4.106	Set the <code>DefRef</code> of an <code>Ecuc</code> model instance	100
4.107	Get the <code>CeState</code> of an <code>Ecuc</code> parameter instance	101
4.108	Retrieve the user-defined flag of an <code>Ecuc</code> parameter in Groovy	101
4.109	Set an <code>Ecuc</code> parameter instance to user defined	101
4.110	Get the <code>IEcucDefinition</code> of an <code>Ecuc</code> model instance	101
4.111	Get the <code>IEcucHasDefinition</code> of an <code>Ecuc</code> model instance	102
4.112	<code>referencesPointingToMe</code> sample	102
4.113	<code>systemDescriptionObjectsPointingToMe</code> sample	102
4.114	Derived Container API access	103
4.115	Delete a derived container unconditionally	103
4.116	Get the AUTOSAR root object	103
4.117	Get the active <code>Ecuc</code> and all module configurations	103
4.118	Iterate over all module configurations	104
4.119	Get module configurations by definition	104
4.120	Get subContainers and parameters by definition	104
4.121	Check parameter values	105
4.122	Get integer parameter value	106
4.123	Get reference parameter value	107
4.124	Get the <code>FlatExtract</code> and <code>FlatMap</code> paths by the <code>SystemDescription</code> API	107
4.125	Get <code>FlatExtract</code> instance by the <code>SystemDescription</code> API	107
4.126	Execute a transaction	108
4.127	Execute a transaction with a name	108
4.128	Check if a transaction is running	109
4.129	Undo a transaction with the <code>transactionHistory</code>	109
4.130	Redo a transaction with the <code>transactionHistory</code>	110
4.131	Activation of the <code>ModuleConfiguration</code> Dio	110
4.132	Model synchronization inside an open project	112
4.133	Retrieve and use a variant view by name	112
4.134	The default view is the <code>IPostBuildInvariantValuesView</code>	113
4.135	Execute code in a model view	114
4.136	Get a <code>UserAnnotation</code> of a container	115
4.137	Create a new <code>UserAnnotation</code>	116
4.138	Create or get the existing <code>UserAnnotation</code> by label name	116
4.139	Basic structure	117
4.140	Validate with default project settings	118
4.141	Generate with standard project settings	118
4.142	Generate one module	118
4.143	Generate one module	119
4.144	Generate two modules	119

4.145Generate one module with two configurations	120
4.146Execute an external generation step	120
4.147Retrieval of the TargetType of a Generation Step	121
4.148Evaluate the generation result	121
4.149Use a script task as generation step during generation	122
4.150Use a script task as custom workflow step	123
4.151Hook into the GenerationProcess at the start with script task	123
4.152Hook into the GenerationProcess at the end with script task	123
4.153Basic Swct structure	124
4.154SWC Templates and Contract Headers generation with standard project settings	124
4.155SWC Templates and Contract Headers generation of all components	125
4.156SWC Templates and Contract Headers generation of one selected component . .	125
4.157Swct generation get component and select component	125
4.158Swct generation of multiple components	126
4.159Access all validation-results and filter them by ID	128
4.160Solve a single validation-result with a particular solving-action	129
4.161Fast solve multiple results within one transaction	130
4.162Solve all validation-results with its preferred solving-action (if available)	130
4.163Access all validation-results of a particular object	131
4.164Access all validation-results of a particular DefRef	132
4.165Filter validation-results using an ID constant	132
4.166Fast solve multiple validation-results within one transaction using a solving- action-group-ID	133
4.167IValidationResultUI overview	134
4.168IValidationResultUI in a variant (post build selectable) project	134
4.169CE is affected by (matches) an IValidationResultUI	135
4.170Advanced use case - Retrieve Erroneous CEs with descriptors of an IValidation- ResultUI	136
4.171Examine an ISolvingActionSummaryResult	137
4.172Create a ValidationResult	138
4.173Report a ValidationResult when MD license option is available	138
4.174Turn off auto solving action execution	139
4.175"Update existing project"	140
4.176Change list of communication extracts and update	141
4.177Accessing IDomainApi as a property	143
4.178Accessing IDomainApi in a scope-like way	143
4.179Accessing ICommunicationApi as a property	143
4.180Accessing ICommunicationApi in a scope-like way	144
4.181Optimizing Can Acceptance Filters	145
4.182Accessing IDiagnosticsApi as a property	147
4.183Accessing IDiagnosticsApi in a scope-like manner	147
4.184Create a new UDS DTC with event	148
4.185Enable OBD II and create a new OBD related DTC with event	148
4.186Enable WWH-OBd and create a new OBD related DTC with event	149
4.187Open a project, enable J1939 and create a new J1939 DTC with event	149
4.188Accessing IModeManagementApi as a property	150
4.189Accessing IModeManagementApi in a scope-like way	150
4.190ECU State Handling Auto Configuration	151
4.191Inspecting Auto Configuration Elements	152
4.192Accessing IRuntimeSystemApi as a property	153
4.193Accessing IRuntimeSystemApi in a scope-like way	153

