Incremental Assurance Plans and Instances

The *Alisa* notation lets users specify *assurance cases* that consist of one or more *assurance plan*s. Each assurance case is kept in a separate file with the extension *alisa*.

An *assurance plan* configures how a system is to be assured. It identifies the AADL model that represents an implementation to be verified against the requirements. It also indicates whether subsystems can be assumed to have been verified separately or whether their verification is part of this plan.

An *assurance task* allows users to focus on a subset of the requirements and verification activities at a time by specifying a set of filter criteria in terms of category labels.

Assurance cases get automatically instantiated as *assurance case result instances*. Assurance case result instances are then executed to verify AADL instane models for the root system implementation specified in each assurance plan and the results are recorded. Assurance case result instances are represented by the *Assure* notation in files with the extension *assure*.

Assurance Case and Assurance Plan

Users will define at least one assurance case for a system. It specifies the complete set of verification activities to be performed for the system. Users can then specify filtered subsets of verification activities as assurance tasks.

The assurance case may involve multiple AADL model instances, each with a different level of fidelity, i.e., expanded out to different levels of detail and properties. They are represented by separate assurance plans.

Users may define separate assurance cases and plans for subsystems of the system. Such an assurance case specification allows the subsystem to be verified separately. Users can then configure the assurance plans of the system to include the verification of the subsystem, or assume that the subsystem has been verified separately.

For each assurance plan the following verification plans will be included to generate the assurance case result instance:

- Verification plans for the *system requirement set* of the component implementation that is the target of the assurance plan and those of all component classifiers that this classifier inherits from – according to the same inheritance rules as for features and properties in core AADL. This includes all component implementations that this classifier extends, and all componen types and their extension ancestors.
- Verification plans for global requirements that have been included in any of the system requirement specifications or are explicitly specified in an **assure global** declaration. They will be included for the target component and any subcomponent that matches the specified component categories. For those subsystems that are not listed in an **assume subsystem** declaration, this will be done for the complete instance model hierarchy.
- If a subsystem assuance is not assumed, then the verification plans of the subsystem will be included according to the assurance plans for that subsystem. If no assurance case declaration

can be found, all verifications associated with the system requirements of that subsystem classifier will be included – as well as verification plans for global requirements included in the system requirements declaration.

Assurance case and assurance plan declarations have the following syntax:

```
AssuranceCase ::=
assurance case qualifiedname ( : "descriptive title" )?
for <component type reference>
[
 ( description Description )?

 AssurancePlan+
 AssuranceTask*
]

AssurancePlan ::=
assurance plan name ( : "descriptive title" )?
for <component implementation reference>
[
 ( description Description )?

 ( assure <verification plan reference>* )?
 ( assure global <global verification plan reference>* )?
 ( assure subsystem <assure subsystem reference>+ | all )?
 ( assume subsystem <assumed subsystem reference>+ | all )?
 ( issues "issue text"+ )?
]
```

The assurance case consists of:

- *Qualifiedname:* a <dot> separated sequence of identifiers. The assurance case name acts as qualifier for assurance plans and tasks.
- *Title:* a short descriptor of the verification method registry. This optional element may be used as more descriptive label than the name.
- *For:* component type reference that identifies the system to be assured by its type. The component implementations specified in the assurnace plans must be an implementation of this type according to the extends hierarchy.
- *Description:* a description of the verification method.
- *AssurancePlan:* one or more assurance plans that make up the assurance case configuration.
- *AssuranceTask:* zero or more filtered views of the assurance case that specifies a subset of verification activities according to specified **category**, **phase**, and **quality** labels.

The assurance plan consists of:

- *Name:* identifier of the plan. Assurance plan references are qualified with the enclosing assurance case name.
- *Title:* a short descriptor of the verification method registry. This optional element may be used as more descriptive label than the name.
- *For:* component implementation reference that identifies the system implementation to be assured. The component implementation is the root of the instance model on which verification activities are executed.

- *Description:* a description of the verification method.
- *Assure:* optional list of references to verification plans for the system. This list can be derived by the workbench or explicitly specified.
- *Assure global:* optional list of references to global verification plans that are not included as part of the system.
- *Assure subsystem:* names of subsystems in the component implementation whose assurance and verification plans should be included. **All** indicates all subsystems. The list of names is without commas.
- *Assume subsystem:* names of subsystems in the component implementation whose assurance and verification plans should be excluded. **All** indicates all subsystems. The list of names is without commas.
- *Issues:* allows users to record issues that may be encountered as a set of textual notes (Strings).

Assurance Task

Assurance tasks specify a set of filter criteria for a focused verification of a subset of requirements, verification activities, and methods according to **phase**, **quality**, and selection **category** labels. The assurance tasks apply to the assurance case they are contained in.

