



Enterprise Architect

User Guide Series

# Business Process Simulation (BPSim)

How to simulate a business process? In Sparx Systems Enterprise Architect, create a process model in BPMN and a business process simulation (BPSim) configuration, and execute it using a BPSim simulation engine, comparing multiple simulation results.

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# Business Process Simulation (BPSim)

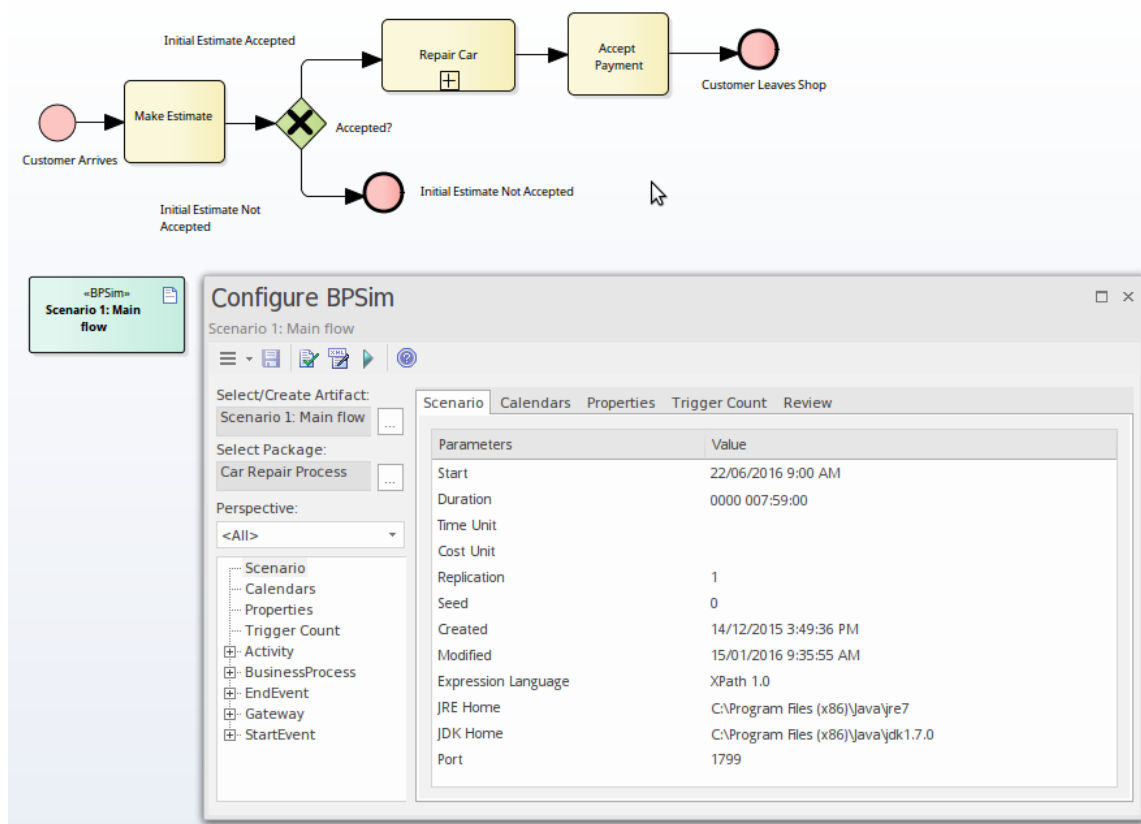
The open BPSim specification provides a rich set of material on how to configure and assign resources to activities/tasks, how to raise events, decision making and other real-world capabilities. Once configured according to the BPSim specification, a business process model (constructed in BPMN) can be sent to a suitable BPSim simulation engine and run according to the process defined in the BPMN model, using the configuration data attached in the BPSim information.

The BPSim specification is very detailed and offers the interested modeler and business strategist an unprecedented flexibility in assigning operating information to a model and then assessing the quality of the solution based on information received back from the Simulation engine. This section describes in detail the various screens and options available when configuring a model for BPSim execution.

Sparx Systems provide a BPSim-capable simulator (for separate purchase) - the **MDG BPSim Execution Engine**. This Add-In integrates with the BPSim and BPMN models defined in Enterprise Architect, providing the capability to run and store the results from multiple simulations and to perform convenient comparisons across each configuration's result set.

Installing the Sparx Systems **MDG BPSim Execution Engine** and registering the licence for it are pre-requisites for accessing and using the built-in BPSim configuration facilities. Once you have set up a BPSim configuration, you can export the BPMN model along with its BPSim data in a standard form that can be consumed by the Sparx Systems BPSim Execution Engine and by any other standards-compliant BPSim engines.

## BPMN Model with BPSim Configuration



The BPMSim configuration screens have been divided into multiple Perspectives, each of which focuses on one aspect of the set up process at a time. The three Perspectives are:

- Control Perspective, which examines how activity flows through the process, moderated by the likelihood of a sequence of events and the priorities of certain events
- Time (Temporal) Perspective, which examines how the duration of one or more phases in the processing of an

Activity influences the business process

- Resource Perspective, which examines the involvement of types and roles of workers and other resources, their required numbers, their costs and their availability

A fourth Perspective (<All>) presents all of the options of the other three Perspectives.

You can also maintain multiple versions of a configuration and easily compare the differences between versions to see how each configuration will vary the flow of the proposed simulation or process execution. You might, for example, establish a baseline configuration and then create multiple 'what-if?' configurations that vary one or more parameters. Once run through a simulation engine you can examine each result and decide on the relative merits of each configuration. One useful facility to apply here is the simple inheritance of common, unchanged data in one configuration by another configuration that contains only the data being varied.

Users can combine the BPSim and Charting facilities to quickly vary, simulate and compare aspects of a Business Process model, and show the differences between the simulations in one of the many Chart formats.

If you are working across multiple projects, you can export and import the BPSim configurations between them. The configuration automatically carries with it the BPMN 2.0 model on which it is based.

The Enterprise Architect Business Process Simulation configuration tool is based on the BPSim Framework developed by the Workflow Management Coalition (WfMC).

## Install the BPSim Execution Engine

You can purchase and download the MDG BPSim Execution Engine from the 'Products' page of the Sparx Systems website ([sparxsystems.com/products](http://sparxsystems.com/products)). As part of this process, you will receive a registration key by email, to enable you to use the system beyond a 14-day trial period.

The MDG BPSim Execution Engine installer does not include JRE or JDK, therefore you must install JRE version 1.7 or higher to use the simulation and, if your BPSim Configuration contains any property parameters, you must also install JDK version 1.7 or higher.

You do not need to do any further configuration of the engine unless you have multiple versions of JRE/JDK on your system and you want to specify which version the execution engine should use. In this case, apply these environment variables as shown:

1. Click on the Windows 'Start' icon and select the 'Computer' option.
2. From the banner menu, select the 'System properties' option.
3. From the side panel, select the 'Advanced system settings' option.
4. On the 'Advanced' tab of the 'System Properties' dialog, click on the Environment Variables button.
5. On the 'Environment Variables' dialog, in the 'System variables' panel, click on the New button.
6. On the 'New System Variable' dialog, complete the fields with the values shown:

For JRE:    Variable name:   MDG\_BPSIM\_JRE\_HOME  
             Variable value:   C:\Program Files\Java\jre7

For JDK:    Variable name:   MDG\_BPSIM\_JDK\_HOME  
             Variable value:   C:\Program Files\Java\jdk1.7.0\_51

7. Click on the OK button.
8. You must re-start your machine for the new variables to take effect.

## Notes

- If you click on a business process element or connector in a diagram or in the Browser window, it is highlighted and selected in the Configure BPSim window
- The Business Process that you simulate can contain elements from more than one Package; to include the external elements in the simulation, you must create a Package diagram containing the 'parent' Package and either the



'external' Packages containing the external elements, or the external elements themselves; create a:

- Package Import connector from the parent Package to each external Package, or
- Dependency connector from the parent Package to each external element

## BPSim Configuration

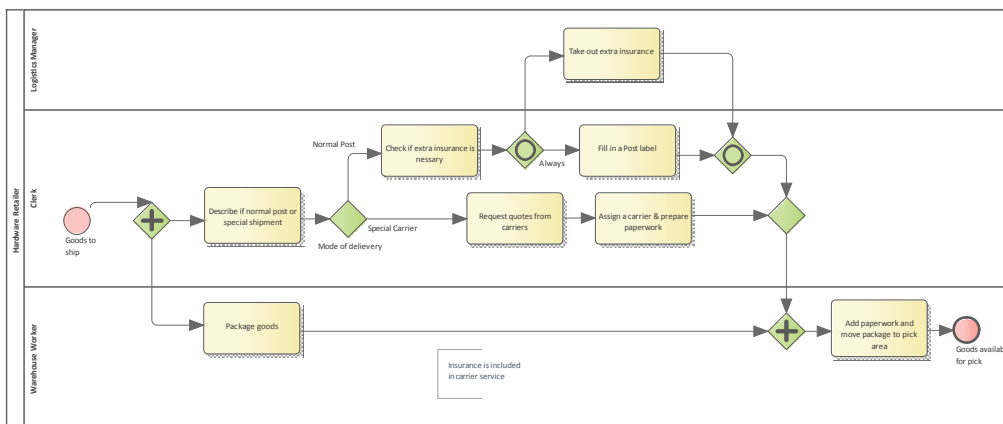
A Business Process Simulation (BPSim) configuration is represented and contained in a Business Process Simulation Artifact element, which you can create on a diagram in any Package in the same project as the BPMN model that you are working with.

### Create a Business Process Model

Each BPSim configuration is created specifically for and from an existing Business Process, defined in BPMN. Therefore you will need to create or import the BPMN model on which the configuration is to be based, before you use the Business Process Simulation Artifact.

This example diagram can be found and worked on in the EAExample model, in:

Analysis and Business Modeling > BPMN 2.0 Examples > Process Diagrams > Shipment Process of a hardware retailer



### Create a Business Process Simulation Artifact

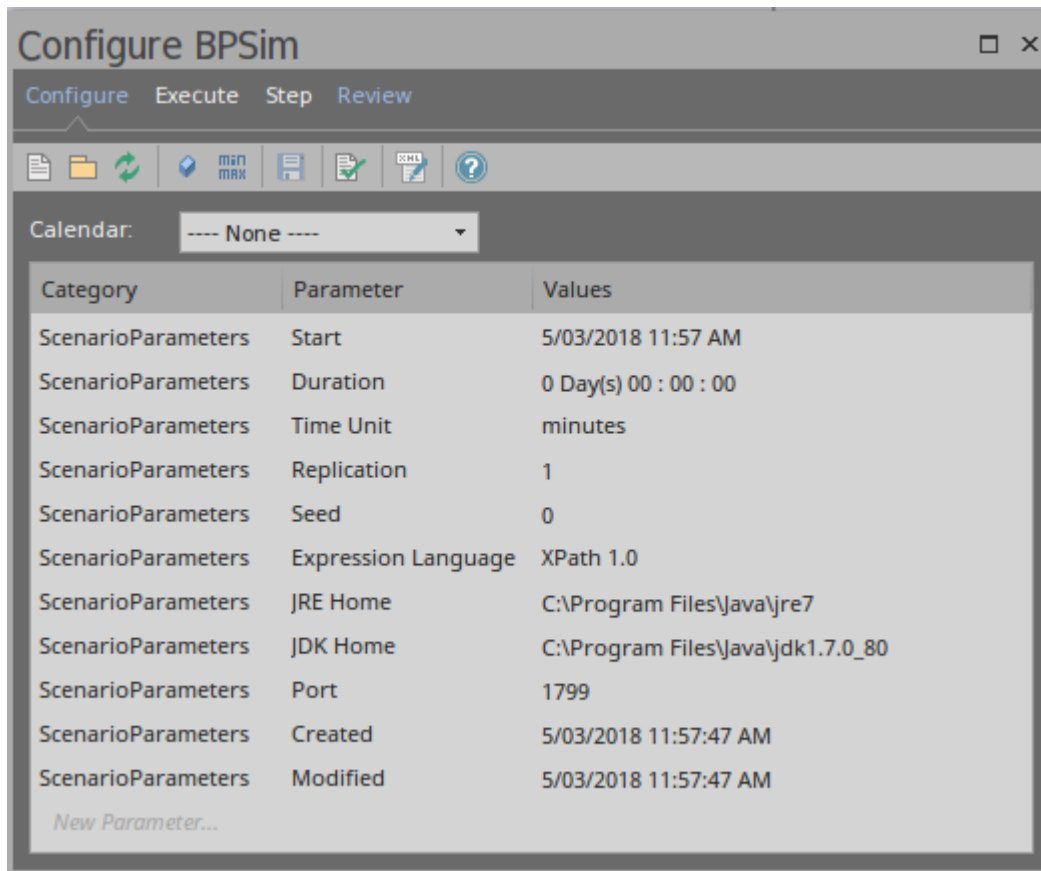
Open a diagram in which to create the Artifact, and display the Diagram Toolbox (press Ctrl+Shift+3). Expand the common 'Artifacts' page, and drag the 'Business Process Simulation' icon onto the diagram.

When you set up the Artifact, consider whether you might create separate Artifacts and use Generalization connectors between them so that one Artifact inherits the data you have defined in another Artifact. This way, you do not have to keep re-defining the whole configuration in every Artifact you create.

Double-click on the element and give it an appropriate name, such as (for the example) 'Shipment Process - Resource'.

### Configure BPSim Window Overview

Right-click on the Artifact element (either in the diagram or in the Browser window) and select the 'Configure BPSim' option. The Configure BPSim window displays for the Artifact.



This window contains four tabs: Configure, Executive, Step and Review.

- **Configure:** Configure BPSim parameters for each BPMN Element; Define Property Parameters, Calendars and Scenario Parameters.
- **Execute:** Execute the BPMN model with BPSim configuration.
- **Step:** Step Over / Step In to provide an insight look to the execution process, including token status, property values and resource allocations per time/step.
- **Review:** Review / Compare configuration artifact(s), Standard / Customized simulation result report(s)

## BPSim - Configure Page

The BPSim Artifact will be configured to a Package. All BPMN elements under this Package or its sub-Packages will be loaded. By default, the Package containing this Artifact will be configured when loaded into this window.










This window is context sensitive. When an element is selected on a diagram or the Browser window, the list will show current configurations for the element; also, the combo boxes will only show available parameters for the element.

When the BPSim Artifact is the context element, the list will show the ScenarioParameters.

### Access

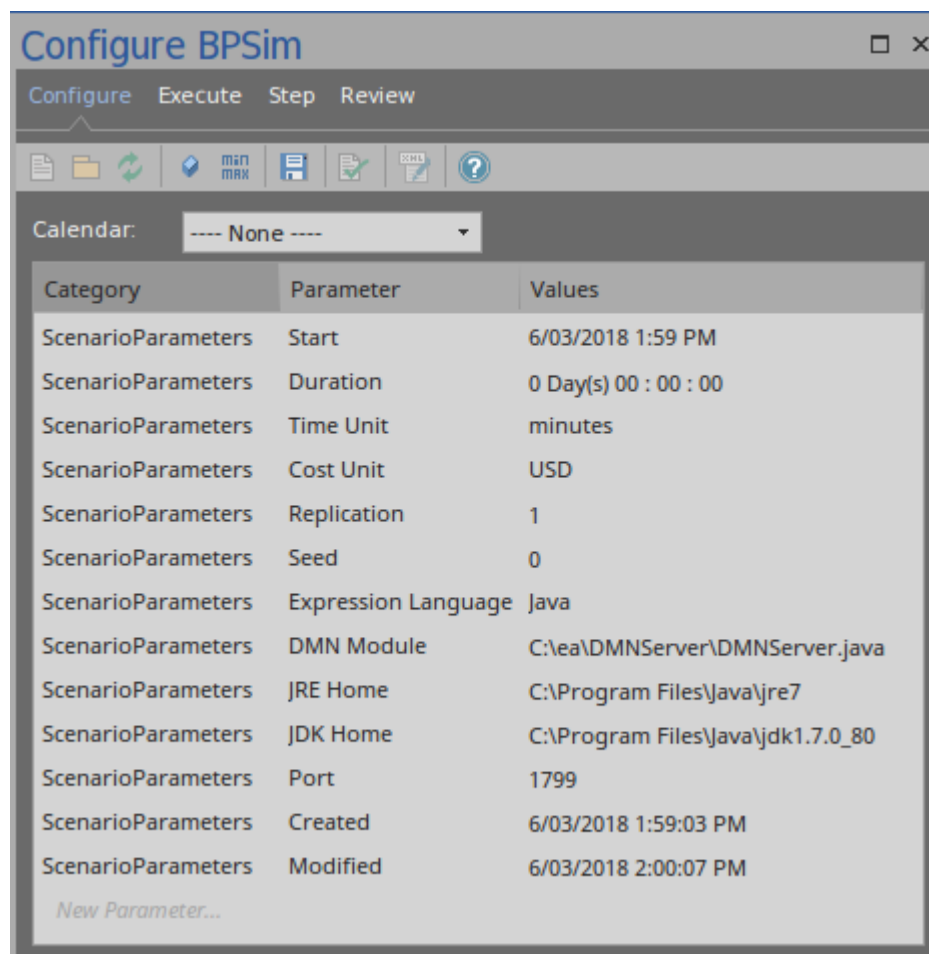
Ribbon	Simulate > Process Analysis > BPSIM > Open BPSIM Manager > Configure Page
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### Toolbar Options






Option	Description
	Click on this button to select or create a DMNSimConfiguration element.
	Click on this button to set a Package for the BPSim Artifact. All BPMN elements under this Package or its sub-Packages will be loaded.
	Click on this button to reload BPMN elements from the configured Packages. For example, when some BPMN elements are modified, run this command to reload the Package so that the changes will be taken into account for BPSim Simulation.
	Click on this button to define Properties, which can be used as Property Parameters on BPMN elements.
	Click on this button to define Calendars, which can be used to configure element parameters.
	Click on this button to show or hide the 'Result Request' column. Result Request configuration is required for a Custom simulation. The execution report will only contain results that are requested.
	Click on this button to save the BPSim Simulation window information to a BPSim Artifact element.
	Click on this button to validate the BPMN model and the BPSim Configurations. Error or Warning messages might display in the System Output window if they are generated.
	Click on this button to export the BPMN model with the BPSim configuration. This exported BPMN file conforms to the BPMN and BPSim specifications and can be used by third-party BPSim Execution engines.

## Scenario Parameters

A scenario is composed of a collection of element parameters. The scenario itself defines parameters used by all elements as global settings.



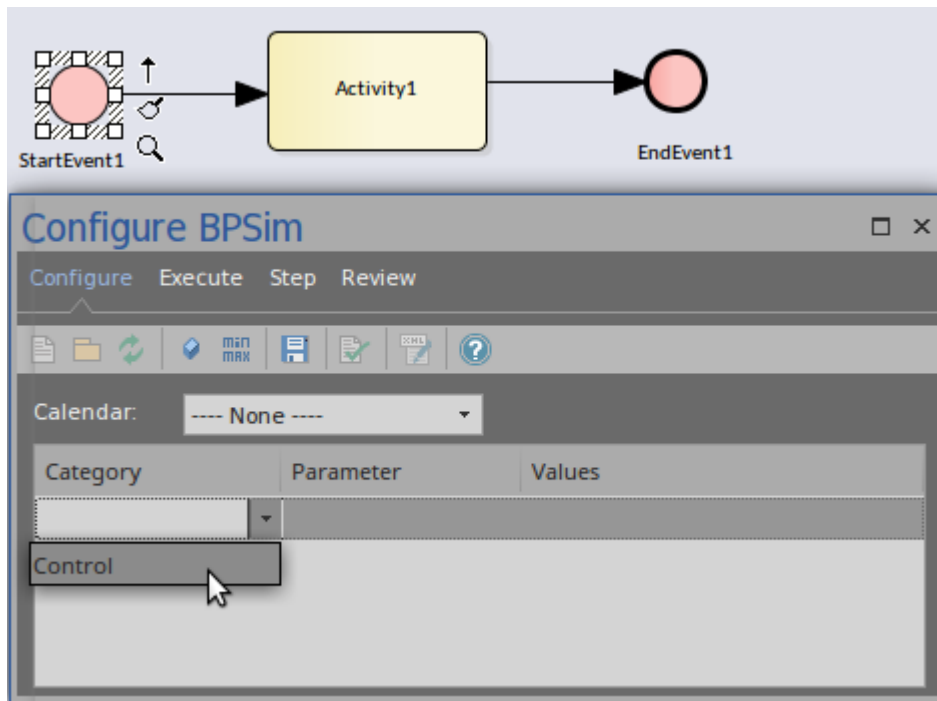
Name	Description
Start	The date and time at which the process starts to take effect. You can edit this by overtyping the values or, for the date, by selection from a drop-down calendar.
Duration	The length of time the process takes. The 'Duration' parameter is a required value. It must be long enough to accommodate a complete simulation; for example, if a process (and hence its simulation) takes three hours to complete, the 'Duration' parameter must be set to a value greater than three hours. You can edit this by overtyping the appropriate segment in the format 'days hours:minutes:seconds'.
Time Unit	The base unit in which periods of time are expressed in this scenario. All numeric and floating values representing time should be considered as being expressed in this unit, unless overridden locally. You can edit this by clicking on the drop-down arrow and selecting the unit.

Cost Unit	<p>The currency unit of any costs recorded in the process. All numeric and floating values representing a cost should be considered as being expressed in that currency code, unless overridden locally.</p> <p>You can edit this by clicking on the drop-down arrow and selecting the unit abbreviation.</p>
Replication	<p>The number of replications of the scenario to be executed. Defaults to 1.</p> <p>You can edit this by simply typing a value in.</p>
Seed	<p>A random seed to be used to initialize a pseudo-random number generator.</p> <p>You can edit this by simply typing a value in.</p>
Expression Language	<p>XPath 1.0 and Java - XPath 1.0 is the default language. If Java is specified as the expression language, JDK Home must be set.</p> <p>You can edit this by clicking on the drop-down arrow and selecting the language.</p>
DMN Module	<p>When business rule tasks are used in the BPMN Model, you can implement these tasks as a DMN Model.</p> <p>You might first create a DMN Model and generate a DMN Server in Java, then click on the  button to specify the generated DMN Server file.</p>
JRE Home	<p>The Enterprise Architect BPSim Execution Engine runs in a Java Environment, therefore a JRE Home has to be specified. Click on the  button to choose a directory; for example, C:\Program Files\Java\jre7.</p> <p>You can edit this by clicking on the  button again to browse the directory.</p>
JDK Home	<p>When the expression language is Java, the Enterprise Architect BPSim Execution Engine will generate Java code and compile with javac as the vendor extension. So a JDK Home must be specified. Use the  button to choose a directory (such as C:\Program Files\Java\jdk1.7.0_80).</p> <p>You can edit this by again clicking on the  button to browse the directory.</p>
Port	<p>The Port number that Enterprise Architect used to communicate with the BPSim Execution Engine. The default port number is 1799.</p>
Created	<p>Read only field. The timestamp when the BPSim Artifact was created.</p>
Modified	<p>Read only field. The timestamp when the BPSim Artifact was last modified.</p>

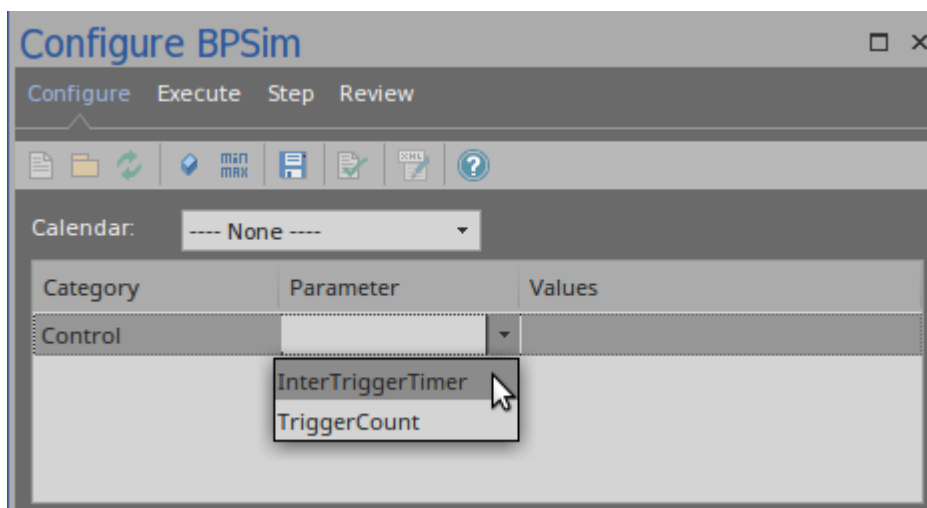
## Control Parameters


To begin defining Control Parameters:

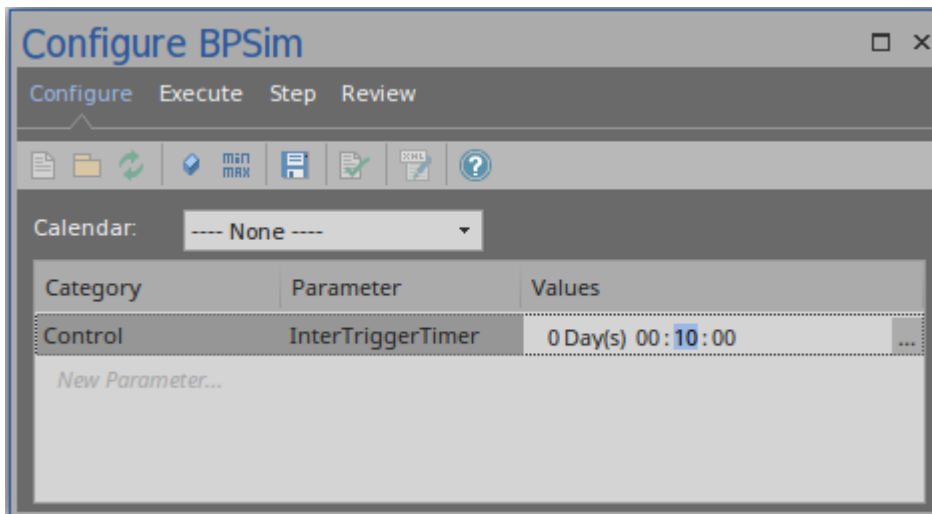
- Select the element on the diagram, then choose 'Control' in the 'Category' column in the list



- After the category selection, the combo box in the 'Parameter' column will be filled with all the available parameters for the selected element



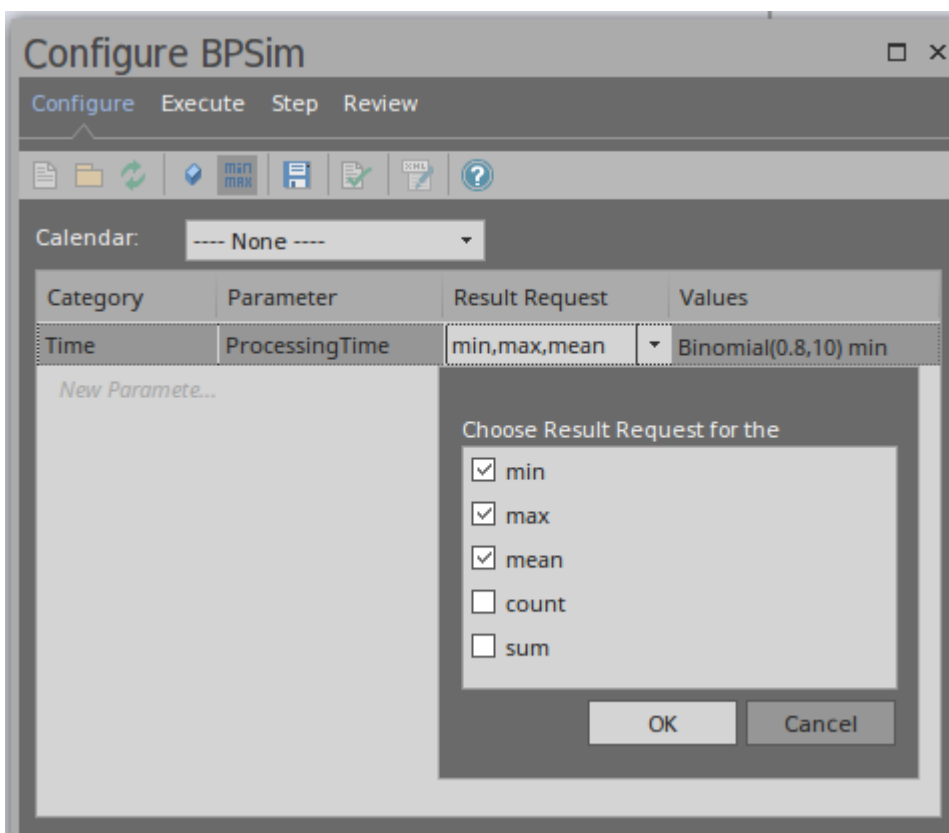
- After the parameter selection, you can enter the parameter value in the field or use the  button to open the 'Parameter Value' dialog



## Temporal Parameters

To begin defining Time Parameters:


- Select the element on the diagram, then choose 'Time' from the 'Category' column in the list
- After you select the category, the combo box in the 'Parameter' column will be filled with the available parameters for the selected element
- After you select the parameter, you can enter the value in the field or use the button to open the 'Parameter Value' dialog
- You can toggle the 'Result Request' column by clicking on the min/max button on the toolbar to customize the simulation result by requiring certain results

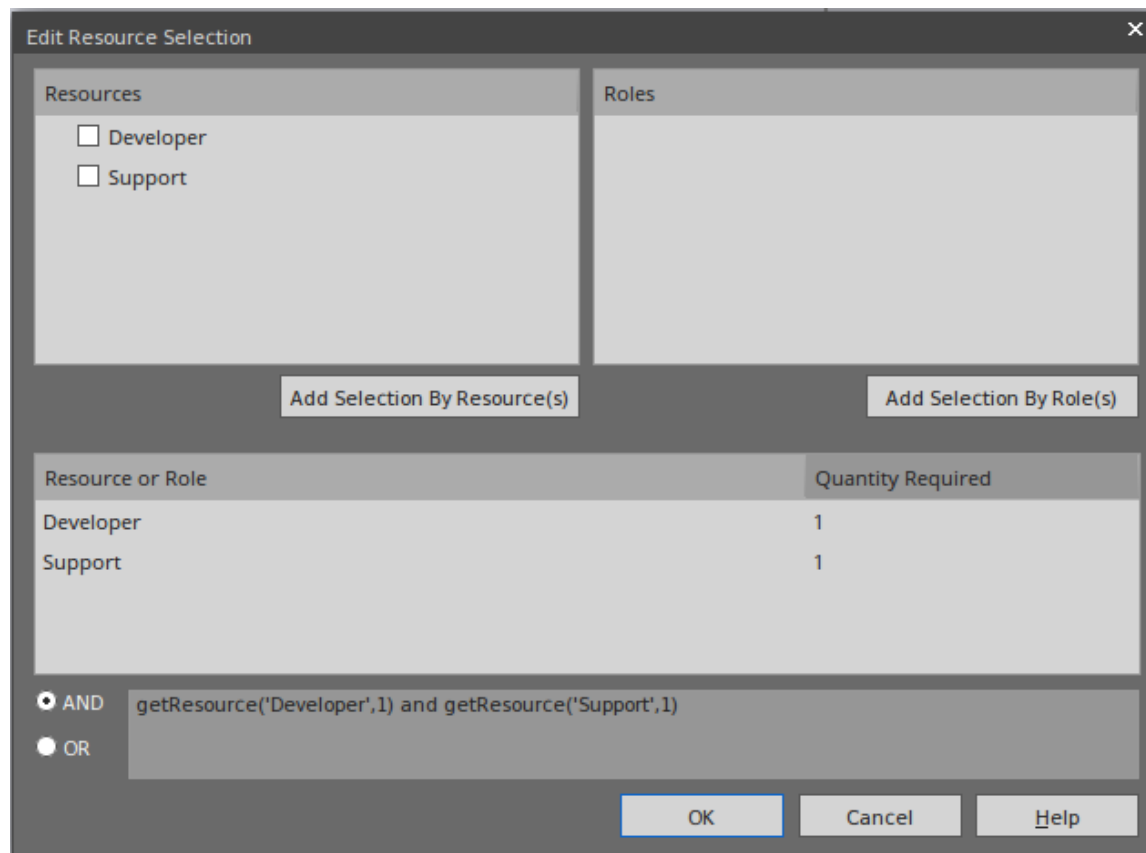




## Resource Parameters

To begin defining the Resource Parameters:

- Select the BPMN Task element on the diagram, then choose 'Resource' from the 'Category' column and 'Selection' from the 'Parameter' column
- Click on the  button to open the 'Edit Resource Selection' dialog



Resource or Role	Quantity Required
Developer	1
Support	1

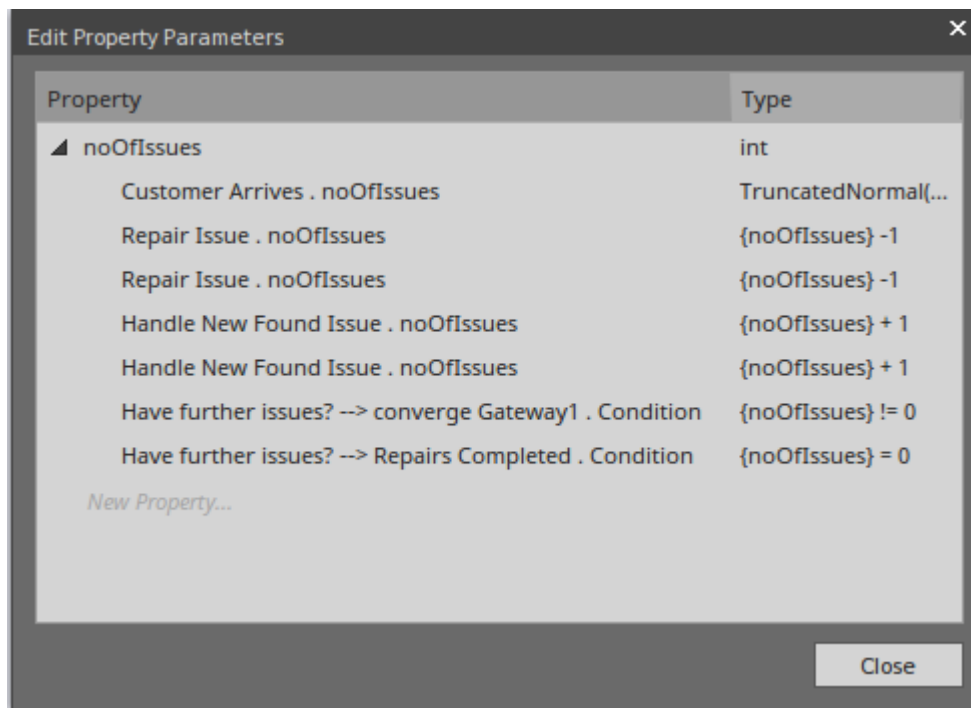
☒ AND `getResource('Developer',1) and getResource('Support',1)`  
☐ OR

- The top left list will be filled with the defined Resource elements; use the Add Selection By Resource(s) button to confirm the selection
- The top right list will be filled with the defined Roles on the resource elements; use the Add Selection By Role(s) button to confirm the selection
- Edit the numbers in the 'Quantity Required' column
- Click on the appropriate radio button to set the logical relationship to AND or OR for the selection
- The final expression for Resource selection is composed and displayed in the text field

## Property Parameters

To begin defining the Property Parameters:

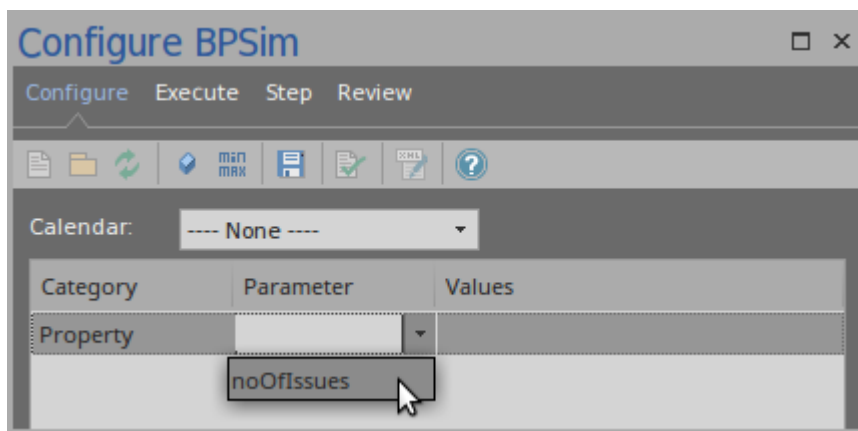
- Click on the Property button on the toolbar




The defined properties and their references are listed.

