Example Use of ReqSpec

This section describes the use of ReqSpec in OSATE. First, we describe how ReqSpec files are created in OSATE. Then we illustrate several use scenarios on an example.

Installing ReqSpec and ALISA in OSATE

Users extend an installation of OSATE [OSATE 2016] with the ReqSpec extension or the ALISA extension [ALISA 2016]. Users also include a copy of an Eclipse project called *AlisaBasics*[1], which contains the predefined category types and a verification method registry for the analysis plugins available in OSATE. This project and example projects using ReqSpec and ALISA are available at https://github.com/osate/alisa-examples.

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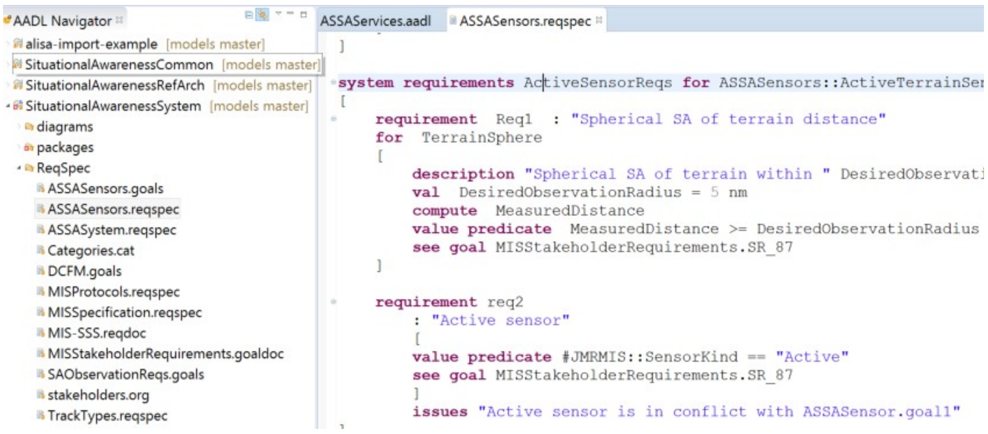
[1] In the near future AlisaBasics will be included automatically.

ReqSpec Declarations in OSATE

In this section we describe how ReqSpec files are created, updated, and analyzed through an Xtext-based textual editor. A navigator, forms and graphics based user interface is currently in development.

Figure 2 shows the AADL Navigator on the left. The SituationalAwarenessSystem project is shown as containing AADL model packages organized into subfolders. In this example we have chosen to put the ReqSpec files into a separate folder called *Requirements*. Note the different extensions used to distinguish between different types of ReqSpec files.

The right hand side shows a specification of system requirements. The editor understands the syntax of the *Organization* notation. It provides syntax coloring and ensures that each element of a stakeholder specification, e.g., the phone number, is specified at most once. It also supports content assist. When the user types <control> <spacebar> the editor provides syntactically legal choices.



```
]

system requirements ActiveSensorReqs for ASSASensors::ActiveTerrainSe
[
    requirement  Req1  : "Spherical SA of terrain distance"
    for  TerrainSphere
    [
        description "Spherical SA of terrain within " DesiredObservat
        val  DesiredObservationRadius = 5 nm
        compute  MeasuredDistance
        value predicate  MeasuredDistance >= DesiredObservationRadius
        see goal MISStakeholderRequirements.SR_87
    ]

    requirement req2
        : "Active sensor"
        [
        value predicate #JMRMIS::SensorKind == "Active"
        see goal MISStakeholderRequirements.SR_87
        ]
        issues "Active sensor is in conflict with ASSASensor.goal1"
```

Figure 2 Project with ReqSpec and Organization Files

The ReqSpec files could be placed in a separate project if desirable. In that case the user will have to add a Project Reference into the project containing the ReqSpec files to reference the project containing the AADL models. This tells the ReqSpec tool where to find the AADL model.

Project references are set in the properties dialog for the project containing the ReqSpec files. It can be invoked by selecting the project in the AADL navigator and invoking it through the context menu.

