DaVinci Configurator AutomationInterface

Development Documentation of the AutomationInterface (AI)

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Contents

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 19 for details.

Debugging Support The scripts can be debugged via IntelliJ IDEA. See 7.8 on page 251.

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.

[1] See chapter 7 on page 246 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 13.

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.

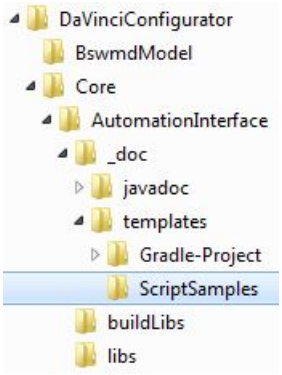


Figure 2.1: Script Samples location

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.

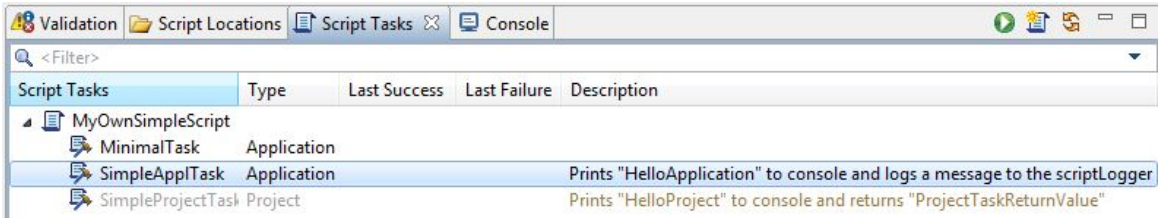


Figure 2.3: Script Tasks View

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 25. 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 16.
- **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 16.
- **Build system**: To build the script project the build system Gradle is required. See chapter 2.4.4 on page 17 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** dialogs 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 17.
- **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.

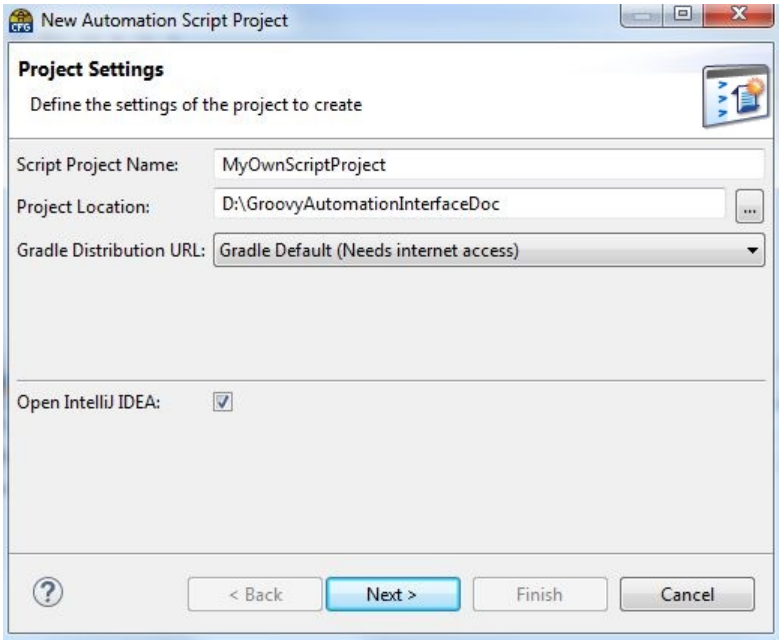


Figure 2.5: Project Settings

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 25. 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 247. If you have trouble with IntelliJ, see 7.5.4 on page 249.

Debugging To debug the script project follow the instructions in chapter 7.8 on page 251.

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 11. 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 246.

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. Download[1] a version that supports Java and Groovy and that is in the list of supported versions (see list 7.5.1 on page 247).

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.

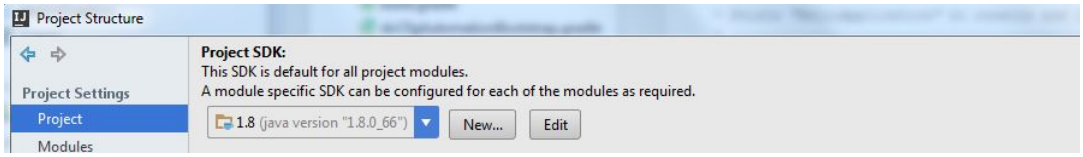


Figure 2.7: Project SDK Setting

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`

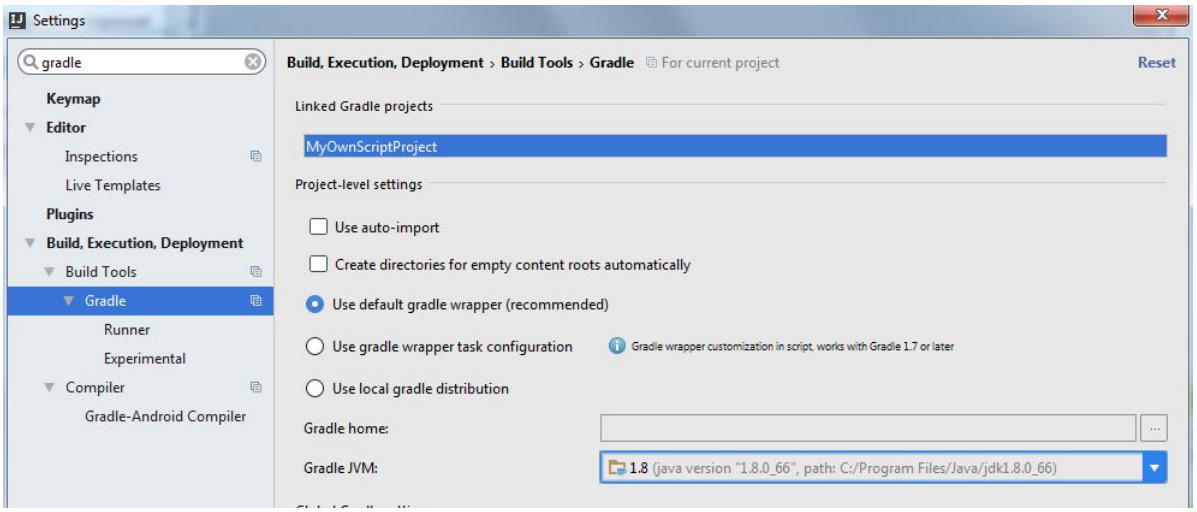


Figure 2.8: Gradle JVM Setting

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 252 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.

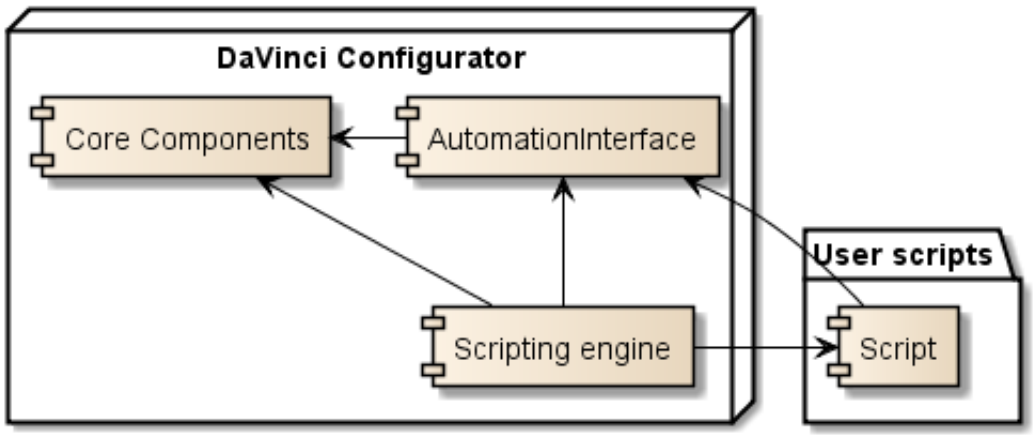


Figure 3.1: DaVinci Configurator components and interaction with scripts

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

- Stable API for script writters
  - 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:

- Java[1]
- Groovy[2]

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 developers[3].

- Groovy syntax is 95%-compatible with Java[4]
- 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]

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

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

[5] Groovy 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`.

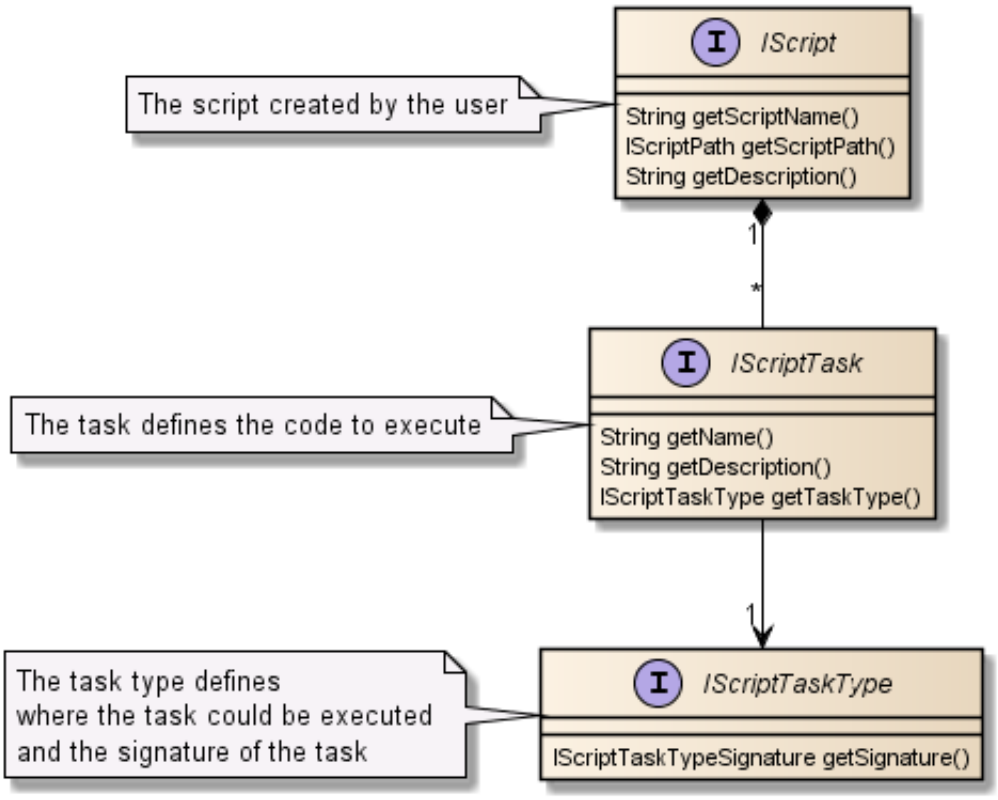


Figure 3.2: Structure of scripts and script tasks

You create the `IScript` and `IScriptTask` instance with the API described in chapter 4.2 on page 26.

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 30 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 246.

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 246 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 30 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.