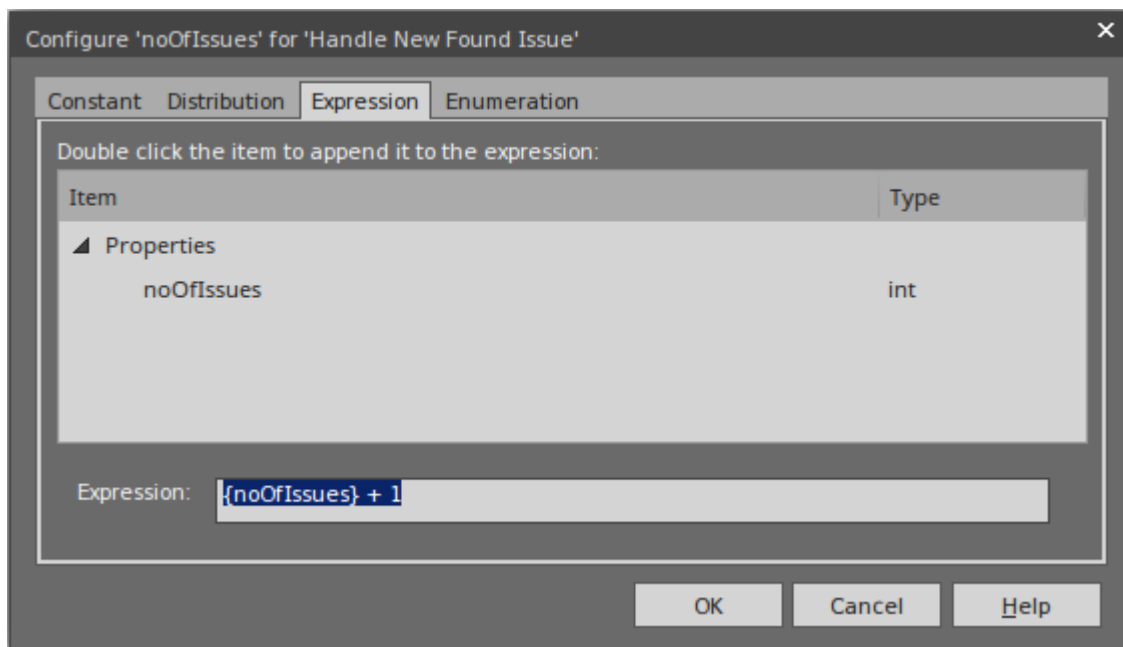
You can add a new property, delete the selected property, or update a property's name and type.

- With the defined properties, you can set property parameters on BPMN elements:



Choose 'Property' as a category and a defined property for 'Parameter'.

- Click on the  button on the 'Values' column to display the 'Parameter Value' dialog



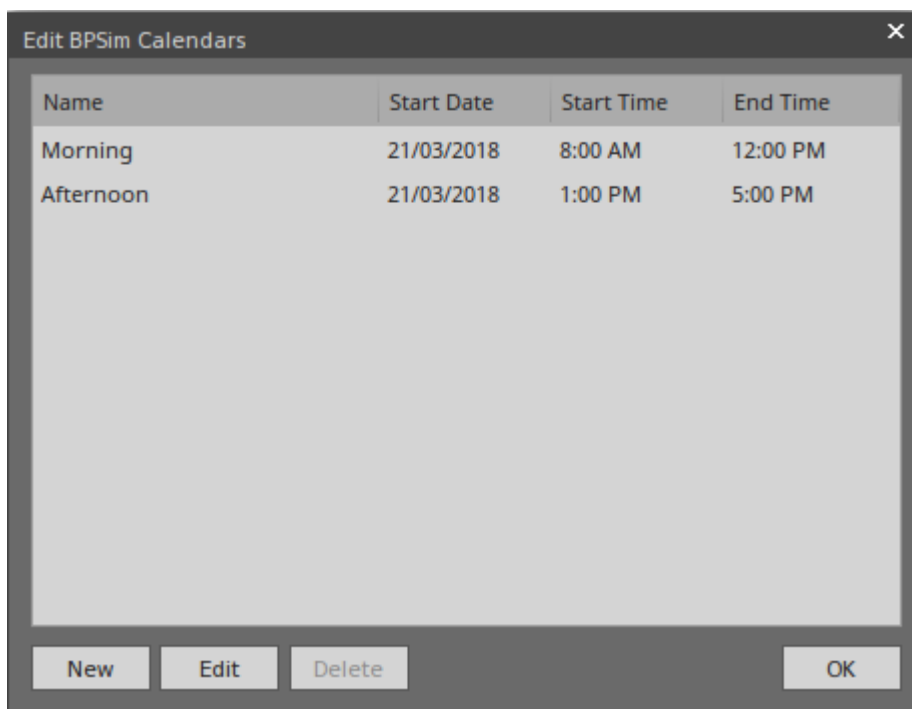
Navigate to the 'Expression' tab; all the defined properties are listed and you can double-click on an item to enclose the property in curly brackets and append it to the edit control. In this example, we compose '{noOfIssues} + 1'

## Calendars

With calendars, you can define any number of special periods of time that can influence the process, such as working days, shifts, holidays or periodic events (for example, stock-taking, inventory or auditing).

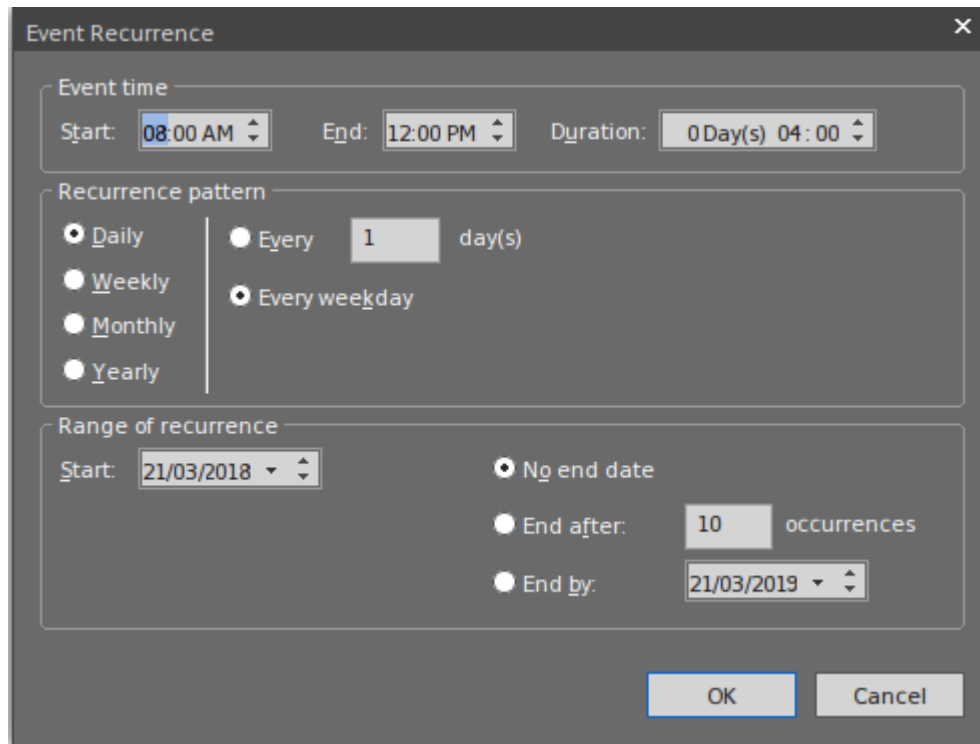
To begin defining the Calendars:

- Click on the Calendar button on the toolbar; the defined calendars will be listed



You can add a new calendar, or edit or delete a selected calendar; to add a new calendar period:

- Click on the New button to display the 'Event Recurrence' dialog.



The 'Event Recurrence' dialog box is divided into three main sections:

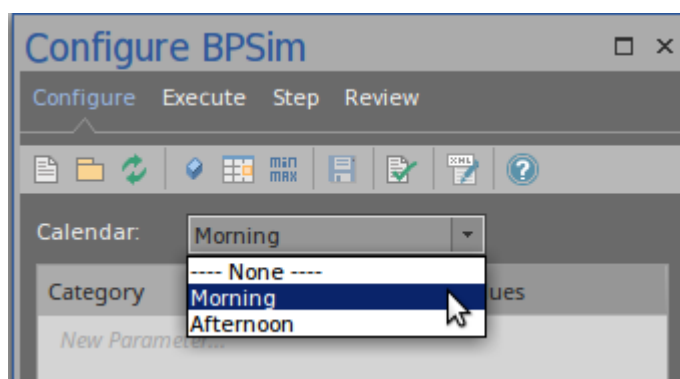
- Event time:** Contains 'Start' (08:00 AM), 'End' (12:00 PM), and 'Duration' (0 Day(s) 04:00) fields with spin arrows.
- Recurrence pattern:** Features radio buttons for 'Daily', 'Weekly', 'Monthly', and 'Yearly'. The 'Daily' option is selected, showing 'Every 1 day(s)' and 'Every weekday' sub-options.
- Range of recurrence:** Includes a 'Start' date (21/03/2018) and three radio buttons: 'No end date' (selected), 'End after: 10 occurrences', and 'End by: 21/03/2019'.

At the bottom are 'OK' and 'Cancel' buttons.

- In the 'Event time' panel, the 'Start' and 'End' fields both default to the current time. The 'Start' field is the anchor; a change to either the 'End' field or the 'Duration' field automatically updates the other field, in reference to the 'Start' field. Click on the hour and minute segments of each field (and, for the 'Duration' field, the 'Day(s)' segment) separately, and use the 'spin' arrows to set the start time and the end time or duration of the period.
- In the 'Recurrence pattern' panel, select the radio button for the interval at which the calendar period recurs. Each option displays an appropriate set of fields in the right of the panel for refining that interval to every day/week/month or every two/three/four days/weeks/months, on a particular day of the week, or day or date of the month, or day or date in the year. Select the checkboxes or values in drop-down lists as appropriate.
- In the 'Range of recurrence' panel, select the date on which the calendar period takes effect and select the appropriate radio button to define when the period ceases to apply - never, after a set number of occurrences, or on a specific date. You can select an end date either from a drop-down calendar or using the 'spin' arrows on each segment of the date.
- Click on the OK button to set the calendar period.

As you define calendar periods, they are listed in order of the start date and/or time, earliest first.

- With defined calendars, you can configure parameters on a selected calendar



## Validation

After configuring BPSim parameters for some BPMN Elements, run the Validation model. Any BPMN or BPSim

errors/warnings will be displayed in the System Output window. Fix the issues according to messages.

Then we are ready for the next topic: BPSim Execute Page.





## BPSim - Execute Page

After the configuration, you can choose a Standard simulation or a Customized simulation. The execution will generate a result report and a list of records used to replay (step through) the simulation.

### Access

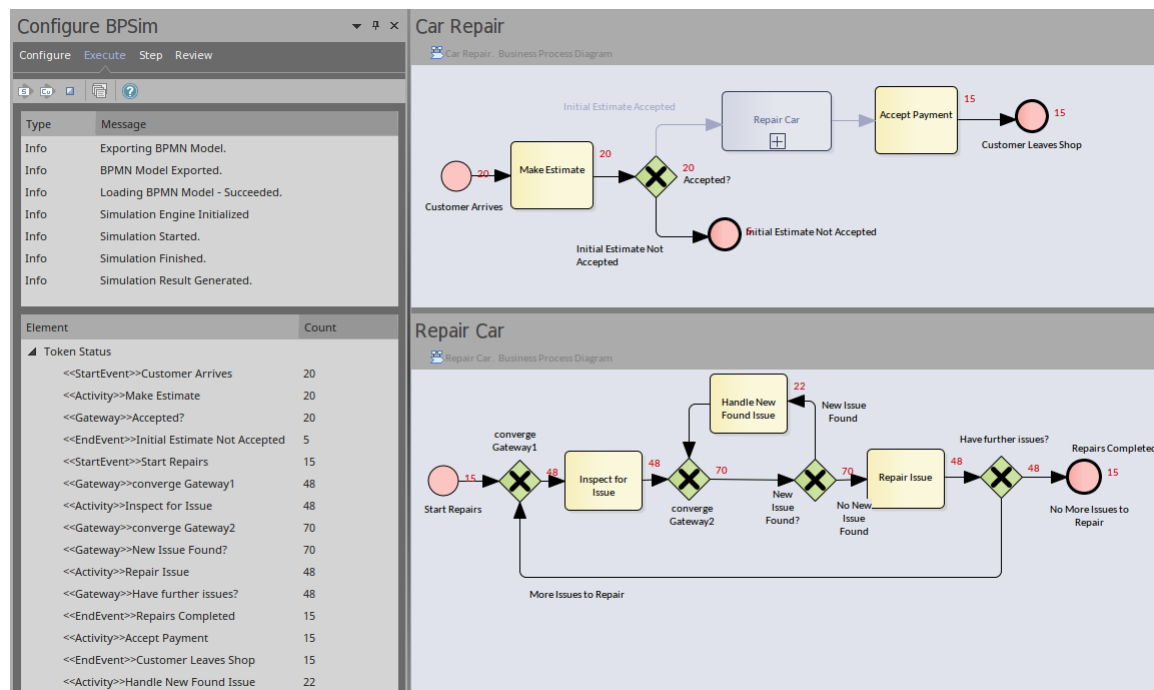
Ribbon	Simulate > Process Analysis > BPSIM > Open BPSIM Manager > Execute page
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### Toolbar Options

Option	Description
	Click on this button to execute the BPMN file with the BPSim configuration and generate a standard report.
	Click on this button to execute the BPMN file with the BPSim configuration and generate a customized report based on the 'Result Request' settings.
	Click on this button to stop the execution and exit the simulation mode.
	Click on this button open the generated report in the 'Review' page.

### Execution

When you click on the Standard / Customized Execute button, the BPMN model with BPSim Configuration will be exported and loaded into the Execution engine.



- The token status list will flash with runtime values
- The diagram will flash with runtime token counts

In this example, BPMN elements under the Process 'Car Repair' and sub-process 'Repair Car' get triggered as new customers arrive at regular intervals.

## BPSim - Step Page

After successfully running the execution, you get an execution report that tells you the process status in general, such as the average time of a task, the total waiting time of customers and how many issues are repaired.

In addition, you can inspect the process from various angles. For example:








- From the timestamp - what was the status of this process at 9:30 AM?
- From the token - what did the 3rd customer do in the shop?
- From the property - how does the number of issues decrease and increase for the 2nd car?
- From multiple threads - can I see customers walk in and simulate automatically on the diagram?
- From the resources - when is a support busy or idle? Why is a customer waiting for 40 minutes?

All of these kinds of question can be answered on the 'Step Simulation' page.

### Access

Ribbon	Simulate > Process Analysis > BPSIM > Open BPSIM Manager > Step tab
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### Toolbar Options

Option	Description
	Click on this button to simulate the process automatically based on the execution result. Click on the menu option 'Set Speed for Replay' and adjust the simulation speed. For example, input '60' means 60 times faster than actual; 1 minute in real life will be simulated in 1 second.
	Click on this button to pause the auto-replay simulation.
	Click on this button to exit the simulation mode.
	Click on this button to 'Step over' to the next timestamp. Each 'Step over' can contain multiple 'steps'.
	Click on this button to play a single step. This represents a single movement of a token in the process.
	Click on this button to generate a Timing Diagram for the simulation. You can choose from the menu, either 'Generate a single timeline for each token' or 'Generate multiple timelines for each token'.
	Click on this button to export the filtered records on this step page to a CSV file. You can choose which tab to export.



## Tokens Page

After running the execution, this page will be filled with token information during the simulation; the sequence of entries is in order of triggering time.

**Car Repair**

Car Repair - Business Process Diagram

Initial Estimate Accepted

Initial Estimate Not Accepted

Accepted?

Repair Car

Accept Payment

Customer Leaves Shop

Customer Arrives

Make Estimate

Initial Estimate Not Accepted

**Configure BPSim**

Configure Execute Step Review

Tokens Property Parameters Resources

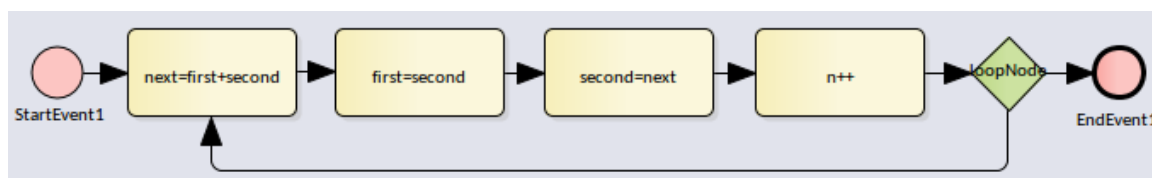
Token ID	Element	Action	Relative Time	Absolute Time
03	Customer Arrives	Enter	072	22/06/2016 10:12:00 AM
03	Customer Arrives	Leave	072	22/06/2016 10:12:00 AM
03	Make Estimate	Enter	072	22/06/2016 10:12:00 AM
03	Make Estimate	Leave	074	22/06/2016 10:14:00 AM
03	Accepted?	Enter	074	22/06/2016 10:14:00 AM
03	Accepted?	Leave	074	22/06/2016 10:14:00 AM
03	Initial Estimate Not Accepted	Enter	074	22/06/2016 10:14:00 AM
03	Initial Estimate Not Accepted	Leave	074	22/06/2016 10:14:00 AM

- 'Apply Filter' in the 'Token ID' column will only show records for a specific token
- One click on the Step in button will play one record in the list
- Double-clicking on a record is equivalent to 'Step to' that record from the beginning
- If time parameters are set on the elements, 'Step over' will run to the last record of the next time event
- When a record in the list is played, the simulation snapshot will show on the diagram

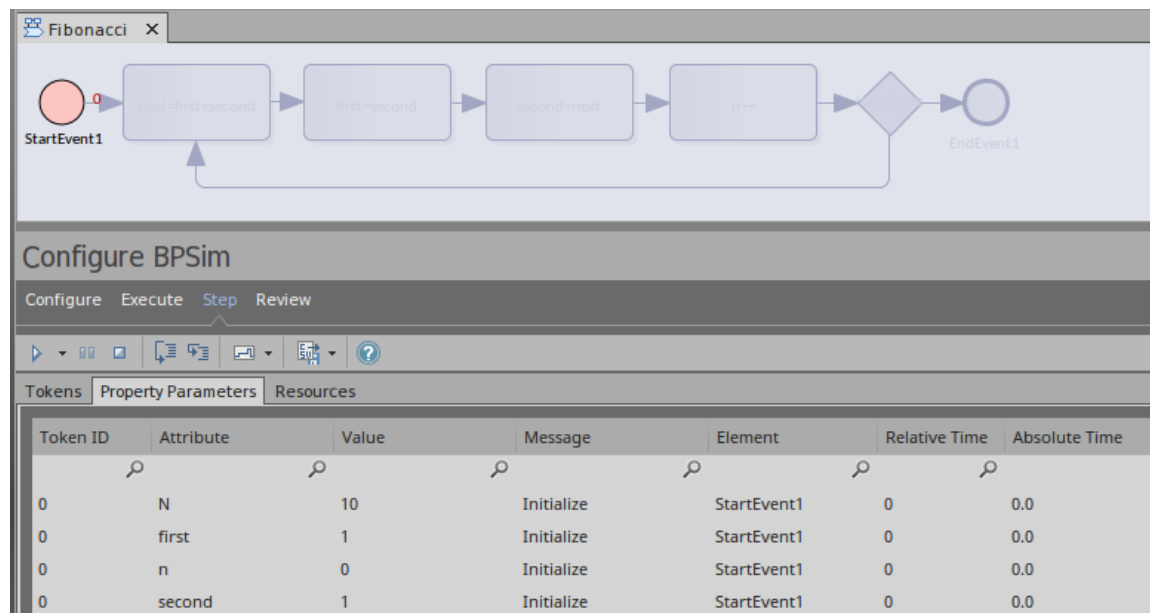
## Property Parameters Page

While the records on the 'Tokens' page are played, the 'Property Parameters' page will show the runtime value of properties at the timestamp.

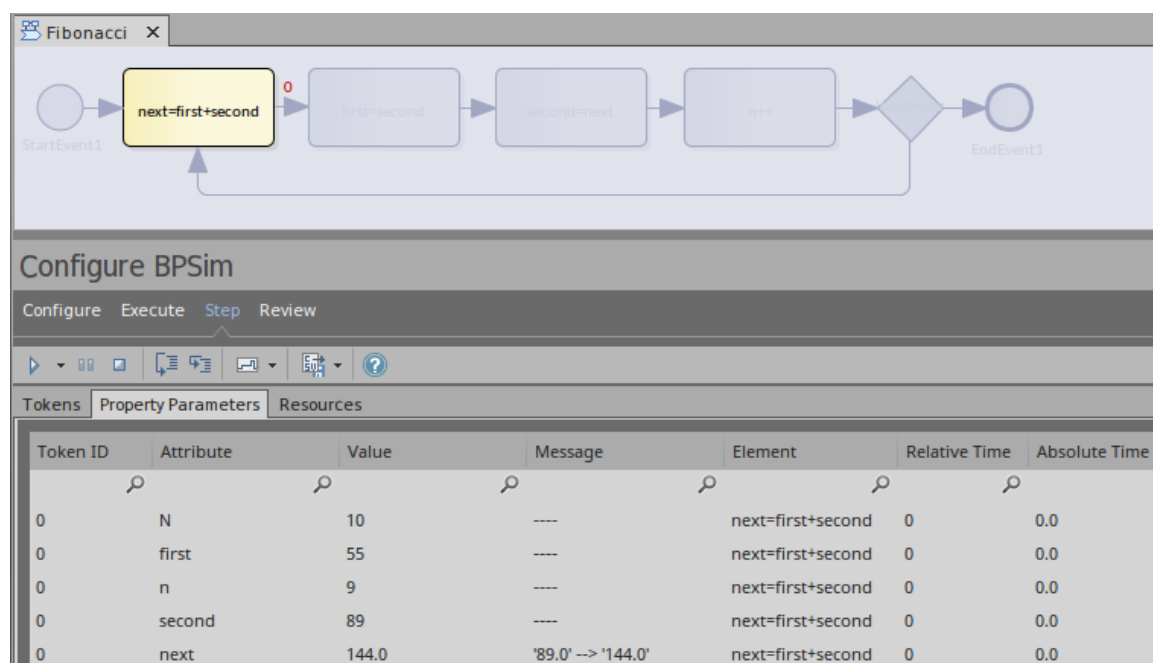
For example, a BPMN process to calculate Fibonacci numbers might be modeled in this way:



After defining property parameters, configuring BPSim parameters for each element and executing the model, we are ready for the step simulation:



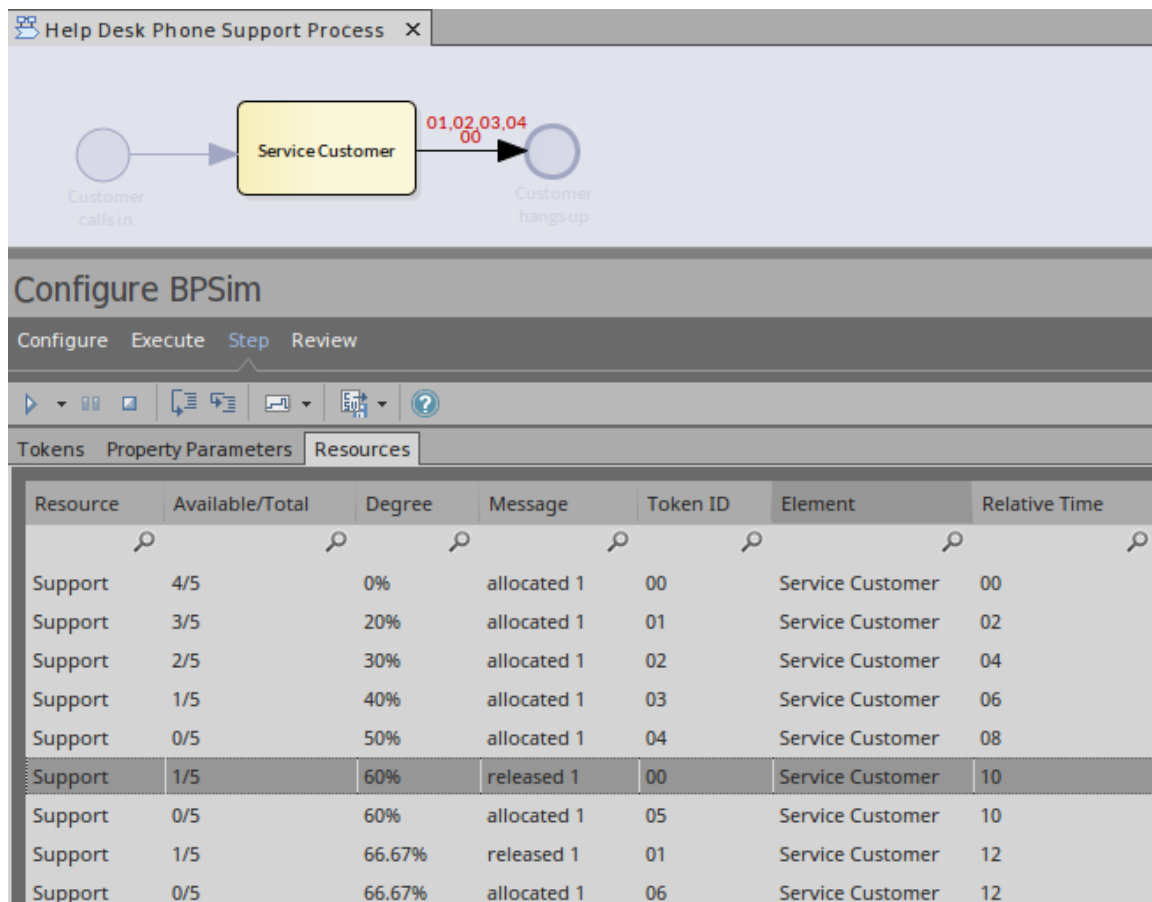
The 'Message' column indicates that properties 'N, first, n, second' are initialized.



Keep clicking on the Step in button; the properties in the list will change their values. This figure shows that on entering task 'next = first + second', the value of property 'next' changes from 89 to 144.

## Resources Page

While the records on the 'Tokens' page are played, the 'Resources' page will show the runtime resource available, quantities and allocation/release events at the timestamp.



## Generate Timing Diagram

When the time parameters are configured on the BPMN elements, Enterprise Architect will be able to generate a Timing diagram for the simulation process.

