

# EMF2EMF Transformation Framework

## Developers Manual

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## 1 EMF2EMF Translator Overview

EMF2EMF is a generic framework for writing EMF to EMF model transformations in Java. Translators can be written by declaring a translator and a set of rule classes. Each rule class handles instances of a particular EMF meta-class as input. EMF2EMF provides a lightweight and efficient framework with a small footprint compared to declarative and interpretive M2M translators such as QVT, ATL or ETL. The down-side is that you have to write the details in Java instead of a nice declarative language. However, the framework structures your translation into manageable tasks to ease the task of writing your translator.

## 2 Getting Started

### 2.1 Setup

- In order to start using the EMF2EMF translator you need to make the EMF2EMF translator plugin available to your code. You do this either by importing the plug-in source code project into your workspace or by installing the published SDK version of the feature into your Eclipse development target. The latter is usually preferable.

The plug-in source code can be found in the git repository **EMF\_Translator** in the **Event-B Soton** area of github.

[https://github.com/eventB-Soton/EMF\\_Translator.git](https://github.com/eventB-Soton/EMF_Translator.git)

The plug-in you need to import is `ac.soton.emf.translator`. If you prefer to work with the latest release you can find this in the git history of the plug-in and check out that commit.

Alternatively, install the published SDK feature into your target platform using the update site - look for **EMF Translator SDK**.

- Add a dependency to `ac.soton.emf.translator` in the `manifest.mf` file of your plugin.

## 2.2 Setting up the UI to initiate your translator

Unless you intend to always start your translator programmatically (i.e. from another piece of code), you will need some way to tell your translator to start. There are many options for adding commands to the Eclipse UI. As long as you configure a way for the user to invoke the command handler it doesn't matter where you put your additions to the UI. Here, as an example, we show the extensions necessary to add a button in the main toolbar area. This is using standard Eclipse extension points so you can find more details on-line. Basically you need to define a command, a way to invoke that command (e.g. a menu button) and a handler to deal with that command when it is initiated. EMF2EMF provides a handler for you, so unless you have a strong reason to modify the way the handler works, it is recommended that you just use the provided one (as explained below). Note that the provided handler `ac.soton.emf.translator.handler.TranslateHandler` has stubs for pre and post processing. If you need to do any processing before or after your translation, you can extend the provided translator, and then declare your modified translator in the extensions shown below in place of the provided one. The provided handler uses the `commandId` that you enter below in order to identify and run your translator. (So make sure you invent a unique **commandId** and use it consistently in all the extensions defined below. To make this clear all fields marked (**commandId**) must have the same string value and it must be something that no other plug-in developer is likely to choose).

1. Open the `plugin.xml` file of your plug-in and add an extension for `org.eclipse.ui.commands`. Then via its context menu add a new `command`. Fill in the extension point element details as follows.
  - **id:** (**commandId**) this must be a unique identifier for the command.  
e.g. we would use something like `ac.soton.<pluginName>.<CommandName>`
  - **name:** a name that will appear in the UI to identify the command.  
e.g. translate x to y.
  - **description:** (optional) some text that will appear (hover) in the UI to describe what the command does.
  - **categoryId:** (optional) the id of a category of commands that this command will be added to. If you don't specify this it will appear in a global default group.
2. Add an extension for `org.eclipse.ui.menus`. Then via its context menu add a new `menuContribution`. Fill in the extension point element details as follows.
  - **locationURI:** this must be the identifier of a area in the UI that you want to add to. Usually this would be defined in another one of your plug-ins. For example we usually set this to `toolbar:ac.soton.eventb.emf.diagrams.toolbar?after=transformations` which is an area of the main toolbar used for iUML-B menu buttons.
  - **allPopups:** set to `true` - probably not used for the main menu but in case you change to a pop-up menu.

Now right click on the `menuContribution` and add a child `command` with details as follows.

