

Scenario Checker User Manual

Dr Colin Snook
ECS, University of Southampton
`cfs at soton dot ac dot uk`

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1 Overview

The Scenario Checker is a tool to help develop useful Event-B models. The Scenario Checker focusses on a behaviour-driven approach to validate model behaviour. The Scenario Checker does not verify that models are consistent: Rodin automatic provers should be used to verify models. The Scenario Checker uses the ProB animator to execute the model.

The Scenario Checker allows scenarios to be animated and recorded while visualising the state of variables and enabledness of events in the model. When the model has been modified, scenarios can then be re-played to check for changes.

It is assumed that part of the model represents a controller and other parts represent the controlled devices in the environment. Events designated as internal steps of the controller are run automatically until completion (i.e. until no more internal events are enabled) and private variables of the controller are ignored. Events may also be prioritised to resolve non-deterministic choices remaining in the model.

1.1 Release Notes

- **0.0.0** - prototype release

1.1.1 Known Issues

- using the small step button in playback can result in errors

2 Getting Started

2.1 Setup

The Scenario Checker is installed into Rodin from the plugin update site in the normal way. It is located under the Utilities category.

The Scenario Checker depends on (and will install elements from)

- ProB - de.prob

- ProB Support - ac.soton.eventb.probsupport
- Event-B EMF framework - org.eventb.emf
- Oracle - persistence for scenarios

2.2 Perspective

The Scenario Checker defines a perspective (see Fig. 1) which includes the Scenario Checker Control Panel view and the Scenario Checker State view. The perspective also includes the ProB History view which is used to see the executed scenario (including internal events). The ProB State view is also included (stacked behind Scenario Checker State) in case a more detailed view of state is needed.

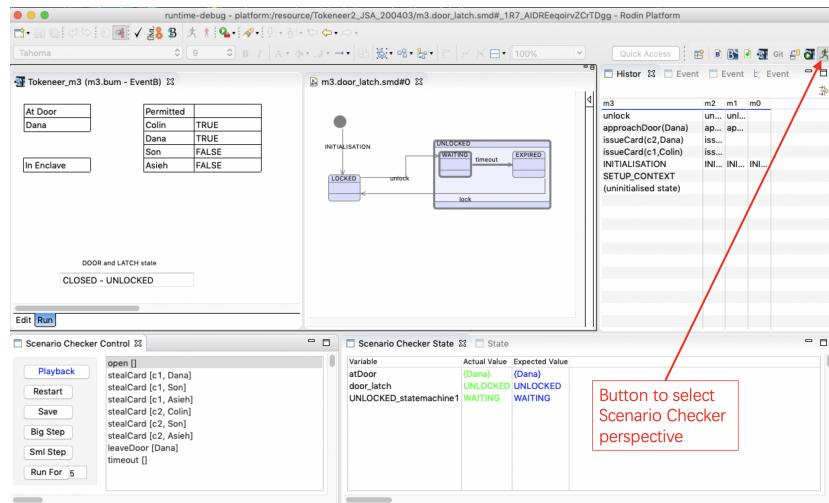


Figure 1: Scenario Checker Perspective

The Scenario Checker views are also contributed to the BMotion Studio Run perspective and are available as short cuts on the Event-B perspective.

2.3 Starting

The Scenario Checker is started using the context menu of a machine as shown in Fig. 2. I.e. by right clicking on a machine in the Event-B navigator and selecting the **Scenario Checker** menu item.

An alternative way to start the Scenario Checker is to ensure that at least one of the scenario views is opened (e.g. by selecting the Scenario Checker perspective) and then using the toolbar button of the ProB support plug-in (the green running man shown circled in red in 3).

In either case, the ProB support plug-in will be used to simultaneously launch the scenario checker and any other participating animation plugins

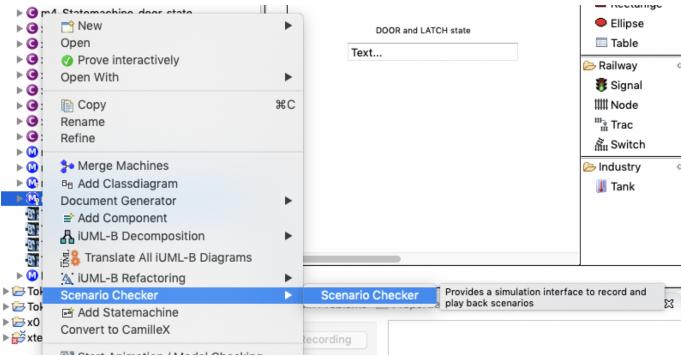


Figure 2: Starting the Scenario Checker from the context menu

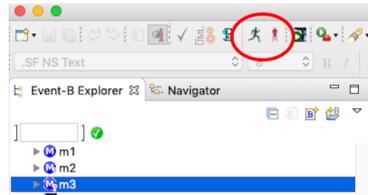


Figure 3: Starting/Stopping the Scenario Checker using the toolbar icons

that are open for the same machine. For example, a BMotion Studio visualisation and/or a UML-B state-machine could be used to visualise the state of the model to assist validation.