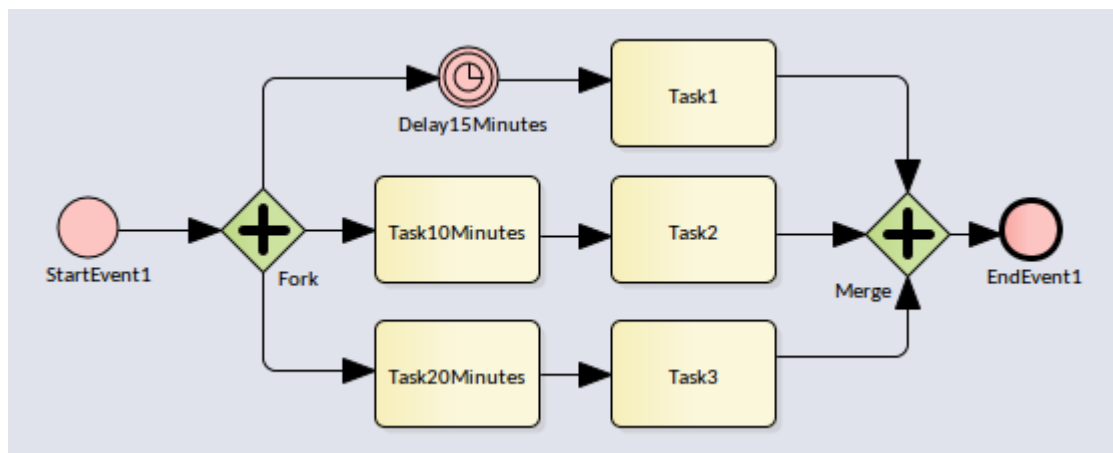
- Generate a single timeline for each token

Use this option for a 'single threaded' process; for example, no parallel gateway or event sub processes

- Generate multiple timelines for each token

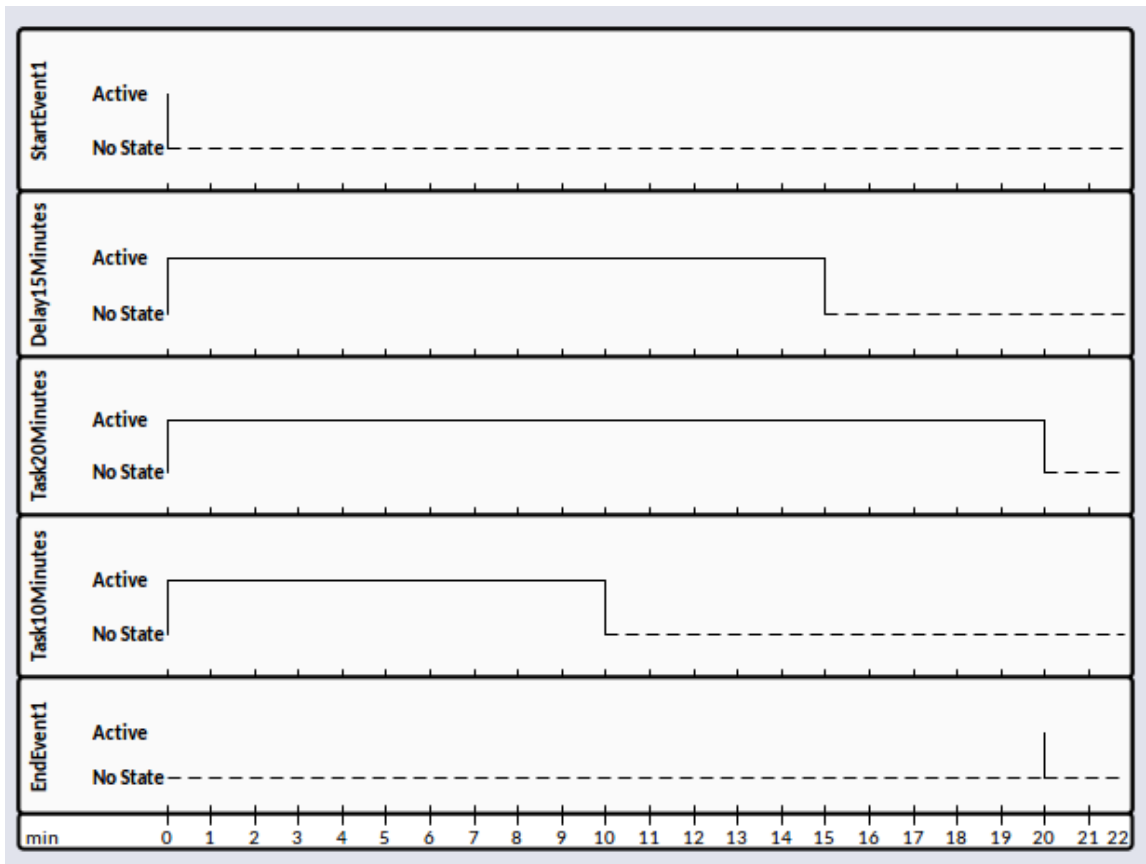
Use this option in cases when the 'Generate a single timeline for each token' option does not apply.

For example:



Execute this model and click on 'Generate multiple timelines for each token' the generated Timing diagram resembles

this:



## BPSim - Review Page

This review page contains three tabs:

- Configuration Summary
- Standard Results Report
- Custom Results Report

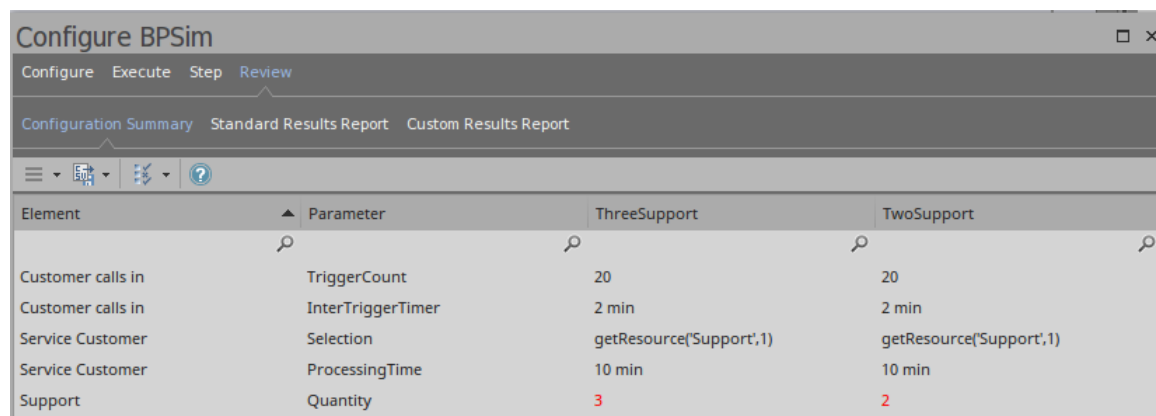
These tabs work in a similar way: add one Artifact for review or multiple Artifacts for comparison. This makes it easy for you to do what-if analyses.

### Access

Ribbon	Simulate > Process Analysis > BPSIM > Open BPSIM Manager   Review Page
--------	--

### What-If Analysis

In the Help Desk Support example, we can compare two Artifacts and their corresponding results.



The screenshot shows the 'Configure BPSim' window with the 'Review' tab selected. The 'Configuration Summary' sub-tab is active, displaying a table comparing parameters for two artifacts: 'ThreeSupport' and 'TwoSupport'.

Element	Parameter	ThreeSupport	TwoSupport
Customer calls in	TriggerCount	20	20
Customer calls in	InterTriggerTimer	2 min	2 min
Service Customer	Selection	getResource('Support',1)	getResource('Support',1)
Service Customer	ProcessingTime	10 min	10 min
Support	Quantity	3	2

We only show the different parameter values.

Configure BPSim				
Configure   Execute   Step   Review				
Configuration Summary   Standard Results Report   Custom Results Report				
<div> <div></div> <div></div> <div></div> <div></div> </div>				
Element	Parameter	ThreeSupport- Result	TwoSupport- Result	
Help Desk Phone Support Process	Maximum Time	34	64	
Help Desk Phone Support Process	Standard Deviation Time	7.72	17.23	
Help Desk Phone Support Process	Average Time	21.4	37	
Service Customer	Average Number Of Tokens Waiting For Resource	3.17	5.29	
Service Customer	Average Time In Task	21.4	37	
Service Customer	Average Time Waiting For Resource	11.4	27	
Service Customer	Maximum Number Of Tokens Waiting For Resource	8	12	
Service Customer	Maximum Time In Task	34	64	
Service Customer	Maximum Time Waiting For Resource	24	54	
Service Customer	Total Time In Task	428	740	
Service Customer	Total Time Waiting For Resource	228	540	
Support	Degree Of Utilisation	92.59%	98.04%	
Support	Number Started Immediately	3	2	
Support	Total Time Available	216	204	
Support	Total Time Idle	16	4	
Support	Average Number Available	0.22	0.04	


In this example, we see that when the number of support staff decreases from 3 to 2, the average time waiting for resources increases from 11.4 minutes to 27 minutes.

## Using the Parameter Value Dialog

The 'Parameter Value' dialog helps you to define values for a wide range of parameters throughout the BPSim Configuration. It supports the definition of simple fixed values through to distributions and expressions that yield a derived value. Not all types of value or derivation are appropriate to all types of parameter.

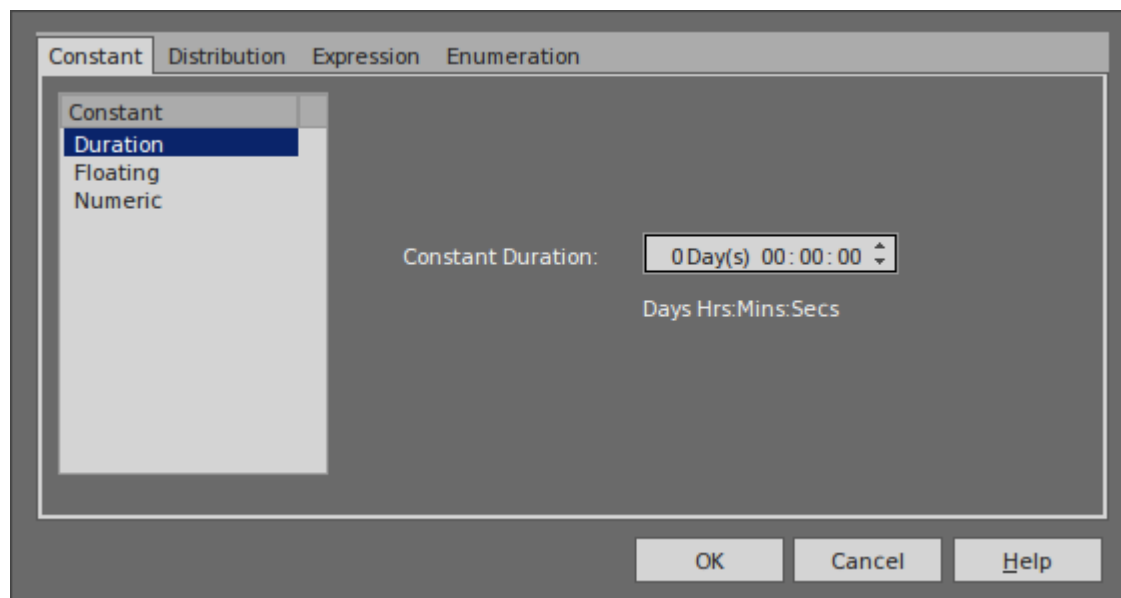
The dialog name is taken from the object name and the name of the parameter being defined; for example, Configure 'Processing' for 'Activity1'.

### Access

With a BPSim Artifact loaded in the Configure BPSim window, select a BPMN Element on the diagram or Browser window, then click on  in the 'Values' field. (If the parameter is not already created, choose Category and Parameter in the list to create a new one.)

### Constant Tab

Use this tab to define a specific value for the parameter - a numeral, text string or time, for example.



In the 'Constant' panel, select the type of constant:

- Floating
- Numeric
- String
- DateTime
- Boolean, or
- Duration

Appropriate fields display to the right of the panel; type the value and, if required, the unit in which the value is expressed (for example, a unit of time or of currency). For some types of parameter a drop-down list is available from which you can select a value.

## Distribution Tab

On this tab, you can apply a statistical sampling method to obtain the parameter value; for each type of distribution available, the appropriate fields display for you to enter the parameters of the distribution. All distributions require you to identify the unit of expression.

The distribution parameters are not necessary for the business process you are developing, but (if you are deriving values from a distribution) are required for the simulation.

You can select from these types of distribution:

- **Beta** - a continuous probability distribution providing 'real' values within a short range, commonly 0 to 1
- **Weibull** - a continuous probability distribution providing 'real' values, commonly used for object lifetime analysis
- **Gamma** - a continuous probability distribution providing 'real' values, useful for modeling exponentially distributed random variables
- **Binomial** - an 'integer' distribution, providing values based on the number of trials and the probability of a certain outcome
- **Erlang** - provides 'real' values based on the Erlang  $K$  value and the mean of the distribution
- **Normal** - provides 'real' values based on the mean and standard deviation of the distribution
- **LogNormal** - a continuous probability distribution of 'real', random variables whose logarithm is normally distributed
- **Poisson** - a discrete ('integer') probability distribution that expresses the probability of a given number of events occurring independently in a fixed interval of time or space (volume, distance or area)
- **NegativeExponential** - provides 'real' values based on the mean of the distribution
- **Triangular** - provides 'real' values based on the mode of the distribution and the minimum and maximum values of a range
- **TruncatedNormal** - provides 'real' values based on the mean and standard deviation of points within the minimum and maximum values of a range
- **Uniform** - provides 'real' values between the minimum and maximum values in a range

## Expression Tab

On this tab, you type in an XPATH 1.0 expression to combine explicit values, operators and functions to be processed at runtime to provide a value. Each property parameter of an expression must be enclosed in braces - {xxx}.

Example 1: In order to represent  $c = a + b + 10$ , we assign this expression to a property 'c':

`{a} + {b} + 10`

where 'a' and 'b' are properties defined in the BPSim model.

Example 2: In order to represent  $c = t - p * (a - b)^2$ , we assign this expression to a property 'c':

`{t} - {p} * Math.pow({a} - {b}, 2.0)`

Note: When simulating a model with this expression, please select 'Java' as the language in order to use the java built-in function `Math.pow()`.

## Enumeration Tab

On the 'Enumeration' tab, you can define an enumeration to supply a collection of constant values. You would have obtained these values from real-world, historical data or from analysis and simulation of a model. Every time the parameter is evaluated, the next enumeration value is returned.



As you define each numeration value, click on the Save button to add it to the list of possible values, and click on the New button to clear the data fields ready to enter another value. For some types of enumeration value you might be asked to define the unit in which the value is expressed. The types of enumeration you can define include:

- String
- Floating
- Numeric
- Duration
- DateTime
- Boolean

# The BPSim User Interface Components

The BPSim Perspectives have four pages, or tabs, of data in common. These are the 'Scenario', 'Calendars', 'Properties' and 'Review' tabs, the first three of which are also reflected in the data hierarchy on the left of the window. The data specific to each Perspective is discussed in separate topics.

The Save button, Validate Button, Export button and Run button are also available across the configuration, to save all changes made, to validate the configuration, to export the configuration and to execute the Sparx Systems Business Process Simulation engine (if available) on the current configuration.

Because these tabs are in common, you might prefer to populate them with data in a 'base' version of the configuration and use inheritance to make that data available to other configurations. This helps reduce the work in defining the data in the first place, and avoids errors in repeatedly entering the same information in different configurations - you only have to enter it once.

## The Scenario Tab

This tab defines the general characteristics of the scenario that the configuration represents, such as:

- The date and time at which the process takes effect; you set and edit this by overtyping the values or, for the date, by selection from a drop-down calendar
- The length of time the process takes; overtype the appropriate segment with the number of years:days:hours:minutes:seconds:milliseconds
- The base unit in which periods of time are expressed in this scenario (unless overridden); click on the drop-down arrow and select the unit
- The currency unit of any costs recorded in the process; click on the drop-down arrow and select the unit abbreviation
- The number of times the scenario as a whole will be repeated in an execution cycle, which you simply type in
- The 'seed' or starting number for any sequence of randomly-generated numbers in the process, which you simply type in
- The date and time on which the scenario was created
- The date and time at which the scenario was last modified
- The JRE Home directory, which you can browse for and select
- The JDK Home directory, which you can browse for and select
- The number of the Port through which Enterprise Architect communicates with the BPSim Execution Engine; this defaults to 1799

## The Properties Tab

This tab is used for defining **global** properties; that is, properties of the scenario, or properties that have even broader application, such as 'Number of Issues' or 'Net Cost'.


Type	Value	Unit	Calendar
New Property...			

Parameter	Result Request	KPI	SLA

A number of objects throughout the configuration have their own 'Property' tab, for features specific to that object.

#### To create a global property

1. Click on the *New Property* text and type in the name of the property.
2. Click on the  icon in the 'Value' field. The 'Parameter Value' dialog displays, from which you select the appropriate tab to define the value itself or the expression to derive the value. When you have defined the value, click on the OK button.
3. In the 'Unit' field, if necessary, type the unit of expression of the value you have defined. For example, Hours or \$K.
4. In the 'Calendar' field, if this property can be modified by a defined calendar period, click on the drop-down arrow and select the appropriate period.

#### Result Requests

In the lower panel of the 'Properties' tab, and of the object parameter tabs throughout the configuration, most of the possible types of parameter appropriate to the tab are listed. For many of these parameters, you can click on the drop-down arrow in the 'Result Request' column and select the type of processing of that parameter you want to check for in the simulation results, such as a count of the number of times it was used, or the sum, mean, minimum or maximum value used, in the context of a specific activity or of the Business Process as a whole. Certain parameters, such as 'Priority' and 'Probability', would not have any meaning in this context and either are not listed or cannot be set in the 'Result Request'.

You would then execute a **customized** simulation, which will only show the parameters you have selected to review.

You can also specify whether the parameter is a 'Key Performance Indicator' (KPI) or part of a 'Service Level Agreement' (SLA), by selecting the appropriate checkbox against the parameter.

Scenario   Calendars   **Properties**   Review

Type	Value	Unit	Calendar
<i>New Property...</i>			
General Issues	50		Monthly Review
Net Cost	$NC = (FT + PT + HP) - TC$		Workers Holiday

Parameter	Result Request	KPI	SLA
General Issues	mean	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Net Cost	sum	<input checked="" type="checkbox"/>	<input type="checkbox"/>

## The Review Tab

The 'Review' tab presents a summary of the saved changes that have been made to the object parameters and properties in the configuration, during the current work session. You cannot change the data captured on this tab.

## BPMN Validation

It is possible to validate your BPMN Model and BPSim Configuration. Click on the Validate button in the configuration to validate the model and configuration; all errors and warnings will be reported in the System Output window.

Alternatively, you can select a root Package containing a BPMN model and BPSim Configuration, and then select the 'Design > Model > Manage > Validate > Validate Current Package' ribbon option.



## The BPSim Control Perspective

The Control Perspective targets how activity flows through the process, moderated by the likelihood of a sequence of events and the priorities of certain events when they occur.

When you initially select 'Control' in the 'Perspective' field, the hierarchy on the left of the screen groups all elements in the Business Process (including the Business Process itself) by type and, for each element that has one or more connections to other elements, lists those connections by name and/or by the name of the target element. The Configure BPSim window also initially displays the 'Trigger Count' tab.

### Access

Use one of the methods outlined in this table to open the Configure BPSim window and load a Business Process Simulation Artifact element, using the 'Control' perspective.

Ribbon	<p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager &gt; click toolbar icon  &gt; Select Artifact &gt; [select a Business Process Simulation Artifact] &gt; Set 'Perspective' to 'Control'</p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager &gt; click toolbar icon  &gt; [select a Package] &gt; Create Artifact : Add New &gt; [provide a name] &gt; Set 'Perspective' to 'Control'</p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Find BPSim Configuration Artifacts &gt; double-click an Artifact in search results &gt; Set 'Perspective' to 'Control'</p>
Context Menu	In the Browser window or a diagram   Right-click Business Process Simulation Artifact   Configure BPSim   Set 'Perspective' to 'Control'

### The Control Tab

The 'Control' tab displays when you click on the name of a Start Event, Intermediate Event or connector in the hierarchy. Through this tab you can define a small number of parameters, dependent on the nature of the object; some objects cannot take control parameters, some can take only certain types, and others a wider range.

To define a control parameter, click on the drop-down arrow after the *New Parameter* text in the 'Type' column and select from the list of available parameters. An object that cannot take parameters has the text *No parameter items* in the 'Type' column.



If you have set any applicable calendar periods, for each parameter you can click on the drop-down arrow in the 'Calendar' field and select the period during which the parameter takes effect. You can set multiple parameters of one type if the value varies according to time or chronological event.

### The Trigger Count Tab

The 'Trigger Count' tab lists the elements in the Business Process, grouped by stereotype. Against each element, in the 'Trigger Count' column, is a checkbox that you can select to capture the number of times the element is accessed during a simulation. It provides a quick and simple way to specify the actions to specifically monitor in a customized simulation. You can also use the 'Result Request' column in the 'Properties' or 'Control' tabs to capture the count of accesses for each element individually (and those settings update and are updated by the 'Trigger Count' tab), but the tab helps you set or clear the count requests in one place. You do need to use the 'Result Request' column to capture the number of times a pathway (connector) *between* elements is accessed.


On the 'Trigger Count' tab you can, if you prefer, use the arrows in the column heads and/or the Filter bar to list the elements in a different sequence by Stereotype, Name or selected/cleared 'Trigger Count' checkbox.

## Control Parameters

Parameter	Description
Condition	This parameter simply defines some type of condition that must be satisfied before processing continues. It can be either a simple constant, a statistically-derived value, a value calculated from an expression, or an enumerated value. In the 'Value' field, click on the  button and work on the 'Value' dialog.
Probability	This parameter assigns a weighting to the object or connector so that when there is a choice of paths, the simulation will process that object or connector a fixed proportion of the times. Probability is expressed as a decimal portion of 1.0, so in the 'Value' field you type a value such as 0.25 (25% of the time, the simulation will process this object). You should check that the probabilities of all paths in the same choice add up to 1.0.
InterTriggerTimer	This parameter defines the time interval between triggers for the action that the object or connector represents. This interval can be either a simple constant, a statistically-derived value, a value calculated from an expression, or an enumerated value. In the 'Value' field, click on the  button and work on the value dialog as for a global property.
TriggerCount	<p>The TriggerCount sets the number of times the object or connector should be processed during one execution of the simulation, so that the processing cycle imitates the typical demand for a particular chain of actions. It is generally set for Start Event elements.</p> <p>Note that this TriggerCount <b>sets</b> the number of times the element or connector <b>is to be</b> processed in a normal or customized simulation, whilst the TriggerCount in the 'Trigger Count' tab and 'Result Requests' <b>gets</b> the number of times the element or connector <b>has been</b> processed in a customized simulation.</p>

## The Priority Tab

The 'Priority' tab displays when you select an Activity element. The tab identifies whether the activity can be interrupted by another activity, and what the relative priority is of the activity if there is a choice as to which activity is executed first.

Parameter	Description
Interruptable	This parameter defines whether the activity can be interrupted, and takes a value of True or False. You can create more than one instance with different values for different calendar periods.
Priority	This parameter defines the priority of the activity relative to other activities that might be executed at the same time. In the 'Value' field, click on the  button and work on the value dialog to set either a simple constant or a derived value for the priority. Take into consideration whether the competing activities are



	<p>interruptable and what their priority values are.</p> <p>You can set different priorities for the same activity, corresponding to different calendar periods.</p>
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## The BPSim Resource Perspective

The 'Resource Perspective' targets the involvement of types and roles of workers and other resources in a process, reviewing the required numbers, combinations, costs and availability. Before you define how the resources can be deployed in the process, you must create the appropriate BPMN 2.0 Resource elements within your model. These are then listed in the 'Resource' folder in the Configure BPSim window hierarchy. You can also use ResourceRoles that you might have defined in your model, but it is quicker and easier to create and use any roles you require within the BPSim configuration.

### Access

Use one of the methods outlined in this table to open the Configure BPSim window and load a Business Process Simulation Artifact element, using the 'Resource' perspective.

Ribbon	<p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager &gt; click toolbar icon  &gt; Select Artifact &gt; [select a Business Process Simulation Artifact] &gt; Set 'Perspective' to 'Resource'</p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager &gt; click toolbar icon  &gt; [select a Package] &gt; Create Artifact : Add New &gt; [provide a name] &gt; Set 'Perspective' to 'Resource'</p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Find BPSim Configuration Artifacts &gt; double-click an Artifact in search results &gt; Set 'Perspective' to 'Resource'</p>
Context Menu	In the Browser window or diagram   Right-click Business Process Simulation Artifact   Configure BPSim   Set 'Perspective' to 'Resource'

### The Resource Tab

The 'Resource' tab is available when you click on a Resource element in the 'Resource' folder. On this tab, you define how many instances of each resource are available for each calendar period that you have defined, and any roles the resource might be specialized into. You can provide multiple instances of each resource parameter, depending on how the resource availability varies across any defined calendar periods.

When you have finished defining the resource availability, click on the Save button. The 'Resource' tab has no 'Result Request' facility.

Parameter	Description
Availability	<p>In the 'Type' column, select this parameter.</p> <p>In the 'Value' column, click on the drop-down arrow and select either 'True' (the resource is available) or 'False' (this resource is not available). You can also define mechanisms for establishing availability, using the 'Parameter Value' dialog, as long as they result in a value of True or False.</p> <p>In the 'Calendar' column, click on the drop-down arrow and select the calendar period to which this availability applies.</p>
Quantity	<p>In the 'Type' column, click on the drop-down arrow and select this parameter.</p> <p>In the 'Value' column, either type in a simple numerical value or click on the drop-down arrow and use the 'Parameter Value' dialog to define a constant or derived value for the quantity of this resource that is available for assignment.</p>



	In the 'Calendar' column, click on the drop-down arrow and select the calendar period during which this quantity of the resource is available.
Role	To add a role to the panel, click on the <i>New Role</i> text and type in the role name. At this point the new roles remain as parameters within the BPSim configuration and are not reproduced in the model.

## The Cost Tab

The 'Cost' tab is available when you select an Activity element or a Resource element in the Configure BPSim window hierarchy. To add a parameter, click on the drop-down arrow after the 'New Parameter' text in the 'Type' column. You can have multiple costs if the cost varies according to the calendar period in which it is incurred.

Parameter	Description
Fixed Cost	<p>This parameter defines the fixed cost of calling the resource or activity into use, automatically expressed in the unit of currency defined on the 'Scenario' tab. For example, the call-out fee for an electrician.</p> <p>In the 'Value' column, either type in the cost or click on the drop-down arrow and define how the cost is derived. A derived cost must resolve to a floating or numeric value.</p> <p>If necessary, in the 'Calendar' column click on the drop-down arrow and select the calendar period during which the fixed cost applies.</p>
Unit Cost	<p>This parameter defines the unit cost of using the resource or running the activity, automatically expressed in the unit of currency and per the unit of time defined on the 'Scenario' tab. For example, the hourly rate of the electrician.</p> <p>In the 'Value' column, either type in the cost or click on the drop-down arrow and define how the cost is derived. A derived cost must resolve to a floating or numeric value.</p> <p>If necessary, in the 'Calendar' column click on the drop-down arrow and select the calendar period during which the unit cost applies.</p>



## The ResourceRole Tab

The 'ResourceRole' tab is available when you select an Activity element or Business Process element in the 'BPSim Configuration' hierarchy. Its main purpose is to define the resources for an Activity, but if necessary you can assign resources that act within the Business Process definition itself.

You can apply the resources as defined within the model. Alternatively, you can define a combination of resources and roles that is not identified in the model, which overrides the original definition. For example, the model might show that an Activity 'Take Customer Call' is associated with the resource 'Front Office'. In the BPSim configuration you can qualify that relationship to indicate that the Activity actually uses 50 Front Office staff. But you might instead override the model relationship to indicate that the work can be done by 50 resources from either Front Office or Support, if (for example) the Support resources have the role of Switchboard Operators.

The resource selection for the Activity is also displayed as an expression, at the bottom of the tab.

Panel	Description
Resource Roles defined in	In this panel, you assign a resource to the selected Activity in the BPMN model, as

BPMN	<p>shown:</p> <ol style="list-style-type: none"> <li>1. Click on the Add button, which adds a ResourceRole element to the 'Type' column and to the Activity in the model.</li> <li>2. Click on the 'BPMN Resource' column and on the  button, and select a Resource from the Tagged Values browser (which assigns the resource to the 'ResourceRef' Tagged Value of the new ResourceRole element).</li> <li>3. If necessary, type a role for the resource in the 'Role(Name)' column (preferably using the roles you defined for the resource on the 'Resource' tab). This value is reflected in the ResourceRole element defined for this Activity.</li> <li>4. In the 'Quantity' column, the quantity of this resource that the Activity uses on each iteration defaults to 1. If necessary, overwrite this number with a different value.</li> <li>5. Click on the Save button. Note that the quantity is reflected in the 'Advanced Override for Single Resource Role' panel.</li> <li>6. If you need to add another type of resource, or a different role of the same resource, you can repeat steps 1 to 5 <b>or</b> (preferred) use the Advanced Override. Note that the quantity reflected in the 'Advanced Override for Single Resource Role' panel is for one selected ResourceRole entry.</li> </ol>
Advanced Override for Single Resource Role	<p>In this panel, you can define a <i>combination</i> of resources to use in place of a relationship defined in the model. All resources currently defined in the model are automatically listed in the panel. The override applies to a single selected ResourceRole entry in the 'Resource Roles defined in BPMN' panel; if you have more than one entry in this panel, set the 'Quantity' value for the other entries to 0.</p> <ol style="list-style-type: none"> <li>1. Select the radio button to indicate whether the combination of resources you are defining is an AND relationship (so many of Resource X and so many of Resource Y at the same time), or an OR relationship (0 to n of Resource X OR 0 to n of Resource Y at any time).</li> <li>2. Double-click in the 'Quantity Required' column and type the required number of each resource for the activity.</li> <li>3. Click on the Save button. Note that the 'Resource Selection Expression for Activity' panel at the foot of the tab shows the expression that will apply this combination of resources.</li> </ol> <p>If a resource is defined in the 'Resource Roles defined in BPMN' panel, a change to the quantity of that resource is reflected in that panel, but the addition of a subsequent resource in the 'Advanced Override for Single Resource Role' panel changes the value of the 'Quantity' field to 'Override'.</p> <p>If you want to make the <b>role</b> of a resource significant in the combination, you must have at least one resource identified in the upper panel. This adds a 'Role' item to the end of the list in the 'Advanced Override for Single Resource Role' panel.</p> <ol style="list-style-type: none"> <li>1. Click on the 'Role' item and on the  icon in the 'Resource or Role' column. The 'Roles for Selection' dialog displays, listing the roles available for each resource in the configuration (as you defined on the 'Resource' tab, previously).</li> <li>2. Select the checkbox against the required role (or more than one role, if appropriate) and click on the Save button. The roles are shown in the 'Resource or Role' column.</li> <li>3. In the 'Quantity Required' column, type in the required number of resources of this role or these roles.</li> <li>4. Click on the Save button. The 'Role' item moves underneath the appropriate resource name, and another empty 'Role' item is added to the end of the list. The 'Resource Selection Expression for Activity' panel is updated to show the resource roles you have specified.</li> </ol> <p>If you do not want to keep a resource or role in the defined combination, set its</p>



	'Quantity Required' value to 0. It will remain at this value while you remain on this Activity, but when you return to the Activity after working elsewhere the field is clear.
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## The BPSim Time Perspective

The 'Time' (or 'Temporal') Perspective helps you to examine how the duration of one or more phases in the processing of an Activity influences the business process. In this Perspective you only set parameters on Activity elements, but you can monitor (through the 'Result Request' column) the occurrence, minimum, maximum, mean and sum duration of a parameter for the Business Process as a whole or for the Activities involving a defined Resource.


### Access

Use one of the methods outlined in this table to open the Configure BPSim window and load a Business Process Simulation Artifact element, using the 'Temporal' perspective.

Ribbon	<p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager &gt; click toolbar icon  &gt; Select Artifact &gt; [select a Business Process Simulation Artifact] &gt; Set 'Perspective' to 'Temporal'</p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager &gt; click toolbar icon  &gt; [select a Package] &gt; Create Artifact : Add New &gt; [provide a name] &gt; Set 'Perspective' to 'Temporal'</p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Find BPSim Configuration Artifacts &gt; double-click an Artifact in search results &gt; Set 'Perspective' to 'Temporal'</p>
Context Menu	In the Browser window or diagram   Right-click Business Process Simulation Artifact   Configure BPSim   Set 'Perspective' to 'Temporal'

### The Time Tab

On this tab, for a selected Activity element, you define the duration of a number of stages through which the Activity might pass. For each stage you:

- Click on the drop-down arrow in the 'Type' field and select the type as a parameter
- Click on the  button in the 'Value' field and define the duration (either as a fixed value or as a derived value) and unit of measurement, and
- If appropriate, click on the drop-down arrow in the 'Calendar' field and select a calendar period to which this duration applies

Parameter	Description
Processing Time	<p>The time spent actually performing the Activity. This can be strictly defined, or more broadly set to represent the duration of the Activity (the duration being the time it takes to complete the Activity; in strict use, the sum of the 'Setup Time', 'Processing Time', 'Validation Time' and 'Rework Time').</p> <p>For this and the other six parameters, you use the 'Parameter Value' dialog to define a constant or derived value in the appropriate unit of time; a derived value must resolve to a NumericParameter, a FloatingParameter or a DurationParameter.</p>
Queue Time	The delay between the Activity being offered and the Activity being processed; a refinement of the lag time.
	The time spent redoing or correcting the work of the Activity; a refinement of the

Rework Time	duration.
Setup Time	The time expended between the element being offered and the element being allocated to perform the actual work; a refinement of the duration.
Transfer Time	The time spent traveling from the previous processing step; a refinement of the lag time.
Validation Time	The time taken to review or inspect the work done; a refinement of the duration.
Wait Time	The time between the element being allocated and its action actually starting. This can be strictly defined, or more broadly used to represent the lag time of the Activity (the lag time being the time between the action of one Activity stopping and the action of the next Activity starting; in strict use the sum of the 'Transfer Time', 'Queue Time' and 'Wait Time').