- **commandId:** this must be the identifier of the command that you added at the start of section 2.2.
  - **label:** a name for the menu item (this is what will be written in the menu/toolbar etc.).
  - **icon:** a relative path to the icon to be displayed. Usually `icons/<myicon>.png`.
  - **style:** set to *push*
3. Add an extension for `org.eclipse.ui.handlers`. Then via its context menu add a new `handler`. Fill in the extension point element details as follows.
- **commandId:** this must be the identifier of the command that you added at the start of of section 2.2.
  - **class:** Set this to a handler which will be called when the user triggers your command. For example, `ac.soton.emf.translator.handler.TranslateHandler` is a generic handler provided by EMF2EMF which will look at the `commandId` and select your translation rules.

## 2.3 Declaring your translator

You now need to declare your translator to EMF2EMF so that it knows about your translation and what kind of EMF models it handles. This is also done using extensions in your `plugin.xml` file. (If you want to look at the definitions of these extension points they are defined in the EMF2EMF plugin, `ac.soton.emf.translator`). We first declare the translator and link it to the command that you defined in section 2.2, then we define a set of rules (ruleset) for the translator. The reason for defining the ruleset separately is so that several rulesets can be defined for the same translator. For example, other developers may want to extend your translator with new translation rules.

Open the `plugin.xml` file of your plug-in and add an extension for `ac.soton.emf.translators`. Then via its context menu add a new `translator`. Fill in the extension point element details as follows.

- **translator\_id:** this must be a unique identifier for the translator. e.g. we would use something like `ac.soton.<pluginName>.translator`
- **source\_package:** this is the nsURI identifier of the source EMF meta-model (ecore). It is used to find the meta-model for your source model that you want to translate. (The nsURI is a property defined in the ecore file).
- **root\_source\_class:** this is the name of a meta-class in the ecore meta-model defined by `source_package`. It is the root (top) level of your source model. Everything that your translator translates must be contained within a tree structure starting from an element of this class. Elements of this class must be contained by the resource (File) when you save your model. Your translator will not start unless you invoke it with one of these selected in the UI.

- **name:** this is just a readable name used for your translator in the extensions (not very important but helps you maintain these extensions).
- **commandId:** this must be the identifier of the command that you added at the start of section 2.2.
- **adapter\_class:** this class, which must implement `ac.soton.emf.translator.configuration.IAdapter`, provides some methods which configure the translator to your needs. It deals with variations in behaviour which are difficult to configure declaratively. A default adapter which does very little is provided by EMF2EMF. To use this default set **adapter\_class** to `ac.soton.emf.translator.configuration.DefaultAdapter`. If you need to configure the behaviour, clicking on the field name **adapter\_class** will start a wizard to create a new class that implements `IAdapter`. We recommend setting Superclass to the `DefaultAdapter` so that you only have to deal with the methods you need to change. More details on configuring the adapter class are given in section 3.1.

## 2.4 Declaring Rules

Add an extension for `ac.soton.emf.translator.rulesets`. Then via its context menu add a new **ruleset**. Fill in the extension point element details as follows.

- **translator\_id:** this must be the id of your translator. I.e. it must match the field with the same name in the translators extension above.
- **name:** this is just a readable name used for your ruleset in the extensions (not very important but helps you maintain these extensions).

Now right click on the **ruleset** and add a child **rule** with details as follows. For this first rule you should focus on something near the root of your model. I.e. the element that contains everything else you want to translate. This does not have to be the `root_source_class` defined in the translators extension but it is the first (highest) level element that is of interest to your translation. For example, a root element is often used as an organisational device for persistence purposes and then it contains some components that you would like to translate.

- **source\_class:** the meta-class of elements that this rule will translate. Unless you specify a different `source_package` (see below), the meta-class must be in the ecore meta-model that you specified in the translators extension using the `source_package` field in section 2.3.
- **rule\_class:** a java class in your plug-in that will do the translation of elements of this kind. As you don't have any rules classes, you can click on the blue field name, *rule\_class* in order to create a new class in your plug-in. Your rule should extend `AbstractRule` and implement `IRule`.
- **name:** this is just a readable name used for your rule in the extensions (not very important but helps you maintain these extensions).

- **source\_package**: if the `source_class` is in the `source_package` defined for the translator in section 2.3, you can leave this field blank. However, sometimes a model may contain children from a different meta-model. In this case you need to specify the nsURI of the ecore meta-model that contains the `source_class`.