The Scenario Checker should be stopped by selecting the machine again and using the red standing man toolbar button.

Warning: If another animation is started using the ProB support plugin, any current animation will be aborted.

2.4 Setup

The Scenario Checker always fires the ProB setup operation whenever it can (i.e. when it is started or re-started or replayed). It is important for the sets and constants in the model, to be instantiated with suitable values to record a desired scenario. The same values must also be instantiated in order for previously recorded scenarios to be replayed. This can be done by adding an animation context that is seen by the machine to be animated.

2.5 Persistence

Scenarios are persisted in the Oracle format. This is an XML based format consisting of two types of elements (Steps and Snapshots) which are expected to alternate. A **Step** records the event signature that fired as part of the scenario. A **Snapshot** records the state of any variables and

constants that changed value as a result of the preceding step. The first step is always the ProB SETUP operation and this is followed by the first snapshot giving the values of sets and constants. The second step is the INITIALISATION followed by the snapshot giving the initial value of all variables. After this the steps and snapshots depend on the scenario. The oracle format is defined and generated from an EMF meta-model and hence is the default EMF XMI format for that meta-model. Scenarios can be read and edited using an EMF editor such as Rose.

3 Concepts

The Scenario Checker is based on the following concepts:

- A model represents a closed system involving a controller and the sensed and controlled environment.
- A scenario consists of a sequence of external events that occur in the sensed environment.
- After each external event, a resulting state is expected.
- The model of the controller may include internal events which are not specified in the scenario. Events in the model may be designated as internal by adding a generic boolean attribute, `Internal=true`, or inserting `<INTERNAL>` in the comment property.
- The model of the controller may include private variables which are not specified in the scenario. Variables in the model may be designated as private by adding a generic boolean attribute, `Private=true`, or inserting `<PRIVATE>` in the comment property.
- Events may be given a priority to add control of ordering of events when this is not specified by the model. Event priority is given by adding a generic integer attribute, `Priority=n`, or inserting `<PRIORITY=n>` in the comment property, where n is a natural number. (Low priority numbers are executed first). Note that prioritising events results in validating a particular refinement of the actual model.

The Scenario Checker provides:

- A Control Panel to control the execution of external events, recording and playback of scenarios, and to view the enabled external events.
- A State View to monitor the value of variables and to indicate differences from the expected values.

4 Tasks

The Scenario Checker has two modes: Recording and Playback. The mode of the Scenario Checker is shown in the label at the top of the control panel (see Fig. 4).

The Scenario Checker is always started in the recording mode. It changes to playback mode when the mode indicator button is pressed while it



Figure 4: Changing Mode in the Scenario Checker

displays recording. It changes to recording mode when the mode indicator button is pressed while it displays playback.

4.1 Recording a Scenario

With the Scenario Checker in recording mode, the user can choose from the available external events and arguments that are listed in the Scenario Checker Control Panel (see lower left view in Fig. 5). The chosen event is executed (either by double clicking on it, or selecting it and then pressing the Big Step button). The Scenario Checker automatically runs internal events until completion and then updates the Scenario Checker State view to show the state of all non-private variables.

At any point, after firing a sequence of events, the scenario can be saved without altering the current scenario execution. This makes it easy to record intermediate points in a scenario. The ProB history view can be used to return to any point in the scenario history. For example if the user makes a mistake or decides that a different event trace would have been better, the ProB History view can be used to discard the later part of the trace and a new sequence can be continued from that point on. (Note that, when saving, the scenario execution is always obtained from the ProB animation history, rather than any user interaction with the Scenario Checker).

In recording mode, the Scenario Checker Control Panel buttons have the following function:

- **Mode (Recording)** Switches to playback mode and allows the user to select a previously recorded scenario oracle file to play. This discards the current scenario after a warning confirmation from the user.
- **Restart** Discards the current scenario and restarts animation from the INITIALISATION. If the scenario had progressed beyond the INITIALISATION event, a warning and confirmation message box is displayed.
- **Save** Saves the current scenario and continues without interruption. This enables common prefixes to be saved as partial scenarios for later completion. The scenario is saved in a folder called **Oracle** inside the Event-B project. The filename is automatically constructed from the machine name and a timestamp with the extension, **.oracle**.
- **Big Step** Executes events until completion of the next big step. If an operation has been selected from the list of enabled external

events in the Scenario Checker Control Panel (by single clicking on it), that event will be executed. If no such event is selected, one will be picked at random. In either case, if after executing the external event any internal events are enabled, one will be executed at random and according to any priority that has been defined in the model (see Section 3). Firing of internal events will continue in this way until none are enabled or a loop is detected. (A loop is detected when the same event has already been executed in this run to completion). Double clicking on an event in the list of enabled events in the Scenario Checker Control Panel is exactly the same as selecting the event and using the big step button.