## Notes

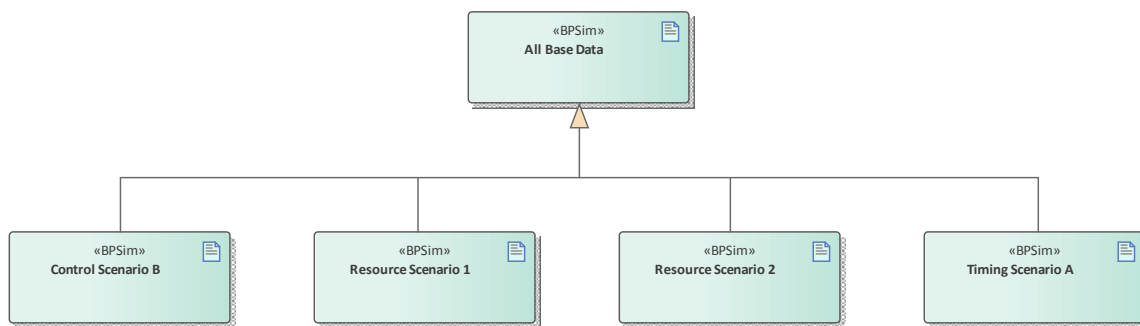
- In the BPSim configuration you can set values for seven different time parameters; however, the BPSim Simulation engine, during a simulation, amalgamates the values of these parameters into one ProcessingTime parameter. You can vary the initial values and value generation methods of the individual parameters to observe the effect each has on the eventual processing time, or to define a simulation to be exported into a different tool for analysis and/or execution.
- An example of the behavior of the Time parameters during simulation is provided in the EAExample model.

## Configuration Inheritance

When you define a BPSim configuration it can contain a lot of data, some relating to each of the three separate Perspectives, and some being base data for the configuration grouped on three pages or tabs of the 'Configuration' dialog. A major objective of performing simulations of a business process using BPSim is to observe the effects of varying the values of certain parameters, whilst leaving others unchanged. It would be very useful, then, to maintain all of the standard data in a single place where it is created only once, and work on the variable data in one or more separate places that refer back to the base data. This would also mean that if you changed any of the standard data, the changes would be reflected in all the configurations that refer to it.

In BPSim, you can achieve this arrangement using inheritance between configuration Artifact elements.

In essence, you would define the standard data in a base configuration, and the data you are manipulating (and only that data) in configurations called, say, Resource Scenario 1, Resource Scenario 2, Timing Scenario A, or Control Scenario B. You would then create Generalize connectors from the scenario configuration Artifacts (the sources) to the base configuration Artifact (the target).



When you run a simulation on a scenario configuration, it will inherit the data defined in the base configuration and the simulation will perform as if it were processing a single configuration containing all the data. If the scenario configuration contains data that is also defined in the base, the (changed) values in the scenario take precedence.

## Comparisons

To keep track of how the base and scenario configurations have been set up, and what the differences are between them, you would run a 'BPMN Simulation Configuration' report on one of them and drag the other(s) into the same report.


Whether or not you select the 'Show Only Different Items' option or the 'Highlight Different Items' option, you will see all the base configuration data in one column and a much smaller volume of scenario data in another. Where the data occurs in both columns, you can compare values and check what the scenario values have been changed to.







Similarly, when you run simulations on both configurations, you can display the 'BPMN Simulation Report View' and compare the results of the simulations. In this case if you select either the 'Show Only Different Items' or the 'Highlight Different Items' option, you will see a much smaller data set where the scenario values differ from the base configuration values, because in the **simulation** the scenario will have inherited all of the base configuration data and will produce substantially the same output.

## Using the MDG BPSim Execution Engine

The MDG BPSim Execution Engine is an Add-In that you can purchase to execute the simulations that you have defined using the Business Process Simulation (BPSim) facility in Enterprise Architect. Installation of the Engine is a prerequisite for accessing and using the facilities of BPSim.

### Access

Open the Configure BPSim window, load a Business Process Simulation Artifact and click on  on the toolbar.

Ribbon	<p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager : click  on the toolbar &gt; Select Artifact &gt; [select a Business Process Simulation Artifact] : click on </p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager : click  on the toolbar &gt; [select a Package] &gt; Create Artifact : Add New &gt; [provide a name] : click on </p> <p>Simulate &gt; Process Analysis &gt; BPSim &gt; Find BPSim Configuration Artifacts &gt; double-click an Artifact in search results : click on </p>
Context Menu	<p>Right-click on a Business Process Simulation Artifact element   Configure BPSim : </p>
Other	<p>Right-click on a Business Process Simulation Artifact element   Simulate BPMN with BPSim</p>

### Execute and Control a Simulation

Click on the Run button and select either:

- 'Standard Simulation' or
- 'Customized Simulation'

These options trigger the same processing, except that while 'Standard Simulation' generates a report on all built-in parameters set in the simulation, 'Customized Simulation' extracts results for only the parameters you have specifically flagged using the 'Result Request' columns in the configuration.

The simulation executes, displaying processing messages in the top section of the dialog, and the elements and parameters processed with the runtime values used from the configuration.



While the simulation is in progress, you can use the Pause button and Resume button to temporarily halt processing and then resume, or you can click on the Stop button to cancel the simulation altogether.

The results of the simulation are written to an Artifact element added to the Business Process parent Package. A Standard simulation writes to a <<BPSimReport>>-stereotyped Artifact, whilst a Customized simulation writes to a <<BPSimCustomReport>>-stereotyped Artifact.

## Track Property Values

As well as the built-in parameters, you can define your own process-specific Property parameters (attributes) in the configuration. When the simulation has finished, and if you have defined property parameters, the Attributes button is enabled. When you click on this button the 'BPSim PropertyParameter Values' dialog displays, through which you can track how the run-time values of all the property parameters accrue or change through the business process.



## Review a Simulation

When the simulation has finished processing, click on the Open Result button. The 'BPMN Simulation Report View' tab opens in the main work area, showing the results for the built-in parameters in the current simulation (but not for the user-defined property parameters). If you have already run a simulation of another configuration based on the same business process, that is also displayed in the report as an additional column. Otherwise, you can click on the report Artifact element and drag it onto the report tab, to compare the runtime values of the built-in parameters under two (or more) configurations.

BPMN Simulation Report View		
Item	Base BPSim Configuration - Result	1 Extra Warehouse worker- Result
<div>Time</div> <div> <div>+</div> Take out extra insurance           <div>+</div> Fill in a Post label           <div>+</div> Logistics Manager           <div>+</div> &lt;&lt;Gateway&gt;&gt;           <div>+</div> Assign a carrier &amp; prepare paperwork           <div>+</div> Clerk           <div>+</div> Check if extra insurance is nessary           <div>+</div> Request quotes from carriers           <div>+</div> &lt;&lt;Gateway&gt;&gt;           <div>+</div> &lt;&lt;Gateway&gt;&gt;           <div>+</div> Hardware Retailer           <div>+</div> Package goods           <div>+</div> Mode of delievery           <div>+</div> &lt;&lt;Gateway&gt;&gt;           <div>+</div> Warehouse Worker           <div>+</div> Describe if normal post or special shipment           <div>+</div> Add paperwork and move package to pick area           <div>+</div> &lt;&lt;Gateway&gt;&gt;         </div> <div>Control</div> <div>Resource</div> <div> <div>+</div> Take out extra insurance           <div>+</div> Fill in a Post label           <div>+</div> Logistics Manager           <div>+</div> Assign a carrier &amp; prepare paperwork           <div>+</div> Clerk           <div>+</div> Check if extra insurance is nessary           <div>+</div> Request quotes from carriers           <div>+</div> Goods available for pick           <div>+</div> Hardware Retailer           <div>+</div> Package goods           <div>+</div> Warehouse Worker           <div>+</div> Describe if normal post or special shipment           <div>+</div> Add paperwork and move package to pick area         </div> <div>Message</div> <div> <div>+</div> Take out extra insurance           <div>+</div> Fill in a Post label           <div>+</div> Assign a carrier &amp; prepare paperwork           <div>+</div> Check if extra insurance is nessary           <div>+</div> Request quotes from carriers           <div>+</div> Package goods           <div>+</div> Describe if normal post or special shipment           <div>+</div> Add paperwork and move package to pick area         </div>		

To make it easier to view the data from the report, you can drag the 'BPMN Simulation Report View' tab out of the main view so that it becomes a floating window, and enlarge the window to a suitable size.

Click on the expansion boxes against the parameters you want to check. You can also expose and filter the information using right-click context menu options.

You can represent specific differences between the results from separate simulations as Charts. The simulation result Artifacts (<<BPSimReport>>name - Result elements) must exist before you can set up the Chart Artifacts. There is a template Chart Artifact for Standard simulations and one for Customized simulations.

## BPMN Simulation Report Options

Option	Description																														
Collapse All	Select this option to collapse the parameter hierarchy down to just the parent tab names.																														
Expand All	Select this option to expand the parameter hierarchy out to the lowest value type.																														
Show Only Different items	(When you have two or more simulations shown.) Select this option to restrict the display to those parameters where the values differ between the simulations. Click on the option again to deselect it.																														
Highlight Different Items	<p>(When you have two or more simulations shown and where some of their parameter values are different.) Displays the differing parameter values in red. This option is disabled if you select the 'Show Only Different Items' option.</p> <div><div>BPMN Simulation Report View</div><table><tr><th>Item</th><th>Base BPSim Configuration - Result</th><th>1 Extra Warehouse worker- Result</th></tr><tr><td><div>Time</div></td><td></td><td></td></tr><tr><td><div>Logistics Manager</div></td><td></td><td></td></tr><tr><td><div>Total Time Available</div></td><td>134</td><td>91</td></tr><tr><td><div>Sum Of Wait Time</div></td><td>104</td><td>61</td></tr><tr><td><div>Clerk</div></td><td></td><td></td></tr><tr><td><div>Total Time Available</div></td><td>134</td><td>91</td></tr><tr><td><div>Sum Of Wait Time</div></td><td>50</td><td>7</td></tr><tr><td><div>&lt;&lt; Gateway &gt;&gt;</div></td><td></td><td></td></tr><tr><td><div>Total Token Wait Time</div></td><td>181</td><td>380</td></tr></table></div>	Item	Base BPSim Configuration - Result	1 Extra Warehouse worker- Result	<div>Time</div>			<div>Logistics Manager</div>			<div>Total Time Available</div>	134	91	<div>Sum Of Wait Time</div>	104	61	<div>Clerk</div>			<div>Total Time Available</div>	134	91	<div>Sum Of Wait Time</div>	50	7	<div>&lt;&lt; Gateway &gt;&gt;</div>			<div>Total Token Wait Time</div>	181	380
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<div>&lt;&lt; Gateway &gt;&gt;</div>																															
<div>Total Token Wait Time</div>	181	380																													
Show Only Non Empty Items	Select this option to filter the display to show only parameters that have a specific value other than 0.																														
Remove Model	(When you have selected a specific result, which identifies the simulation in the report.) Select this option to remove the simulation column from the report.																														

## BPSim Execution Engine - Simulation language

The MDG BPSim Execution Engine supports simulation on XPath 1.0 or Java, where the appropriate language is defined as the Expression Language in the simulation configuration. It also supports the use of process instance data in BPSim Property Parameters, where the actual value is only determined during execution.

### XPath 1.0 Operators

These operators can be used in BPSim expression parameters.

Operator	Description
	The Union operator, used for resource acquisition. Example: <code>getResource('w1',1)   getResource('w2',1)</code>
+	Addition. Example: <code>4 + 6</code>
-	Subtraction. Example: <code>6 - 4</code>
*	Multiplication. Example: <code>6 * 4</code>
div	Division. Example: <code>8 div 4</code>
=	Equality. Example: <code>4 = 4 (True)</code>
!=	Not Equal. Example: <code>5 != 3</code>
<	Less than. Example: <code>6 &lt; 9</code>
<=	Less than or equal to. Example: <code>x &lt;= 6</code>
>	Greater than. Example: <code>9 &gt; 6</code>
>=	Greater than or equal to. Example: <code>n &gt;= 7</code>
or	Alternative. Example: <code>n = 6 or n &lt;= 6</code>

and	Combination. Example: $n = 5$ and $m < 8$
mod	Modulus division. Example: $5 \bmod 2$
getProperty	Get a property value. Example: <code>getProperty ("amount")</code>
getResource	Get a resource assignment. Example: <code>getResource ('w1',1)</code>

## Note

The Expression Language can be set in the Configure BPSim window, on the 'Scenario' tab; the two options 'XPath 1.0' and 'Java' are available.

If you select 'Java', you must set the property 'JDK Home' to a valid JDK directory.

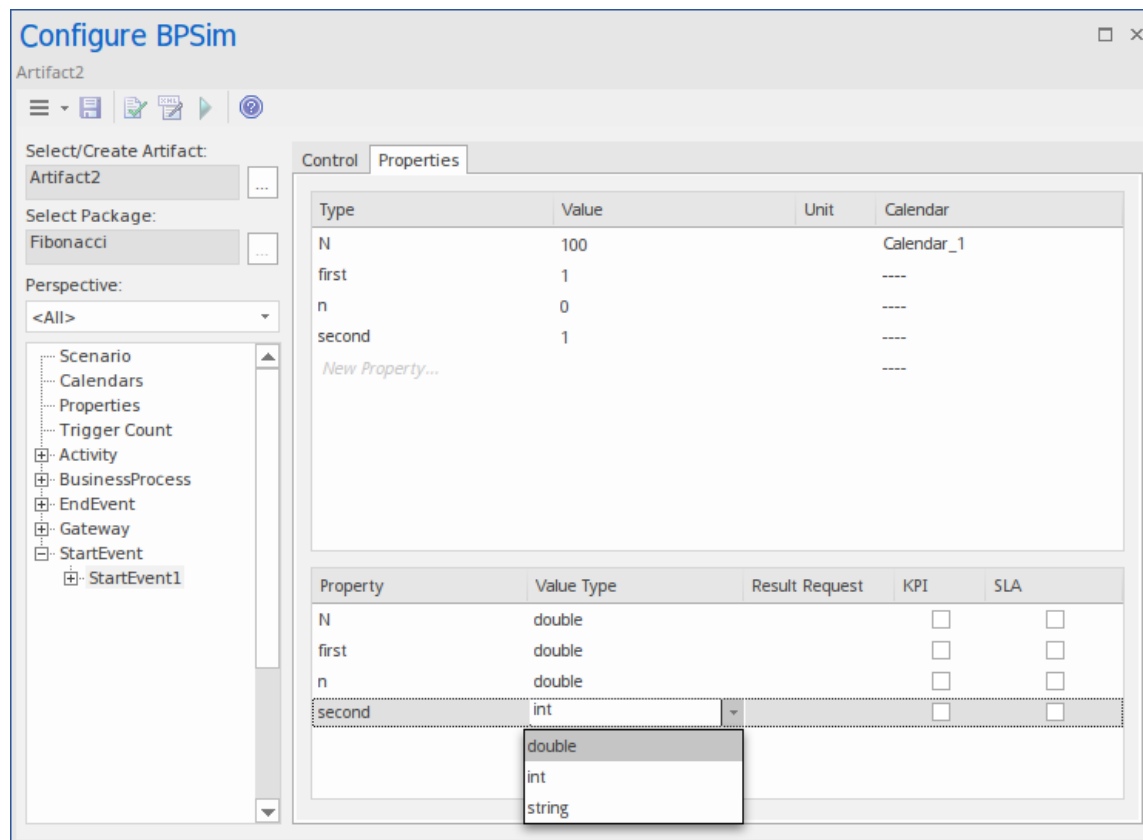
**Tip:** You can use `{PropertyName}` as a short form of `getProperty('PropertyName')`, which is useful when writing the value for the expressions; for example:

`{n} < {N}` instead of `getProperty('n') < getProperty('N')`

The short form of the `getProperty` operator can be used in both XPath 1.0 and Java.

## BPSim Property Parameters

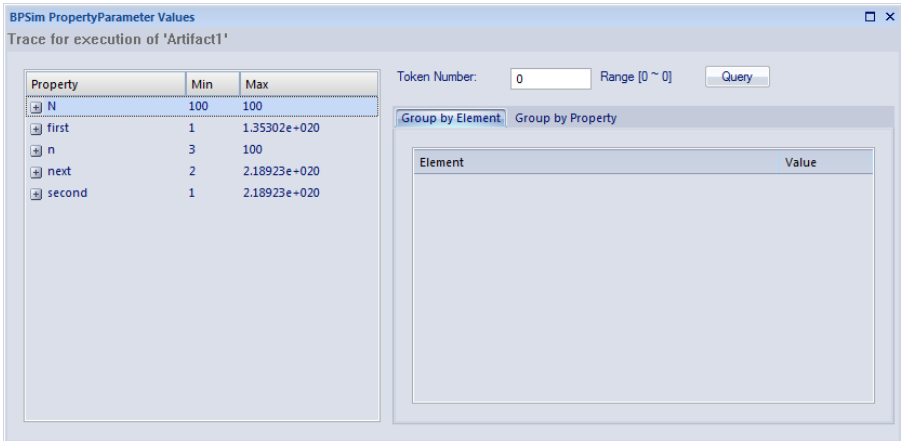
In Enterprise Architect release 13.0 and higher, BPSim property parameters can hold process instance data to which no value is assigned until run time. You can define the property parameter type on the 'Properties' page of the Configure BPSim window; the supported types are 'int', 'double' and 'string'.



## Tracking Property Parameter Values

The Business Process Simulator (BPSim) helps you to model and test the operating details of a business process, such as the resourcing of activities and tasks, the intervention of events, and the impact of decision points and the decisions made at those points. You add these process-specific property parameters, or attributes, to the BPSim configuration and, as you run simulations on the model according to the configuration, the BPSim engine helps you to capture the run-time values of the property parameters for every iteration of the simulation, and to filter the results to examine specific pathways or decision points. This gives you an incredibly detailed insight into what might actually happen in your business process under a specific condition or combination of conditions, either to generate a result or to show what processing path produces that result.

### Access

Context Menu	<p>Right-click on a defined Business Process Simulation configuration Artifact [Simulate BPMN with BPSim... : Run (select simulation type) : Attributes (The Attributes button is not available if the simulation configuration does not contain any property parameters)</p> 
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### BPSim PropertyParameter Values dialog fields

Option	Action
Property	<p>This table lists the properties defined for the process, and shows the minimum and maximum possible values for each property for the whole process.</p> <p>If you click on the expansion box for a property, the table shows the minimum and maximum values for the property at each activity or event (element) during the process.</p>
Token Number	<p>Type the number of the 'token' to examine; this number must lie within the range shown to the right of the field. A 'token' is an independent trigger, such as a customer or an order entering a business and initiating the business process under review. There can be any number of customers or orders each having no relationship with any other customer or order, and each potentially following a</p>

	<p>different route through the business process.</p> <p>Where there is only one possible instance of one possible trigger event, such as an on/off switch being thrown, the token is regarded as being 0.</p>
Query	Click on this button to initiate a query on the token simulation, to populate the 'Group by Element' and 'Group by Property' tabs.
Group by Element	Displays the results from the perspective of how a property parameter's value changes within a selected element. The tab shows a list of the elements in the process and, for each element, the value of each property applied in the element on each iteration of the simulation. Using the 'Toggle Filter Bar' option on the header bar, you can refine the display to show only a particular property and see how often it is used by the element and with what values.
Group by Property	Displays the results from the perspective of how the value of each property changes during the whole process. The tab shows a list of properties that are applied during the process and, for each property, the value in each activity (element) on each iteration of the process.

## Examples

In the EAExample Model, you can study two examples of generating information on property parameters from a simulation of a BPMN business process model. These will demonstrate how you define property parameters in the configuration, based on the model. You can initially just run a simulation on each example, and examine the output as described here. You can then examine the business processes and configurations themselves, and change or add to the property parameters provided.

The examples are described in the *Tracking Property Values - Examples* topic. Briefly, they are:

- 'Fibonacci' - a very simple recursive business process that calculates a series of Fibonacci numbers through ten iterations; you can see how the property parameters increment in each iteration through the elements of the process (in Example Model > Model Simulation > BPSim Models > Fibonacci)
- 'Car Repair' - a more complex and realistic process that represents what might happen when a series of individual 'walk-in' customers bring vehicles into a car repair shop for estimation and repair (in Example Model > Model Simulation > BPSim Models > Car Repair Process)

There is also a small example of the behavior of the Time Parameters (in Example Model > Model Simulation > BPSim Models > Time Parameter).

## Notes

- If a BPSim configuration contains result requests and a Custom simulation is performed on it, the 'BPMN Simulation Report' shows only the built-in parameters requested in the configuration; in contrast, the 'BPSim PropertyParameter Values' dialog lists all property parameters regardless of any result request settings or type of simulation

## Tracking Property Parameter Values - Examples

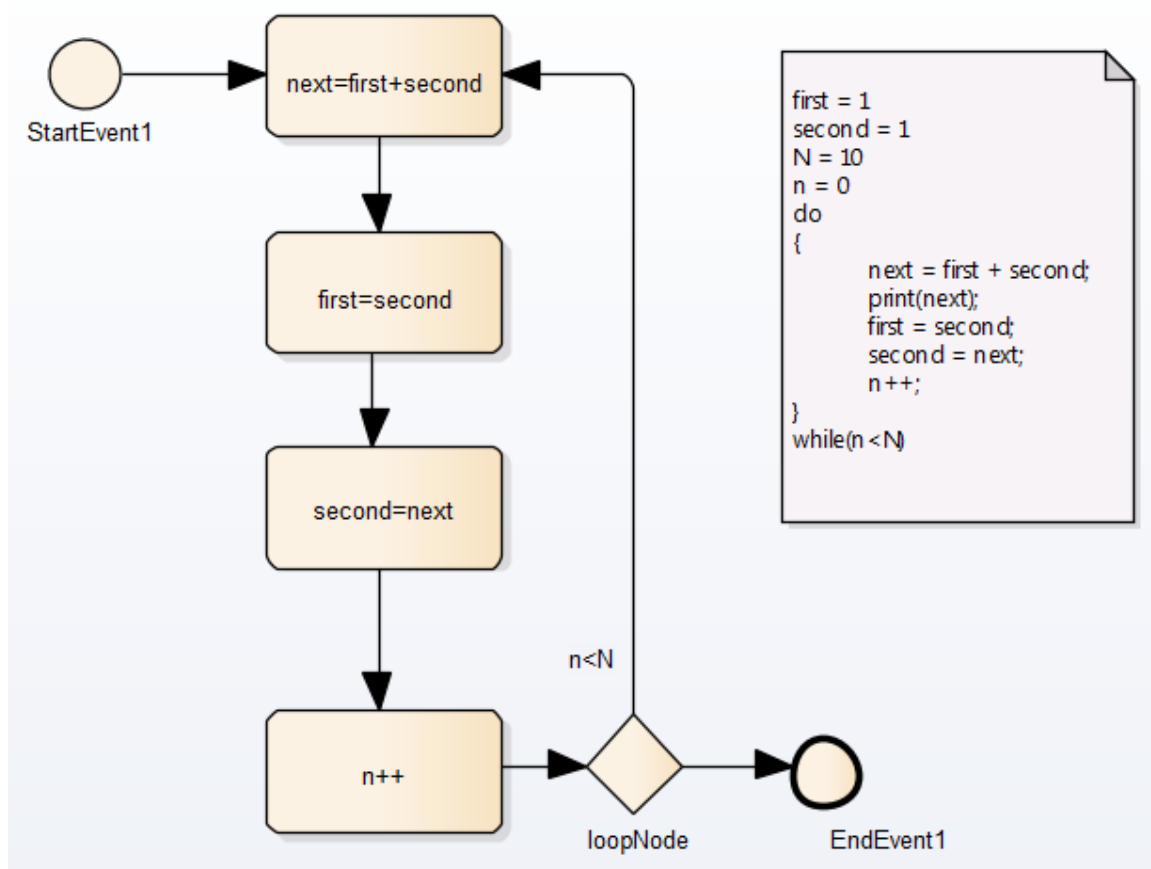
To help you learn about the facility for generating information on property parameters from a simulation of a BPMN business process model, Sparx Systems provide two examples that you can explore in the EAExample model. These are the:

- Fibonacci process - a very simple example to help you become familiar with the parameter tracking facilities
- Car Repair process - a more complex example that you can manipulate to see how a real-life process might be investigated

At the end of this topic is a section that briefly discusses how you might work with an integer-based process containing parameters that are initialized by 'real' distributions, and a section describing the example of the behavior of the Time Parameters.

### The Fibonacci Example

This is a very simple recursive business process that calculates a series of Fibonacci numbers through ten iterations; you can see how the property parameters increment in each iteration through the elements of the process. Open Example Model > Model Simulation > BPSim Models > Fibonacci.

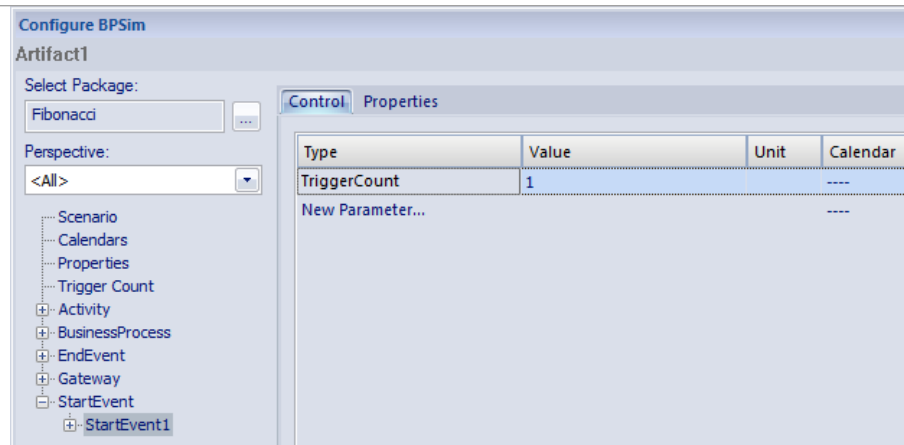


The pseudocode of the process is shown in the Notes element on the diagram. The statement 'print(next)' will output the number series 2, 3, 5, 8, 13, 21, 34, 55, 89, 144.

The BPSim configuration for this process is set up as described here.

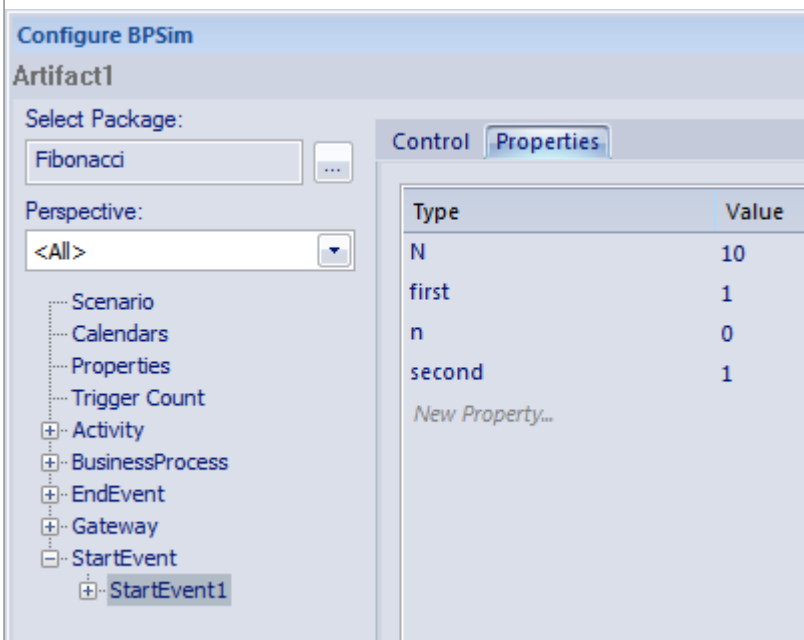
Step	Action
1	





On the 'Control' tab for the StartEvent element, set 'TriggerCount' to '1', and on the 'Properties' tab create and initialize the properties:

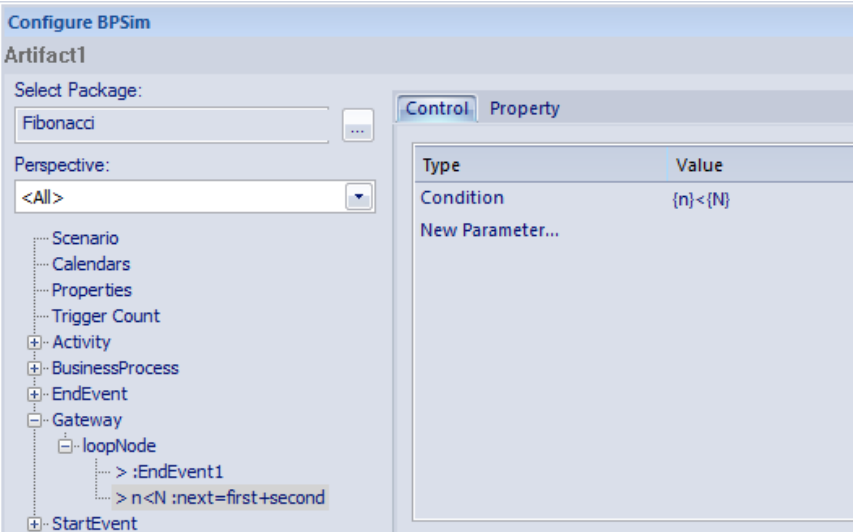
- 'N' as '10'
- 'first' as '1'
- 'second' as '1'
- 'n' as '0'

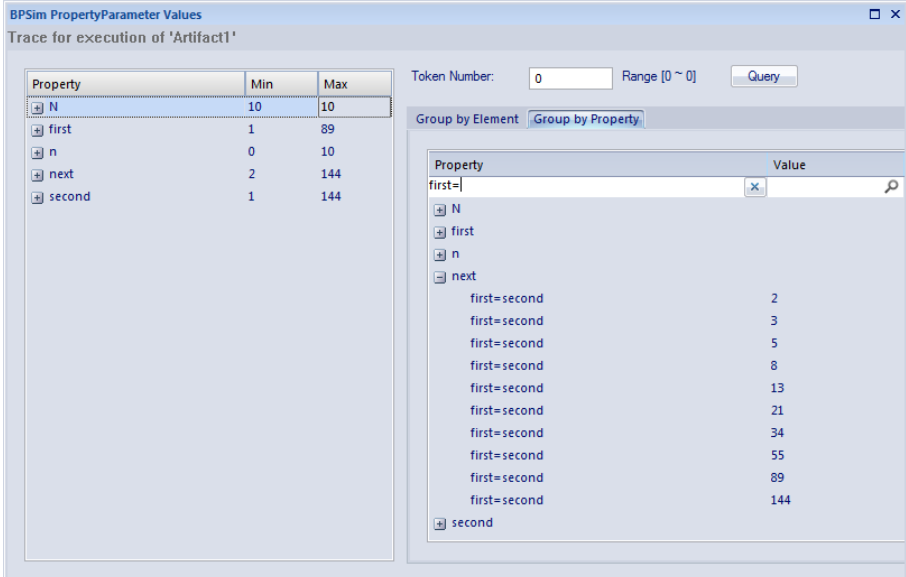


2

Now define the properties for each of the Activities in the process, on the 'Properties' tab. Note that the values for these properties are derived from **Expressions**, the components of which must be enclosed in braces - {xxx}. For the Activity:

- next=first+second - set the property 'next' and define the value as the Expression {first} + {second}

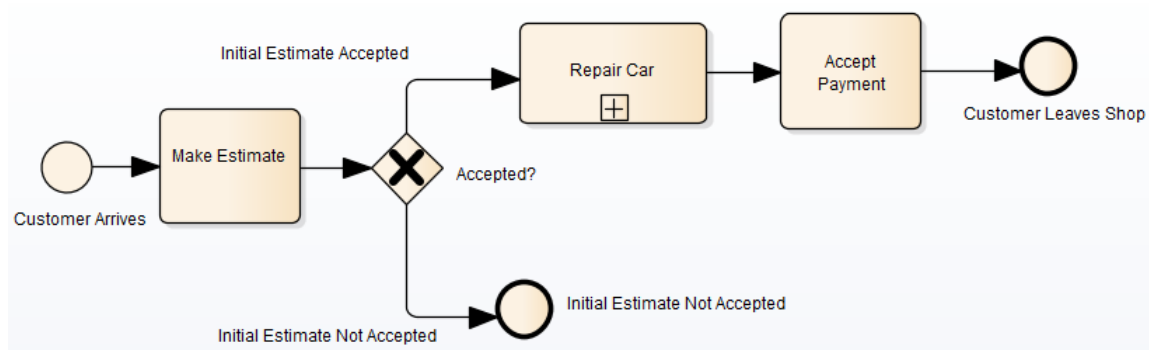
	 <ul style="list-style-type: none"> <li>• first=second - set the property 'first' and define the value as the Expression {second}</li> <li>• second=next - set the property 'second' and define the value as the Expression {next}</li> <li>• n++ - set the property 'n' and define the value as the Expression {n} + 1</li> </ul>
3	<p>Set the 'Condition' property parameters for the two Sequenceflow connectors issuing from the 'loopNode' Gateway element, on the 'Control' tab.</p> <p>Expand the Gateway   loopNode element and for the link to:</p> <ul style="list-style-type: none"> <li>• next=first+second - set the Control parameter to 'Condition' and define the value as the Expression {n}&lt;{N}</li> </ul>  <ul style="list-style-type: none"> <li>• EndEvent1 - set the Control parameter to 'Condition' and define the value as the Expression {n}&gt;={N}</li> </ul>
4	<p>Having completed the configuration, click on the Run button on the Configure BPSim window and on the 'BPSim Simulation Controller' dialog, selecting a Standard simulation.</p> <p>When the simulation is complete, click on the Attributes button.</p>

	<p>On the 'BPSim PropertyParameter Values' dialog, set the 'Token number' field to '0' and click on the Query button.</p>
5	<p>Now examine the values of the 'next' property on entering the first=second Activity in each iteration of the simulation. Click on the 'Group by Property' tab and expand the 'next' item.</p> <p>The list of values is long, so right-click on the column headers and select the 'Toggle Filter Bar' option. Under the 'Property' column heading, type 'first='. This filters the list to show only the property parameter values on entering the first=second Activity.</p> 

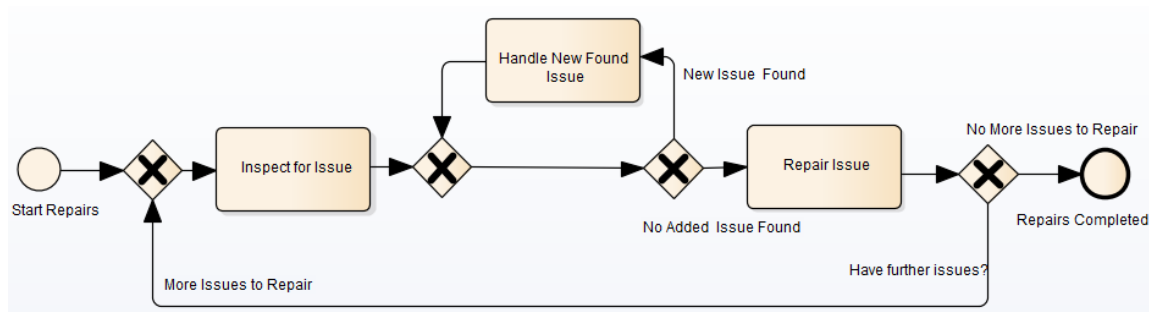
## The Car Repair Example

This more complex example is based on a realistic model of a car repair process, where a number of individual customers request an estimate for repair and either proceed with the repair or decline to continue; you can see how the property parameters vary as different decisions are made during the process. Open Example Model > Model Simulation > BPSim Models > Car Repair Process.