Assurance task declarations have the following syntax:

```
AssuranceTask ::=
assurance task name ( : "descriptive title" )?
[
 ( description Description )?

 ( category categorylabels | any )?
 ( issues "issue text"+ )?
]
```

The assurance task consists of:

- *Name:* identifier of the task. Assurance task references are qualified with the enclosing assurance case name.
- *Title:* a short descriptor of the verification method registry. This optional element may be used as more descriptive label than the name.
- *Description:* a description of the verification method.
- *Category:* list of selection category labels (without comma separation) , one of which must match the quality labels of requirement or verificaiton method. **Any** indicates that a requirement, verification method, or verification activity without category labels is considered a match.
- *Issues:* allows users to record issues that may be encountered as a set of textual notes (Strings).

Assurance Case Result Instance

The *Assure* notation is used to represent assurance case results for an instance of an assurance case associated with a set of AADL model instances. Assurance results files are automatically generated from an assurance case specified in an *Alisa* file. The generated file has the extension *assure* and is placed in the *assure* folder.

At this time users will open the file in the editor. The outline view will allow the user to execute the assurance task instance and show the assurance results. Users can also open an Assure View. In this view users can see the results in a table-based and graphical form.

The *assurance case result instance* representation maintains the state of verification activities, preconditions, and validations as well as the cumulative state for individual claims as well as all claims for a specific system instance model as specified by assurance plans, and for the whole assurance case. The following A*ssureResult* objects are maintained:

- *Assurance case result:* the results of the complete instance of an assurance case.
- *Model result:* the assurance results for a system according to an assurance plan. This includes claim results for the system as well as Assure results (model results or subsystem results) for any subsystem that is part of a given assurance plan.
- *Subsystem result:* the assurance results for a subsystem according to its verification plans. For subsystems with explicit assurance plans Model result is used.
- *Claim result:* the claim results for a requirement of a system, i.e., all its verification activity results, any subclaims. The verification activities are executed, and their results evaluated according to the argument expression specified as part of the claim.
- *Verification activity result:* the result of executing a verification activity. A verification activity may have preconditions that must be satisfied to be executed. The verificationa ctivity result validity may be determined by a *validation activity.*
- *Precondition/validation result:* the result of executing a precondition/validation activity.
- *then/else result:* the result of the *then* or *else* operator. The *else* result tracks whether the unsuccessful left hand operand was a *fail*, *timeout*, or *error.*

A verification activity, precondition, and validation has *execution state* and *result state*.

The execution state has the following values:

- *todo:* verification activity is to be executed
- *running:* execution of the verification activity is in progress
- *completed:* execution is complete with results
- *redo:* a verification activity, whose execution is in progress, must be re-executed due to user changes. When the execution completes the state transitions to *todo*.

The result state has the following values:

- *tbd:* the result value is to be determined by executing the verification activity. In the viewer this state is shown as *[tbd]*.
- *success:* the verification activity completed and the evaluated predicate returned a positive result. In the viewer this state is shown as *[S]*.

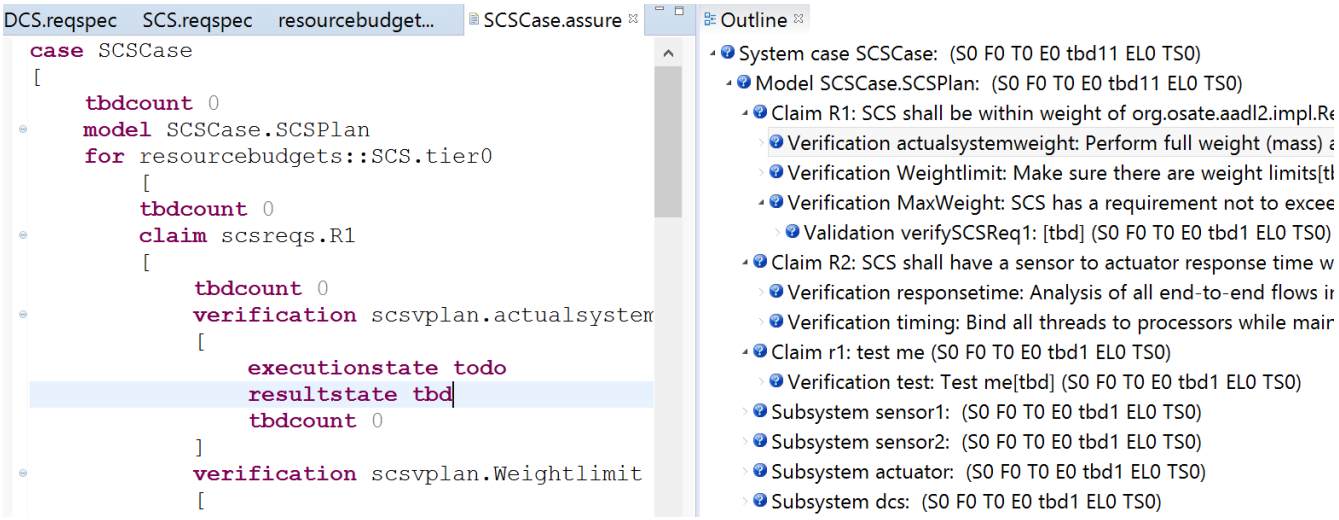
- *fail:* the verification activity completed and the evaluated predicate returned a negative result. In the viewer this state is shown as *[F]*.
- *error:* the verification activity did not complete, thus, the result is unknown. For example, the verification method crashed or threw an exception. In the viewer this state is shown as *[E]*.
- *timeout:* the verification activity did not complete because it exceeded the alloted time (see *timeout* limit in verification activity). In the viewer this state is shown as *[T]*.