[6] https://www.ietf.org/rfc/rfc2119.txt

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:

```
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 52 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 18 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.

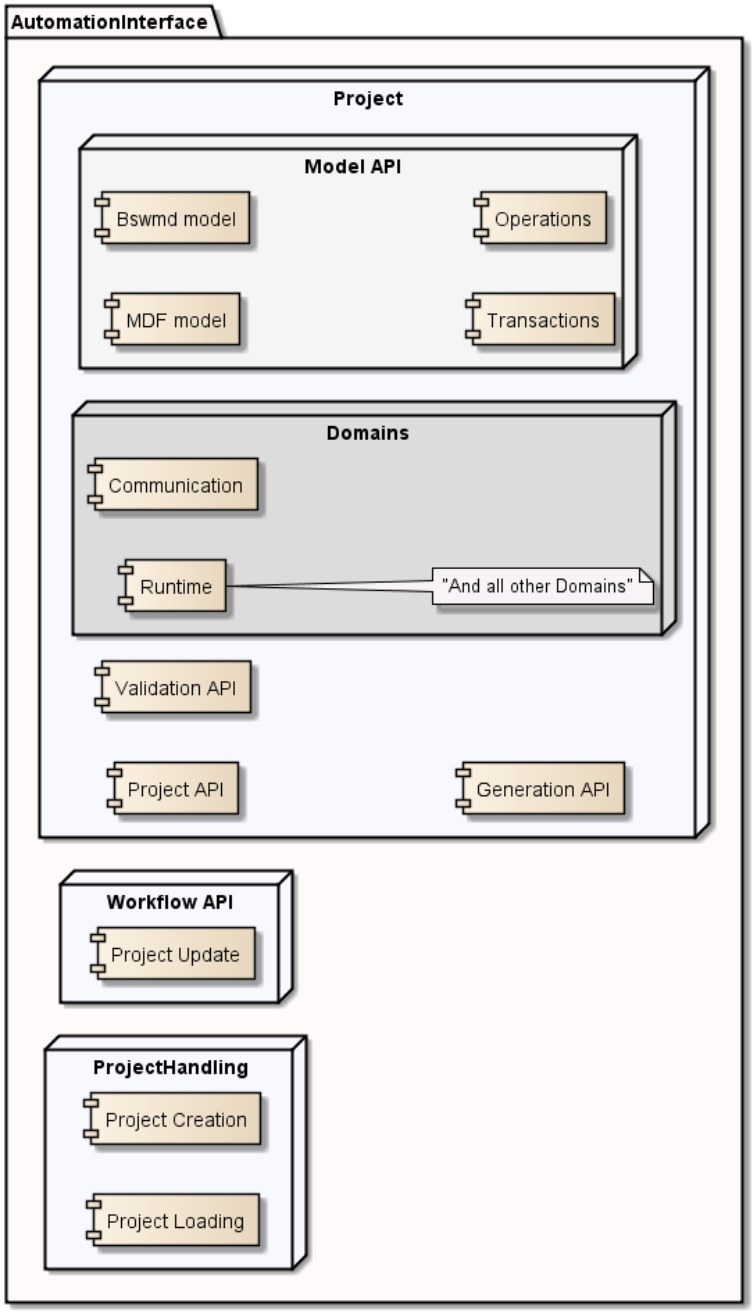


Figure 4.1: The API overview and containment structure

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 Workflow Update 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 30 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 30


```
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 is 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 22.

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

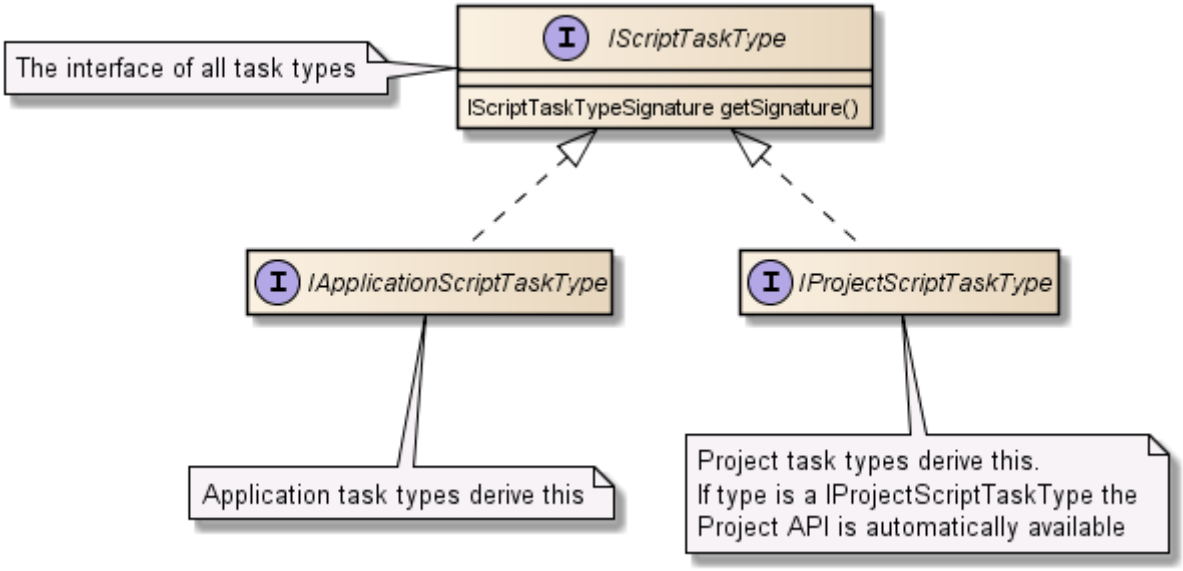


Figure 4.2: IScriptTaskType interfaces

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 115 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 115 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 115 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 115 for usage samples.

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 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 30 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 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.

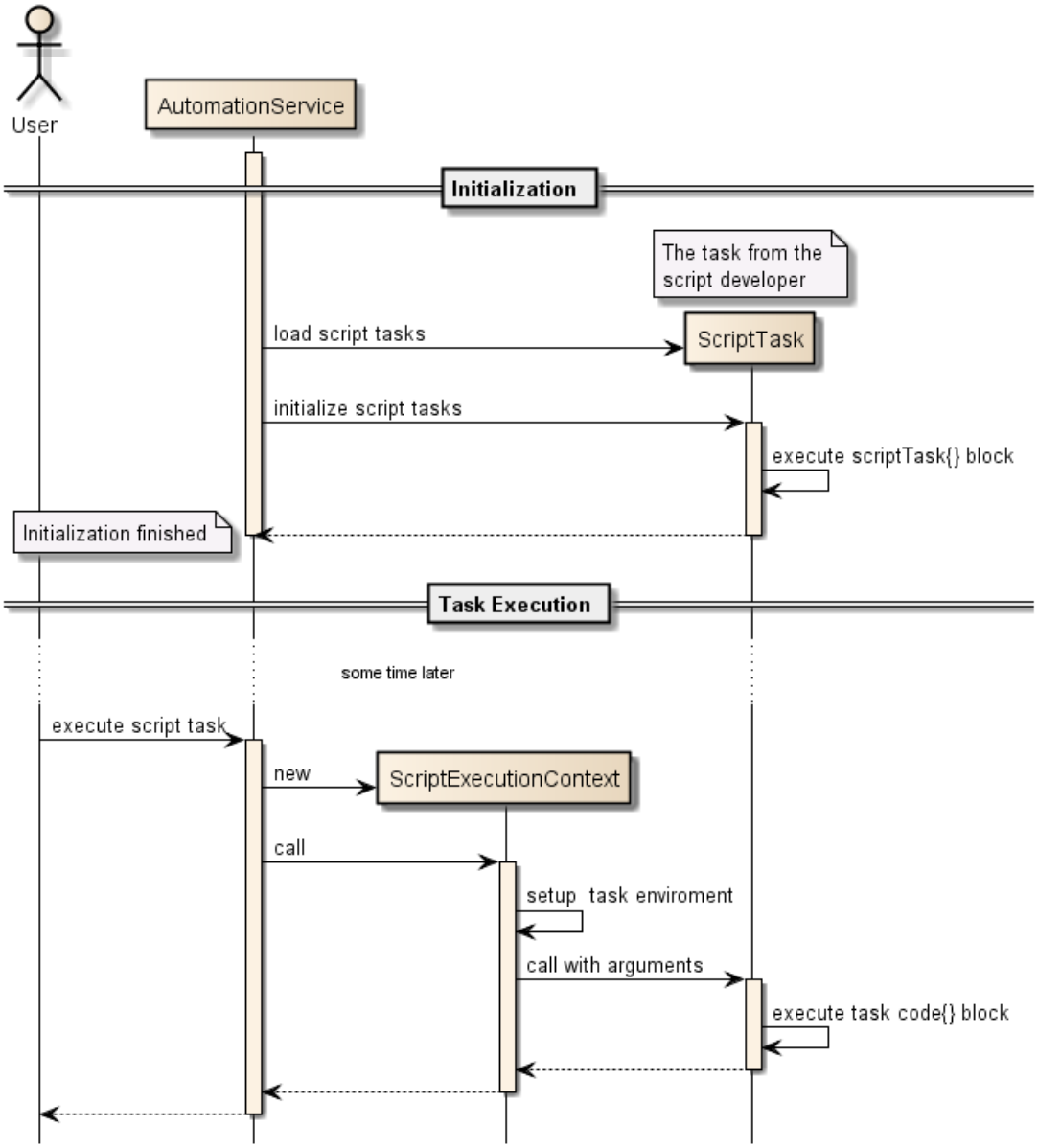


Figure 4.3: Script Task Execution Sequence

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 55 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 37.

```
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 37.

```
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 an 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`.

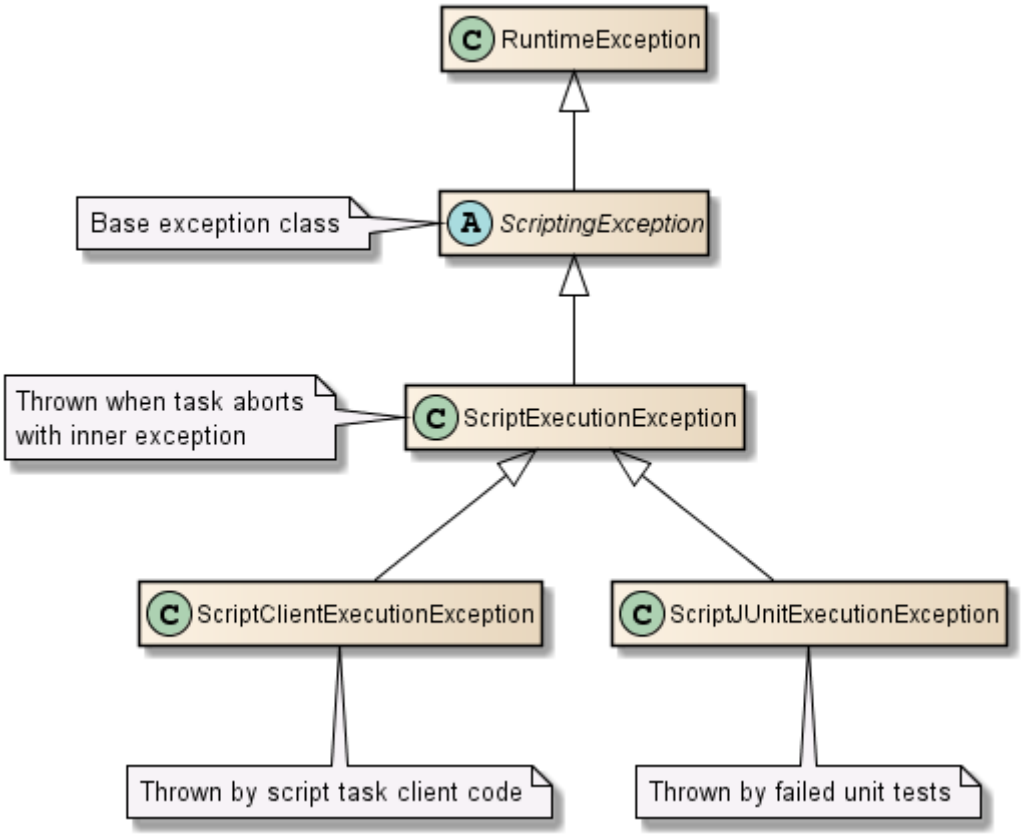


Figure 4.4: ScriptingException and sub types

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 reversed 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 a 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 193 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, your 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.