The overall process is represented by this diagram:



The *Repair Car* Activity is a composite element that contains this sub process diagram:



Step	Action
1	In the Browser window, expand the 'BPSim' child Package underneath the 'Car Repair Process' Package, and double-click on the 'Scenario 1: Main Flow' Artifact. The Configure BPSim window displays. On the 'Scenario' tab look at the 'Duration' field; this has been set to 2 days and 12 hours (that is, 60 hours).
2	<p>In the process hierarchy on the left of the window, expand the 'Start Event' category and click on 'Customer Arrives'. Select the 'Control' tab and look at the 'InterTriggerTimer' parameter, which has the value 24 minutes; that is, a customer arrives every 24 minutes (so over the 60 hour duration, 150 customers pass through the repair shop).</p> <p>Each customer enters the repair shop with one or more issues to be evaluated and repaired. The number of issues each customer presents can be randomly generated using one of the Distributions supported by BPSim. As the issue number is counted in discrete units (rather than measured on a continuous scale) we would use an 'integer' distribution. If you select the 'Properties' tab for the 'Customer Arrives' Start Event, you will see that the 'noOfIssues' property value is initialized from a Poisson distribution with a mean of 3.</p>
3	Now expand the decision Gateway 'Accepted?' and its connectors, in the process hierarchy. 'Initial Estimate Accepted' has a Control parameter 'Probability', set to 0.67. The alternative connector, 'Initial Estimate Not Accepted' has a similar Control parameter 'Probability' set to 0.33. That is, we expect an average of one issue in three to be withdrawn - or not pursued - by the customer.
4	<p>Further into the process, when an issue is being assessed on the vehicle, there is a possibility of another issue being discovered.</p> <p>In the list of Gateway elements, the last 'unnamed element' has two paths: 'New Issue Found' and 'No Added Issue Found'. Click on each of these and look at the 'Control' tab; the 'Probability' parameter for 'New Issue Found' is set to 0.25 and, for 'No Added Issue Found', to 0.75. So on average, for every four issues reported and assessed, one new one is discovered.</p> <p>The 'New Issue Found' path takes the process to the 'Handle New Found Issue' Activity, which adds 1 to the number of issues to be processed for the current customer. Expand the Activity group, and click on the 'Handle New Found Issue' element and on the 'Property' tab. You will see that the property 'noOfIssues' here has the Expression value <code>{noOfIssues} + 1</code>.</p>
5	When a problem with the vehicle is resolved, the 'Repair Issue' Activity deducts 1 from the number of issues to be repaired for the current customer. Click on the 'Repair Issue' element in the Activity group and on the 'Property' tab. You will see that the property 'noOfIssues' here has the Expression value <code>{noOfIssues} - 1</code> .
6	<p>The value from the 'Repair Issue' Activity is tested at the 'Have Further Issues?' Gateway.</p> <p>Click on the 'More Issues to Repair' connector and on the 'Control' tab; the Condition parameter for following this path is set to the Expression value <code>{noOfIssues} &gt; 0</code>; flow passes to the Gateway prior to the 'Inspect for Issue' Activity.</p> <p>Similarly, if you click on the 'No More Issues to Repair' connector and on the 'Control' tab, the Condition parameter for following that path is set to the Expression value <code>{noOfIssues} &lt;= 0</code>, and flow passes to the</p>

	<p>'Repairs Completed' End Event.</p> <p>Now that you have examined the process flow and configuration settings, you can run a simulation and review the results.</p>
7	<p>On the Configure BPSim window, click on the Run button, and then on the 'BPSim Simulation Controller' dialog click again on the Run button, selecting the 'Standard' simulation (however, the type of simulation makes no difference for reviewing property parameters).</p> <p>On the 'BPSim Simulation Controller' dialog, you can review the Token status (and see that an additional customer manages to enter the shop at the very last minute) but it is difficult to see exactly how this summary data resulted. Click on the Attributes button to obtain the detailed property parameter values information on the 'BPSim PropertyParameter Values' dialog.</p>
8	<p>On the left hand side of the dialog is a summary of the minimum and maximum values for the property parameter (attribute) for each element in the process. For example, for the 'Customer Arrives' element the 'noOfIssues' parameter has a minimum of 0 and a maximum of 8, as generated by the Poisson (3) distribution.</p> <p>In the 'Token Number' field, type in a number (N) between 0 and 150 to select for the Nth customer who entered the repair shop. Click on the Query button to obtain the property parameter values used in the process for that customer. Review the results on each of the two tabs:</p> <ul style="list-style-type: none"> <li>On the 'Group by Element' tab, see how the attribute's value changes in each element; for example, for customer 24 the 'noOfIssues' parameter is initialized with a value of 4 by the random distribution, and the 'Inspect for Issue' Activity is called six times with the parameter value being adjusted to 3 for three of those calls before cycling to 1, and the 'Handle New Found Issue' Activity is called twice with the parameter value at 3 both times</li> <li>On the 'Group by Property' tab see how the parameter value changes as the process cycles through the Activities to completion, starting at 4, being adjusted between 3 and 4 a number of times and then decrementing to 0 at the end</li> </ul>
9	<p>Continue to explore the results as required, selecting different customers (Tokens). You can also return to the BPSim configuration and change the parameter initializations and add new ones, or change the decision points, to experiment with the process.</p>

## Responding to real numbers in the simulation of an integer-based process

In some cases, you might need to generate property parameter values using a distribution that returns 'real' numbers when the activities in the process operate with integers, or when you want to see what impact forcing integer values has on the process.

One mechanism to apply in such cases is to set conditions to avoid absolute numbers. So, for example, you might have a counter that decrements by 1, that is initialized to a 'real' number. If you set a condition to 'value==0' (equals 0) or 'value !=0' (does not equal 0), the two conditions might never be True or might always be True, respectively, causing an infinite loop. To avoid that, in the conditions you would use operators such as:

'value > 0'

'value < 0'

'value >= 0'

'value <= 0'

Another mechanism is to edit the code template used by the BPSim engine, to intercept and replace the real numbers provided to specific parameters with integers, as shown:

1. Select the 'Develop > Preferences > Options > Edit Code Templates' ribbon option.
2. In the Code Template Editor, in the 'Language' field, click on the drop-down arrow and select 'MDGBPSimExecutionEngineExtension'.

3. In the list of (Java) templates, click on 'MDGBPSimExecutionEngineExtension Compute Value'. The template contents display in the 'Template' panel.
4. Find this line:

```
double %bpsimPropertyParameterName% = (double) distribution.next();
```

Change it to:

```
%if bpsimPropertyParameterName == "noOfIssues" or bpsimPropertyParameterName == "noOfVisitors"%  
double %bpsimPropertyParameterName% = (int) distribution.next();  
//double %bpsimPropertyParameterName% = Math.ceil(distribution.next());  
//double %bpsimPropertyParameterName% = Math.floor(distribution.next());  
//double %bpsimPropertyParameterName% = Math.round(distribution.next());  
%else%  
double %bpsimPropertyParameterName% = (double) distribution.next();  
%endIf%
```

5. Replace the property parameter names with your own property parameters.
6. Click on the Save button, close the Code Template Editor and reload the project.

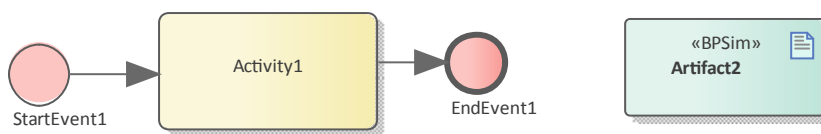
As presented, for each specified parameter the code template will simply replace any 'real' number initialized by the distribution with an integer. If you prefer, you can use one of the commented lines instead:

- Math.ceil() will take the 'real' number and convert it to the next highest integer
- Math.floor() will take the 'real' number and convert it to the next lowest integer
- Math.round() will take the 'real' number and round it up or down depending on whether it is greater than or less than n.5

## Time Parameter Behavior

In the BPSim configuration, you can set a number of Time parameters for an Activity, such as Queue Time and Wait Time. You can also set a Result Request on each of these, for a Custom simulation. However, the BPSim simulation engine combines these parameters into a single 'Processing Time' quantity.

Consider the simple model TimeParameter in the Example Model (Example Model > Model Simulation > BPSim Models > Time Parameter), represented by this diagram:



If you double-click on the Artifact2 element, the Configure BPSim window displays. Click on the Activity1 element in the diagram to expand the Activity group, to select Activity1 in the hierarchy at the left of the dialog, and to display the first tab, 'Time', for the element in the configuration, as shown.

**Configure BPSim**

Artifact2

Select Package: TimeParameter

Perspective: <All>

- Scenario
- Calendars
- Properties
- Trigger Count
- Activity
  - Activity1
- BusinessProcess
- EndEvent
- StartEvent

Type	Value	Unit	Calendar
TransferTime	000:000:000 000:01:00		----
QueueTime	000:000:000 000:02:00		----
WaitTime	000:000:000 000:04:00		----
SetUpTime	000:000:000 000:08:00		----
ProcessingTime	000:000:000 000:16:00		----
ValidationTime	000:000:000 000:32:00		----
ReworkTime	000:000:000 001:04:00		----
New Parameter...			----

Parameter	Result Request	KPI	SLA
TransferTime	mean	<input type="checkbox"/>	<input type="checkbox"/>
QueueTime	mean	<input type="checkbox"/>	<input type="checkbox"/>
WaitTime	mean	<input type="checkbox"/>	<input type="checkbox"/>
SetUpTime	mean	<input type="checkbox"/>	<input type="checkbox"/>
ProcessingTime	mean	<input type="checkbox"/>	<input type="checkbox"/>
ValidationTime	mean	<input type="checkbox"/>	<input type="checkbox"/>
ReworkTime	mean	<input type="checkbox"/>	<input type="checkbox"/>

Buttons: Save, Validate, Export, Run, Help

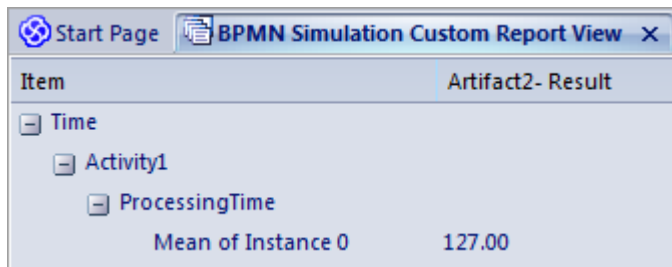
Note that in the upper panel there are seven system-supplied 'Time' parameters, which have been given initial values of - in order - 1, 2, 4, 8, 16, 32 and 64 minutes (the 64 minutes is 1 hour and 4 minutes). Note also that in the lower panel, each of these has a Result Request for the mean runtime value of the parameter.

Click on the Run button, and on the 'BPSim Simulation Controller' dialog click on the Run button and select 'Standard Simulation'. The simulation is configured to cycle through the process once. When the simulation is complete, click on the Open Result button, and on the 'BPMN Simulation Report View' right-click and select the 'Show Only Non-Empty Items' option. This gives you, for the Activity1 element on which the parameters were set, these results:

Item	Artifact2- Result
Time	
Activity1	
Mean Of Processing Time	127
Average Time In Task	127
Max Of Processing Time	127
Maximum Time In Task	127
Min Of Processing Time	127
Minimum Time In Task	127
Sum Of Processing Time	127
Total Time In Task	127

All of these derived results are 127 minutes, the sum of the initial values of the original seven 'Time' parameters. The individual parameters are not processed separately.

If you return to the 'BPSim Simulation Controller' dialog and click on the Run button, selecting 'Custom Simulation' this time, the Open Result button displays the 'BPMN Simulation Custom Report View'. In the configuration, the Result Requests were for the mean values of the seven parameters. In the Report View for the simulation, you only see the mean of the single aggregated parameter, ProcessingTime, as 127 minutes.



Item	Artifact2- Result
Time	
Activity1	
ProcessingTime	
Mean of Instance 0	127.00



## Compare BPSim Configurations

When you develop a BPSim configuration, you can define a wide range of parameters to set prior to running simulations and observing the effects of those settings, and of changes in selected settings. To facilitate using and managing multiple 'what-if' scenarios, it is recommended that you create copies of the original configuration (as Artifact elements) and make the setting changes in the copies.

A useful facility in creating variations of a configuration is to apply inheritance, whereby the data and parameters you do NOT intend to vary are held in one configuration, and only those parameters that you change are held in another. The 'variable' configuration uses (inherits) the common data held in the base configuration, so you do not have to re-create that common data in the 'variable' configuration.

You can then run simulations on the changed configurations and on the original 'baseline' and compare the simulation reports to see what differences occurred in the run-time variables, and then run and display the comparisons of the configurations to see what changes in parameter settings gave rise to those run-time differences.

By running simulations under the original and copy configurations, comparing the results and the changes that caused the results, and modifying the model accordingly, you can achieve a very high degree of control in streamlining the business process you are developing.

### Access

Context Menu	On a diagram or the Browser window   Right-click Business Process Simulation Artifact   Show BPSim Configuration
--------------	--

## The BPMN Simulation Configuration Report View

This view initially displays a hierarchy of the parameters in the selected configuration that have values and, in the column under the configuration name, the values set for those parameters. You can expand or collapse individual tab and parameter items using the +/- expansion/contraction boxes, or the hierarchy as a whole by right-clicking on the view and selecting the 'Collapse All' or 'Expand All' options. To review the results more easily, you can also drag the tab off the workspace to become a floating display, and expand the display to full screen size.

To compare two (or more) configurations, click on another configuration Artifact element in the Browser window or diagram and either:

- Drag it onto the report view or
- Select the 'Show BPSim Configuration Results' option

The parameter hierarchy now contains any additional parameters in that configuration, and its parameter values display in a column to the left of the original configuration values.

BPMN Simulation Report View		
Item	1 - Control perspective - Variations	1 - Control perspective Master
Time		
Find solution 1st level issue		
WaitTime		
Default	000:000:000 000:20:00	000:000:000 000:10:00
Control		
Customer issue report		
InterTriggerTimer		
Default	Triangular(2,0.35,2.5)	Triangular(2,0.5,3)
<<SequenceFlow>>[from "Provide solution to 1st level support" to "Issue handled by 2 nd level support"]		
Resource		
2nd Level Technical Support Agent		
Availability		
Default	false	false
1st Level Technical Support Agent		
Availability		
Default	false	true
Cost		
Find solution 1st level issue		
UnitCost		
Default	2	3
Priority		
Find solution 1st level issue		
Interruptible		
Default	false	false
Priority		
Default	0.5	0.6

You can review and manipulate the information on the report using options available from a right-click context menu.

## BPMN Simulation Configuration Report Options

Option	Description
Collapse All	Select this option to collapse the parameter hierarchy down to just the parent tab names.
Expand All	Select this option to expand the parameter hierarchy to the lowest value type.
Show Only Different items	(When you have two or more configurations shown.) Select this option to restrict the display to those parameters where the values differ between the configurations. Click on the option again to deselect it.
Highlight Different Items	(When you have two or more configurations shown and where their parameter values are different.) Displays the differing parameter values in red. This option is disabled if you select the 'Show Only Different Items' option. <div> <div>Find solution 1st level issue</div> <div> <div>WaitTime</div> <div>Default</div> </div> <div>000:000:000 000:20:00</div> <div>000:000:000 000:10:00</div> </div>
Show Only Non Empty Items	Select this option to filter the display to show only parameters that have a specific value other than 0.
Remove Scenario	(When you have selected an item within a configuration.) Select this option to remove the whole configuration from the report.
Edit Parameter	(When you have selected an item within a configuration.) Select this option to display the appropriate tab in the Configure BPSim window, with the parameter and value highlighted, and edit the value. When you have edited the value and clicked

	off it, the Save button is enabled; click on this button to return to the Report View. The hierarchy is collapsed, but when you expand it again the selected parameter value shows the change you made.
--	---

## BPSim Charts

The Artifacts page of the Diagram Toolbox provides two icons specifically to generate charts that reflect selected results from BPSim simulations. These are:

- BPSim Result Chart - to generate a Chart that reflects selected results from a series of standard BPSim simulations
- BPSim Custom Result Chart - to generate a Chart that reflects results from a series of customized BPSim simulations

As for other Chart Artifacts, both BPSim Chart types can be quickly configured to display the simulation results in variations of a line chart, two-dimensional bar chart or 3-dimensional bar chart.

### Prerequisites



To populate the Charts created from the Business Process Simulation Artifacts, you select the Result Artifacts created during the simulation of each configuration that you want to show. Therefore, the initial simulations must be performed first, and the Report Artifacts generated.

### Access

Display the 'Artifacts' page of the Diagram Toolbox using any of the methods outlined in the table.

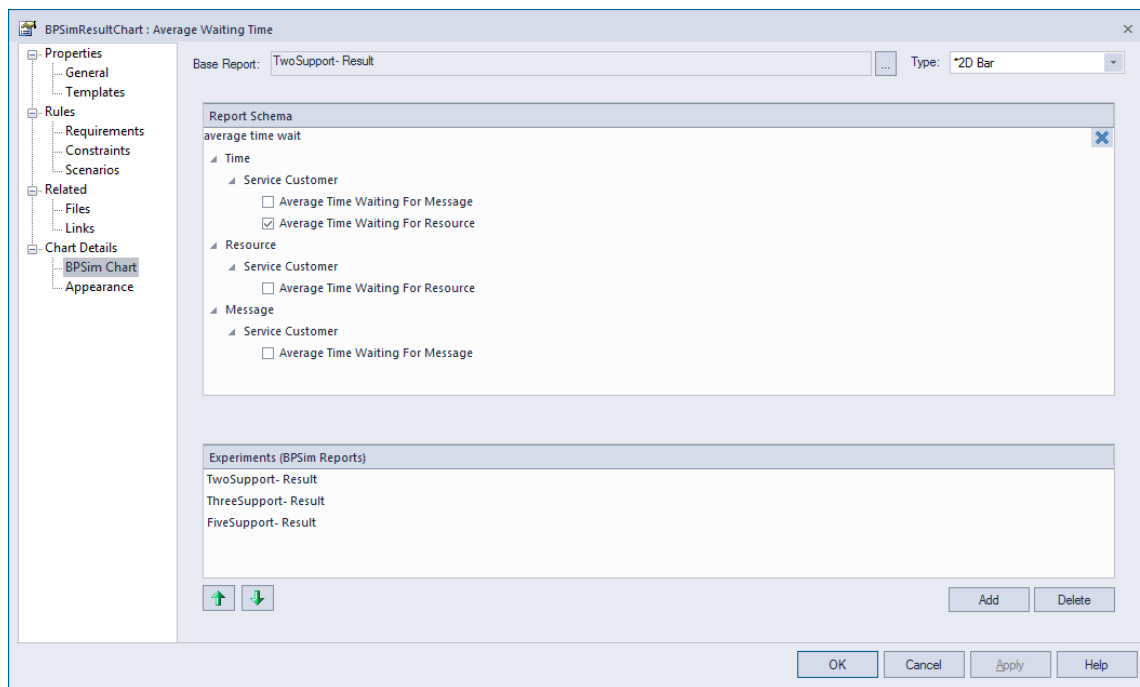
Then, drag the BPSim <type> Chart Artifact icon onto the diagram - a new chart element is created.


Double-click on the new chart element to open the 'Properties' dialog, showing the 'BPSim Chart' page.

Ribbon	Design > Diagram > Toolbox > Artifacts
Keyboard Shortcuts	Ctrl+Shift+3   Artifacts
Other	You can display or hide the Diagram Toolbox by clicking on the  or  icons at the left-hand end of the Caption Bar at the top of the Diagram View.

### Select Results to Display In Chart

Complete the fields on the 'BPSim Chart' page of the Chart 'Properties' dialog.




Option	Action
Base Report	Click on the  button to display the 'Select <<BPSimReport>>Artifact' dialog, and select the report Artifact for the simulation results against which other simulation results will be compared. This Results Artifact is also added to the 'Experiments' panel as the first in the list of report results to be compared.
Type	Click on the drop-down arrow and select the format type of the Chart in which to display the results - 2D Bar, 3D Bar or Line. After you have specified the report parameters to compare, you can select the 'Appearances' page of the dialog and define the appearance of the bar chart or Time line graph.
Report Schema	Expand the hierarchy as necessary and select the checkbox against each property to display on the chart. Each property will be represented by a separate line or group of bars on the chart. Usually you would select similar objects (such as different resources) and the same single property for each object (such as the degree of utilization of the resource). You have a wealth of properties to examine and compare, but any more than a couple on the same chart makes the chart hard to read.
Experiments (BPSim Reports)	<p>This panel lists the simulation report results (as BPSim Result Artifacts) that you have selected to compare using the chart, in the sequence in which their selected parameter will be shown on the Chart. Usually, the Base Report remains as first in the list and the result for its parameter is shown at the left of the Chart. If you want to change the sequence, click on the Result Artifact name and click on the appropriate Up/Down green arrow button.</p> <p>To add further Result Artifact names to the list, click on the Add button and browse for and select the Artifact from the 'Select &lt;&lt;BPSimReport&gt;&gt; Artifact' dialog.</p>

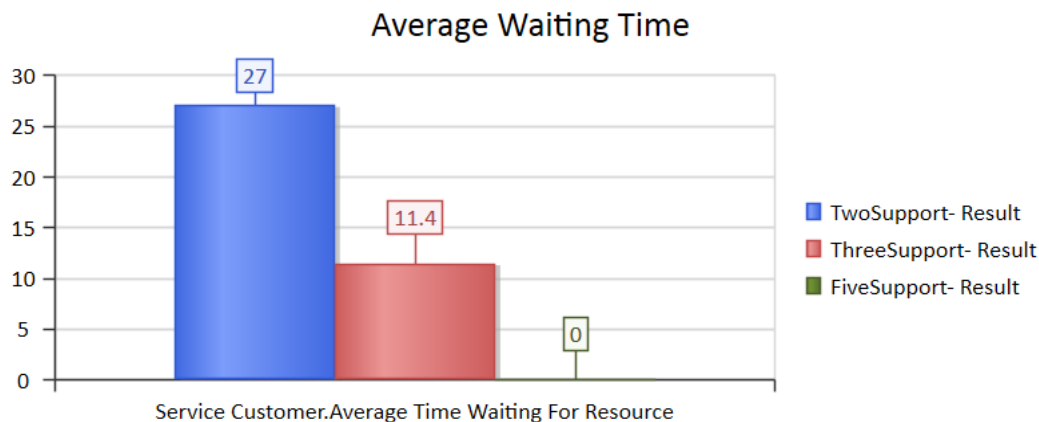
## A BPSim Chart Example

In the Help Desk Phone Support example, we created three BPSim artifacts to do what-if analysis of: 'How many supports do we need to answer the customer's questions over the phones in an economical way?'


We started with two supports, then tried three and five supports. After simulation, we have a BPSim Report based on different configurations: TwoSupport-Result, ThreeSupport-Result, FiveSupport-Result.

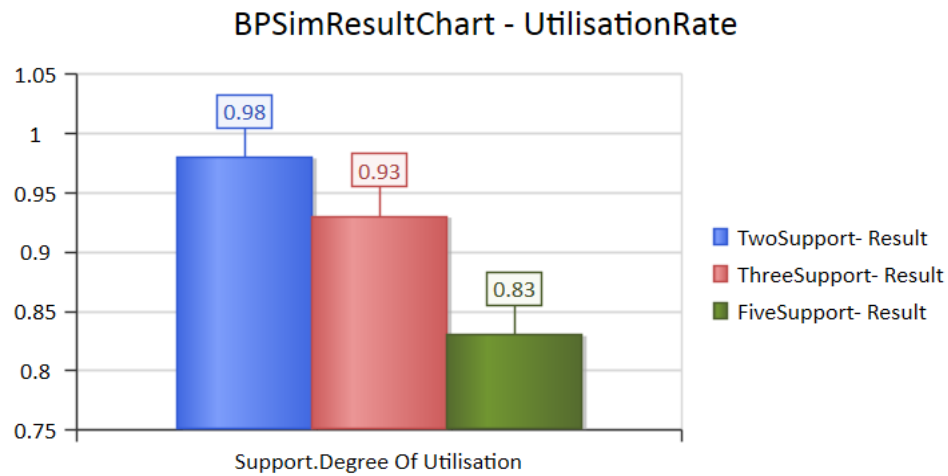
**These are the steps to create a chart to compare the customer's average time waiting for support:**

1. Create a BPSim Result Chart on the diagram, and name it *Average Waiting Time*.
2. Double-click on the chart to open the Properties window, then open the 'BPSim Chart' tab.
3. Click on the  button to select a Base Report, from which we define the schema (legends) to use in the chart. Select 'TwoSupport-Result'.
4. Choose this schema:
  - Time | Service Customer | Average Time Waiting For Resource
5. Click on the Add button to add another two BPSim Reports: 'ThreeSupport-Result' and 'FiveSupport-Result'.
6. Click on the OK button, and adjust the size of the chart element. This chart gives us direct information.



**These are the steps to create a chart to compare the degree of use of Support:**

1. Create a BPSim Result Chart on the diagram, and name it *Utilisation Rate*.
2. Double-click on the chart to open the Properties window, then open the 'BPSim Chart' tab.
3. Click on the  button and select a Base Report, from which to define the schema (legends) to use in the chart. Select 'TwoSupport-Result'.
4. Choose this schema:
  - Resource | Support | Degree Of Utilisation
5. Click on the Add button to add another two BPSim Reports: 'ThreeSupport-Result' and 'FiveSupport-Result'.
6. Click on the OK button and adjust the size of the chart element. This chart provides specific information.



## BPSim Examples

This document contains many examples of BPMN modeling, BPSim Configuration and Analysis of the simulation results.

These examples can be accessed from the EAExample model.

The EABPSim Execution Engine is required to run the simulations.



# Help Desk Phone Support Simulation - Resource Perspective

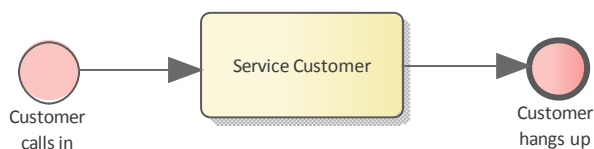
In this example, we create a very simple model to simulate a Help Desk phone support process.

We set up a scenario in which resources are limited and the requests have to be put in a waiting queue for a resource. Then we try to seek a balance point between customer's waiting time and the number of resources, using a what-if analysis.

Firstly, we model this process step-by-step, starting with a simple parameter setting than can be calculated with pen and paper, then verifying it with EABPSim. After that, we perform a what-if analysis that might help the manager to make a decision.

## Create BPMN Model

The model itself is very simple, consisting of a Start Event, a Task and an End Event.



- Create a Start Event called *Customer calls in*
- Add a Sequence Flow to a target Abstract Task called *Service Customer*
- Add a Sequence Flow to a target End Event called *Customer hangs up*

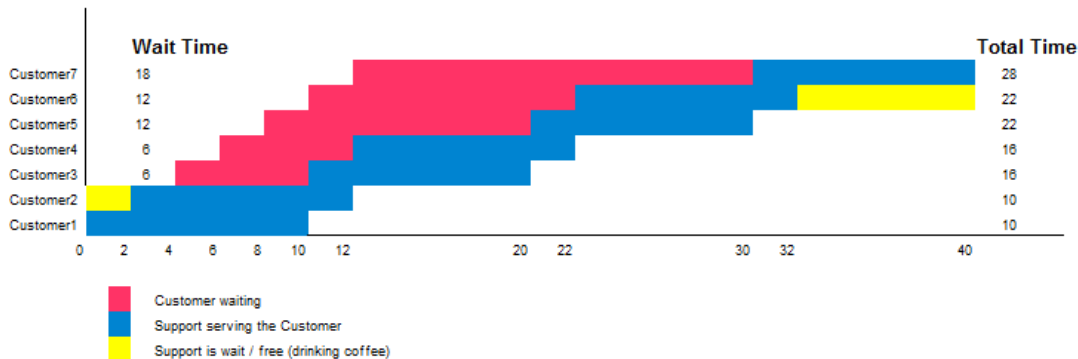
Create a BPMN2.0 Resource named *Support*; this element will be used in the BPSim Configuration.

## Pen and Paper Analysis

We will use pen and paper to analyze this case:

- 7 customers call in at 2 minute intervals
- 2 support resources are available
- Each service will take 10 minutes

## Pen & Paper Analysis on a BPSim Example



Now we can perform some calculations using a pen and paper based approach:

Total Time Waiting For Resource:	$(18+12+12+6+6+0+0) = 54$	number of	
Total Time In Task:	$(28+22+22+16+16+10+10) = 124$		
Average Time in Task:	$124/7 = 17.71$		
Average Time Waiting For Resource:	$54/7 = 7.71$		
Maximum Time In Task:	28		
Maximum Time Waiting For Resource:	18		
Sum of Support's wait time:	$2+8 = 10$	number of	
Sum of Support's time for Task:	$7*10 = 70$	number of	
Degree of Utilisation:	$70/(10+70) * 100\% = 87.5\%$		

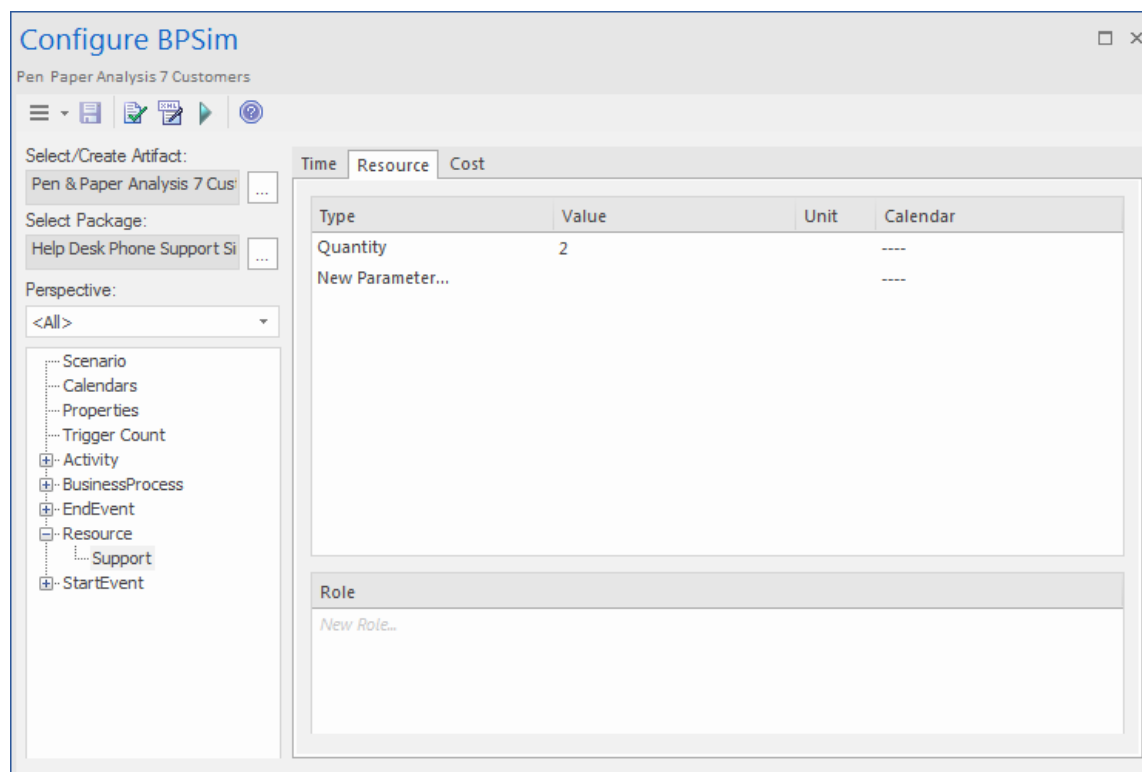
Seen from this result, it is already a very complicated computation for such a simple model when resource constraints are applied. When the process expands and more constraints are applied, analyzing the process with pen and paper will quickly become impossible. We will demonstrate how EABPSim can help.