New ReqSpec (reqspec, goals, reqdoc, goaldoc), Category (cat), or Organization (org) files are created by invoking *File/New/File* and specifying a file name with the appropriate extension.

```
system requirements ASSASystemReqs  for ASSASystem::ASSASystem
[
requirement req1  :  "support offboard and onboard mission planning"
for AMPSInterface
[
description "support offboard and onboard mission planning and replanning"
see goal MISStakeholderRequirements.SR_73 MISStakeholderRequirements.SR_74
MISStakeholderRequirements.SR_75 MISStakeholderRequirements.SR_76
MISStakeholderRequirements.SR_77
]
requirement req2  :  "exchange planning information" for AMPSInterface
[
description "Planning information is communicated through the AMPSInterface."
]
requirement req3  for ThreatAlerts
[ description "alert other manned and unmanned systems"
see goal MISStakeholderRequirements.SR_81
]
```

The top-level requirement specification (e.g. **for** ASSASystem::ASSASystem) identifies the classifier of the ASSA system. The reference is qualified by the package name containing the classifier. These references are hyperlinked to their target. When the user holds down the <control> key while pausing the cursor over the reference it is shown as hyperlink (i.e. underlined) that can be followed by clicking on it. Navigation by hyperlink is tracked in a navigation history. Users can return to the reference origin via navigational commands or toolbar buttons .

The first requirement indicates that it is associated with an interface feature of the ASSA system called the AMPSInterface. This association reflects the fact that it is a requirement for the interaction between the ASSA system and an Aviation Mission Planning System (AMPS). The *See goal* elements identify several stakeholder goals that reflect the need for an interaction between the ASSA system and AMPS.

The second requirement is for the same interface feature and in its original text indicates the name of the interface for the interaction with a mission planning system.

The third requirement is associated with a different interface feature of the ASSA system.

```
system requirements ActiveSensorReqs  for ASSASensors::ActiveTerrainSensor
[
requirement Req1  :  "Spherical SA of terrain distance"
for TerrainSphere
[
description "Spherical SA of terrain within " DesiredObservationRadius " radius for
aircrew"
val DesiredObservationRadius = 5 nm
compute MeasuredDistance
value predicate MeasuredDistance >= DesiredObservationRadius
see goal MISStakeholderRequirements.SR_87
]
```

Figure 6 Requirement Predicate on Values

Figure 6 illustrates a requirement with a parameterized value. The value of the desired observation radius is captured in the variable called *DesiredObservationRadius*. This variable is used in the requirement description and in the requirement predicate. The requirement predicate assures that any *measuredDistance* result from a verification activity is at least as large as the desired observation radius. The *as* clause, when uncommented, specifies that the value is to be correctly reflected in the *JMRMIS::ObservationRadius* property associated with *TerrainSphere*.

The stakeholder requirement for this system requirement can be found as a goal in an imported requirement document.

An Example System in ReqSpec

We are using ReqSpec in three ways for the ASSA system.

First, we have imported the content of the MIS stakeholder requirement document and of the MIS system requirement specification document into the OSATE environment (*MISStakeholderRequirements.goaldoc* and *MIS-SSS.reqdoc*). In this case the requirements are initially not associated with an AADL model. Once imported users can create an AADL model and manually associated the requirements from the requirement document with the model. In the process users may associate different requirements from the same document section with different components in the AADL model. The ReqSpec tool has an analysis that identifies document sections that span multiple system components.

Second, we have created *stakeholder goals* sets and a *system requirements* sets that are associated with different systems in the architecture. We have created separate files for each of the AADL packages. The files contain sets of *goal* and *requirement* specifications, one for each component specification in the AADL package.

Figure 7 shows an example of a *stakeholder goals* set specified for ASSASensor. The keyword *stakeholder goals* introduces a name for a set of goals associated with the component *ASSASensor.* Each *goal* specification has a unique name within the goal set. In our example it includes a *title*, *description*, *stakeholder* reference, and a list of references into the MIS stakeholder *requirement document*.

```
stakeholder goals SensorGoals for ASSASensors::ASSASensor
[ goal goal1
 title: "Passive ASE (ASSA sensor type)";
[ description: "MIS shall support passive SA sensors (ASE)";
 stakeholder mrj.ab
 see requirement: MISStakeholderRequirements.SR_13,
MISStakeholderRequirements.SR_69, MISStakeholderRequirements.SR_15;
 ]
]
```

Figure 7 Goal set for ASSA Sensors

Third, we illustrated requirement specifications that use variables to parameterize the requirement and specify that a property in the AADL model should have the same value as the variable or a particular value. This practice ensures that a verification activity operating on the model utilizes the correct values when performing the verification. In Figure 6, we show two example scenarios. One uses a constant in a *value predicate* to indicate that the value of the variable and a specific AADL property must be the same. In the other, the variable value is passed as a parameter to a verification activity.