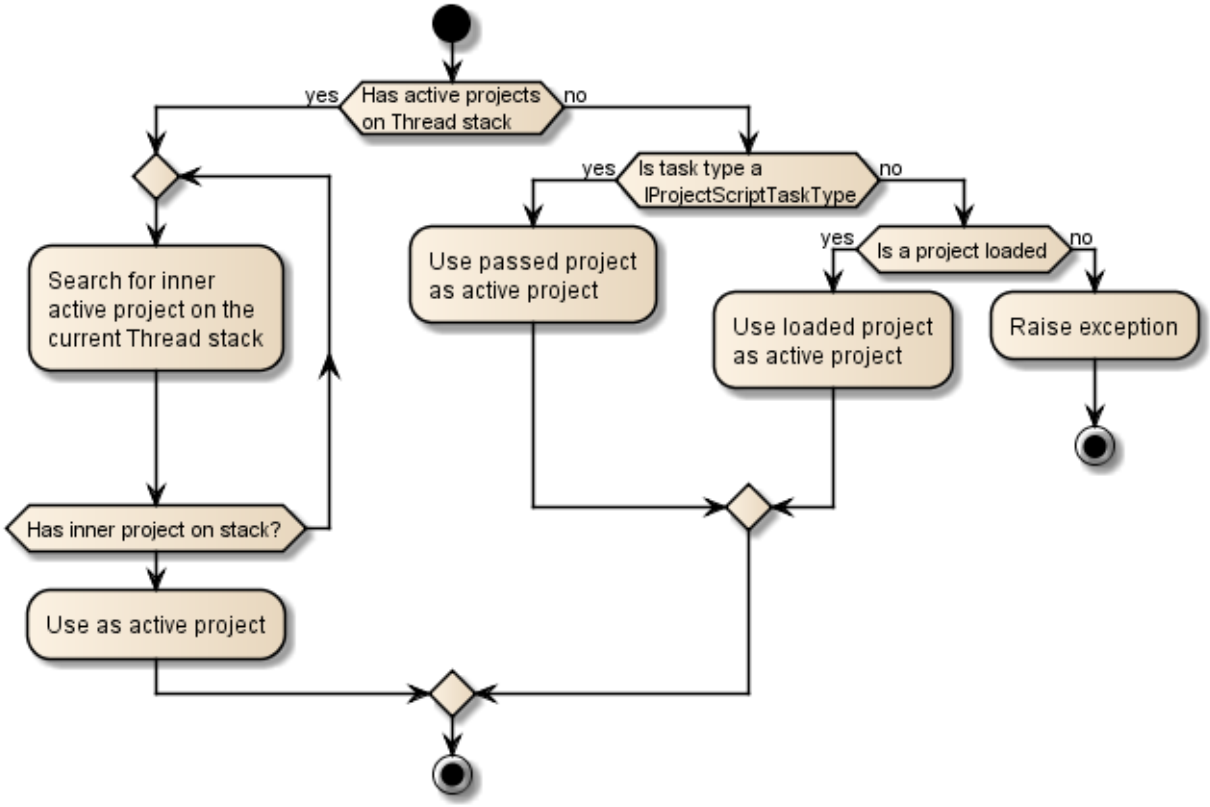


Figure 4.5: Search for active project in getActiveProject()

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 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 4.52: 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 4.53: Creating a new project (with some optional parameters)

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

4.5.3.1 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 193

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 194.

The following constraints apply:

- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 193

4.5.3.2 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 193

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 194.

The following constraints apply:

- `Constraints.IS_NOT_NULL` 4.12.1 on page 193

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 193

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.

4.5.3.3 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)`. This is an optional parameter defaulting to the first element in the collection returned by `getAvailableDerivatives()` (or `null` if the collection is empty). The value given here must be one of the values returned by `getAvailableDerivatives()`.

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)`. This is an optional parameter defaulting to the first element in the collection returned by `getAvailableCompilers()` (or `null` if the collection is empty). The value given here must be one of the values returned by `getAvailableCompilers()`.

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)`. This is an optional parameter defaulting to the first element in the collection returned by `getAvailablePinLayouts()` (or `null` if the collection is empty). The value given here must be one of the values returned by `getAvailablePinLayouts()`.

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

4.5.3.4 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.

4.5.3.5 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 194. 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 193

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 194. 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 193

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 194. 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 193

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 194. 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 193

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 194. 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 193

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 194. 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 193

AUTOSAR Files Folder Set the AUTOSAR files folder for the new project with `setAutosarFilesFolder(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 194. 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 193

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.

4.5.3.6 DaVinci Developer Settings

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

`ICreateProjectDaVinciDeveloperApi` contians 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 194.

The following constraints apply:

- `Constraints.IS_COMPATIBLE_DA_VINCI_DEV_EXECUTABLE` 4.12.1 on page 194

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 194. 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 194
- `Constraints.IS_CREATABLE_FOLDER` 4.12.1 on page 193 (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.

4.5.3.7 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 4.54: 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 194.

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 194.

4.5.4 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 194

```
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 4.55: Opening a project from .dpa file

4.5.4.1 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 4.56: 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 194.

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.

4.5.4.2 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)` 4.5.3 on page 57
- `IProjectHandlingApi.parameterizeProjectLoad(Closure)` 4.5.4 on the preceding 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.

4.5.5 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 4.57: Opening, modifying and saving a project

4.5.6 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 4.58: 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 194.

Raw AUTOSAR Data Mode the method `setRawAutosarDataMode(boolean)` specifies whether or not to use the raw ATUOSAR 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 disabled, see below for details.

4.5.6.1 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 4.59: 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 201 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 base on the AUTOSAR MetaModel. In 5.1 on page 201 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 79 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 4.60: 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 4.61: 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 4.62: 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 4.63: Read with BswmdModel object for an MDF model object

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 80 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 4.64: 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 4.65: 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 4.66: 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 4.67: 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 83 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 4.68: 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 4.69: 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 87 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 101 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 4.70: 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 4.71: 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 4.72: 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 4.73: 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 215.

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 4.74: 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 85 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 4.75: 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 4.76: Read with BswmdModel the EcuC module configuration with DefRef

For more usage samples please see chapter 4.6.2.1 on page 70.

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 4.77: Write with BswmdModel the EcucGeneral container

For more usage samples please see chapter 4.6.2.2 on page 73.

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 223 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.EcucGeneral
  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/EcucGeneral"]
  theDefRef = sipDefRef["/MICROSAR/Dio"]
  theDefRef = sipDefRef["/MICROSAR/Dio/DioConfig/DioPort"]
}
```

Listing 4.78: Usage of the sipDefRef API to retrieve DefRefs in script files

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 79 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 4.79: Usage of generated DefRefs form the bswmd model

4.6.3.6 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 4.80: 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 201.

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 85 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 4.81: 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 4.82: 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 4.83: 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 4.84: 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 '/').

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

Listing 4.85: Get a MIReferrable 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 = mdfModel(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 4.86: 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 `mdfModel(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 `mdfModel(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 `MIParamConfMultiplicity`)
  - 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]*[123l]\$" }`
  - `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 potential slow operation, you should use other `mdfModel()` methods, if possible. Because this method must traverse the whole model in some cases.

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

Listing 4.87: Get elements with mdfModel(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]*[123l]\$" }`
- `/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 `mdfModel(AsrPath)` API, but you have to call specific methods to modify the model objects. The methods are devided in the following use cases:

- Change a simple property like `String`s
- Change or create a single child relateion (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 101 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 4.88: 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 and 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 4.89: 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 4.90: 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 91.

```
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 4.91: 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 thrown 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 thrown 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 thrown 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 thrown a `ModelException`.

- The method `createAndAdd(Class, String)` creates a new `MIReferrable` 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 `MIReferrable` 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 `MIReferrable` 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 `MIReferrable` 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 4.92: 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 `IOperations.deactivateModuleConfiguration(MIModuleConfiguration)` to deactivate the module correctly.

```
// MIParameterValue param = ...

transaction {
    assert !param.isDeleted()
    param.delete()
    assert param.isDeleted()
}
```

Listing 4.93: 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 206 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 4.94: 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 unambiguousness

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 4.95: 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 4.96: Get the AsrPath of an MIReferrable instance

See chapter 5.4.2 on page 227 for more details about AsrPaths.

asrObjectLink The `getAsrObjectLink(MIARObject)` method returns the `AsrObjectLink` of the specified object.

```
MIParameterValue param = ...
AsrObjectLink link = param.asrObjectLink
```

Listing 4.97: Get the AsrObjectLink of an AUTOSAR model instance

See chapter 5.4.3 on page 228 for more details about AsrObjectLinks.

defRef The `getDefRef()` method returns the `DefRef` of the model object.

```
MIParameterValue param = ...
DefRef defRef = param.defRef
```

Listing 4.98: Get the DefRef of an Ecuc model instance

The `MIParameterValue.setDefRef(DefRef)` method sets the definition of this parameter to the defRef.

```
MIParameterValue param = ...
DefRef newDefinition = ...
param.defRef = newDefinition
```

Listing 4.99: 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 is 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 229 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.

```
MIParameterValue param = ...
IParameterStatePublished state = param.ceState
```

Listing 4.100: Get the CeState of an Ecuc parameter instance

See chapter 5.4.5 on page 232 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.

```
MIParameterValue param = ...
def flag = param.ceState.userDefined
```

Listing 4.101: 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 executed inside a transaction because it modifies the model state.

```
MIParameterValue param = ...
transaction {
  param.ceState.userDefined = true
}
```

Listing 4.102: 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 234)
- EcucDefinitionAccess (see 5.5.2 on page 238)

The `getEcucDefinition()` method returns the `IEcucDefinition` of the model object.

```
MIParameterValue param = ...
IEcucDefinition definition = param.ecucDefinition
```

Listing 4.103: Get the IEcucDefinition of an Ecuc model instance

The `getEcuConfiguration()` method returns the `IEcucHasDefinition` of the model object.

```
MIParameterValue param = ...
IEcucHasDefinition cfg = param.ecuConfiguration
```

Listing 4.104: Get the IEcucHasDefinition 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 (`MIReferrable`) 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 (`MIReferrable`) 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 4.105: 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 4.106: 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 4.107: 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 with be deleted by means of `moRemove()`

```
transaction{
    container.derived.delete()
}
```

Listing 4.108: 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 4.109: 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 4.110: 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 4.111: 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 4.112: 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 4.113: 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(MIParameterValue)`
  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 4.114: 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 4.115: 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 4.116: 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 4.117: 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 4.118: 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 205.

```
scriptTask("TaskName", DV_PROJECT){
    code {
        transaction{
            // Your transaction code here
        }
    }
}
```

Listing 4.119: Execute a transaction

```
scriptTask("TaskName", DV_PROJECT){
    code {
        transaction("Transaction name") {
            // The transactionName property is available inside a transaction
            String name = transactionName
        }
    }
}
```

Listing 4.120: 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 4.121: 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 4.122: 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 4.123: 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/EcucDefs/Dio`.