## BPSim Configuration

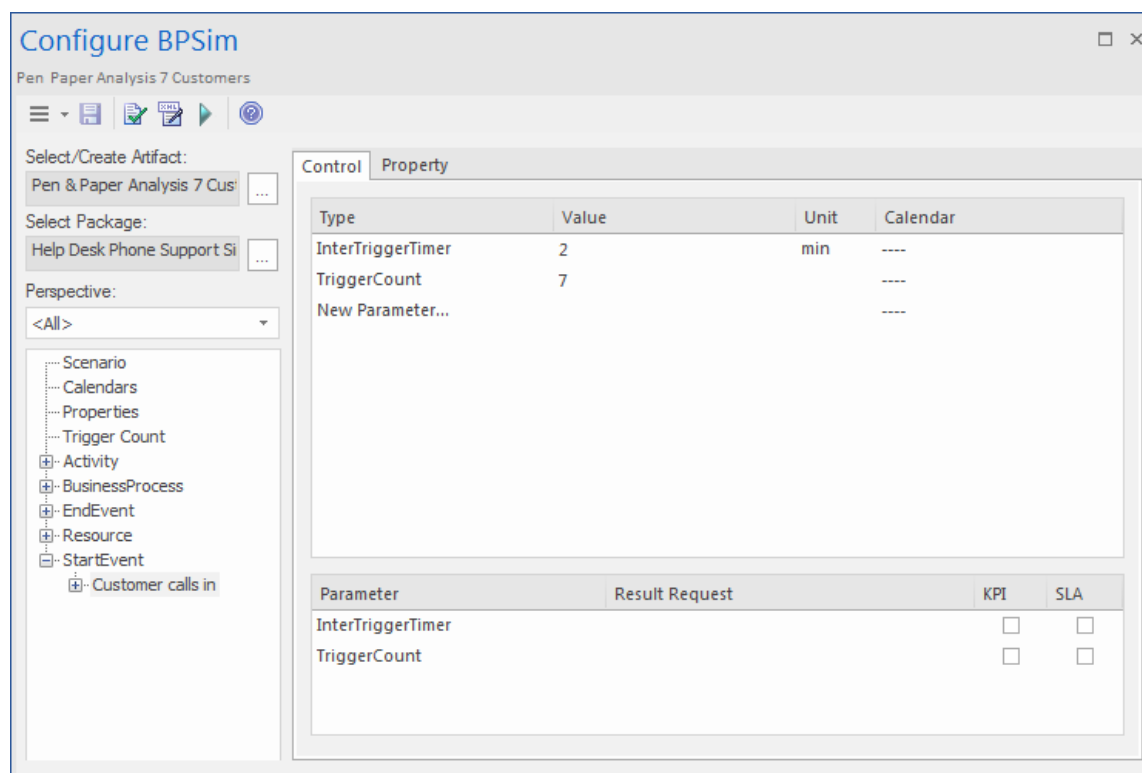
- Open the Configure BPSim window ('Simulate > Process Analysis > BPSim > Open BPSim Manager')
- Create a Business Process Simulation Artifact named *Pen & Paper Analysis 7 Customers*
- Select the Package containing the corresponding BPMN 2.0 model



All the BPMN elements will be loaded in to the Configure BPSim window.

- In the left-hand tree on the window, expand the 'Resource' group and click on *Support*; click on the 'Resource' tab and on the drop-down arrow of the 'New Parameter' field, then select 'Quantity' and, in the 'Value' field, type '2'

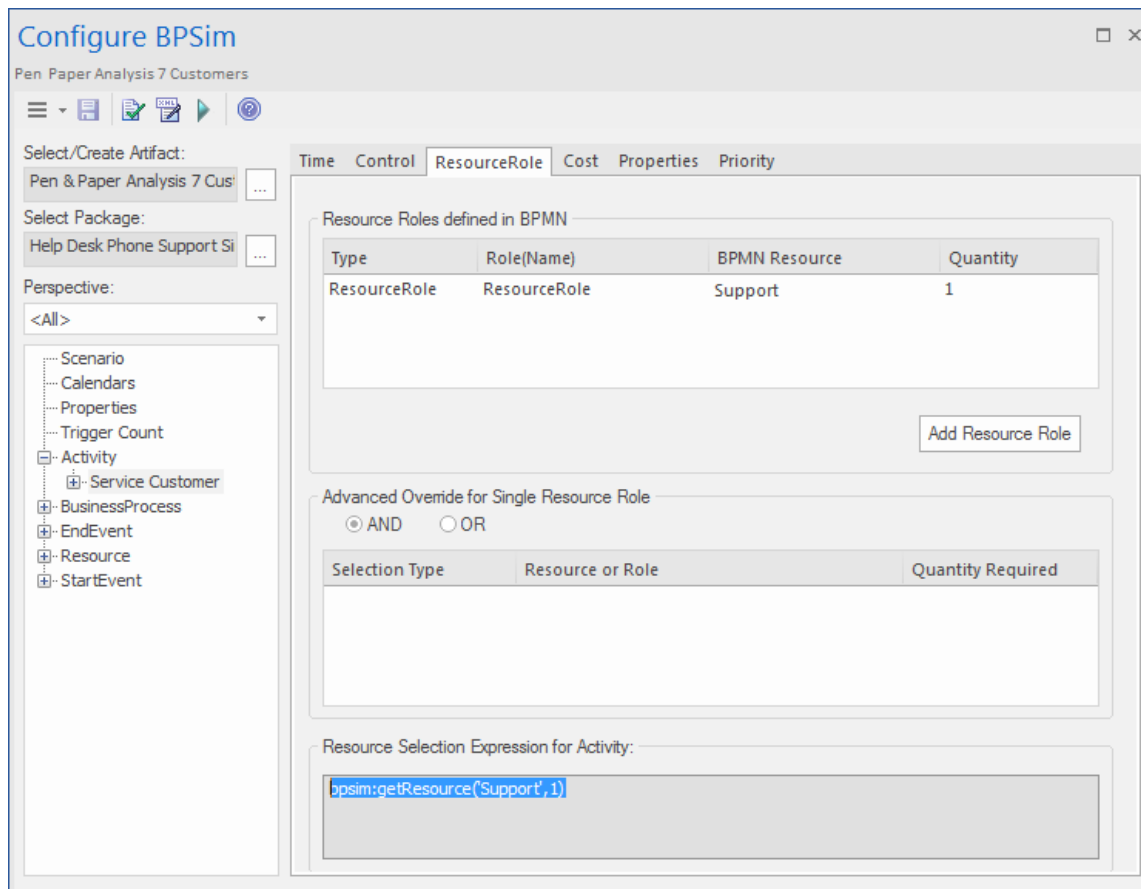


- In the left-hand tree, expand the 'StartEvent' group, then click on *Customer calls in* and on the 'Control' tab
- Click on the drop-down arrow of the 'New Parameter' field and select, in turn:
  - 'InterTriggerTimer' and, in the 'Value' field, click on the  button, select the 'Constant' tab and 'Numeric', type '2' in the 'Constant Numeric' field and select 'minutes' in the 'TimeUnit' field
  - 'TriggerCount', and in the 'Value' field type '7'




- In the left-hand tree, expand the 'Activity' group, then click on *Service Customer* and on the 'Time' tab
- Click on the drop-down arrow of the 'New Parameter' field and select 'ProcessingTime' and, in the 'Value' field, click on the  button and select the 'Constant' tab and 'Numeric', type '10' in the 'Constant Numeric' field and select 'minutes' in the 'TimeUnit' field
- Click on the 'ResourceRole' tab, click on the Add Resource Role button; in the new row in the 'Resource Roles defined in BPMN' panel, click on the  button in the 'BPMN Resource' field and select the *Support* element you created earlier
- In the 'Quantity' field, type '1'

In the 'Resource Selection Expression for Activity' panel the automatically generated expression `bpsim:getResource('Support',1)` displays.



### Run the Simulation

- On the Configure BPSim window Toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button drop-down arrow and select 'Standard Simulation'
- When the simulation is complete, click on the  button on the 'BPSim Simulation Controller' dialog toolbar to open the 'BPMN Simulation Report View'

Item	Value
<b>Time</b>	
<b>Service Customer</b>	
Mean Of Processing Time	10.00
Average Time In Task	17.71
Average Time Waiting For Resource	7.71
Max Of Processing Time	10.00
Maximum Time In Task	28.00
Maximum Time Waiting For Resource	18.00
Min Of Processing Time	10.00
Minimum Time In Task	10.00
Sum Of Processing Time	70.00
Total Time In Task	124.00
Total Time Waiting For Resource	54.00
<b>Support</b>	
Total Time Available	80.00
Sum Of Processing Time	70.00
Total Time For Task	70.00
Sum Of Wait Time	10.00
Help Desk Phone Support Process	
<b>Control</b>	
<b>Resource</b>	
Customer hangs up	
Service Customer	
<b>Support</b>	
Average Number Available	0.25
Degree Of Utilisation	88.00%

*Tip: You can select the 'Show Only Non-Empty Items' option to filter the results.*

The results match the pen and paper analysis.

## Simulation - 2 Support Resources for 20 customers

You can create a new Business Process Simulation Artifact by copying an existing BPSim Configuration. Copy the *Pen & Paper Analysis 7 customers* element and press Ctrl+Shift+V to paste, giving the new element the name *TwoSupport*.

- Double-click on *TwoSupport* to open the 'Configure BPSim' dialog; you can see that all the configurations are kept from the copied source
- Expand the 'StartEvent' group and click on *Customer calls in*; click on the 'Control' tab and, in the 'Value' field for the 'TriggerCount' parameter, change the figure to '20'

### Run simulation and analyze results

BPMN Simulation Report View	
Item	TwoSupport- Result
wait	
Time	
Service Customer	
Average Time Waiting For Resource	27.00
Maximum Time Waiting For Resource	54.00
Total Time Waiting For Resource	540.00

BPMN Simulation Report View	
Item	TwoSupport- Result
util	
Resource	
Support	
Degree Of Utilisation	98.00%

From the report, you can see that:

- The 'Average Time Waiting For Resource' is 27 minutes and the 'Maximum Time Waiting For Resource' is 54 minutes
- The two Support resources - are they busy? If they were not, we might have to change the process to use all of their time and reduce the customer's waiting time; however, the 'Degree Of Utilisation' is at 98%, which indicates that the resources had almost no idle time

## 'What-If' I have more staff? Compare 2 Support Resources with 3 and 5 Support Resources


- Copy *TwoSupport* and press Ctrl+Shift+V to paste, giving the new element the name *ThreeSupport*
- Double-click on *ThreeSupport* to open the 'Configure BPSim' dialog, expand the 'Resource' group and click on *Support*, then click on the 'Resource' tab and, for the 'Quantity' parameter, change the 'Value' field to '3'
- Copy *TwoSupport* and press Ctrl+Shift+V to paste, giving the new element the name *FiveSupport*
- Double-click on *FiveSupport* to open the 'Configure BPSim' dialog, expand the 'Resource' group and click on *Support*, then click on the 'Resource' tab and, for the 'Quantity' parameter, change the 'Value' field to '5'
- Run the simulations and do a comparison; in the Browser window:
  - Ctrl+click on *TwoSupport*, *ThreeSupport* and *FiveSupport*, then right-click and select the 'Show BPSim Configuration' option
  - Ctrl+click on *TwoSupport-Result*, *ThreeSupport-Result* and *FiveSupport-Result*, then right-click and select the 'Show BPSim Report' option

Enterprise Architect			
BPMN Simulation Report View			
Item	FiveSupport	ThreeSupport	TwoSupport
Resource			
Support			
Quantity			
Default	5	3	2

BPMN Simulation Report View			
Item	FiveSupport- Result	ThreeSupport- Result	TwoSupport- Result
Time			
Service Customer			
Average Time In Task	10.00	21.40	37.00
Average Time Waiting For Resource	0	11.40	27.00
Maximum Time In Task	10.00	34.00	64.00
Maximum Time Waiting For Resource	0	24.00	54.00
Total Time In Task	200.00	428.00	740.00
Total Time Waiting For Resource	0	228.00	540.00
Support			
Help Desk Phone Support Process			
Control			
Service Customer			
Resource			
Service Customer			
Support			
Degree Of Utilisation	83.00%	93.00%	98.00%
Sum Of Wait Time	40.00	16.00	4.00

### Tips:

- Use the  button and click on the 'Show only different items' option for both views
- You can dock the views together, so they provide direct comparisons: *THESE* are the differences in results caused by *THOSE* differences in configuration
- Toggle the filter bar to filter the items that interest you


### Analysis

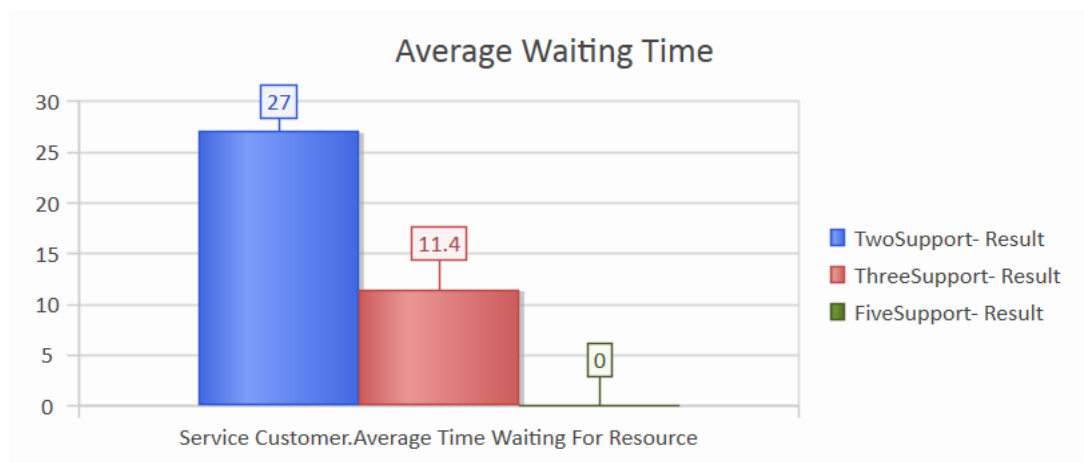
The docked comparison views show the configuration differences and the corresponding result differences.


- The customer's waiting time dropped from 27 minutes (2 Support resources) to 11.4 minutes (3 Support resources) and further down to 0 minutes (5 Support resources)
- The 'Degree Of Utilisation' dropped from 98% (2 Support resources) to 93% (3 Support resources) and further down to 83% (5 Support resources)

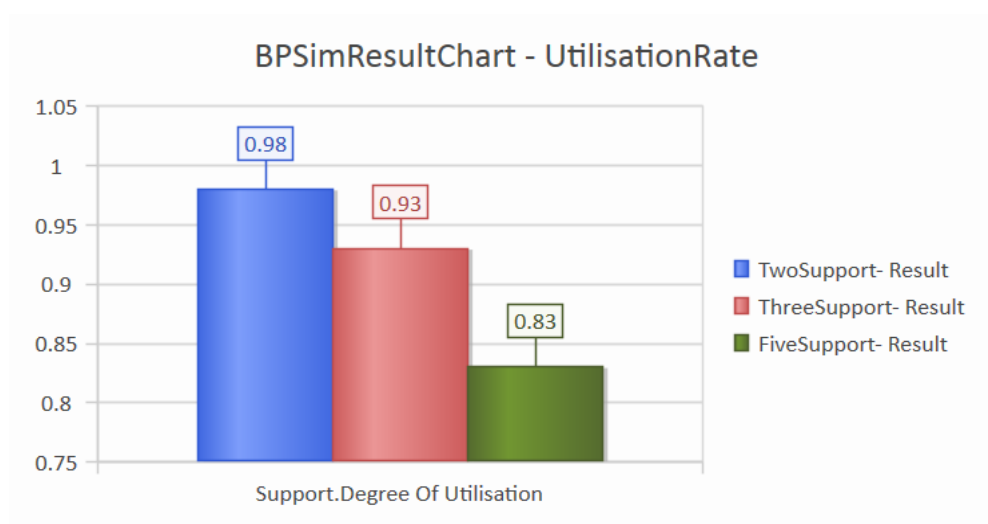
The customers will most likely be satisfied with 5 Support resources; however, the cost might be out of budget. So 3 or possibly 4 Support resources might be a balance point for this case. You are recommended to copy one of the Business Process Simulation Artifacts and configure and run a simulation for 4 Support resources.

### Show Result with Chart

- Drag a 'BPSim Result Chart' icon from the Toolbox onto the diagram and create a BPSim Result Chart Artifact; call it *Average Waiting Time*
- Double-click on the Artifact to display the element 'Properties' dialog and click on the 'BPSim Chart' tab
- Click on the  button and select a Base Report from which to define the schema (legends) to use in the chart; select *TwoSupport-Result*
- Choose the schema 'Time' | 'Service Customer' | 'Average Time Waiting For Resource'
- Click on the Add button to add another two BPSim Reports: *ThreeSupport-Result* and *FiveSupport-Result*
- Click on the OK button and adjust the size of the chart element; this chart gave us very straightforward information



- Create another BPSim Result Chart Artifact on the diagram, called *Utilisation Rate*
- Double-click on the Artifact to display the element 'Properties' dialog and click on the 'BPSim Chart' tab
- Click on the  button and select a Base Report from which to define the schema (legends) to use in the chart; select *TwoSupport-Result*
- Choose the schema 'Resource' | 'Support' | 'Degree Of Utilisation'
- Click on the Add button to add another two BPSim Reports: *ThreeSupport-Result* and *FiveSupport-Result*
- Click on the OK button and adjust the size of the chart element







# Calendar-Based Help Desk Phone Support Simulation

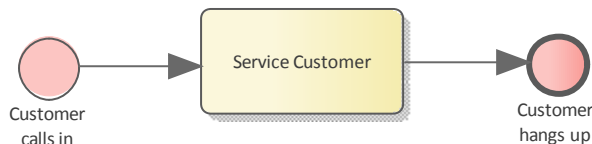
In this example, we create a very simple model to simulate the Help Desk telephone support process, based on calendar settings. We assume that:

- Customers call in at different intervals on weekdays and weekends
- Processing times differ between weekdays and weekends
- There are different numbers of support resources on weekdays and weekends

We model this process step by step, then create calendars and configure the Business Process simulation, which is simple enough to be calculated with pen and paper. After that, we run the simulation to compare that result with the pen and paper analysis.

## Create BPMN Model

The model itself is very simple, consisting of a Start Event, a Task and an End Event.



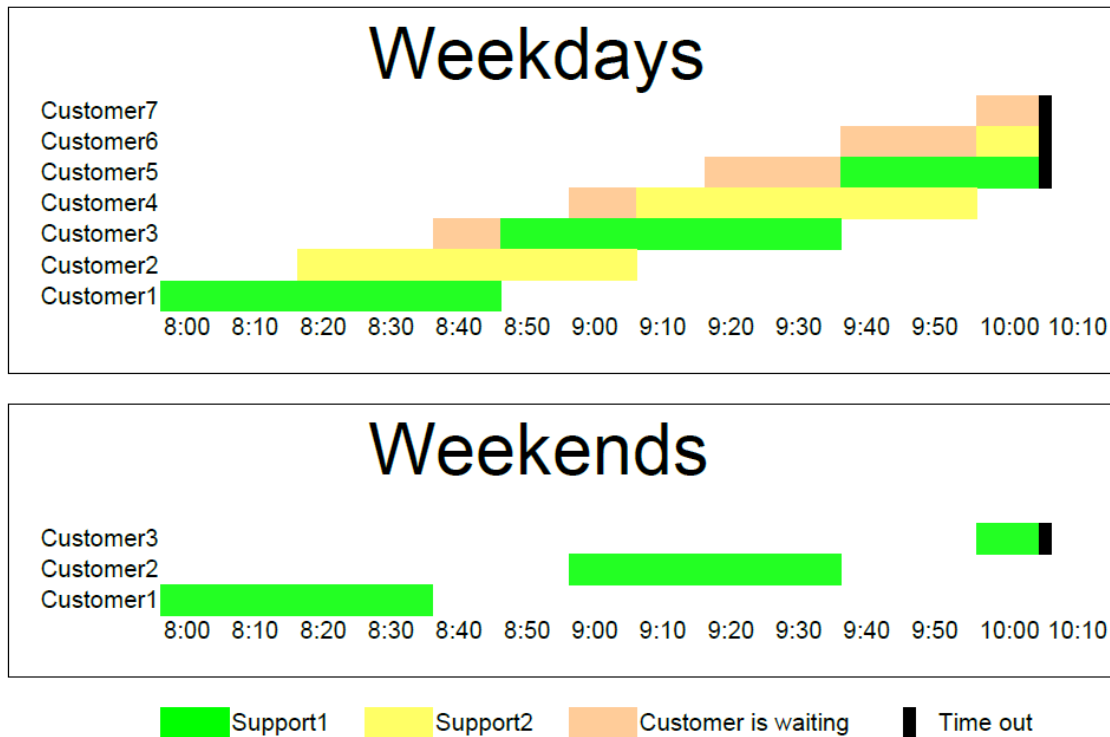
- Create a Start Event *Customer calls in*
- Add a Sequence Flow to the target abstract task Activity *Service Customer*
- Add a Sequence Flow to the target End Event *Customer hangs up*

Create a BPMN2.0 Resource named *Support*. Create a BPMN2.0::ResourceRole inside *Service Customer*, give it the name *support* and set the tag *resourceRef* to the name of the Resource element *Support*.

## Pen and Paper Analysis

We can use pen and paper to analyze this case:

- The simulation duration is 2 hours and 10 minutes, from 8:00AM to 10:10AM
- Customers call in every 20 minutes on weekdays
- Customers call in every 60 minutes on weekends
- To service a customer takes 50 minutes on weekdays
- To service a customer takes 40 minutes on weekends
- There are 2 support resources on weekdays
- There is 1 support resource on weekends



Looking at this result, when resource constraints are applied the computation is very complicated for such a simple model.

#### On weekdays

- 7 customers called at intervals of 20 minutes over a duration of 2 hours and 10 minutes
- 4 customer calls were terminated normally
- 2 customer calls were interrupted because of timeout
- 1 customer call was not answered
- Support1 worked continuously for 130 minutes, Support2 worked continuously for 110 minutes

#### On weekends


- 3 customers called at intervals of 60 minutes over a duration of 2 hours and 10 minutes
- 2 customer calls were terminated normally
- 1 customer call was interrupted because of timeout
- Support1 worked 90 minutes, in 40-minute blocks with an interval of 20 minutes between calls

Now we will see how EABPSim can help.

## BPSim Configuration

In this section, we first create the Calendars, then we set up the Duration and Start parameters.

For element parameters, you can specify one or more calendars for a given parameter. However, **if any calendar is set for a parameter value, a default value (without any calendar specified) must exist**, otherwise the simulation will not work.

Clicking on the  button on the Configure BPSim window toolbar will automatically check this constraint for you.

Task	Action
Create BPSim Artifact and Set Package	<ul style="list-style-type: none"> <li>Open the Configure BPSim window ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>Create a Business Process Simulation Artifact named <i>Calendar Based Support Process Simulation</i></li> <li>Select the Package containing the corresponding BPMN 2.0 model</li> </ul> <p>All the BPMN elements will be loaded in to the Configure BPSim window.</p>
Calendars	<p>Click on the 'Calendars' tab, click on the New button to display the 'Event Recurrence' dialog and complete the fields as shown to create a calendar. Click on the OK button and overtype the <i>Calendar_n</i> text with a name for the calendar. Create two calendars.</p> <ul style="list-style-type: none"> <li>In 'Event Time' set 'Start' to 08:00AM and 'End' to 05:00PM; in 'Recurrence Pattern' select 'Weekly' and select the checkboxes against 'Monday' through to 'Friday'; in 'Range of recurrence' set 'Start' to '04/1/2019' and select 'No end date'; overtype <i>Calendar_1</i> with 'Weekdays'</li> <li>In 'Event Time' set 'Start' to 08:00AM and 'End' to 05:00PM; in 'Recurrence Pattern' select 'Weekly' and select the checkboxes against 'Saturday' and 'Sunday'; in 'Range of recurrence' set 'Start' to '02/1/2019' and select 'No end date'; overtype <i>Calendar_2</i> with 'Weekend'</li> </ul>
Start & Duration	<p>Click on the 'Scenario' tab.</p> <ul style="list-style-type: none"> <li>Duration - input 0000 002:10:00, which means 0 days, 2 hours and 10 minutes</li> <li>Start - for Weekday simulation input 1/07/2016 8:00AM, which means 1st of July, 2016, which is a Friday</li> <li>Start - for Weekend simulation input 2/07/2016 8:00AM, which means 2nd of July, 2016, which is a Saturday</li> </ul>
Customer arrivals	<p>In the left-hand tree on the dialog, expand the 'StartEvent' group and click on <i>Customer calls in</i>; click on the 'Control' tab and, using the drop-down arrow of the 'New Parameter' fields, create these parameters:</p> <ul style="list-style-type: none"> <li>InterTriggerTimer - Value: 100:000:000 000:00:00; Calendar: ---- (this default value is necessary)</li> <li>InterTriggerTimer - Value: 000:000:000 000:20:00; Calendar: Weekdays</li> <li>InterTriggerTimer - Value: 000:000:000 001:00:00; Calendar: Weekends</li> </ul>
Processing Times	<p>Expand the 'Activity' group and click on <i>Service Customer</i>; click on the 'Time' tab and, using the drop-down arrow of the 'New Parameter' fields, create these parameters:</p> <ul style="list-style-type: none"> <li>ProcessingTime - Value: 100:000:000 000:00:00; Calendar: ---- (this default value is necessary)</li> <li>ProcessingTime - Value: 000:000:000 000:50:00; Calendar: Weekdays</li> <li>ProcessingTime - Value: 000:000:000 000:40:00; Calendar: Weekends</li> </ul>
Resources	<p>Expand the 'Resource' group and click on <i>Support</i>; click on the 'Resource' tab and, using the drop-down arrow of the 'New Parameter' fields, create these parameters:</p> <ul style="list-style-type: none"> <li>Quantity - Value: 0; Calendar: ---- (this default value is necessary)</li> <li>Quantity - Value: 2; Calendar: Weekdays</li> </ul>

	<ul style="list-style-type: none"> <li>Quantity - Value: 1; Calendar: Weekends</li> </ul>
Resource Selection (allocation)	<p>In the 'Activity' group, click on <i>Service Customer</i> and click on the 'ResourceRole' tab.</p> <p>Check that the 'Resource SelectionExpression for Activity' panel shows <b>bpsim::getResource('Support',1)</b> as an expression. This expression is loaded from your BPMN model by default. You can do some advanced configurations for resource selection for a task.</p>

## Run Simulation

### Weekdays

- Click on the 'Scenario' tab and set the 'Start' value to '1/7/2016'
- On the dialog Toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button drop-down arrow and select 'Standard Simulation'

A file with the name *Calendar Based Support Process Simulation - Result* is generated. This report file contains the result for a weekday simulation.

### Weekends

- Click on the 'Scenario' tab and set the 'Start' value to '2/7/2016'
- On the dialog Toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button drop-down arrow and select 'Standard Simulation'

The *Calendar Based Support Process Simulation - Result* file is updated to show the result for a weekend simulation.

In each case, check the match between the result file and our analysis with pen and paper.