Now that you have specified a rule for a class of source elements you can start writing some java code to implement the rule. See section 3.3 for details on how to do this. However we recommend that you just add some stub methods first and breakpoint them to check that your declarations in sections 2.2, 2.3 and 2.4 worked and your translator is recognised and called correctly by EMF2EMF. Once you have checked this and discovered how to write rules, you will need to return her to this extension to add more rules for different kinds of source elements that you want to translate (i.e. children of the first `source_class` that you translated). The translator will work irrespective of the order of the rule extensions, but it is more efficient if you can declare them in the order of dependencies. I.e. if rule B needs rule A to have fired before it can work, then declare the extension for rule A before rule B. These dependencies are discussed more in section 3.3.

## 2.5 Configuring your translator

Apart from writing the actual rules, there are a number of issues that can vary depending on the context and nature of your translation. To accommodate these variations, an adapter interface is defined by the translator framework so that you can provide an implementation of the interface to tell the translator how to handle your these issues in your case. Your adapter must implement `IAdapter` and must be declared in your extension declaration (see Section 2.3). The adapter features are described in more detail in Section 3.1.

A default adapter is provided which you can extend if you only need to define a few variations. Or, if the default behaviour is sufficient for your translator, you could just use the default adapter directly (i.e. reference its class in your extension declaration). The default adapter implementation is as follows:

- **initialiseAdapter** - do nothing.
- **isRoot** - return true iff the feature of the given Translation Descriptor is null.
- **GetComponentURI** - return null.
- **getaffectedResources** - return all EMF resources in the same project as the given source element.
- **inputFilter** - return true (i.e. nothing is filtered)
- **outputFilter** - return true (i.e. nothing is filtered)
- **match** - return true if both of the given elements are null, or the elements are equal according to the 'equals' method of the first element.
- **getSourceId** - return null.
- **annotateTarget** - do nothing.

- **isannotated** - return false.
- **setPriority** - do nothing.
- **gotPos** - return the index corresponding to the end of the given list (i.e. size of list).

## 2.6 Release Notes

- **3.0.1** Bug fix: Avoid infinite recursion when getting previously translated elements
- **3.0.0** -
  - move 'getAffectedResources' to adapter so it can be specialised by clients
  - move saving of resources to handler level so that it can be specialised by clients
  - support automatic creation of resources when specified by translation rules
  - Provide an un-translate facility
  - Improve status and exception handling
  - Add support for running validation prior to translation
  - Support several translations for same command id
  - Support translation into same file as source
  - Handler no longer converts Rodin elements to Event-B EMF. A new method getEObject can be overridden by clients to do this (this removes dependencies on Rodin and Event-B EMF plugins)
  - feature renamed from ac.soton.emf.utilities (version numbering inherited)
  - log exceptions thrown by translator command
- **2.1.1** - add release history for 2.1.0 to build
- **2.1.0** -
  - programmatic invocation
  - pre and post processing
  - adaptor support for defining position in containment
- **2.0.0** - more extensible translator extension (ruleset extension)
- **1.1.0** - make handler more flexible to generalise usage
- **1.0.0** - fix dialogue problem

### 2.6.1 Known Issues

- None at the moment!

## 3 Concepts

The Translator framework provides:

- A toolbar button to initiate the generation
- Generic code to remove previously generated elements
- Generic code to organise the incorporation of newly generated elements
- Utilities to aid the creation of new elements
- An abstract basis for client defined rules
- An extension point for clients to declare translators and translation rules

The client rules return generation descriptors (rather than modifying the target model directly). The framework takes care of updating the model (within the clients Transactional Editing Domain) provided the generation completes successfully. This ensures that the model is not left in an inconsistent state should the generation fail. The generation descriptors allow the client to specify where the new element should be contained and a priority which will be used to influence the placement of the new element within the containment ordering. The translator can easily be configured to common use cases by providing an adapter.