```
transaction{
    // Activates the Dio module
    operations.activateModuleConfiguration(sipDefRef.Dio)
}
```

Listing 4.124: 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.
- 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.
- `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 method `createUniqueMappedAutosarPackage()` can be used to create new `MIARPackage`s 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 4.125: 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 variance and model views read 5.2 on page 207.

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 of 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 4.126: 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 4.127: 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.
- The method `getPostBuildInvariantEcucDefView()` returns the PostBuild invariant Ecuc definition view.
- 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 PostBuld 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 209.
- 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 4.128: 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 210.
- 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`
- `MIParameterValues`
- `MIIdentifiables`

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
- `moRemove()` - 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 4.129: 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 4.130: Create a new UserAnnotation

```
transaction{
    // We already have the container "cont"
    def anno = cont.userAnnotations.byLabelOrCreate("MyAnno")
    anno.text = "My Text"
}
```

Listing 4.131: Create or get the existing UserAnnotation by label name

Notes The `IUserAnnotationList` is not updated, when the underlying model changes. You have to retrieve a new instance of `IUserAnnotationList` to reflect 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 117

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 4.132: 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 4.133: 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 4.134: 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 4.135: 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)
            }
            generate()
        }
    }
}
```

Listing 4.136: 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")
            }
            generate()
        }
    }
}
```

Listing 4.137: 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 4.138: 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 4.139: 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 4.140: 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 4.141: Evaluate the generation result

4.7.2 Generation Task Types

There are three types of `IScriptTaskTypes`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 32. 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 4.142: 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 130 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 4.143: 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 4.144: 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 4.145: 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 4.146: 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 4.147: 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 4.148: 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 4.149: 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 4.150: 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 4.151: 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 114 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 letter 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.

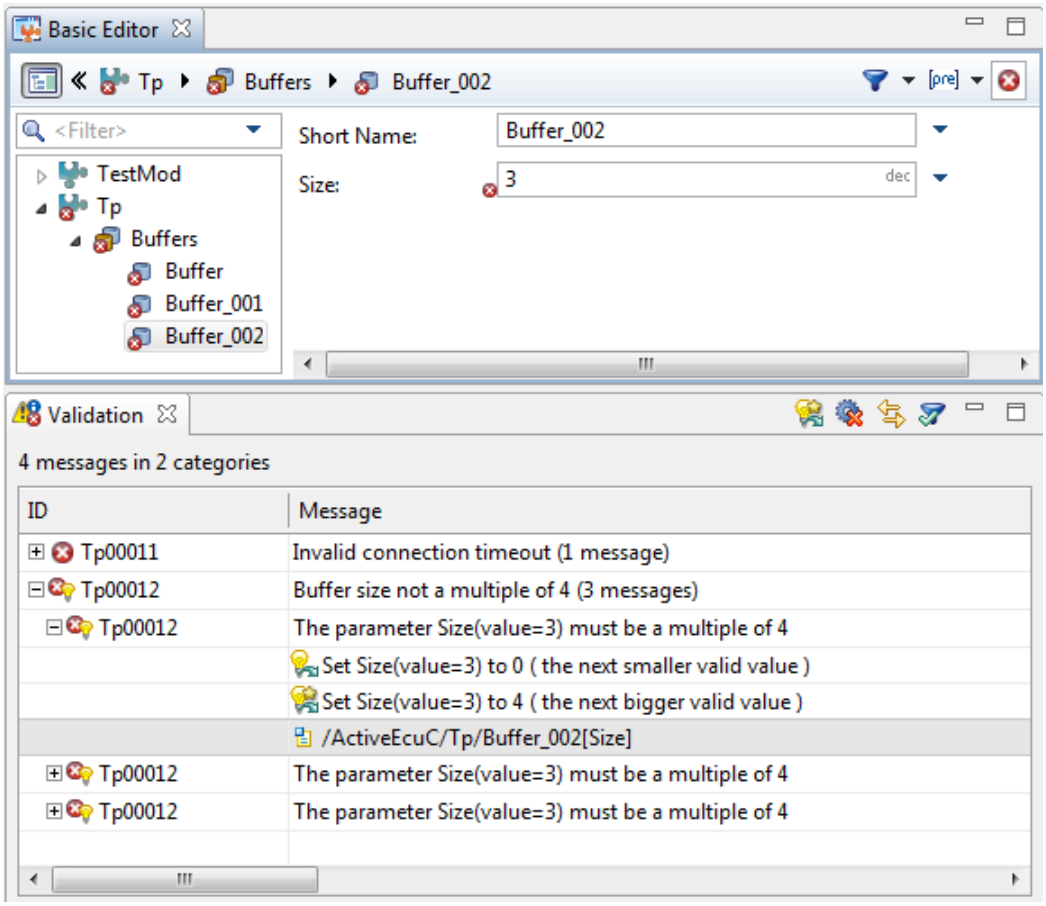


Figure 4.6: example situation with the GUI

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 4.152: 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 4.153: 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 validationResults.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 validationResults.size() == 1
      // Three Tp12 and zero Com34 (didn't exist) results solved. One other
          left
}}}
```

Listing 4.154: 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 validationResults.size() == 4

      solver.solveAllWithPreferredSolvingAction()

      assert validationResults.size() == 1

      // this would do the same
      transactions.transactionHistory.undo()
      assert validationResults.size() == 4

      solver.solve{
        result{true}.withAction{preferred}
      }

      assert validationResults.size() == 1
}}}
```

Listing 4.155: 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 `IValidationResultUI.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 4.156: 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 4.157: 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 validationResults.size() > 3
            assert validationResults.filter{it.isId(*tp12Const)}.size() == 3
        }
    }
}
```

Listing 4.158: 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 validationResults.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 validationResults.size() == 1
      // Three Tp12 validation-results solved.
    }
  }
}
```

Listing 4.159: Fast solve multiple validation-results within one transaction using a solving-action-group-ID

4.8.5.5 Validation-Result Description as MixedText

`IValidationResultUI.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 IValidationResultUI Methods

The following listing gives an overview of other "properties" of an IValidatonResultUI.

```
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 4.160: 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 4.161: 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 4.162: 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 4.163: 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 validationResults.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 validationResults.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 4.164: Examine an ISolvingActionSummaryResult

4.8.5.10 Create a Validation-Result in a Script Task

The `resultCreation` API provides methods to create new `IValidationResults`, which could then be reported to a `IValidationResultSink`. This is can be used to report validation-results similar to a validator/generator, but from within a script task.

ValidationResultSink The `IValidationResultSink` must be obtained by the context and is not provided by the creation API. E.g. some script tasks pass an `IValidationResultSink` 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 `IValidationResultSink` 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 4.165: 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 4.166: 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 validaton-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 4.167: 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 37.

```
scriptTask("UpdateExistingProject", DV_APPLICATION) {
    code {
        workflow.update pathToDpaFile
    }
}
```

Listing 4.168: "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 4.169: 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.

Becaue 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 4.170: 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 4.171: 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 4.172: 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 4.173: 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 XXXXXXXXXXX
          assert 'XXXXXXXXXXX' == ch0.canFilterMasks[0].filter

          // set CanFilterMask value to 01111111111
          ch0.canFilterMasks[0].filter = '01111111111'
          assert '01111111111' == ch0.canFilterMasks[0].filter

          // automatic acceptance filter optimization
          ch0.optimizeFilters { fullCan = true }
        }
      }
    }
    scriptLogger.info('Successfully optimized Can acceptance filters.')
  }
}
```

Listing 4.174: 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 136 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 4.175: 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 4.176: 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 `isWwhObdEnabled()` checks, if WWH-OBD is available in the configuration.

Enable WWH-OBD `setWwhObdEnabled(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 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 4.177: 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 4.178: 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 du 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 4.179: 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 4.180: 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 136 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 4.181: 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 4.182: 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 4.183: 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 isActivated = bswMAutoConfigDomain 'Ecu State Handling' feature '/ECU
        State Machine/Support ComM' activated
    if (isEnabled && isActivated) {
      // 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 4.184: 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 136) 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 4.185: 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 4.186: 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.
- `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 an 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.
- `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.
- `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 4.187: 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 4.188: 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 4.189: Select all unconnected sender/receiver or connected mode-switch 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 4.190: 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 4.191: 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 4.192: 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 4.193: 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 my 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 4.194: 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 4.195: 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 4.196: 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 4.197: 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 4.198: Create mapping between two ports which names do not match.

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 4.199: 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 4.200: 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 mdfObject = signalInstance.getMdfObject()
                           // work on directly on autosar model level ...
                           // select signal instance only which has admin data
                           def select = false
                           mdfObject.adminData {
                              select = true
                           }
                           select
                    }
                  } getSignalInstances()
        scriptLogger.infoFormat("Selected {0} signal instances.",
            signalInstances.size())
      }
    }
  }
}
```

Listing 4.201: 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 4.202: 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 communciation 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 4.203: 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_f1d3783e235e88d3")) {
                  // 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 4.204: 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")) {
                      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 4.205: 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.
- `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 4.206: 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 mdfDataElement = comElement.
                          getDataElementOrOperationMdfObject()
                      // check directly on autosar model level
                      return mdfDataElement.type.refTarget.name.equals("
                          myCustomDataType")
                   }
                   false
               }
             } getCommunicationElements()
        scriptLogger.infoFormat("Selected {0} communication elements.",
            comElements.size())
      }
    }
  }
}
```

Listing 4.207: 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 communciation 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 4.208: Auto data map all unmapped sender/receiver delegation port communication elements

`autoMapTo(Closure)` tries to auto-map the selection of communciation 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 4.209: 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 4.210: 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 4.211: Autodatamap and do expand a specific nested array element

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 componet 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.
- `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 4.212: 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 4.213: 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 4.214: 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 4.215: 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 4.216: 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 MIObject.

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 4.217: 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 swc mode switch events.
- `modeSwitchedAck()` matches events (triggers) which are mode switched acknowledgement events.
- `externalTrigger()` matches events (triggers) which are external trigger occured events.
- `internalTrigger()` matches events (triggers) which are internal trigger occured 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 4.218: Select events example

Selecting and task mapping executable entities `selectExecutableEntities(Closure)` allows the selection of `IExecutableEntitys` 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 exectuable 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 4.219: 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.

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.

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.

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 4.220: 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 4.221: 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 4.222: Map all events of a runnable together

```
import com.vector.cfg.model.sysdesc.api.taskmapping.IPositionInTaskEntry

scriptTask ("orderTaskMapppings", 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 4.223: Manually order the task mappings

```
import com.vector.cfg.model.sysdesc.api.taskmapping.IPositionInTaskEntry

scriptTask ("orderTaskMapppingsOfOsTask", 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 4.224: 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 4.225: 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 4.226: Filter task mappings

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 4.227: 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 4.228: 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 4.229: 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 4.230: 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 4.231: 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 4.232: 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 4.233: 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 4.234: 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 4.235: 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 4.236: Exports two elements and all references elements

4.11.2 Model Import

The `modelImport` allows to import MDF model data from `.arxml` files.

To access the import functionality use one of the `getModelImport()` or `modelImport(Closure)` methods.

Currently no import API is provided. Please inform Vector, if you need an import API.

```
// You can access the API in every active project
def importApi = persistency.modelImport

//Or you use a closure
persistency.modelImport {

}
```

Listing 4.237: Accessing the model import persistency API

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).

IS_COMPATIBLE_DA_VINCI_DEV_EXECUTABLE Ensures that the given `Path` points to a compatible DaVinci Developer executable (DaVinciDEV.exe).

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 37.

ScriptConverters.TO_SCRIPT_PATH Attempts to convert arbitrary `Objects` to `Paths` using `IAutomationPathsApi.resolveScriptPath(Object)` 4.4.3.3 on page 38.

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 `String`s (`Object.toString()`) and passed to `BigInteger.BigInteger(String)`.

ScriptConverters.TO_BIG_DECIMAL Attempts to convert arbitrary `Object`s to `BigDecimal`s. The following conversions are implemented:

- For `null` or `BigDecimal` arguments the given argument is returned. No conversion is applied.
- `Float`s and `Double`s, are converted using `BigDecimal.valueOf(double)`.
- `Integer`s, `Long`s, `Short`s and `Byte`s are converted using `BigDecimal.valueOf(long)`.
- All other types of objects are interpreted as `String`s (`Object.toString()`) and passed to `BigDecimal.BigDecimal(String)`.

ModelConverters.TO_MDF Attempts to convert arbitrary `Object`s to `MDFObject`s. The following conversions are implemented:

- For `null` or `MDFObject` arguments the given argument is returned. No conversion is applied.
- `IHasModelObject`s are converted using their `getMdfModelElement()` method.
- `IViewedModelObject`s are converted using their `getMdfObject()` method.
- For all other `Object`s `ClassCastException`s are thrown.

For thrown `Exception`s 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 4.238: 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 4.239: 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 4.240: 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.html[1]

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 246.

[1]Last 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
- 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 4.241: Run all JUnit tests from one class

You can access the Automation API with the `ScriptApi` class. See chapter 4.4.8 on page 47 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 4.242: 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.github.io/spock/docs/1.0/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 4.243: Run unit test with the Spock framework

You can access the Automation API with the `ScriptApi` class. See chapter 4.4.8 on page 47 for details.

You have to add a Spock dependency in your `build.gradle` file:

```
dependencies {
    compileDvCfg "org.spockframework:spock-core:1.0-groovy-2.4"
}
```

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 4.244: Add a UnitTest task with name MyUnitTest

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.

[2]Last accessed 2016-05-24

[3]Last accessed 2016-05-24

```
project.ext.automationClasses = [
        "sample.MyScript",
        "sample.MyUnitTestSuite", // This is a test suite
        // Add here your test or suite class with full qualified name
]
```

Listing 4.245: The projectConfig.gradle file content for unit tests

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 70. 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 hiearchy

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 following 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 `MIParameterValue` therefore has the same base type
- All `MIIdentifiable`s can hold ADMIN-DATA and ANNOTATIONs
- All MDF objects in the AUTOSAR model tree inherit from `MIObject` which is again an `MIObject`

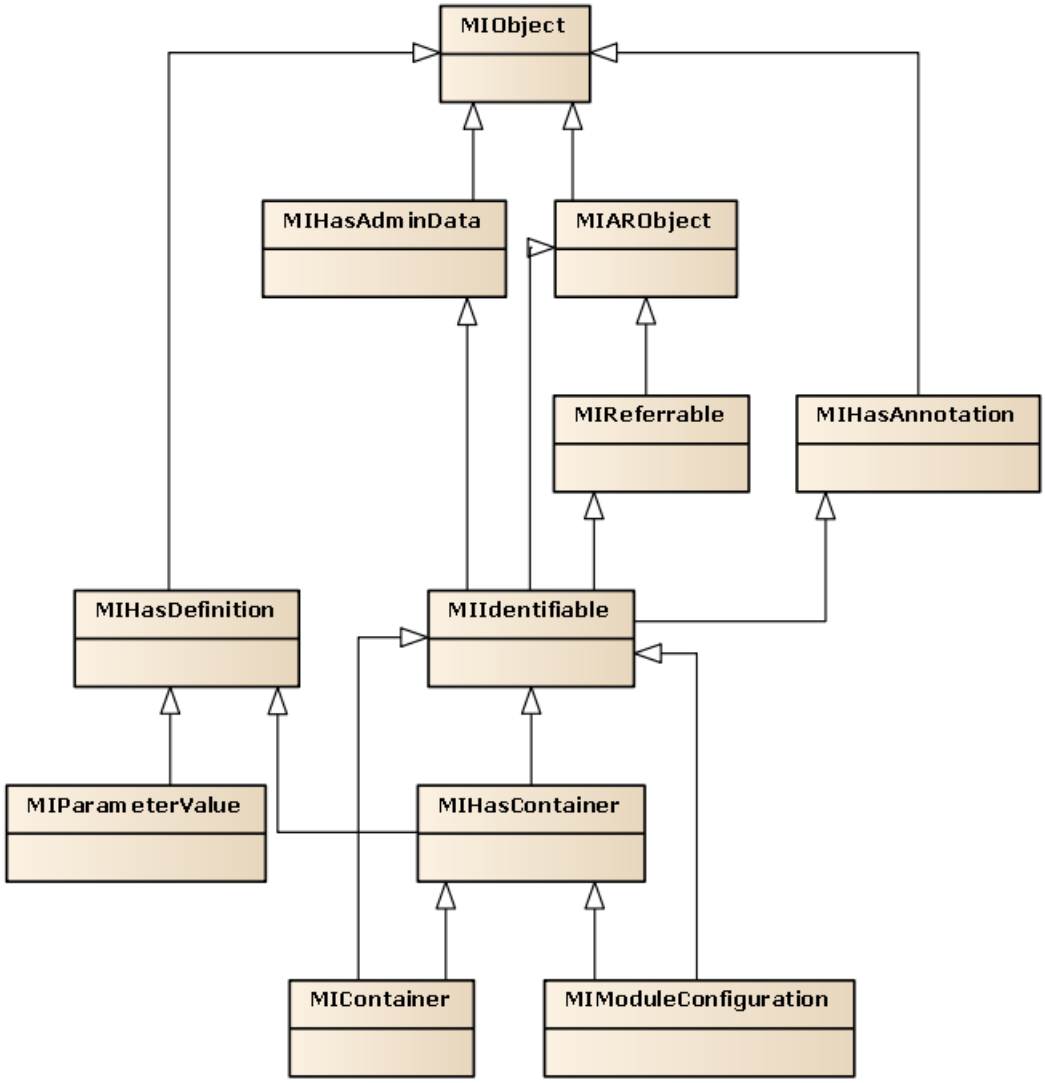


Figure 5.1: ECUC container type inheritance

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 next 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 following page shows a simple example of an MDF object containment hierarchy. This example contains two AUTOSAR packages with module configurations below.

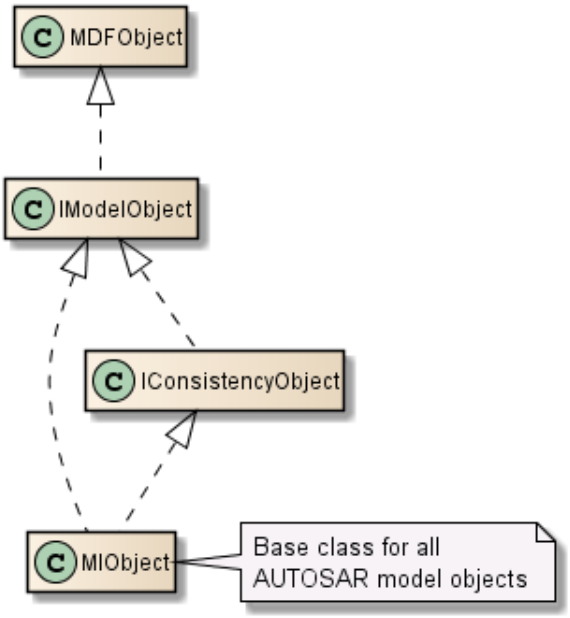


Figure 5.2: MIObject class hierarchy and base interfaces

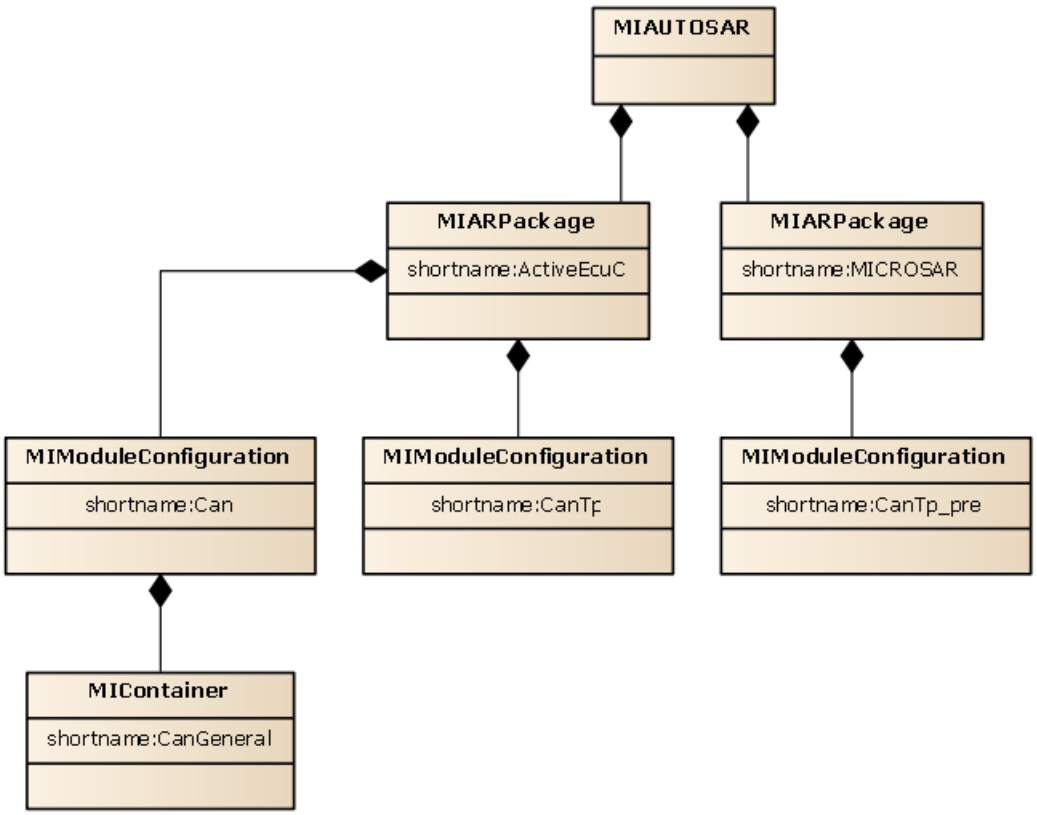


Figure 5.3: Autosar package containment

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 on the next page shows this type hierarchy for the definition reference of an ECUC container.

In ARXML, such a reference can be specified as:

```
<DEFINITION-REF DEST="ECUC-PARAM-CONF-CONTAINER-DEF">
    /MIRCOSAR/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 `"/MIRCOSAR/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 `"/MIRCOSAR/Com/ComGeneral"` exists in the model, this method will return it

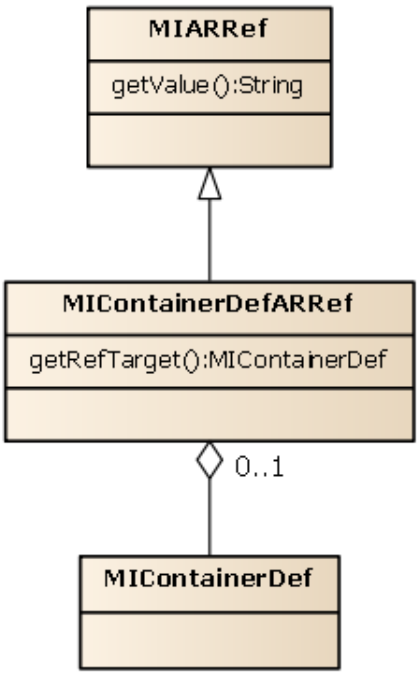


Figure 5.4: The ECUC container definition reference

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 your 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 `MIReferrable`s all of the following conditions apply:
  - They have the same meta-class
  - They have the same AUTOSAR path

  For siblings of non-`MIReferrable`s all of the following conditions apply:
  - Their nearest `MIReferrable`-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 were 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.