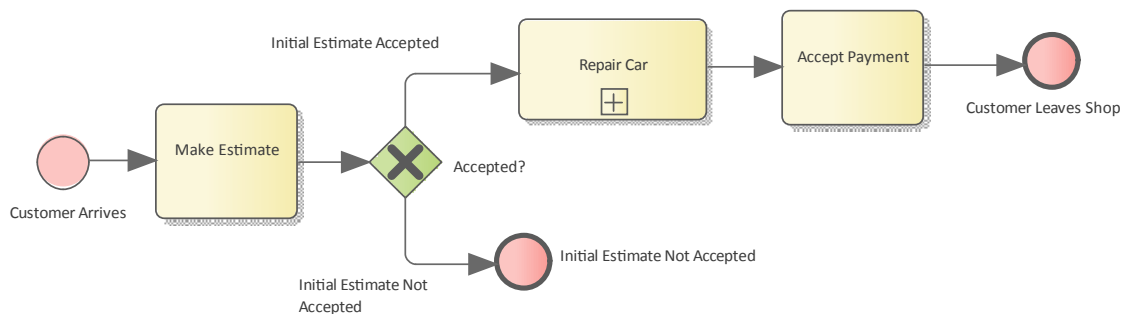
# Car Repair Process

This example simulates the process flow of a Car Repair shop. The BPSim configuration:

- Uses a property parameter initialized by distribution to generate a random number of issues for each customer
- Applies probability to simulate:
  - Acceptance of the initial estimate or not
  - Whether new issues will be found during repair
- Increments or decrements the property parameter's value in each task
- Uses the property parameter's value on conditions of Sequences outgoing from Gateways
- Simulates the customer arrivals for a given start and duration

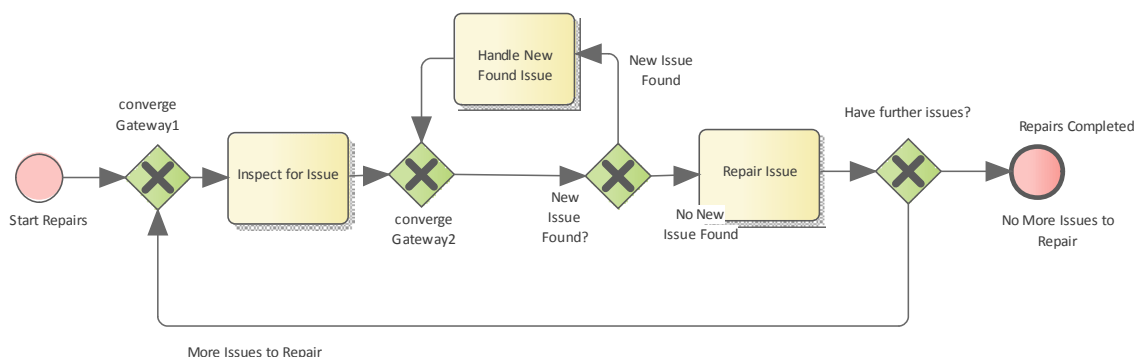
## Create BPMN Model

### Create the main process



- Create a Start Event *Customer Arrives*
- Add a Sequence Flow to a target abstract task Activity *Make Estimate*
- Add a Sequence Flow to a target Exclusive Gateway *Accepted?*
- Add Sequence Flows to:
  - A target End Event *Initial Estimate Not Accepted*
  - A target subProcess *Repair Car*
- From *Repair Car*, add a Sequence Flow to a target abstract task Activity *Accept Payment*
- Add a Sequence Flow to a target End Event *Customer Leaves Shop*




### Create the sub process Repair Car



- Create a Start Event *Start Repairs*
- Add a Sequence Flow to a target Exclusive Gateway *converge Gateway1*
- Add a Sequence Flow to an abstract task Activity *Inspect for Issue*
- Add a Sequence Flow to an Exclusive Gateway *converge Gateway2*
- Add a Sequence Flow to an Exclusive Gateway *New Issue Found?*
- Add Sequence Flows to:
  - A target abstract task Activity *Handle New Found Issue*, then add a Sequence Flow back to *converge Gateway2*
  - A target abstract task *Repair Issue*, then add a Sequence Flow to a target Exclusive Gateway *Have further issues?*
- From the Gateway *Have further issues?* add Sequence Flows to:
  - A target End Event *Repairs Completed*
  - *converge Gateway1*



## Configure BPSim

Task	Description
Artifact and Package	<ul style="list-style-type: none"> <li>• Open the Configure BPSim window ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>• Create a Business Process Simulation Artifact named <i>IntermediateEvent - Boundary - Error</i></li> <li>• Select the Package containing the corresponding BPMN 2.0 model</li> </ul> <p>All of the BPMN elements will be loaded in to the Configure BPSim window.</p>
Start and Duration	<p>We will simulate the processes in a car repair shop whose opening hours are from 9:00 am to 5:00 pm, which is a period of 8 hours. We also suppose that a customer walking in after 4:50 pm will not be served on that day. Therefore the simulation Start time is 9:00 am and the duration is 7 hours and 50 minutes.</p> <p>On the left hand panel of the 'Configure BPSim' dialog, click on the 'Scenario' item in the tree; the 'Scenario' tab is activated.</p> <ul style="list-style-type: none"> <li>• In the 'Start' field, select any date and change the time section to '9:00 AM'</li> <li>• Set the 'Duration' field to '0000 007:50:00' (Tips: the format is: dddd hh:mm:ss)</li> </ul>
Customer Arrives	<p>We will simulate a customer arriving every 24 minutes. The first customer arrives at 9:00 AM and the last arrives at 4:36 PM (the customer arriving at 5:00 PM will not be served today because that is constrained by the 'Duration' setting).</p> <p>With a pen and paper, we can calculate that there are 20 customers served (9:00 AM to 4:36PM = 456 minutes, number of customers: <math>456/24 + 1 = 19 + 1 = 20</math>). We will verify this with the simulation result later.</p> <p>Expand the 'StartEvent' group and select <i>Customer Arrives</i>. Click on the 'Control' tab and the 'New Parameter' drop-down arrow, and select 'InterTriggerTimer'. In the 'Value' and 'Unit' fields type 24 and select 'min' (for '24 minutes').</p>
Property Parameters	<p>We suppose each customer's car might initially have a different number of issues. This could be reflected using a random number generator. BPSim provides a number of distributions to suit your needs.</p> <p>In this example, we use a TruncatedNormal distribution to initialize the property <i>noOfIssues</i>. Tasks <i>Repair Issue</i> and <i>Handle New Found Issue</i> will decrement and increment the value of <i>noOfIssues</i> respectively.</p>

	<ul style="list-style-type: none"> <li>Click on the <i>Customer Arrives</i> Start Event and on the 'Properties' tab</li> <li>Overtyping <i>New Property</i> with <i>noOfIssues</i>, and in the 'Value' field click on the  button; the 'Parameter Value' dialog displays</li> <li>Click on the 'Distribution' tab and select the 'TruncatedNormal' distribution type; in the fields 'Mean', 'StandardDeviation', 'Min' and 'Max' type the values 2, 1, 1 and 1000 respectively</li> </ul> <p><b>Important Note:</b> Some distributions, such as 'TruncatedNormal', return a floating point value but the property is used as an integer. Setting the property's type is important, especially in condition expressions when testing with equality. For example, the condition expression <code>getProperty('noOfIssues') = 0</code> will almost never be satisfied because <i>noOfIssues</i> was initialized by a floating point distribution.</p> <p><b>Tip: How to customize the type for a property</b></p> <p>After you create the property and set a value, click on the Save button on the toolbar so that the created property name is shown in the bottom panel of the 'Property' tab; click on the 'Value Type' drop-down arrow and select the value 'int' instead of the default 'double'.</p> <ul style="list-style-type: none"> <li>Click on the Activity <i>Repair Issue</i> and on the 'Properties' tab, and overtype the <i>New Property</i> text with <i>noOfIssues</i></li> <li>In the 'Value' field click on the  button; the 'Parameter Value' dialog displays</li> <li>Click on the 'Expression' tab and, in the 'Expression' field, type <code>{noOfIssues} -1</code>; click on the OK button</li> <li>Click on the Activity <i>Handle New Found Issue</i> and on the 'Properties' tab, and overtype the <i>New Property</i> text with <i>noOfIssues</i></li> <li>In the 'Value' field click on the  button; the 'Parameter Value' dialog displays</li> <li>Click on the 'Expression' tab and, in the 'Expression' field, type <code>{noOfIssues} +1</code>; click on the OK button</li> </ul>
Probability on Sequence Flows	<p>We assume that 1/3 of the customers will not accept the initial estimate for repairs and 2/3 will accept it. We also assume that for 1/4 of the repairs new issues will be found, and for 3/4 of the repairs no new issues will be found.</p> <p>Expand the 'Gateway' group in the left-hand tree, and expand the <i>Accepted?</i> element. For the:</p> <ul style="list-style-type: none"> <li><i>Initial Estimate Accepted</i> Sequence Flow, click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Probability'; in the 'Value' field type 0.67</li> <li><i>Initial Estimate Not Accepted</i> Sequence Flow, click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Probability'; in the 'Value' field type 0.33</li> </ul> <p>In the 'Gateway' group, expand the <i>New Issue Found?</i> element. For the:</p> <ul style="list-style-type: none"> <li><i>No More Issues to Repair</i> Sequence Flow, click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Probability'; in the 'Value' field type 0.75</li> <li><i>More Issues to Repair</i> Sequence Flow, click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Probability'; in the 'Value' field type 0.25</li> </ul>
Condition on Sequence flows	<p>We use an expression to return a boolean value as a Sequence Flow's condition, which plays a key role in the flow's logic.</p>



In the 'Gateway' group, expand the *Have Further Issues?* element. For the:

- *More Issues to Repair* Sequence Flow, click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Condition'; in the 'Value' field click on the  button to open the parameter dialog, click on the 'Expression' tab and type **{noOfIssues} != 0** in the 'Expression' field
- *No More Issues to Repair* Sequence Flow, click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Condition'; in the 'Value' field click on the  button to open the parameter dialog, click on the 'Expression' tab and type **{noOfIssues} = 0** in the 'Expression' field

Note: All the outgoing transitions from a Gateway should include 100% of the logic; for example, you would not enter **{noOfIssues} > 10** and **{noOfIssues} < 5** as condition expressions, because values in the range **[5, 10]** will not be handled by any outgoing Sequence Flows.

## Run Simulation


- From the 'Configure BPSim' dialog toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button and select 'Standard Simulation'
- When the simulation is complete, it provides this result:

BPSim Simulation Controller : Scenario 1: Main flow	
Type	Message
Info	Export BPMN Model - Succeeded.
Info	Loading BPMN Model - Succeeded.
Info	Simulation Engine Initialized
Info	Simulation Started.
Info	Simulation Finished.
Info	Simulation Result Generated.
Element	Runtime Value
Token Status	
<<StartEvent>> Customer Arrives	20
<<Activity>> Make Estimate	20
<<Gateway>> Accepted?	20
<<StartEvent>> Start Repairs	12
<<Gateway>> converge Gateway1	45
<<Activity>> Inspect for Issue	45
<<Gateway>> converge Gateway2	64
<<Gateway>> New Issue Found?	64
<<Activity>> Handle New Found Issue	19
<<Activity>> Repair Issue	45
<<Gateway>> Have further issues?	45
<<EndEvent>> Repairs Completed	12
<<Activity>> Accept Payment	12
<<EndEvent>> Customer Leaves Shop	12
<<EndEvent>> Initial Estimate Not Accepted	8

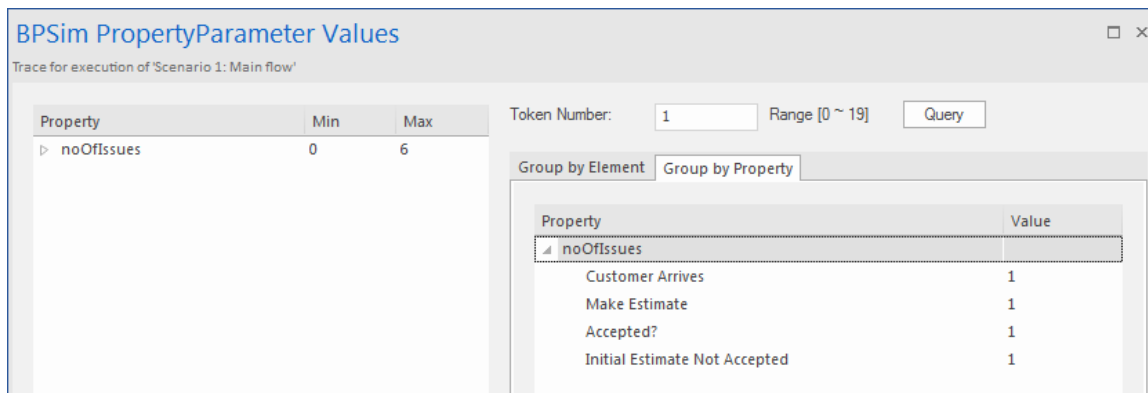
### Token Analysis

- 20 customers arrived, matching the number we calculated manually (see *Customer Arrives* in the *Configure BPSim* table)
- 8 customers out of the 20 did not accept the initial estimate, whilst 12 of the 20 accepted and had their car repaired; these figures roughly match the 1/3 and 2/3 probabilities
- 64 tokens passed the *Gateway New Issue Found?*, of which 19 had new issues and 45 did not; these figures roughly match the 1/4 and 3/4 probabilities

### Analysis on individual customers

Click on the  button on the toolbar to open the 'BPSim PropertyParameter Values' dialog. As there are 20 customers (tokens), you can input a value between 0 and 19 in the 'Token Number' field and click on the Query button to do some analysis:

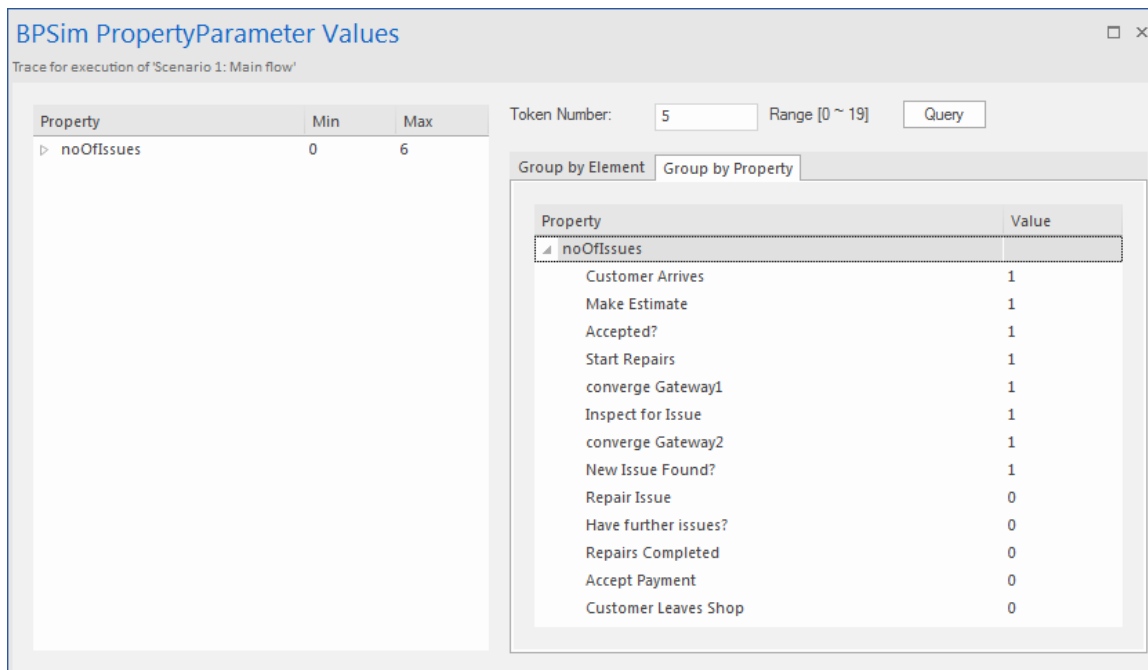
- This customer did not accept the initial estimate, as shown on the 'Group by Property' tab:



The dialog shows the 'BPSim PropertyParameter Values' window. The 'Token Number' field is set to 1. The 'Group by Property' tab is selected, showing the following data:

Property	Value
noOfIssues	6
Customer Arrives	1
Make Estimate	1
Accepted?	1
Initial Estimate Not Accepted	1

- This customer's car had only one issue, which was fixed:



The dialog shows the 'BPSim PropertyParameter Values' window. The 'Token Number' field is set to 5. The 'Group by Property' tab is selected, showing the following data:

Property	Value
noOfIssues	6
Customer Arrives	1
Make Estimate	1
Accepted?	1
Start Repairs	1
converge Gateway1	1
Inspect for Issue	1
converge Gateway2	1
New Issue Found?	1
Repair Issue	0
Have further issues?	0
Repairs Completed	0
Accept Payment	0
Customer Leaves Shop	0

- This customer's car had three known issues and three other issues were found during repair, so in total six issues got fixed (perhaps this is a really old car); switching to the 'Group by Element' tab:

**BPSim PropertyParameter Values**

Trace for execution of 'Scenario 1: Main flow'

Property: noOfIssues    Min: 0    Max: 6    Token Number: 13    Range [0 ~ 19]    Query

Group by Element    Group by Property

Element	Value
Customer Arrives	
noOfIssues	3
Make Estimate	
Accepted?	
Start Repairs	
converge Gateway1	
Inspect for Issue	
converge Gateway2	
New Issue Found?	
noOfIssues	3
noOfIssues	4
noOfIssues	5
noOfIssues	6
noOfIssues	5
noOfIssues	4
noOfIssues	3
noOfIssues	2
noOfIssues	3
noOfIssues	4
noOfIssues	5
noOfIssues	4
noOfIssues	3
noOfIssues	2
noOfIssues	1

## BPMN2.0 Event Examples

An Event is something that happens during the course of a Process. These Events affect the flow of the Process, usually having a cause or an impact, and in general requiring or allowing for a reaction. For example, the start of an Activity, the end of an Activity, the change of state of a document, or the arrival of a Message could all be considered to be Events.

Events allow for the description of 'event-driven' Processes. In these Processes, there are three main types of Events:

- Start Events, which indicate where a Process will start
- End Events, which indicate where the path of a Process will end
- Intermediate Events, which indicate where something happens between the start and end of a Process

Within these three types, Events can be one of two subtypes:

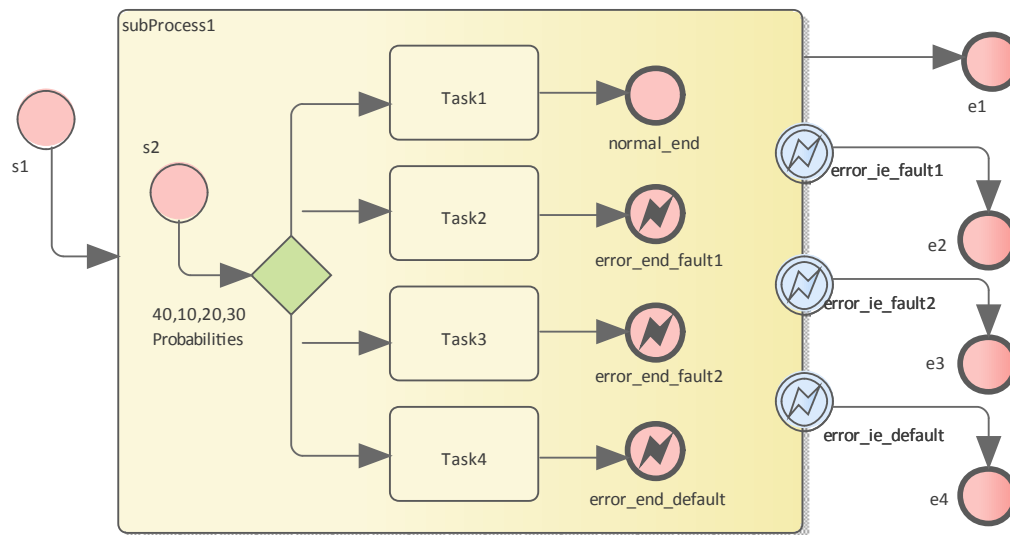
- Events that catch a trigger - all Start Events and some Intermediate Events are catching Events
- Events that throw a Result - all End Events and some Intermediate Events are throwing Events that could eventually be caught by another Event

In this section, we provide examples illustrating many of the commonly-used BPMN 2.0 events. In each example, we provide step-by-step BPMN modeling and BPSim configuration instructions, and a thorough analysis of the simulation result. All the examples are available in the EAExample model.

## Error Event

When an Intermediate Error Event connects to the boundary of an Activity, it becomes part of an exception flow. The event is triggered when a token causes a fault name to be raised in the normal flow, going through to an Error End Event.

### Create BPMN Model



#### Create the main process

- Create a Start Event *s1*
- Add a Sequence Flow to a target Activity element *subProcess1*; enlarge the Activity and right-click, selecting the 'Is Expanded' option, then open the 'Properties' dialog and set 'Type' to 'subprocess'
- Add a Sequence Flow to a target End Event element *e1* ('Type' set to 'None')
- Create three Boundary Intermediate Events, dragging the elements from the Toolbox and dropping them on *subProcess1*; from the instant menus select 'Edge-Mounted' and 'Error':
  - *error\_ie\_fault1*; add a Sequence Flow to a target EndEvent element *e2* ('Type' set to 'None')
  - *error\_ie\_fault2*; add a Sequence Flow to a target EndEvent element *e3* ('Type' set to 'None')
  - *error\_ie\_default*; add a Sequence Flow to a target EndEvent element *e4* ('Type' set to 'None')


#### Create the subprocess

Within the *subProcess1* Activity:


- Create a Start Event *s2*, 'Standalone' and set 'Type' to 'None'
- Create a Sequence Flow to a target Gateway element set to 'Exclusive' and with the name '*40,10,20,30 Probabilities*'
- Create Sequence Flows to four target Activity elements of Type 'abstractTask' called:
  - *Task1*, and add a Sequence Flow to a target EndEvent called *normal\_end*, 'Type' set to 'None'
  - *Task2*, and add a Sequence Flow to a target EndEvent called *error\_end\_fault1*, 'Type' set to 'Error'
  - *Task3*, and add a Sequence Flow to a target EndEvent called *error\_end\_fault2*, 'Type' set to 'Error'
  - *Task4*, and add a Sequence Flow to a target EndEvent called *error\_end\_default*, 'Type' set to 'Error'

#### Create BPMN2.0::Error elements

Create the Error elements *Fault1* and *Fault2*, which will be used as error code by Events.

- Double-click on the *error\_end\_fault1* element and, in the 'Properties' dialog 'BPMN2.0' tab, locate the 'errorRef' tag
- In the 'Value' field, click on the  button and browse to the Package containing this model
- Click on the Add New button and, in the 'Name' field, type the name *Fault1*, then click on the Save button
- Again click on the Add New button and, in the 'Name' field, type the name *Fault2*, then click on the Save button
- Click on the OK button, and again on the next OK button


### Set up Events for Error Codes

- Double-click on the *error\_end\_fault1* element and, in the 'Properties' dialog 'BPMN2.0' tab, locate the 'errorRef' tag
- In the 'Value' field, click on the  button and browse to the Package containing this model
- Click on *Fault1*, then on the OK button, and again on the OK button.

Do the same for these elements:

- *error\_end\_fault2*, clicking on *Fault2*
- *error\_ie\_fault1*, clicking on *Fault1*
- *error\_ie\_fault2*, clicking on *Fault2*

## Configure BPSim

Object	Action
Artifact & Package	<ul style="list-style-type: none"> <li>• Open the Configure BPSim window ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>• Create an Artifact named 'IntermediateEvent - Boundary - Error' (in the 'Select/Create Artifact' field, click on the  button and select its parent Package and click on the Add New button, then type in the element name and click on the Save button and the OK button)</li> </ul> <p>Then all the BPMN elements will be loaded in to the Configure BPSim window.</p>
s1	<ul style="list-style-type: none"> <li>• From the tree on the left of the Configure BPSim window, expand 'StartEvent' and click on 's1'</li> <li>• On the 'Control' tab, in the 'New Parameter...' field, click on the drop-down arrow and select 'TriggerCount'</li> <li>• In the 'Value' field, type '100'</li> </ul>
Probability	<p>From the tree on the left of the Configure BPSim window, expand 'Gateway   40,10,20,30 Probabilities'.</p> <p><i>Tips: You can also float the Configure BPSim window, then click on the element or connectors on the BPMN diagram; the element in the Configure BPSim window will be automatically selected.</i></p> <p>For each of the <i>Taskn</i> elements, in the 'Control' tab click on the 'New Parameter' drop-down arrow and select 'Probability', then type the corresponding value in the 'Value' field:</p> <ul style="list-style-type: none"> <li>• For Task1 type '0.4'</li> <li>• For Task2 type '0.1'</li> <li>• For Task3 type '0.2'</li> <li>• For Task4 type '0.3'</li> </ul>

## Run Simulation

- On the 'Configure BPSim' dialog Toolbar, click on the 'Run' icon to open the 'BPSim Controller' dialog
- Click on the Run button and select 'Standard Simulation'
- The results of the simulation resemble this:

BPSim Simulation Controller : IntermediateEvent - Boundary - Error	
Type	Message
Info	Export BPMN Model - Succeeded.
Info	Loading BPMN Model - Succeeded.
Info	Simulation Engine Initialized
Info	Simulation Started.
Info	Simulation Finished.
Info	Simulation Result Generated.

Element	Runtime Value
Token Status	
<<StartEvent>>s1	100
<<StartEvent>>s2	100
<<Gateway>>40,10,20,30 Probabilities	100
<<Activity>>Task1	36
<<EndEvent>>normal_end	36
<<EndEvent>>e1	36
<<Activity>>Task3	23
<<EndEvent>>error_end_fault2	23
<<EndEvent>>e3	23
<<Activity>>Task5	30
<<EndEvent>>error_end_default	30
<<EndEvent>>e4	30
<<Activity>>Task2	11
<<EndEvent>>error_end_fault1	11
<<EndEvent>>e2	11

### Analysis:

The Probability set on the Sequence Flows outgoing from *40,10,20,30 Probabilities* are 0.4, 0.1, 0.2 and 0.3 respectively.

- 36 out of 100 passes finished at *normal\_end*, which flowed to *e1*
- 11 out of 100 passes finished at *error\_end\_fault1*, which triggered *error\_ie\_fault1* by the ErrorRef *Fault1*, and the exception flowed to *e2*
- 23 out of 100 passes finished at *error\_end\_fault2*, which triggered *error\_ie\_fault2* by ErrorRef *Fault2*, and the exception flowed to *e3*

- 30 out of 100 passes finished at *error\_end\_default*, which triggered *error\_ie\_default* because they did not set ErrorRef and the exception flowed to *e4*

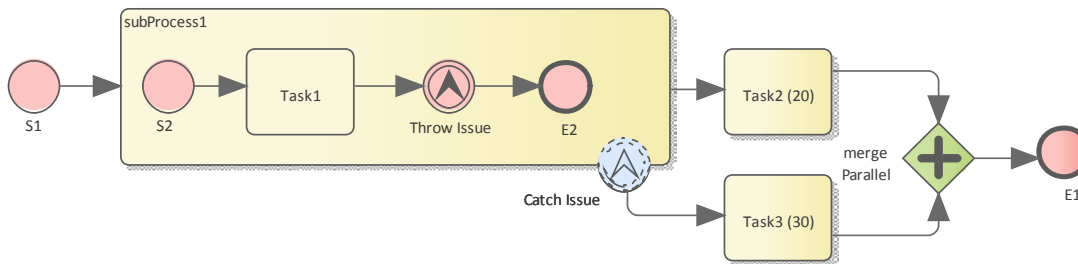
The numbers 36, 11, 23 and 30 add up to 100, which was set as the TriggerCount in *s1*, so they match the 100% probability



# Escalation Event

In BPMN, Escalation is the non-interrupting counterpart of Error, with similar throw-catch behavior. Unlike Error, however, the normal flow and exception flow exits from the Activity are parallel paths, not alternative.

## Create BPMN Model



### Create the main process

- Create a Start Event *S1*
- Add a Sequence Flow to a target Activity *subProcess1*; enlarge the Activity and right-click, selecting the 'Is Expanded' option, then open the 'Properties' dialog and set 'Type' to 'subprocess'
- Add a Sequence Flow to a target abstractTask Activity element *Task2 (20)* (open the 'Properties' dialog and set the 'Type' field to 'abstractTask')
- Add a Sequence Flow to a target parallel Gateway element *merge Parallel* (open the 'Properties' dialog and set the 'Type' field to 'parallel')
- Add a Sequence Flow to a target End Event *E1*
- On *subProcess1*, add a boundary non-interrupting Escalation Event *Catch Issue* (drag the 'Intermediate Event' icon onto *subProcess1*, and from the instant menus select 'Edge Mounted' and 'Escalation'; double-click on the element to display the 'Properties' dialog and add the name, then in the 'Type' field select 'Boundary Non-Interrupting > Escalation')
- Add a Sequence Flow to a target abstractTask Activity element *Task3 (30)* (open the 'Properties' dialog and set the 'Type' field to 'abstractTask')
- Add a Sequence Flow to the target element *merge Parallel*



### Create the sub process

- Within (or under) *subProcess1*, create a Start Event *S2*
- Add a Sequence Flow to a target abstractTask Activity element *Task1* (open the 'Properties' dialog and set the 'Type' field to 'abstractTask')
- Add a Sequence Flow to a target Throwing Escalation Intermediate Event *Throw Issue* (open the 'Properties' dialog and in the 'Type' field select 'Throwing > Escalation')
- Add a Sequence Flow to a target End Event *E2*

### Create BPMN2.0::Escalation elements



From the Diagram Toolbox, expand the 'BPMN 2.0 Types' page, drag the 'Escalation' icon onto the diagram, and give the element the name *Escalation1*; this will be used as the escalation code by the Events.

### Set up Events for Escalation Codes:


- Double-click on *Throw Issue* and in the 'Value' field for the escalationRef tag click on the  icon and locate and select *Escalation1*
- Double-click on *Catch Issue* and, again, in the 'Value' field for the escalationRef tag click on the  icon and locate and select *Escalation1*

(The exception flow exits from the Activity are parallel.)

## Configure BPSim

Task	Action
Artifact & Package	<ul style="list-style-type: none"> <li>• Open the Configure BPSim window ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>• Create an Artifact named 'Escalation Event Simulation' (in the 'Select/Create Artifact' field, click on the  button and select its parent Package and click on the Add New button, then type in the element name and click on the Save button and the OK button)</li> </ul> <p>Then all the BPMN elements will be loaded in to the Configure BPSim window.</p>
Trigger Count of Start Event	<ul style="list-style-type: none"> <li>• From the tree on the left of the Configure BPSim window, expand 'StartEvent' and click on <i>SI</i></li> <li>• On the 'Control' tab, in the 'New Parameter...' field, click on the drop-down arrow and select 'TriggerCount'</li> <li>• In the 'Value' field, type '1'</li> </ul>
ProcessingTime	<ul style="list-style-type: none"> <li>• In the left-hand tree expand 'Activity' and click on <i>Task2 (20)</i>; in the 'Value' field for 'Processing Time' type '20' and in the 'Unit' field type 's' (for 20 seconds)</li> <li>• Click on <i>Task3 (30)</i>; in the same way, set 'ProcessingTime' to 30 seconds</li> </ul>
dummyVariable for Trace	<p>In order to show the exact trace of a given token, you must set a dummy variable on <i>SI</i>.</p> <ul style="list-style-type: none"> <li>• In the left-hand hierarchy click on <i>SI</i>, and on the 'Properties' tab overwrite the <i>New Property</i> text with the name of a variable (such as 'dummyVariable')</li> <li>• In the 'Value' field, click on the  button and, on the '&lt;&lt;StartEvent&gt;&gt;S1 : &lt;variable name&gt;' dialog click on 'Numeric' and type a 'Constant Numeric' value of '0'; click on the OK button</li> </ul>

## Run Simulation

- On the 'Configure BPSim' dialog Toolbar, click on the 'Run' icon to open the 'BPSim Simulation Controller' dialog
- Click on the 'Run' icon drop-down arrow and select 'Standard Simulation'
- After simulation, click on the  button on the tool bar to display the 'BPSim PropertyParameter Values' dialog
- Click on the Query button and on the 'Group by Property' tab, and expand 'dummyVariable' (or the name you assigned to the variable)

Trace for execution of 'Escalation Event Simulation'

Property	Min	Max
dummyVariable	0	0

Token Number:  Range [0 ~ 0]

Group by Element Group by Property

Property	Value
dummyVariable	
S1	0
S2	0
Task1	0
Throw Issue	0
Task3 (30)	0
E2	0
Task2 (20)	0
merge Parallel	0
merge Parallel	0
E1	0

**Analysis:**

Unlike *Error*, the normal flow and exception flow exits from *subProcess1* are not alternative paths but parallel. This feature can be easily discovered from the trace:

- *E2* and *Task2 (20)* still get traversed after *Task3 (30)* started
- *E1* was reached after *mergeParallel* was traversed twice

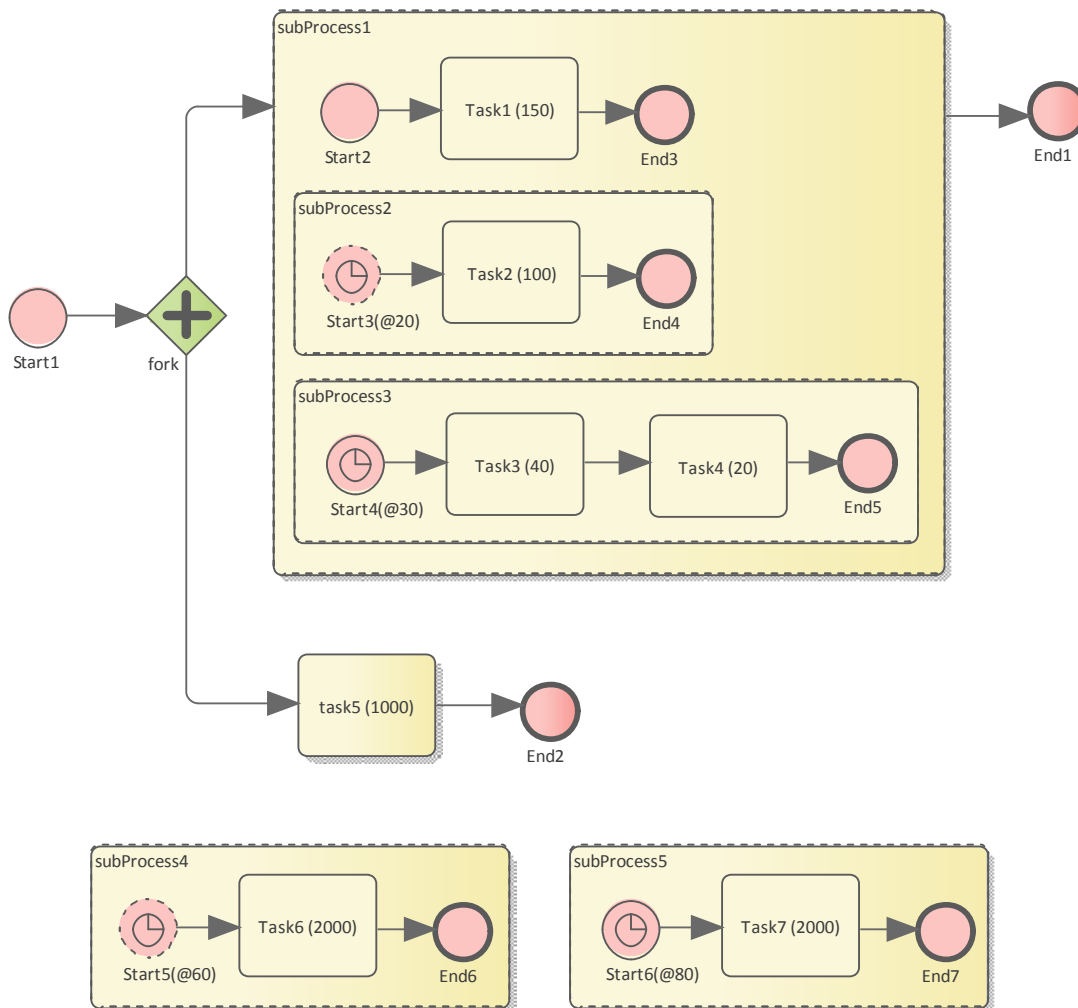
## Event Sub-Process

Event Sub-Processes enable your system to handle an Event within the context of a given Sub-Process or Process. An Event Sub-Process always begins with a Start Event; it is not instantiated by normal control flow, but only when the associated Start Event is triggered. Event Sub-Processes are self-contained and **MUST** not be connected to the rest of the Sequence Flows in the Sub-Processes.