To define a particular generator a client should:

1. Define extensions of the eclipse UI extension points to provide a command handler as defined in section 2.2
2. Define extensions of the translator and ruleset extension points as defined in sections 2.3 and 2.4
3. Extend the translators adapter class to specialise behaviour to a particular use case as described in section 2.5.
4. Implement rule classes as described in section 3.3

### 3.1 Adapter

The adapter allows you to specify some functions which are likely to vary for different translations. Your adapter must implement IAdapter, but it can do this by extending the default adapter, DefaultAdapter. The adapter has the following methods:

- **intialiseAdapter(Object sourceElement)** - If the adapter needs to store some kind of state throughout the translation it can be set up here. (It could then be used in later calls to methods in the adapter). This method will be called at the start of each translation with the source element of the translation.
- **isRoot(TranslationDescriptor translationDescriptor)** - This allows you to specify which kind of newly generated elements should be the root of a model in a resource. Return true if the translation descriptor describes a new root level element.

- `getComponentURI(TranslationDescriptor translationDescriptor, EObject rootElement)` This allows you to control where the output will be persisted. Return a resource URI to be used in creating the new resource. The root element of the translation is passed in case it is needed to construct the URI. (E.g. to find the containing project).
- `getAffectedResources(TransactionEditingDomain editingDomain, EObject sourceElement)` - This should return a collection of potentially affected resources. The resources should all be loaded in the resource set of the given editing domain. N.B. CURRENTLY ALL RESOURCES ARE ASSUMED TO BE WITHIN THE SAME PROJECT AS THE SOURCE ELEMENT.
- `inputFilter(Object object, Object sourceID)` - You can use this to filter out (i.e. ignore) any source elements that should not be translated. Return true if the object should be translated and false to filter it out.
- `outputFilter(TranslationDescriptor translationDescriptor)` - You can use this to filter out any translationDescriptors that should not be acted upon. Return true if this translation descriptor should be acted upon and false if it should be filtered out (ignored).
- `match(Object obj1, Object obj2)` - This allows you to specify whether two object should be considered to be essentially the same thing. The translator needs to know this when it is searching for elements elsewhere in the output model.
- `getSourceId(Object object)` - This allows you to define an id for the given source root element. This will be used to annotate all of the translation output elements. Return null if you don't want any such annotation.
- `annotateTarget(Object sourceID, Object object)` - This allows you to control how translation output objects are annotated. For example, if the object is an EObject and the sourceID is a String you could add an annotation with the sourceID in it.
- `isAnnotatedWith(Object object, Object sourceID)` - The translator needs to know whether this output object is annotated with the given source ID. Return true if it is, false otherwise.
- `setPriority(int pri, Object value)` - This allows you to record the given integer priority for the given object so that it can be used in `getPos` below.
- `getPos(List<?> list, Object object)` - The translator needs to know where in the given list to put the given object. Return the index position in the given list.

## 3.2 Translation Descriptors

Each rule should return a collection of one or more Translation Descriptors. Translation Descriptors have the following fields which are explained in this section.



- EObject parent;
- EStructuralFeature feature;
- Object value;
- Object before;
- Integer priority;
- Boolean remove;

The feature of the parent will be changed in the following ways:

**If remove is false:**

- If the feature is a containment and the value is an element of the correct kind, the value will be added to the containment in a position according to the priority
- If the feature is a reference and the value is an element of the correct kind, the value will be added to the reference in a position according to the priority
- If the feature is an EAttribute and the value is of the correct type, the feature will be set to the value

**Before** can be used to control the position of the generated elements. The generated element will be positioned just before the given object if it exists in the feature.

**Priority** can be used to control the relative position of the generated elements as follows

- 1 - must come first
- 10 - not important
- —user entered items—
- 0 must come after user entered items
- -10 must come last

**If remove is true:**

- If the feature is a containment and the value is an element of the correct kind, the value will be deleted from the containment
- If the feature is a reference and the value is an element of the correct kind, the value will be removed from the reference
- If the feature is an EAttribute, the feature will be unset

### 3.3 Rules

Rule classes must implement `IRule`. It is recommended the rule classes extend

```
ac.soton.eventb.emf.diagrams.generator#AbstractRule
```

which provides some concise constants for the commonly needed containments and defines some default behaviour (always enabled and dependencies ok). Note that the rule will only be attempted for the type of source element defined in the extension point. However, this could be defined as an abstract base class to allow the rule to operate on several types of element.