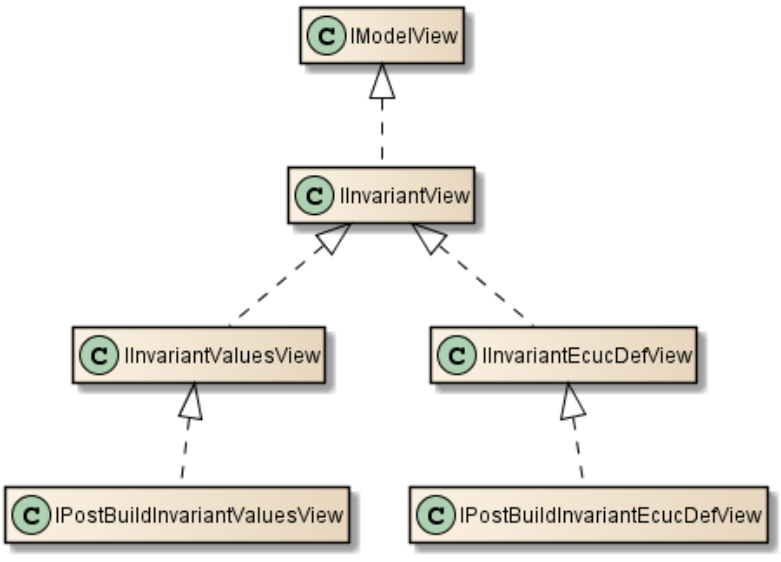


Figure 5.5: Invariant views hierarchy

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

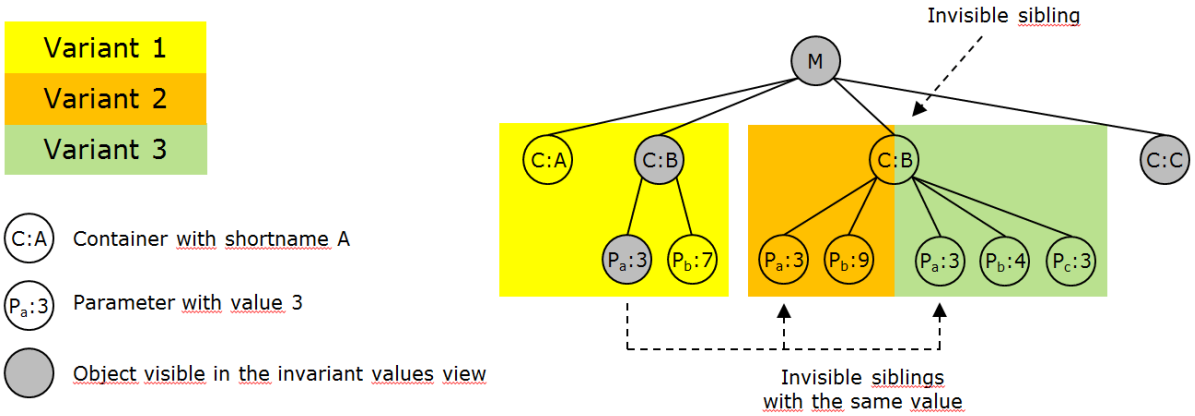


Figure 5.6: Example of a model structure and the visibility of the IInvariantValuesView

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 (`MIContainer`, `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 is 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`
- `DefRef`

- `AsrPath`
- `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 `MIObject` and an `IModelView` that was used when viewing the `MIObject`.

The interface provides getter for the `MIObject`, and the `IModelView` which was active during creation of the `IViewedModelObject`. So the `IViewedModelObject` represents a tuple of `MIObject` and `IModelView`.

This could be used to preserve the state/tuple of a `MIObject` 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`.

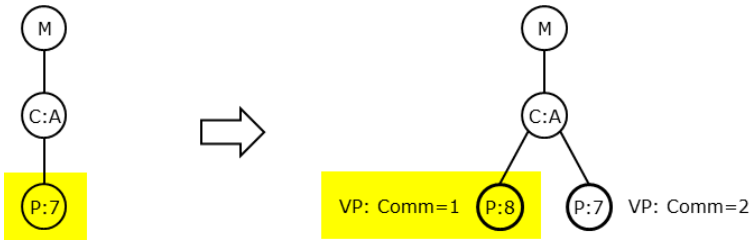
It is not guaranteed, that the `MIObject` is visible in the creation `IModelView`, after the model is changed. It is also possible to create an `IViewedModelObject` of a `MIObject` and a `IModelView`, where the `MIObject` is invisible.

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 following page.



Criterion	Left	Right
Comm	1	2

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 `IInvariantView` 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 next 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

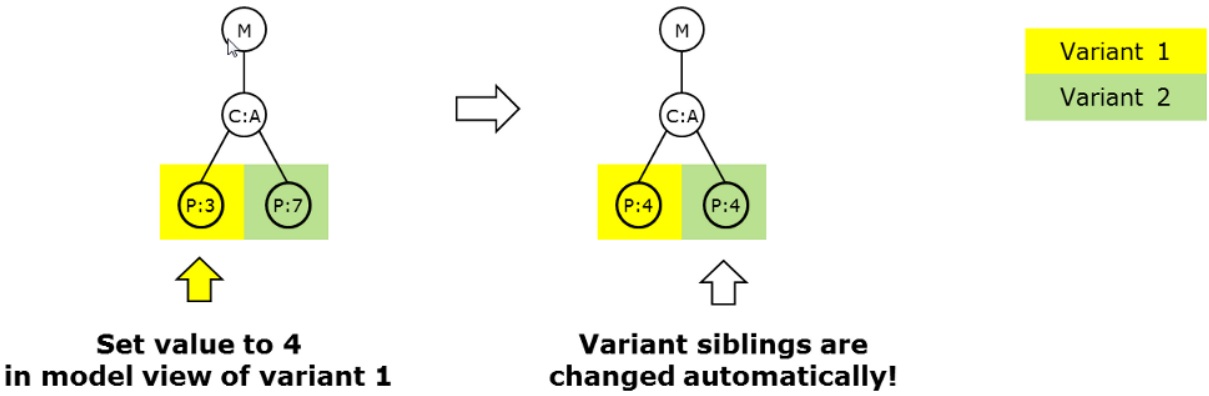


Figure 5.8: Variant common change of a parameter value

- 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.

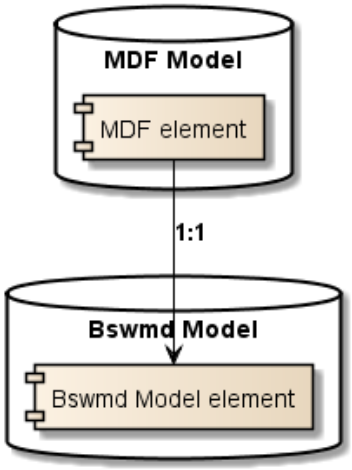


Figure 5.9: The relationship between the MDF model and the BswmdModel

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 - `GIParameter<?>`
  - 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 corresonding classes.

AUTOSAR type	MDFModel	"Untyped" BswmdModel	"DefinitionTyped"
ModuleConfiguration	`MIModuleConfiguration`	`GIModuleConfiguration`	`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)`
- `GIModuleConfiguration.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 Refference traget 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 next 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.

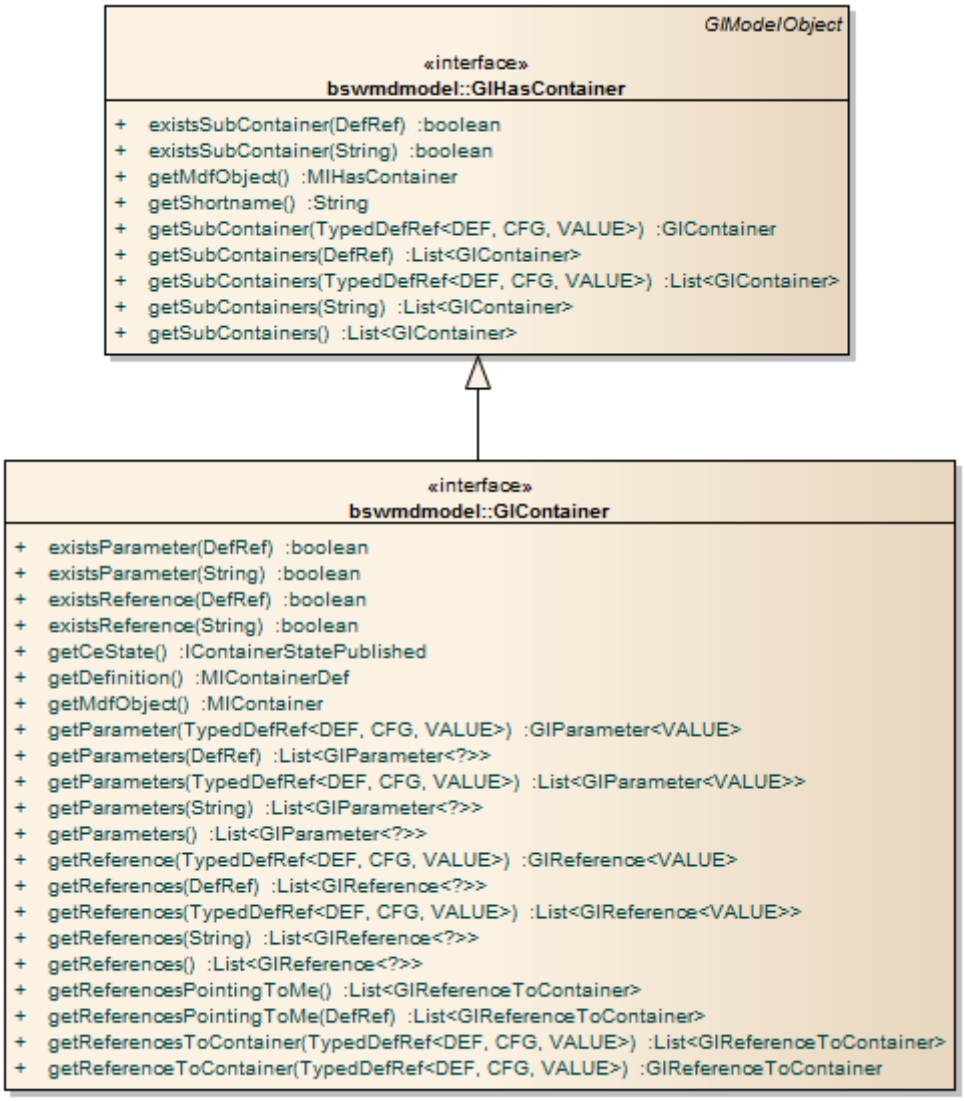


Figure 5.10: SubContainer DefRef navigation methods

5.3.1.3 References

All references in the BswmdModel are subtypes of `GIReference`. The generated model contains generated DefintionTyped 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>`.

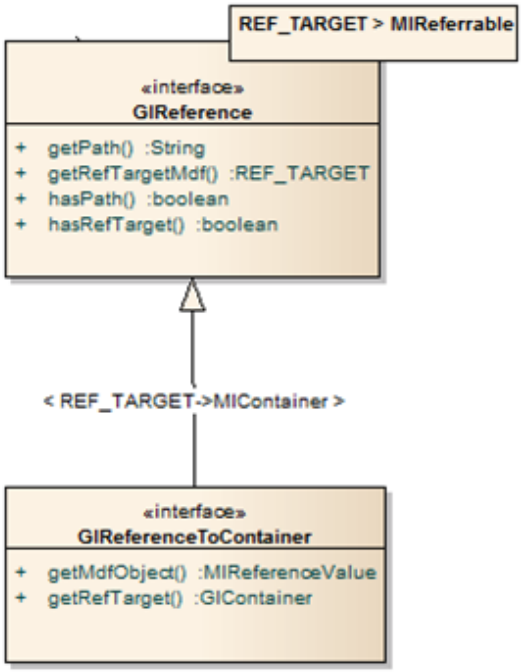


Figure 5.11: Untyped reference interfaces in the BswmdModel

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 BswmdModel 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 following 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.

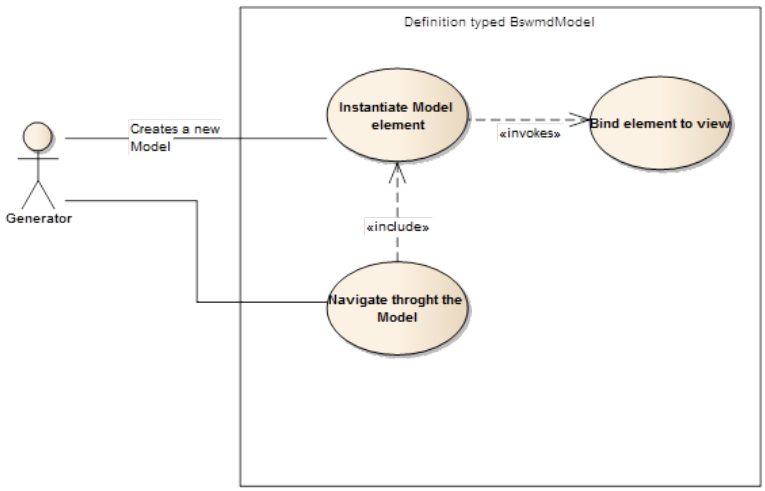


Figure 5.12: Creating a BswmdModel in the Post-build selectable use case

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 next 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.