4.194	Selects all component ports	156
4.195	Selects all unconnected component ports	157
4.196	Select all unconnected sender/receiver or connected mode-switch component ports	157
4.197	Selects not completed component ports	158
4.198	Use origin context predicates for selecting component ports	158
4.199	Tries to auto-map all ports	159
4.200	Tries to auto-map all unconnected component ports	159
4.201	Tries to auto-map all unconnected sender/receiver and client/server ports	160
4.202	Tries to auto-map port determined by advanced filter	160
4.203	Tries to auto map all unconnected ports to the ports of one component prototype	161
4.204	Tries to auto-map all unconnected ports and evaluate matches	162
4.205	Another example for using evaluate matches	163
4.206	Auto-map a component port and realize 1:n connection by using evaluate matches	164
4.207	Create mapping between two ports which names do not match.	165
4.208	Use the origin context for the port name matching	166
4.209	Example how to create a simple assembly connection	167
4.210	Example how to create a simple delegation connection	167
4.211	Create connector with port interface mapping	168
4.212	Terminate port using the component port selection API	169
4.213	Remove port terminator using the component port selection API	169
4.214	Create a port terminator using the simple API	170
4.215	Remove a port terminator using the simple API	170
4.216	Select all unmapped signal instances	173
4.217	Select all unmapped rx or transformed signal instances	173
4.218	Select signal instances using an advanced filter	174
4.219	Auto data map all unmapped signal instances	174
4.220	Auto data map all unmapped signal instances to unmapped communication ele- ments and evaluate	175
4.221	Auto data map all signal instances and do not expand nested array elements . .	176
4.222	Auto data map all signal instances and expand specific nested array element . .	177
4.223	Select all unmapped delegation port communication elements	179
4.224	Select communication elements using an advanced filter	179
4.225	Auto data map all unmapped sender/receiver delegation port communication elements	180
4.226	Auto data map all unmapped communication elements to unmapped rx signal instances and evaluate	181
4.227	Autodatamap and do not expand nested array elements	182
4.228	Autodatamap and do expand a specific nested array element	183
4.229	Create sender receiver to signal mapping	185
4.230	Create data mapping for delegation port	185
4.231	Create client server to signal mapping	186
4.232	Map record to signal group	187
4.233	Map array to signal group	188
4.234	Terminate port using the communication element selection API	189
4.235	Remove port terminator using the communication element selection API	190
4.236	Select component type by name	191
4.237	Select not instantiated component types	192
4.238	Create component prototypes for not instantiated types	192
4.239	Specify name of created component	193
4.240	Create more than 1 component prototype	193
4.241	Switch between MDF and model abstraction example	195