- **Small Step** Executes one event which is selected as follows. If an operation has been selected from the list of enabled external events in the Scenario Checker Control Panel (by single clicking on it), that event will be executed. Otherwise, if any internal events are enabled, one will be executed at random and according to any priority that has been defined in the model (see section 3). Note that it is possible to ignore internal events using the small step button which may lead to scenarios that fail when played back (since it is not usual behaviour to ignore internal events).
- **Run For..** Executes the number of big steps shown in the text box next to the button. The number can be changed by clicking in the box and editing the number.

In recording mode, if the scenario has progressed beyond INITIALISATION (i.e. there is a useful scenario that could be saved) the Scenario Checker Control Panel indicates that a scenario could be saved by displaying an * in the title bar.

In recording mode the Scenario Checker View displays the current value of all non-private variables irrespective of whether they have changed or not. The Expected value column is left blank.

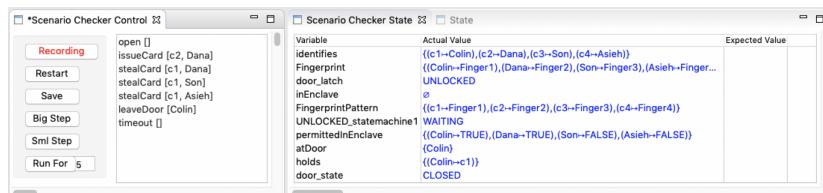


Figure 5: Scenario Checker in Recording Mode

4.2 Re-playing a Scenario

With the Scenario Checker in playback mode (see Replay button in Section 5), the execution of events is taken from the scenario oracle file being replayed. The user should not try to control the execution of events and an information message will be displayed if she attempts to select events from the Scenario Checker Control Panel. (Note that it is not possible to

prevent other animation plug-ins (including the ProB ‘Events’ view) from executing events but this would most likely make the scenario fail. The user presses the Big Step button to tell the Scenario Checker to execute the next recorded external event followed by any enabled internal events (similar to in recording mode). The Scenario Checker then updates the Scenario Checker State view to show the state of any non-private variables that have changed state. The expected value from the recording is shown and any differences are highlighted in red. At any point, the playback can be stopped and an alternative ending can be recorded.

In playback mode, the Scenario Checker Control Panel buttons have the following function:

- **Mode (Playback)** Switches to recording mode. The scenario execution is left in whatever state it was during the playback. This allows multiple alternative scenarios to be recorded using a common recorded prefix.
- **Restart** Discards the current scenario execution and restarts the same recorded scenario animation from the INITIALISATION.
- **Save** Saves the current scenario execution and continues without interruption still in playback. This enables common prefixes to be saved as partial scenarios for later completion. The scenario is saved in a folder called ‘Oracle’ inside the Event-B project. The filename is automatically constructed from the machine name and a timestamp with the extension, ‘oracle’.
- **Big Step** Executes events until completion of the next big step. The external event is taken from the recording. If, after executing the external event, any internal events are enabled, one will be executed at random and according to any priority that has been defined in the model (see section 3). Firing of internal events will continue in this way until none are enabled or a loop is detected. (A loop is detected when the same event has already been executed in this run to completion).
- **Small Step** Executes one event which is selected as follows. If any internal events are enabled, one will be executed at random and according to any priority that has been defined in the model (see section 3). Otherwise, attempts to play the next external event from the scenario being played, but does not automatically fire subsequent internal events. Note that after firing a single step without firing the internal events, the state will probably not match the expected state in the scenario.
- **Run For..** Executes the number of big steps shown in the text box next to the button. The number can be changed by clicking in the box and editing the number.

In playback mode, the next external event in the recorded scenario (i.e. the event that will be executed when the big step button is next pressed) is highlighted in the list of enabled external events in the Scenario Checker Control Panel.

In playback mode the Scenario Checker View displays the current value of any non-private variables that have changed value since the last step. The Expected value column displays the corresponding value from the recorded scenario for comparison. If the values are the same the current value is displayed in green. If the values differ the current value is displayed in red.

When all steps in the recorded scenario have been played, the user is prompted to switch to recording mode. The Scenario Checker switches to recording mode without disturbing the current state of the scenario execution. This allows the scenario to be extended to make a new, longer, recorded scenario.



Figure 6: Scenario Checker in Playback Mode

5 Reference

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