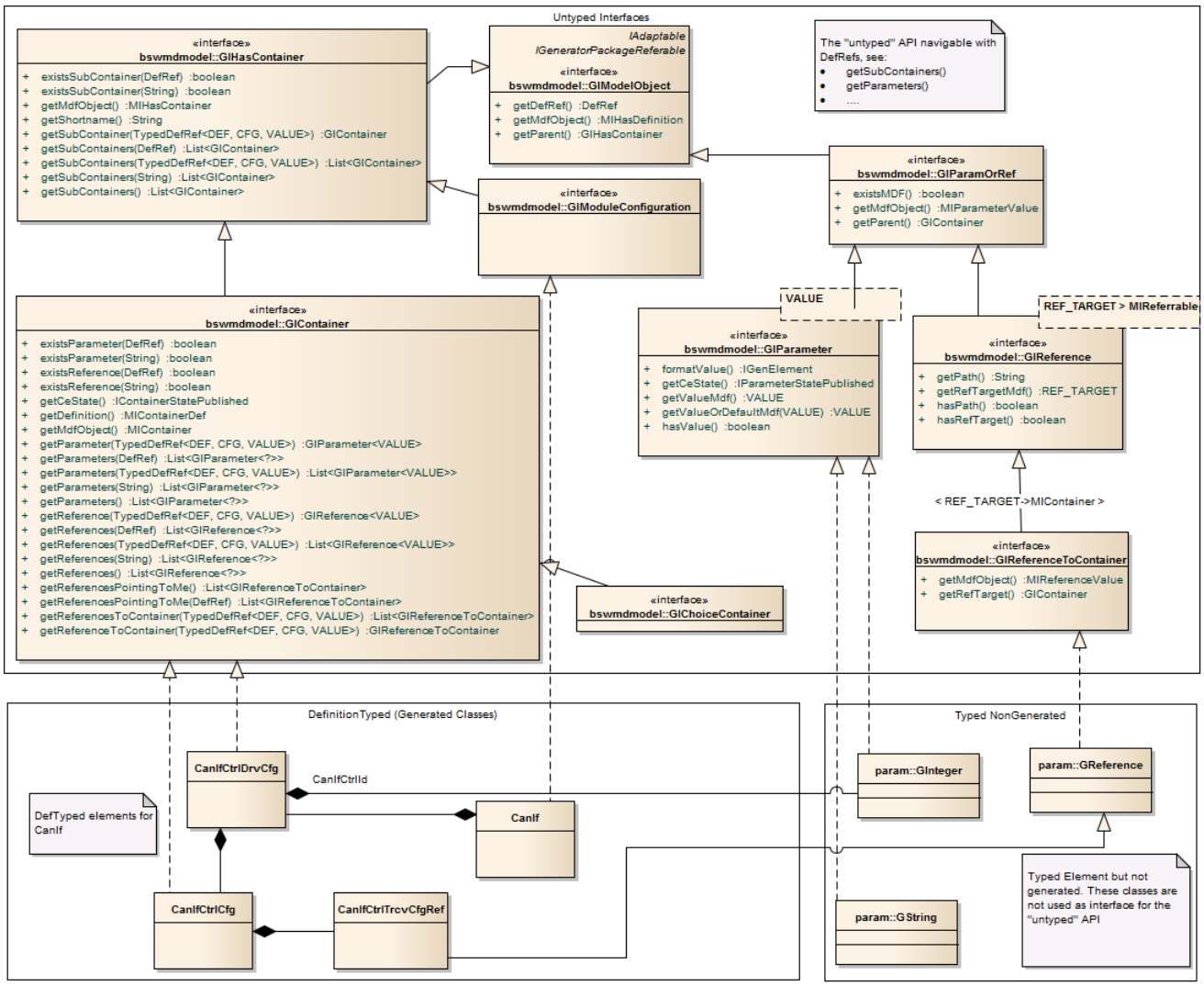


Figure 5.13: Class and Interface Structure of the BswmdModel

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.

`AsrPath`s 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 Object links depend on the MDF object type

- **Referrables**
  The object link is actually identical with the AUTOSAR path
- **Ecuc objects with a definition** (module, container and parameter)
  The object link additionally stores the DefRef
- **Ecuc parameters**
  The object link additionally stores the parameters index. This is the index of all parameters with the same definition below the same parent container instance in the unfiltered model view
- **All other types - feature object link**
  The object link also describe paths to all other types in the model by the meta model feature name prefixed with an `@featureName`. If the feature is a `List` the feature name is post fixed with the position of the `List`. The link can also contain variant information. Examples:
  - `/ActiveEcuC/Can/CanConfigSet/@adminData`
  - `/ActiveEcuC/Can/CanConfigSet/@adminData/@docRevision[2]`

5.4.3.2 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

5.4.3.3 Examples for object link strings

The method `getObjectLinkString()` returns for example the following strings:

- For a container, module configuration or all other `MIReferrable` objects, the AUTOSAR path is returned:
  `/ActiveEcuC/Can/CanGeneral`
- For a parameter, the parents AUTOSAR path, the last shortname of its definition and a positional index in the list of parameters with the same definition is used:
  `/ActiveEcuC/Can/CanGeneral[2:SomeDefName]`

- In case of variant objects, all variants, this object is visible in, are added: `/ActiveEcuC/Can/CanConfigSet/CanHardwareObject[0:CanControllerRef]{VariantA, VariantB}`
- For all other elements a feature object link is created: `/ActiveEcuC/Can/CanConfigSet/@adminData/@docRevision[2]`

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 it's 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 shows the structure of the `DefRef` class and its sub classes.

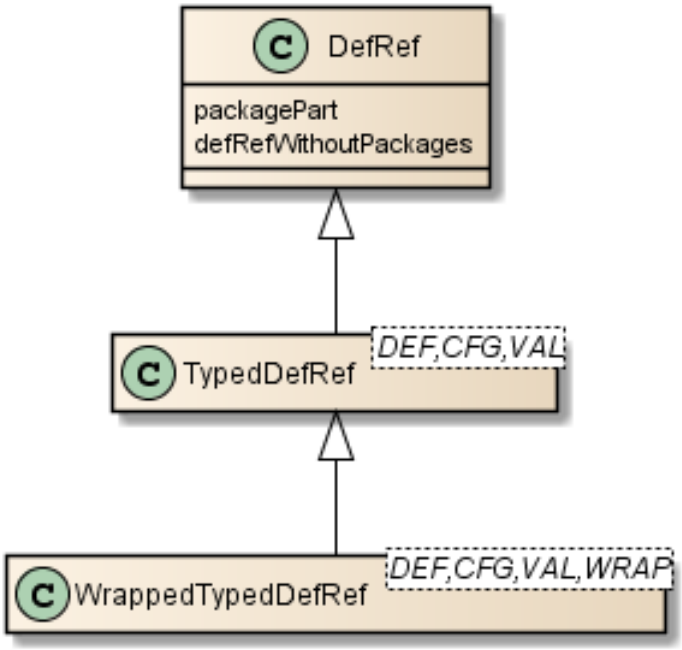


Figure 5.14: DefRef class structure

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

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 next 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 (typically containers or parameters).

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 `GIParameter` and `GIContainer` are interface base types in the BSWMD models):

```
GIParameter 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 on the following page shows the inheritance hierarchy of the `IParameterStatePublished` class and its sub classes.

Parameters have different types of state information:

- **Simple state retrieval**
  Example: The method `isUserDefined()` returns true when the parameter has a user-defined flag.

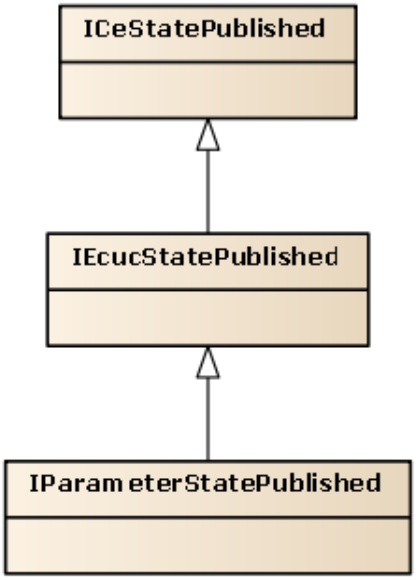


Figure 5.15: IParameterStatePublished class structure

- **States and values** (pre-configuration, recommended configuration and inital (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 next page shows the inheritance hierarchy of the `IContainerStatePublished` class and its sub classes.

This API provides state information similar to IParameterStatePublished. Some of the states are container-specific, of course. `getCreationPhase()`, for example, which returns the phase a container in a post-build loadable configuration has been created in.

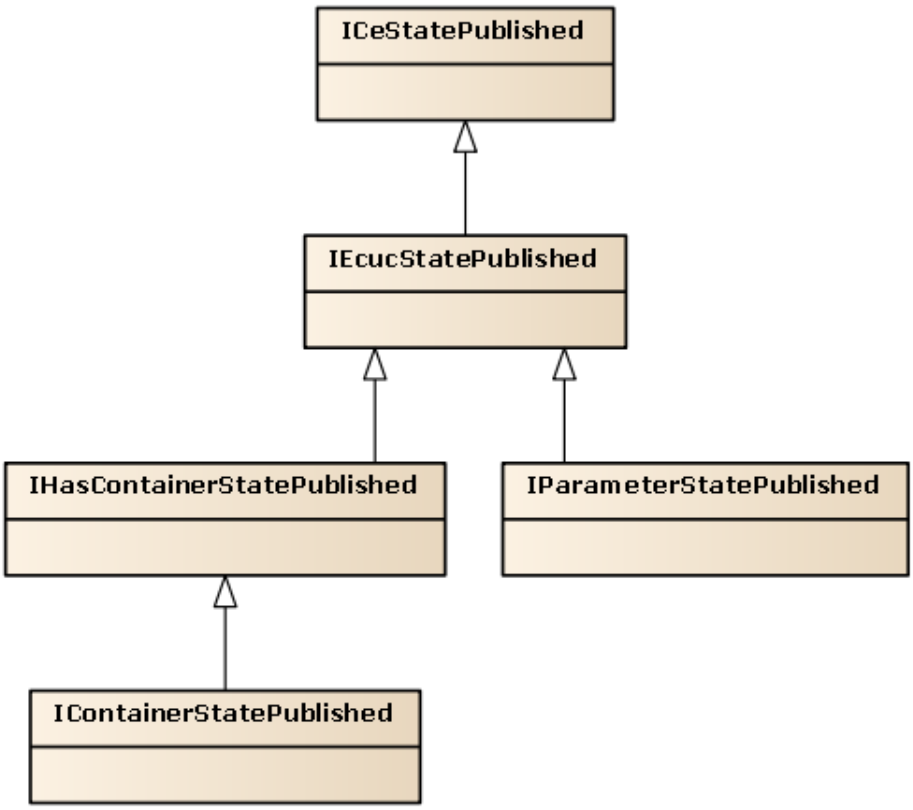


Figure 5.16: IContainerStatePublished class structure

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 AUROSAR 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 AUROSAR 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 AUROSAR 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 supportedSupportedConfigurationVariants 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 AUROSAR 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 `postBuildVariantMultiplicity` flag for AUROSAR 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 `postBuildVariantValue` flag for AUROSAR 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 IEcucIntegerParameter) {
    IEcucIntegerParameter intCfg = (IEcucIntegerParameter) numCfg;

    // Get the parameter value
    boolean hasValue = intCfg.hasValue();
    BigInteger value = intCfg.getValue();

    // Get the related definition wrapper
    IEcucIntegerDefinition def = intCfg.getEcucDefinition();
}
```

Listing 5.25: Integer parameter configuration access examples

5.5.2.1 Post-build loadable

EcucModuleConfiguration `IEcucModuleConfiguration` 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 252
    - **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 DVCfg__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 next page.