In our first example, the user has developed the model with a property *JMRMIS::EnergyLevel*. In this case, we specify in a *value predicate* that the constant value is consistent with the property value.

In the second example, the value of the requirement is defined by a constant; in our example, it is called *DesiredObservationRadius*. This value will then be used in a verification plan associated with the requirements to indicate that its value is to be passed to a verification method via a property in the AADL model. In this case, the AADL model is automatically annotated with the appropriate property value. Note that specifications of verification activities are expressed by the *Verify* notation, which is part of the incremental lifecycle assurance tool environment.

```
system requirements PassiveSensorReqs for ASSASensors::PassiveTerrainSensor
[
requirement Req4 : "Passive sensor"
 [
 val EnergyLevel = 0
 description "Passive sensor radiates " EnergyLevel " energy"
value predicate #JMRMIS::EnergyLevel == EnergyLevel
see goal MISStakeholderRequirements.SR_27
 ]
 requirement Req1 : "Spherical terrain awareness for aircrew"
 for TerrainSphere
[
 description "Spherical SA of terrain within " DesiredObservationRadius " radius for aircrew"
 val DesiredObservationRadius = 5 nm
compute measuredDistance
 value predicate measuredDistance >= DesiredObservationRadius
 see goal MISStakeholderRequirements.SR_27
 ]
]
```

Figure 8 Example of Requirement Specification Aligned with AADL Model

References

[ALISA 2016]

Architecture-Led Incremental System Assurance (ALISA) Workbench. https://github.com/osate/alisa

[Delange 2016]

Delange, J., Feiler, P., Ernst, N., *Incremental Life Cycle Assurance of Safety-Critical Systems*, Proc. 8th European Congress on Embedded Real Time Software and Systems, Jan 2016. http://www.erts2016.org/inc/telechargerPdf.php?pdf=paper_13

[Eclipse 2015]

Eclipse. Xtend. 2015. http://www.eclipse.org/xtend

[FAA 2009]

Federal Aviation Administration. *Requirements Engineering Management Handbook*. DOT/FAA/AR-08/32. FAA. 2008. http://www.faa.gov/aircraft/air_cert/design_approvals/air_software/media/AR-08-32.pdf

[Feiler 2015]

Feiler, Peter. *Requirements and Architecture Specification of the Joint Multi-Role (JMR) Joint Common Architecture (JCA) Demonstration System*. CMU/SEI-2015-SR-031. Software Engineering Institute, Carnegie Mellon University. 2015. http://resources.sei.cmu.edu/library/asset-view.cfm?assetid=447184

[IEEE 2009]

Institute of Electrical and Electronics Engineers. IEEE Standard 830-1998: Recommended Practice for Software Requirements Specifications. IEEE Standards Association. 2009.

[Lamsweerde 2009]

van Lamsweerde, Axel van. *Requirements Engineering: From System Goals to UML Models to Software Specifications*. Wiley. 2009.

[Nolan 2011]

Nolan, A. J.; Abrahao, S.; Clements, P.; and Pickard, A. Managing Requirements Uncertainty in Engine Control Systems Development. 259–264. *19th IEEE International Requirements Engineering Conference (RE)*. Aug. 29–Sep. 2, 2011. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6051622&tag=1

[OMG 2015]

Object Management Group. OMG Systems Modeling Language. OMG. 2015. http://www.omgsysml.org

[OSATE 2016]

Open Source AADL Tool Environment (OSATE). https://wiki.sei.cmu.edu/aadl#OSATE.

[SAE 1996]

SAE International. ARP4761: Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment. SAE. 1996.