4.242Select events example	198
4.243Select executable entities example	200
4.244Check which events are currently mapped to OsTask	206
4.245Perform task mapping example	207
4.246Do not combine runnable and bsw module entity via symbol	208
4.247Map all events of a runnable together	208
4.248Manually order the task mappings	209
4.249Order task mappings on OsTask	210
4.250Use execution order constraints for the task mapping	211
4.251Filter task mappings	212
4.252Use the queue option example	212
4.253Advanced Filter for Events	213
4.254Simple example of ordering the task mappings	214
4.255Set the activation offset while mapping to a task	215
4.256Order the task mappings by defining successor relationships	216
4.257Order groups by using successor calls	217
4.258Set the activation offset using the event selection	218
4.259Set the activation offset using the executable entity selection	219
4.260Select PortInterface by name and type	221
4.261Select PortInterfaces by component ports	221
4.262Create delegation port simple	222
4.263Create delegation port customized	223
4.264Create delegation port with name of other port	224
4.265Select ends of incomplete connections	228
4.266Select the ends of incomplete connections for a specific flat extract component port	228
4.267Create a delegation port using the port interface of an origin context port	229
4.268Accessing the model export persistency API	230
4.269Export the ActiveEcuc to a file	230
4.270Export the ActiveEcuc into a folder	230
4.271Export a PostBuild project into files per predefined variant	231
4.272Export a PreBuild project into files per predefined variant	231
4.273Export the project with an exporter into a folder	232
4.274Export the project with an exporter and checks	232
4.275Export an AUTOSAR package into a file	233
4.276Export an AUTOSAR package into a folder	233
4.277Exports two elements and all references elements	233
4.278Use exporter arguments like in the commandline	234
4.279Accessing the model import persistency API	234
4.280Accessing the import module configuration persistency API	234
4.281Specify the module configuration import mode and filter	235
4.282Java code usage of the IScriptFactory to contribute script tasks	239
4.283Accessing WorkflowAPI in Java code	240
4.284Java Closure creation sample	240
4.285Run all JUnit tests from one class	241
4.286Run all JUnit tests using a Suite	241
4.287Run unit test with the Spock framework	242
4.288Additional Spock dependency in Gradle	242
4.289Add a UnitTest task with name MyUnitTest	242
4.290The projectConfig.gradle file content for unit tests	243
4.291Usage of the ITransactionUndoAllRule in a JUnit test	243
4.292Usage of the IProjectLoadRule in a JUnit test	243

4.293	DaVinci Configurator build Gradle DSL API - generatorTests	245
4.294	DaVinci Configurator build Gradle DSL API - generatorTests - genDevKit . . .	245
4.295	Spock test using a GeneratorPackage	246
4.296	JUnit test using a GeneratorPackage	246
4.297	Spock test case which generates an OutputFile and verifies the content	246
4.298	JUnit test case which generates an OutputFile and verifies the content	247
4.299	Spock test case which verifies a ValidationResult	247
4.300	JUnit test case which verifies a ValidationResult	248
5.1	Check object visibility	255
5.2	Get all available variants	255
5.3	Execute code with variant visibility	255
5.4	Get all variants, a specific object is visible in	257
5.5	Retrieving an InvariantValues model view	259
5.6	Retrieving an InvariantEcucDefView model view	260
5.7	Execute code with variant specific changes	262
5.8	Sample code to access element in an Untyped model with DefRefs	266
5.9	Resolves a Reference target of a Reference Parameter	266
5.10	The value of a GIPParameter	266
5.11	Java: Execute code with creation IModelView of BswmdModel object	269
5.12	Java: Execute code with creation IModelView of BswmdModel object via runnable	270
5.13	Java: Execute code with creation IModelView of BswmdModel object	270
5.14	Additional write API methods for EcucGeneral	272
5.15	EcucCoreDefinition as GICList<EcucCoreDefinition>	273
5.16	Deleting model objects	273
5.17	Duplication of containers	274
5.18	Set parameter values with the BswmdModel Write API	274
5.19	Set reference targets with the BswmdModel Write API	274
5.20	Settings.xml sample for DerivativeMapping	275
5.21	DefRef isDefinitionOf methods	277
5.22	Creation of DefRef with wildcard from EDefRefWildcard	279
5.23	Getting CeState objects using the BSWMD model	279
5.24	Integer parameter definition access examples	281
5.25	Integer parameter configuration access examples	286
7.1	The automationClasses list in projectConfig.gradle	300
7.2	The dvCfgInstallation in projectConfig.gradle	300
7.3	The dvCfgInstallation with an System env in projectConfig.gradle	300
7.4	@CompileStatic with Automation API	302
7.5	@TypeChecked with Automation API	302
7.6	DaVinci Configurator build Gradle DSL API	303
7.7	DaVinci Configurator build Gradle DSL API - useBswmdModel	303
7.8	DaVinci Configurator build Gradle DSL API - useJarSignerDaemon	303
7.9	DaVinci Configurator build Gradle DSL API - includeDependenciesIntoJar . . .	304
8.1	Additional Groovy XML dependency	308

Todo list