6.3.2 Javadoc HTML Pages

You find this documentation as described in chapter 6.2 on the preceding 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 previous 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 preceding page . And it contains other libraries which are described in **libs** in 6.2 on the previous 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 252.

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 13.

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 252 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 containg 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:

- 2016.1
- 2016.2
- 2016.3
- 2017.2

Please use one of the versions above. With other versions, there could be problems with the editing, code completion and so on.

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.

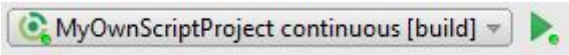


Figure 7.2: Project Continuous Build

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.

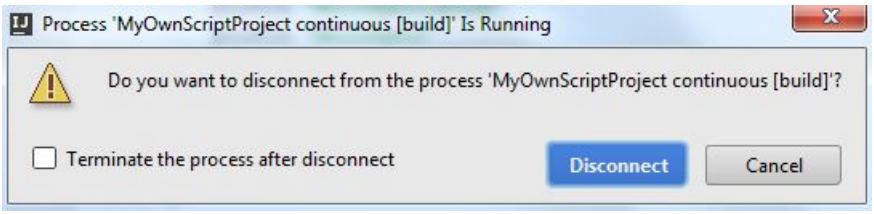


Figure 7.4: Disconnect from Continuous Build Process

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 251.

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.

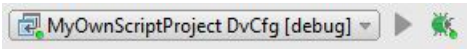


Figure 7.5: Project Debug

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.

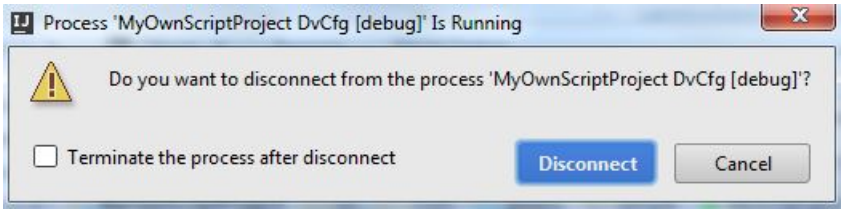


Figure 7.7: Disconnect from Debug Process

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 16.

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 16.

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 247.

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 251.

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 following page.

Download of Gradle Distribution Error If you get an error when you start the `gradlew` like:

```
Downloading
http://vistrcfgci1.vi.vector.int/buildcomponents/Gradle/distributions/gradle-4.0.1-bin.zip

Exception in thread "main" java.io.FileNotFoundException:
http://vistrcfgci1.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 located[1]. 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 257. Normally the versions have **NO** breaking changes! The default text is something like:

[1] The vector internal server `http://vistrcfgci1.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

If you update your DaVinci Configurator version in your SIP, it could be necessary to execute the IntelliJ IDEA task of Gradle to update your compile dependencies.

Steps to execute:

1. Close IntelliJ IDEA.
2. Update the DaVinci Configurator in your SIP
3. Open a command shell (`cmd.exe`) at your project folder
   - Folder containing the `gradlew.bat`
4. Type `gradlew idea` and press enter
5. Wait until the task has finished
6. Open IntelliJ IDEA

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 257) 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 249.

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 Gradle[2] 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 17.

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 Wrapper[3])
- `build.gradle`
  - General build file - You can modify it to adapt the build to your needs
- `settings.gradle`
  - General build project settings - See Gradle documentation[4]
- `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 two 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]

[3] `https://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 prefered 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 an place it in your project[5], but this is **NOT** recommended.

The referenced libraries will be automatically bundled into your Automation project, see chapter `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]
  - **Prefered 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://vistrcfgci1.vi.vector.int/artifactory/all' }
    // Or reference MavenCentral server
    mavenCentral()
}
```

- Update the IntelliJ IDEA project
  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

Now your project has access to the specified library.

7.9.3.2 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:

[5]See Gradle online documentation, how to add local jar files to the build dependencies

[6]Gradle and Java online documentation for details how to set proxy settings

```
@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

7.9.3.3 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

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
	Access to project settings	
	Open ARXML files as Project without DPA	5.14
	Switch configuation phase (Post-build loadable)	
Model	Access to the whole AUTOSAR model (EcuC and SystemDesc)	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 valdiation 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	
Reporting	Create predefined project reports	
	Create report based on specific CE set	
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	
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-R19 - Cfg5.16

8.2.1 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.

8.2.2 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 251.

8.2.2.1 Groovy

The used Groovy version was updated from 2.4.7 to 2.4.12, please see Groovy website for details.

8.2.2.2 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.

8.2.2.3 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2017.2 was added to the supported versions. See 7.5.1 on page 247 for details.

8.2.3 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 54 for details.

8.2.4 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 42 for details.

8.2.5 Project Handling

Advanced API to open a Project added, which is not automatically closed, see section 4.5.4.2 on page 66 for details.

8.2.6 Model Automation API

8.2.6.1 Derived Containers

New API added to retrieve information about derived containers and delete derived containers, see chapter 4.6.4.12 on page 95 for details.

8.2.6.2 Variance API

Old Variance API deprecated and replaced by new names with PostBuild:

- `getAllVariantViews()` => `getAllPostBuildVariantViews()`
- `getInvariantValuesView()` => `getPostBuildInvariantValuesView()`
- `getInvariantEcucDefView()` => `getPostBuildInvariantEcucDefView()`
- `getAllVariantViewsOrInvariant()` => `getAllPostBuildVariantViewsOrInvariant()`
- `isValueInvariant()` => `isPostBuildValueInvariant()`
- etc.

8.2.6.3 CE State

The methods `ICeStatePublished.isChangeable()` and `ICeStatePublished.isDeletable()` are now part of the published API.

8.2.6.4 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.

8.2.7 Persistency

8.2.7.1 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)`

8.2.8 Generation

8.2.8.1 Generation Steps

Now the `IGenerationStep` class has a getter for the TargetType (`EEnvironmentTargetType`). See chapter 4.7.1.2 on page 113 for details.

8.2.9 Runtime System Domain

8.2.9.1 Component Port Selection

Automation API supports now trigger interfaces and trigger to signal mappings. See 4.10.4.1 on page 147 and 4.10.4.2 on page 164.

Added predicates to the component port selector to filter component ports for attributes of their component types. See 4.10.4.1 on page 147.

8.2.9.2 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 157.

8.2.9.3 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 173.

8.2.9.4 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 171.

8.2.9.5 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 179.

8.3 Changes in MICROSAR AR4-R18 - Cfg5.15

8.3.1 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.

8.3.2 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 251.

8.3.2.1 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2016.3 was added to the supported versions. See 7.5.1 on page 247 for details.

8.3.2.2 BuildSystem

Groovy - Static compilation The AutomationInterface Groovy compiler extension added. This allows you to use Automation API in static compiled Groovy code. See 7.9.3.2 on page 254.

includeDependenciesIntoJar The `includeDependenciesIntoJar` Gradle build setting added. See 7.9.3.3 on page 255 for details. The Gradle build will now automatically include jar dependencies into your project jar.

8.3.3 Script Execution

8.3.3.1 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 49 for details.

8.3.4 Project Handling

New API added to create empty raw AUTOSAR model projects, see chapter 4.5.6.1 on page 69 for details.

8.3.5 Project Creation vVIRTUALtarget settings

New API added to customize vVIRTUALtarget project and executable settings for project creation. See chapter 4.5.3.7 on page 63 for details.

8.3.6 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.diagnosticextract.dcm.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.

8.3.7 Model Automation API

8.3.7.1 IVarianceApi

New method `IVarianceApi.getAllVariantViewsOrInvariant()` added.

8.3.7.2 Access methods

New access methods for the EcuConfigurationAccess and EcucDefinitionAccess added. See chapter 4.6.4.10 on page 94 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 85 details.

8.3.7.3 Reverse Reference Resolution - ReferencesPointingToMe

New methods to query references starting from reference targets added. See chapter 4.6.4.11 on page 95 for details.

8.3.7.4 Operations

New method `setConfigurationVariantOfAllModuleConfigurations()` added to `IOperations` class. See chapter 4.6.6.2 on page 103 for details.

New method `createUniqueMappedAutosarPackage()` added to `IOperations` class. See chapter 4.6.6.2 on page 103 for details.

8.3.7.5 User Annotations

New API to access and modify User Annotations was added. See chapter 4.6.9.1 on page 108 for details.

8.3.7.6 Variance

New method `variance.variantView(String name)` added to retrieve a variant view by name.

8.3.7.7 Model Synchronization

New API added to execution the new Model Synchronization operation. See chapter 4.6.7 on page 104 for details.

8.3.8 Persistency

New Persistency model exporter added `exportModelTree()`. See chapter 4.11 on page 188 for details.

8.3.9 Workflow

New workflow API added to configure settings with `updateSettings{}`:

- Select the update mode (`ECUC_ONLY, ECUC_AND_DEVELOPER_WORKSPACE`)
- Parameter uuidUsageInStandardConfigurationEnabled
- Parameter uuidUsageInSystemDescriptionEnabled

8.3.10 Validation

8.3.10.1 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()`

8.3.11 Generation

8.3.11.1 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 117 for details.

8.3.12 BswmdModel

8.3.12.1 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)`

8.3.12.2 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 227 for more details.

8.3.13 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 143 for details.

8.3.14 Runtime System Domain

8.3.14.1 Data Mapping

'autoMapTo' allows control now about the handling of nested arrays of primitive. See 4.10.4.2 on page 161 and 4.10.4.2 on page 167.

8.4 Changes in MICROSAR AR4-R17 - Cfg5.14

8.4.1 General

This is the **first** stable version of the DaVinci Configurator AutomationInterface.

8.4.2 Script Execution

8.4.2.1 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 52 for more details.

8.4.3 Automation Script Project

You have to migrate your project to the new compile bindings. Please execute the instructions in chapter 7.7 on page 251.

8.4.3.1 Groovy

The used Groovy version was updated from 2.4.5 to 2.4.7, please see Groovy website for details.

8.4.3.2 Supported IntelliJ IDEA Version

The IntelliJ IDEA version 2016.2 was added to the supported versions. See 7.5.1 on page 247 for details.

8.4.3.3 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 7.9.3.3 on page 255 for details.

8.4.4 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`.

8.4.5 UserInteraction

UserInteraction API added to show messages to the user, see 4.4.5.1 on page 41.

8.4.6 Project Load

8.4.6.1 AUTOSAR Arxml Files

New API added to open AUTOSAR `arxml` files as a temporary project. See chapter 4.5.6 on page 68 for details.

8.4.7 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.

8.4.7.1 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

8.4.7.2 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 83 for the read API and 4.6.4.3 on page 87 for the write API.

8.4.7.3 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 100 for details.

8.4.7.4 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.

8.4.8 Persistency

New Persistency API added to import and export model data. See chapter 4.11 on page 188 for details.

8.4.9 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 32 for details.

The return type of validation and generation methods has changed to `IGenerationResultModel`. This type provides more detailed information about the executed steps.

8.4.10 BswmdModel

8.4.10.1 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 223 for more details.

8.4.11 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 4.6.3.6 on page 82.

8.4.12 Diagnostics Domain

Introduced new API which allows creation and querying of diagnostic events. Also OBD and J1939 state of the configuration can be queried.

8.4.13 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`.

8.4.14 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.

8.5 Changes in MICROSAR AR4-R16 - Cfg5.13

8.5.1 General

This is the **first** version of the DaVinci Configurator AutomationInterface.

8.5.2 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.

8.5.3 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

Tables

Listings

Todo list