Where a tree structure is entirely generated within one rule firing (e.g. an event with guards and actions) it is more efficient to construct the entire event and return a single Translation Descriptor that adds that event. It is also possible to do this by returning separate Translation Descriptors to add the event and each guard and action individually. Using a single descriptor is more efficient but means that some features of the translator framework are bypassed. For example, the priority scheme cannot be used, your code will determine the order.

A typical line from a rule class might look like this:

```
ret.add(Make.descriptor(machine,invariants,
Make.invariant("myInvariantName", "myVar >0","my comment")
,10));
```

where, `ret` is the list to be returned and `machine` is the parent element containing the invariants to be added to.

A rule has 4 methods:

- `boolean enabled (final EventBElement sourceElement)`
- `boolean dependenciesOK(EventBElement sourceElement, List<TranslationDescriptor> generatedElements)`
- `boolean fireLate()`
- `List<TranslationDescriptor> fire(EventBElement sourceElement, List<TranslationDescriptor> generatedElements)`

The **enabled** method can be used to restrict when it applies. More than one rule can be defined for the same kind of element allowing the generation to be decomposed in a maintainable way.

The **DependenciesOK** method allows the method to be deferred since the success of rules may depend on what has already been generated. The `dependenciesOK` method is passed the list of `TranslationDescriptors` created so far.

The **fireLate** method forces the rule to be fired when all other rules have been fired. This is usually used when the rules behaviour depends on what other rules have done.

The **fire** method must return a list of `TranslationDescriptors` describing what should be generated. The Utility class, `Make`, provides a convenience

method to help construct a TranslationDescriptor from the parent element, the containment feature, the new child and the priority indicator and if needed the editable setting.

### 3.4 Priorities

Priority may be from 10 to -10, where 1 indicates first in the containment and -10 last in the containment. Elements in the containment that are not (currently) being generated are placed between priorities 10 and 0. Bear in mind that the relative position of different diagrams (extensions) is preserved within each priority band. Also the order of source elements within their containment is preserved within each priority band.

```
1 2 3 4 5 6 7 8 9 10 <other content> 0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10
```

For example, a basic type invariant that doesn't depend on other variables might be placed at position 1 whereas a theorem or invariant included purely for proof purposes might be placed at position -10.

A current limitation of the priority scheme is that there are a limited number of priorities. For example, this could be a problem if a rule needs to calculate positions of each element within a collection based on dependencies of the element instance.

### 3.5 Remove

In most cases the translation descriptor remove parameter should be set to 'true'. In this case the element will be deleted and re-generated on each invocation of the translator. The user should not change any attributes of the element nor add to its children (since any changes will be overwritten the next time the element is removed and re-generated by the translator). In some cases, however, it is necessary to generate an element whose contents may be modified by the user. To do this set the remove parameter of the Translation Descriptor to 'false'. In this case the generated element will not be deleted when the generator is next invoked. The rule must take care not to return another Translation Descriptor if the element has already been generated. It should look for a suitable generated element (to use for adding further generated children etc.) and only generate a new one if it doesn't exist.

## 4 Tasks

This section is intentionally blank.

## 5 Reference

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publish new versions (including revisions) of this Agreement from time to time. No one other than the Agreement Steward has the right to modify this Agreement. The Eclipse Foundation is the initial Agreement Steward. The Eclipse Foundation may assign the responsibility to serve as the Agreement Steward to a suitable separate entity. Each new version of the Agreement will be given a distinguishing version number. The Program (including Contributions) may always be distributed subject to the version of the Agreement under which it was received. In addition, after a new version of the Agreement is published, Contributor may elect to distribute the Program (including its Contributions) under the new version. Except as expressly stated in Sections 2(a) and 2(b) above, Recipient receives no rights or licenses to the intellectual property of any Contributor under this Agreement, whether expressly, by implication, estoppel or otherwise. All rights in the Program not expressly granted under this Agreement are reserved.

This Agreement is governed by the laws of the State of New York and the intellectual property laws of the United States of America. No party to this Agreement will bring a legal action under this Agreement more than one year after the cause of action arose. Each party waives its rights to a jury trial in any resulting litigation.