Each of the Assure Result objects maintains cumulative metrics. Currently we track various result counts. In the future we will also track requirement coverage counts. The counts are:

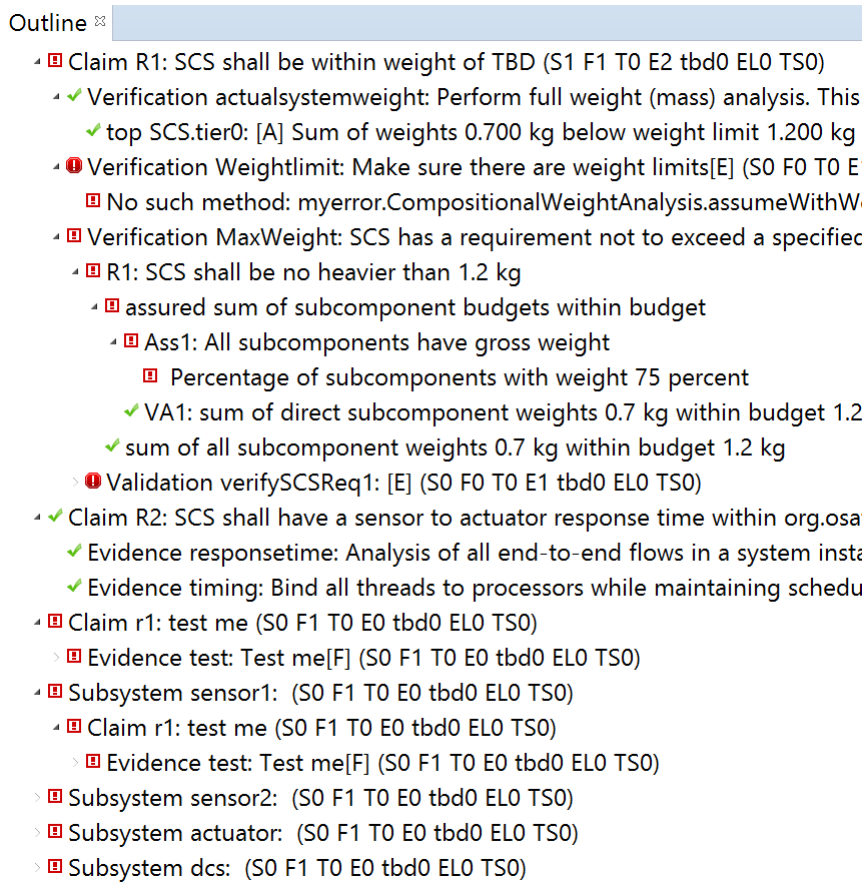
- *success count:* the number of successful verification activities contained in the given assure result. In the viewer this count is shown as *S#, where # is the count.*
- *fail count:* the number of failed verification activities contained in the given assure result. In the viewer this count is shown as *F#.*
- *error count:* the number of verification activities with unknown results contained in the given assure result. In the viewer this count is shown as E#.
- *timeout count: the number of verification activities with unknown results contained in the given assure result. In the viewer this count is shown as E#.*
- *tbd count:* the number of verification activities contained in the given assure result whose results are TBD. In the viewer this count is shown as tbd#.
- *then skip count:* the number of *then* expressions contained in the given assure result, whose left-hand side was unsuccessful, thus, the right-hand side got skipped. In the viewer this count is shown as TS#.
- *else count:* the number of *else* expressions contained in the given assure result, whose left-hand side was unsuccessful. In the viewer this count is shown as EL#.

Assurance case result instances can be viewed with the editor for the *assure* file and thorugh an Assure View. The editor and its Outline View are shown below. The Outline View shows the assurance case result instance as a hierarchy with icons indicating the result state of each entity as well as a presentation of the cumulative count. The figure below shows the hierarchy with the TBD state (blue questionmark).

Users can select the root *system case* and invoke the context menu (right click). Available commands are:



- *Verify all evidence*: Execute all verification activities.
- *Reset all evidence*: Reset an verificaiton activities to the status TBD
- *Open assure view*: Open the Assure View
- *Export evidence*: Export the assurance case evidence in D-Case format for viewing in graphical assurance case notation.



The result of verification activity execution are recorded in the assurance case result instance and presented as follows:

Success is shown as green checkmark. Fail is shown as red exclamation mark inside a red outlined box.

Error is shown as a white exclamation mark in a red box.

Result Issue Report

Verification, precondition, validation activity result objects also have a record of any issues, i.e., error, warning, or info messages providing explanation of the results, in particular if the verification activity fails. In our example inthe previous section, Resolute claim functions that has been registered as verification method. The claim funcitons themselves call other claim functions and computational functions. Recursively executed claim functions create a result report structure in Reolsute format. Our interface with Resolute translates that information into a common Alisa result issue report format for inclusion in the assurance case result instance.