- If the `isInterrupting` attribute of its Start Event is set, an Event Sub-Process cancels execution of the enclosing Sub-Process
- If the `isInterrupting` attribute is not set, execution of the enclosing Sub-Process continues in parallel to the Event Sub-Process

In this example, we demonstrate how Interrupting and Non-Interrupting Event Sub-Processes affect the life line of the enclosing Sub-Process and Process.

### Create BPMN Model



#### Model the main process

- Create a StartEvent *Start1*
- Add a Sequence Flow to a target Parallel Gateway element *fork*
- Add a Sequence Flow to
  - a Sub-Process *subProcess1*, and from that add a Sequence Flow to a target End Event element *End1*

- an abstract Task *Task5*, and from that add a Sequence Flow to a target End Event element *End2*

### Tips on how to model an Event Sub-Process

- Drag an Activity from the 'BPMN2.0 - Business Process' toolbox onto the diagram
- Double-click on the Activity to display the 'Properties' dialog and, in the 'Type' field, select 'subProcess'; set 'triggeredByEvent' to 'true' and click on the OK button
- Right-click on the element and select the 'Is Expanded' option; this will display the element name on the top left corner

### Model the Event Sub-Processes for the main process


- Create an Event Sub-Process *subProcess4*
  - Create a Timer Start Event *Start5(@60)*, then double-click on it to display the 'Properties' dialog and, in the 'Type' field, select 'Event Sub-Process Non-Interrupting > Timer'; click on the OK button
  - Add a Sequence Flow to a target abstract task Activity *Task6(2000)*
  - Add a Sequence Flow to a target End Event element *End6*
- Create an Event Sub-Process *subProcess5*
  - Create a Timer Start Event *Start6(@80)*, then double-click on it to display the 'Properties' dialog and, in the 'Type' field, select 'Event Sub-Process Interrupting > Timer'; click on the OK button
  - Add a Sequence Flow to a target abstract task Activity *Task7(2000)*
  - Add a Sequence Flow to a target End Event element *End7*



### Model the Sub-Process *subProcess1* and the enclosed Event Sub-Processes

- Create a StartEvent *Start2*
  - Add a Sequence Flow to a target abstract task Activity *Task1(150)*
  - Add a Sequence Flow to a target End Event *End3*
- Create an Event Sub-Process *subProcess2*
  - Create a Timer Start Event *Start3(@20)*, then double-click on it to display the 'Properties' dialog and, in the 'Type' field, select 'Event Sub-Process Non-Interrupting > Timer'
  - Add a Sequence Flow to a target abstract task Activity *Task2(100)*
  - Add a Sequence Flow to a target End Event element *End4*
- Create an Event Sub-Process *subProcess3*
  - Create a Timer Start Event *Start4(@30)*, then double-click on it to display the 'Properties' dialog and, in the 'Type' field, select 'Event Sub-Process Interrupting > Timer'
  - Add a Sequence Flow to a target abstract task Activity *Task3(40)*
  - Add a Sequence Flow to a target abstract task Activity *Task4(20)*
  - Add a Sequence Flow to a target End Event element *End5*

## Configure BPSim

Using this table, we create the Artifact in the configuration Package and configure the parameter values of each element.

Task	Action
Create Artifact	<ul style="list-style-type: none"> <li>• Open the Configure BPSim window ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>• Create an Artifact named 'Event Sub Process Interrupting and Non-Interrupting' (in the 'Select/Create Artifact' field, click on the  button and select its parent Package and click on the Add New button, then type in the element name and click on the Save button and the OK button)</li> </ul> <p>Then all the BPMN elements will be loaded in to the Configure BPSim window.</p>

InterTriggerTimer for Start Events in Event Sub-Process	<p>From the tree on the left of the 'Configure BPSim' dialog, expand 'StartEvent'.</p> <p>For each of the elements listed here, on the 'Control' tab click on the drop-down arrow in the 'New Parameter...' field and select the parameter 'InterTriggerTimer'.</p> <p>Click on the  button in the 'Value' field to open the 'Parameter' dialog and select 'Constant &gt; Numeric', then type in the value and select 'seconds'.</p> <ul style="list-style-type: none"> <li>• Start3(@20): 20 seconds</li> <li>• Start4(@30): 30 seconds</li> <li>• Start5(@60): 60 seconds</li> <li>• Start6(@80): 80 seconds</li> </ul>
ProcessingTime for Tasks	<p>From the tree on the left of the Configure BPSim window, expand 'Activity'.</p> <p>For each of the elements listed here, on the 'Time' tab click on the drop-down arrow in the 'New Parameter...' field and select the parameter 'ProcessingTime'. Click on the  button in the 'Value' field to open the 'Parameter' dialog and select 'Constant &gt; Numeric', then type in the value and select 'seconds'.</p> <ul style="list-style-type: none"> <li>• Task1 (150): 150 seconds</li> <li>• Task2 (100): 100 seconds</li> <li>• Task3 (40): 40 seconds</li> <li>• Task4 (20): 20 seconds</li> <li>• Task5 (1000): 1000 seconds</li> <li>• Task6 (2000): 2000 seconds</li> <li>• Task7 (2000): 2000 seconds</li> </ul>

## Run Simulation

- On the 'Configure BPSim' dialog Toolbar, click on the 'Run' icon to open the 'BPSim Simulation Controller' dialog
- Click on the 'Run' icon drop-down arrow and select 'Standard Simulation'

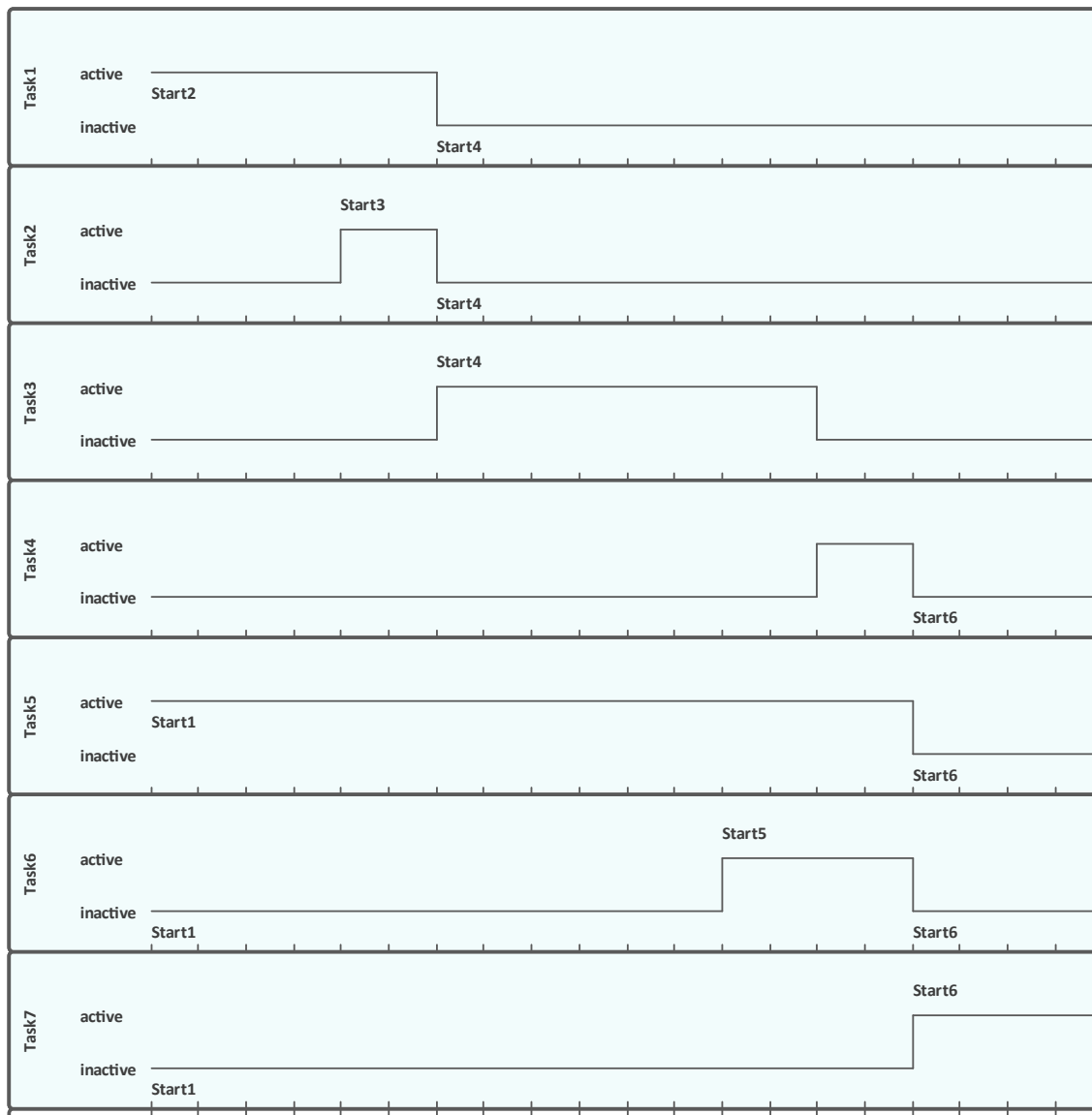
BPSim Simulation Controller : Event Sub-Process Interrupting & Non-Interrupting

Type	Message
Info	Export BPMN Model - Succeeded.
Info	Loading BPMN Model - Succeeded.
Info	Simulation Engine Initialized
Info	Simulation Started.
Info	Simulation Finished.
Info	Simulation Result Generated.

Element	Runtime Value
Token Status	
<<StartEvent>> Start1	1
<<Gateway>> fork	1
<<Activity>> task5 (1000)	1
<<StartEvent>> Start2	1
<<Activity>> Task1 (150)	1
<<StartEvent>> Start3(@20)	1
<<Activity>> Task2 (100)	1
<<StartEvent>> Start4(@30)	1
<<Activity>> Task3 (40)	1
<<StartEvent>> Start5(@60)	1
<<Activity>> Task6 (2000)	1
<<Activity>> Task4 (20)	1
<<StartEvent>> Start6(@80)	1
<<Activity>> Task7 (2000)	1
<<EndEvent>> End7	1

## Analysis

Reading the results, it might not be completely straightforward to see what has happened; however, if we draw the lifeline for each task in a Timing diagram, it becomes clearer.



- Event *Start3(@20)* is Non-Interrupting, it did not stop *Task1* at 20 seconds
- Event *Start4(@30)* is Interrupting, it stopped *Task1* and *Task2* at 30 seconds; it did not affected *Task5* because *Task5*'s enclosing process (main process) level is higher than *Start4*'s enclosing Sub-Process (*subProcess1*)
- Event *Start5(@60)* is Non-Interrupting, it started *Task6* at 60 seconds without affecting *Task3* or *Task5*
- Event *Start6(@80)* is Interrupting, it started *Task7* at 80 seconds and interrupted the running Tasks (*Task4*, *Task5*, *Task6*) that were in the same or lower level of its enclosing process
- Only *End7* is reached as expected



# Fibonacci Number Generator with Link Event

A Link Event is a mechanism for connecting two sections of a Process. Link Events can be used:

- To create looping scenarios, as generic 'Go To' objects within the Process level
- To avoid long Sequence Flow lines; paired Link Events can be used as 'off-page' connectors for printing a Process across multiple pages

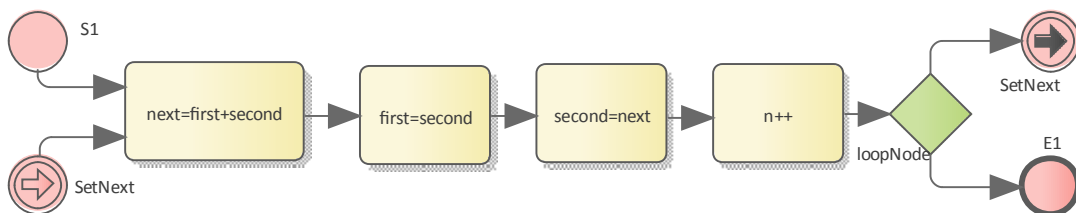
The use of Link Events is limited to a single Process level (that is, they cannot link a parent Process with a sub-Process).

There can be multiple source Link Events, but there can only be one target Link Event.

- The target Link Event marker is unfilled, to 'catch' from the source link
- The source Link Event marker is filled, to 'throw' to the target link

When the EABPSim Execution Engine is running the simulation, the source-target Link Events are paired by element NAME, so they cannot be empty.

## Create BPMN Model








- Create a StartEvent *S1*
- Add a Sequence Flow to a target abstractTask Activity element *next=first+second* (open the 'Properties' dialog and set the 'Type' field to 'abstractTask')
- Add a Sequence Flow to a target abstractTask Activity element *first=second*
- Add a Sequence Flow to a target abstractTask Activity element *second=next*
- Add a Sequence Flow to a target abstractTask Activity element *n++*
- Add a Sequence Flow to a target exclusive Gateway element *loopNode* (on the instant menu, select 'Exclusive')
- Add a Sequence Flow to each of these target elements:
  - A Throwing Link Intermediate Event element *SetNext* (open the 'Properties' dialog and set the 'Type' field to 'Throwing > Link') and
  - An End Event element *E1*
- Create a Catching Link Intermediate Event element *SetNext* (open the 'Properties' dialog and set the 'Type' field to 'Catching > Link')
- Add a Sequence Flow to the target element *next=first+second*


## Configure BPSim

We will use Property Parameters to define how the sequence flow forms a loop during which a Fibonacci Number will be generated. The loop mechanism is implemented via the pair of Link Events.


Open the Configure BPSim window ('Simulate > Process Analysis > BPSim > Open BPSim Manager')

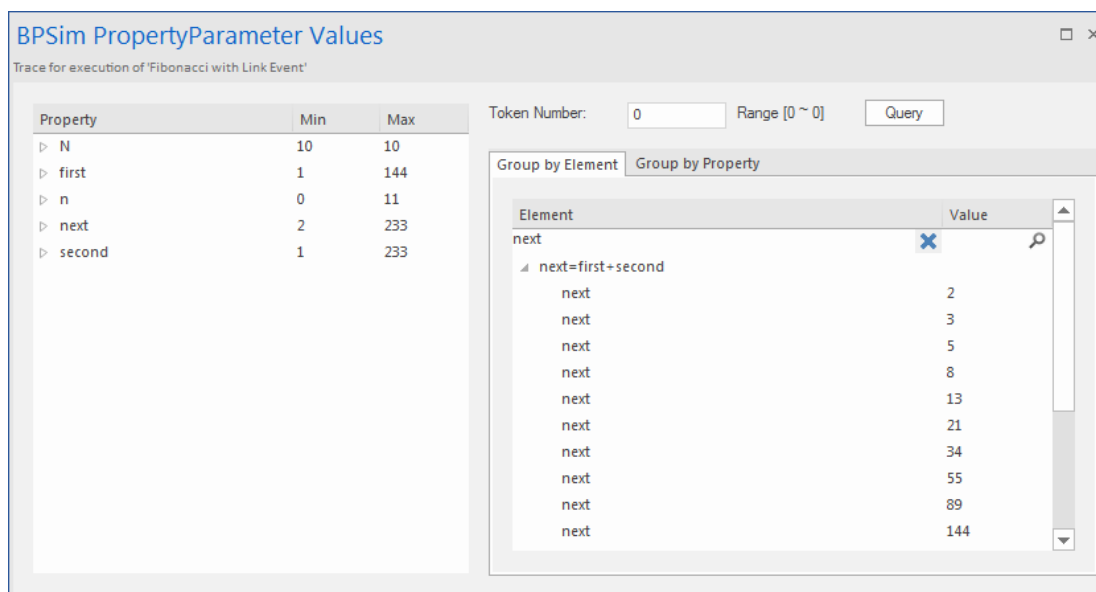
Task	Action
Element: S1	In the element type list on the left, expand the Start Event group and click on <i>S1</i> . Click on the 'Control Tab' and on the 'New Parameter' drop-down arrow; select

	<p>'TriggerCount'.</p> <p>In the 'Value' field type '1'.</p> <p><b>Click on the 'Properties' tab</b></p> <p>Overtyping the <i>New Property</i> text to create these properties:</p> <ul style="list-style-type: none"> <li>• N - and type '10' in the 'Value' field as the total number of Fibonacci Numbers to be generated</li> <li>• first - and type '1' in the 'Value' field</li> <li>• second - and type '1' in the 'Value' field</li> <li>• n - and type '0' in the 'Value' field as the <i>n</i>th new Fibonacci Number</li> </ul>
Element: next=first+second	<p>In the element type list, expand the Activity group and click on <i>next=first+second</i>.</p> <p>Click on the 'Properties' tab and overtype the <i>New Property</i> text with 'next'.</p> <p>In the 'Value' field, click on the  button, click on the 'Expression' tab and type the expression '{first}+{second}'.</p> <p>Click on the OK button.</p>
Element: first=second	<p>In the element type list, in the Activity group click on <i>first=second</i>.</p> <p>Click on the 'Properties' tab and overtype the <i>New Property</i> text with 'first'.</p> <p>In the 'Value' field, click on the  button, click on the 'Expression' tab and type the expression '{second}'.</p> <p>Click on the OK button.</p>
Element: second=next	<p>In the element type list, in the Activity group click on <i>second=next</i>.</p> <p>Click on the 'Properties' tab and overtype the <i>New Property</i> text with 'second'.</p> <p>In the 'Value' field, click on the  button, click on the 'Expression' tab and type the expression '{next}'.</p> <p>Click on the OK button.</p>
Element: n++	<p>In the element type list, in the Activity group click on <i>n++</i>.</p> <p>Click on the 'Properties' tab and overtype the <i>New Property</i> text with 'n'.</p> <p>In the 'Value' field, click on the  button, click on the 'Expression' tab and type the expression '{n}+1'.</p> <p>Click on the OK button.</p>
Conditions of Gateway	<p>In the element type list, expand the Gateway group and the LoopNode element and click on <i>SetNext</i>.</p> <p>Click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Condition'.</p> <p>In the 'Value' field, click on the  button, click on the 'Expression' tab and type the expression '{n} &lt;= {N}'.</p> <p>Click on the OK button.</p> <p>Now click on <i>E1</i>.</p> <p>Click on the 'Control' tab and on the 'New Parameter' drop-down arrow, and select 'Condition'.</p>

In the 'Value' field, click on the  button, click on the 'Expression' tab and type the expression '{n} > {N}'.  
Click on the OK button.

## Run Simulation

- On the 'Configure BPSim' dialog, in the toolbar, click on the 'Run' icon; the 'BPSim Simulation Controller' dialog displays
- Click on the 'Run' icon drop-down arrow and select 'Standard Simulation'
- When the simulation is complete, click on the  icon in the toolbar; the 'BPSim PropertyParameter Values' dialog displays
- Click on the Query button and on the 'Group by Element' tab, and expand 'next=first+second'; all the attributes's snapshot values are listed
- Apply a filter 'next' (right-click on the list header, select 'Toggle Filter Bar' and type 'next' under the 'Element' heading); the results will resemble this image:



Ten more Fibonacci numbers are generated:

2,3,5,8,13,21,34,55,89,144

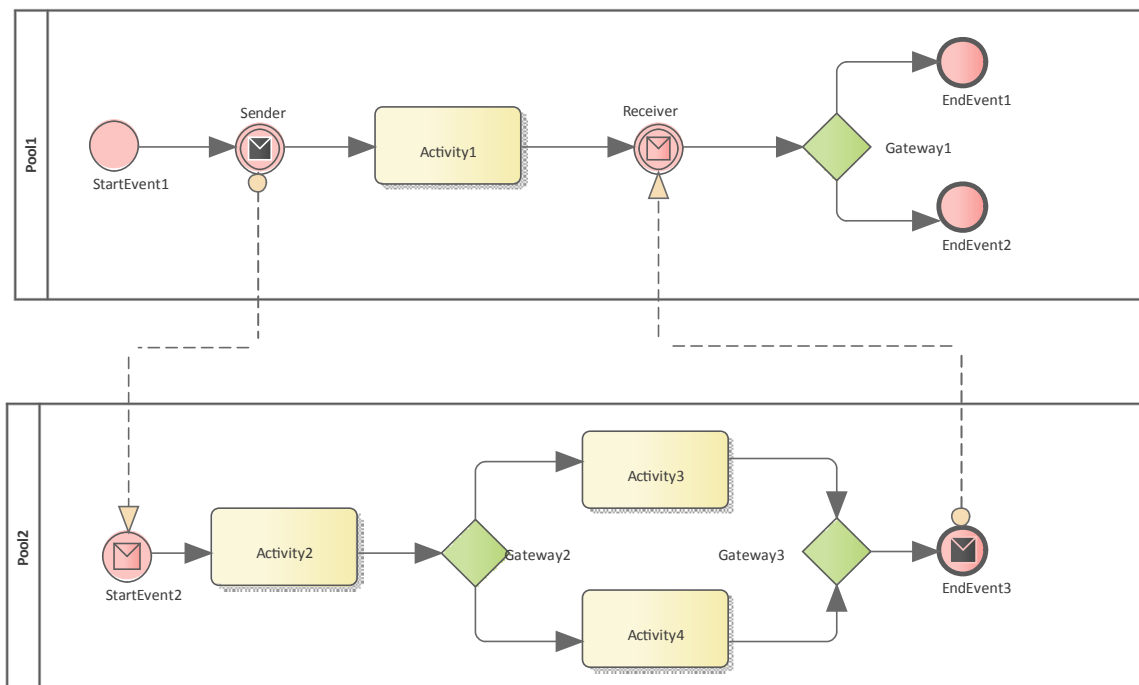
# Message Event

When used in normal sequence flow, the Message Event can be used to either send or receive a message.

- When sending a message to a participant, the values of all property parameters are copied; once the message is sent the token continues along the sequence flow
- When receiving a message, the event is triggered when a message is received.

This example demonstrates the Message Event features. We will first create the BPMN model, then configure BPSim and run the simulation.

## Create BPMN Model



## Sequence

### Pool1

- The token starts from StartEvent1
- On receiving the token, Sender (a Throwing Intermediate Message Event) creates a message and copies the current property values to the message
- Sender sends the *message* to the 'To' participant (Pool2, StartEvent2)
- Sender forwards the *token* along its sequence flow, as far as Receiver
- The token waits at Receiver until a message arrives

### Pool2

- StartEvent2 receives a message and starts a token
- StartEvent2 copies the values from the message and sets these in the token
- StartEvent2 forwards the token along its sequence flow until EndEvent3
- EndEvent3 creates a message and copies the current property values to the message

- EndEvent3 sends the message to the 'To' participant (Pool1, Receiver)

#### *Pool1 continued*

- The waiting Receiver is awakened and the property values are updated from the arriving message

### Create Diagram

- Create a BPMN 2.0 Collaboration diagram
- Select the option 'Create this diagram within a new CollaborationModel'
- Create *Pool1* and *Pool2* by dragging the 'Pool' icon from the Toolbox onto the diagram

#### Within Pool1

- Create a Start Event of type 'None', named *StartEvent1*
- Add a Sequence Flow to the target Intermediate Event of type 'Throwing Message', called *Sender*
- Add a Sequence Flow to the target Activity of type 'abstract', called *Activity1*
- Add Sequence Flows to the target:
  - End Event of type 'None', called *EndEvent1*
  - End Event of type 'None', called *EndEvent2*

#### Within Pool2


- Create a Start Event of type 'Message', called *StartEvent2*
- Add a Sequence Flow to the target Activity of type 'abstract', called *Activity2*
- Add a Sequence Flow to the target Gateway of type 'Exclusive', called *Gateway2*
- Add Sequence Flows to the target:
  - Activity of type 'abstract', called *Activity3*
  - Activity of type 'abstract', called *Activity4*
- Add Sequence Flows from *Activity3* and *Activity4* to the target Gateway of type 'Exclusive', called *Gateway3*
- Add a Sequence Flow to the End Event of type 'Message', called *EndEvent3*










### Message Flows

- Add a Message Flow from *Sender* to *StartEvent2*
- Add a Message Flow from *EndEvent3* to *Receiver*


## Configure BPSim

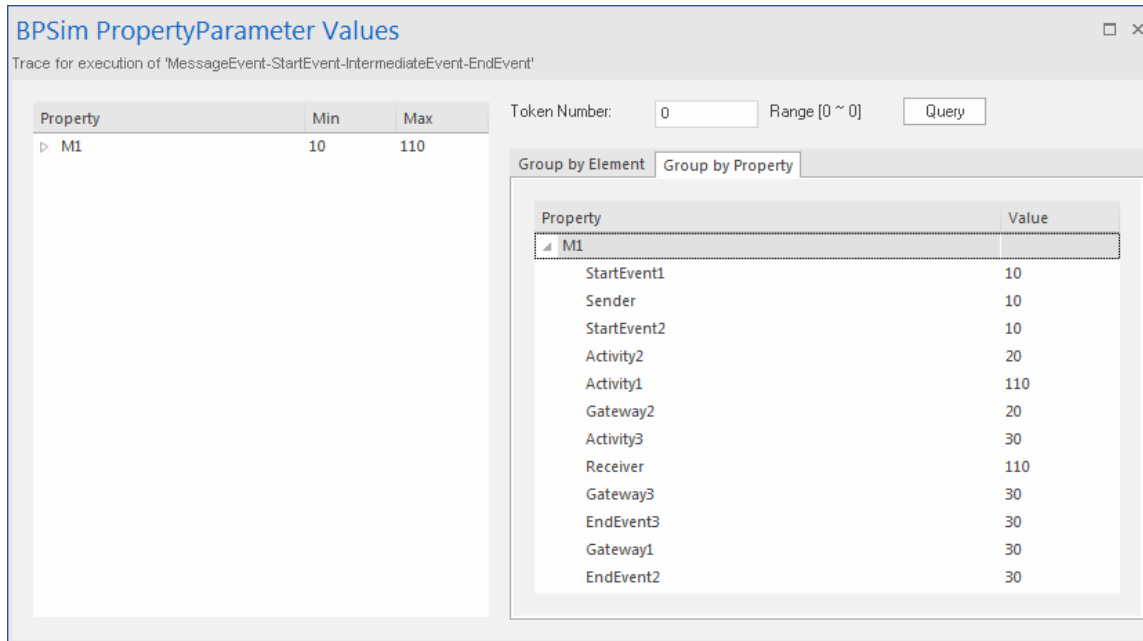
In order to show the Message Flow's ability to carry values, we create a Property Parameter 'M1' and change its value in each Activity. We then use the value of 'M1' as part of the expression for the condition of the Sequence Flow.

Task	Description
Create Artifact and Package	<ul style="list-style-type: none"> <li>• Open the Configure BPSim window ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>• Click on the  button in the 'Select/Create Artifact' field and create an Artifact called 'MessageEvent-StartEvent-IntermediateEvent-EndEvent'</li> <li>• In the 'Select Package' field select the Package containing the model</li> </ul> <p>All the BPMN elements from the model are loaded into the Configure BPSim</p>

	<p>window.</p>
Property Values	<p>We will give the Property Parameter 'M1' an initial value of 10 at <i>StartEvent1</i>. Then we change the value as the token flows through the processes and the value is copied across participants.</p> <p>In the element list on the left of the dialog:</p> <ul style="list-style-type: none"> <li>Expand the 'StartEvent' group, click on <i>StartEvent1</i> and on the 'Properties' tab, and overwrite <i>New Property</i> with 'M1'; in the 'Value' field click on the  button and select 'Constant' and 'Numeric', and type '10' in the 'Constant Numeric' field</li> <li>Expand the 'Activity' group, click on <i>Activity1</i> and on the 'Properties' tab, and overwrite <i>New Property</i> with 'M1'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} + 100' in the 'Expression' field</li> <li>Click on <i>Activity2</i> and on the 'Properties' tab, and overwrite <i>New Property</i> with 'M1'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} + 10' in the 'Expression' field</li> <li>Click on <i>Activity3</i> and on the 'Properties' tab, and overwrite <i>New Property</i> with 'M1'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} + 10' in the 'Expression' field</li> <li>Click on <i>Activity4</i> and on the 'Properties' tab, and overwrite <i>New Property</i> with 'M1'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} + 1' in the 'Expression' field</li> </ul> <p><i>Tip: The format of {PropertyName} is a convenient short form of getProperty("PropertyName").</i></p>
Control Parameters	<p>We only need one token in this simulation for evaluating the behavior of the model.</p> <ul style="list-style-type: none"> <li>In the expanded 'StartEvent' group, click on <i>StartEvent1</i> and the 'Control' tab; click on the 'New parameter' drop-down arrow and select 'Trigger Count', and type in a 'Value' of '1'</li> </ul> <p>Now set up the conditions for the Gateways' outgoing Sequence Flows. In the element list on the left of the dialog, expand the 'Gateway' group:</p> <ul style="list-style-type: none"> <li>Expand <i>Gateway1</i>, click on <i>EndEvent1</i> and on the 'Control' tab, then click on the 'New Parameter' drop-down arrow and select 'Condition'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} &gt;= 50' in the 'Expression' field</li> <li>Click on <i>EndEvent2</i> and on the 'Control' tab, then click on the 'New Parameter' drop-down arrow and select 'Condition'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} &lt; 50' in the 'Expression' field</li> <li>Expand <i>Gateway2</i>, click on <i>Activity3</i> and on the 'Control' tab, then click on the 'New Parameter' drop-down arrow and select 'Condition'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} &gt;= 15' in the 'Expression' field</li> <li>Click on <i>Activity4</i> and on the 'Control' tab, then click on the 'New Parameter' drop-down arrow and select 'Condition'; in the 'Value' field click on the  button and select 'Expression', and type '{M1} &lt; 15' in the 'Expression' field</li> </ul>

## Run Simulation

- On the 'Configure BPSim' dialog toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the 'Run' icon drop-down arrow and select 'Standard Simulation'; the simulation starts
- When the simulation is finished, click on the  button; the 'Property Parameter Values' dialog displays, tracing the values for properties during simulation
- In the 'Token Number' field type '0', then click on the Query button and on the 'Group by Property' tab



**BPSim PropertyParameter Values**

Trace for execution of 'MessageEvent-StartEvent-IntermediateEvent-EndEvent'

Property	Min	Max
M1	10	110

Token Number: 0 Range [0 ~ 0] Query

Group by Element Group by Property

Property	Value
M1	
StartEvent1	10
Sender	10
StartEvent2	10
Activity2	20
Activity1	110
Gateway2	20
Activity3	30
Receiver	110
Gateway3	30
EndEvent3	30
Gateway1	30
EndEvent2	30

## Analysis

As the 'ProcessingTime' of *Activity1* was set as a distribution value, it turns out that:

- [Process1]'s 'M1' value after *Pool1.StartEvent1* is '10', as expected
- \*[Process2] *Pool2.StartEvent2*'s 'M1' value is '10'; this value is carried from a message sent by *Pool1.Sender*

Now there are actually two 'M1's - *Process1.M1* and *Process2.M1*

- [Process2] *Pool2.Activity2* increased *Process2.M1* by 10; [*Process2.M1* == 20]
- [Process1] *Pool1.Activity1* increased *Process1.M1* by 100; [*Process1.M1* == 110]
- [Process2] The condition expressions are evaluated; as '20 > 15', the token will flow to *Activity3* [*Process2.M1* == 20]
- [Process2] *Pool2.Activity3* increased *Process2.M1* by 10; [*Process2.M1* == 30]
- [Process1] *Pool1.Receiver* is reached and waiting [*Process1.M1* == 110]
- [Process2] *Pool2.Gateway3* serves as a Merge node and continues to *EndEvent3* [*Process2.M1* == 30]
- \*[Process1] *Pool1.Receiver* is woken up by a message(carrying *M1* == 30) and *Process1.M1*'s value changes from 110 to 30
- [Process1] The condition expressions are evaluated; as '30 < 50', the token will flow to *EndEvent2* [*Process1.M1* == 30]

## Notes

- The lines marked with an asterisk (\*) are the effects of Message Flows
- The order within a process is defined; however, the order between two processes is not always predictable
- The Throwing Message Event forks another process; the Catching Message serves as thread synchronization



## Signal Events

A Signal Event provides the facility of loosely coupling 'throwers' and 'catchers' by publish-subscribe integration. A 'thrower' will broadcast a signal rather than addressing it to a particular process; any process listening for that particular event could trigger a new instance using a Signal Start Event.

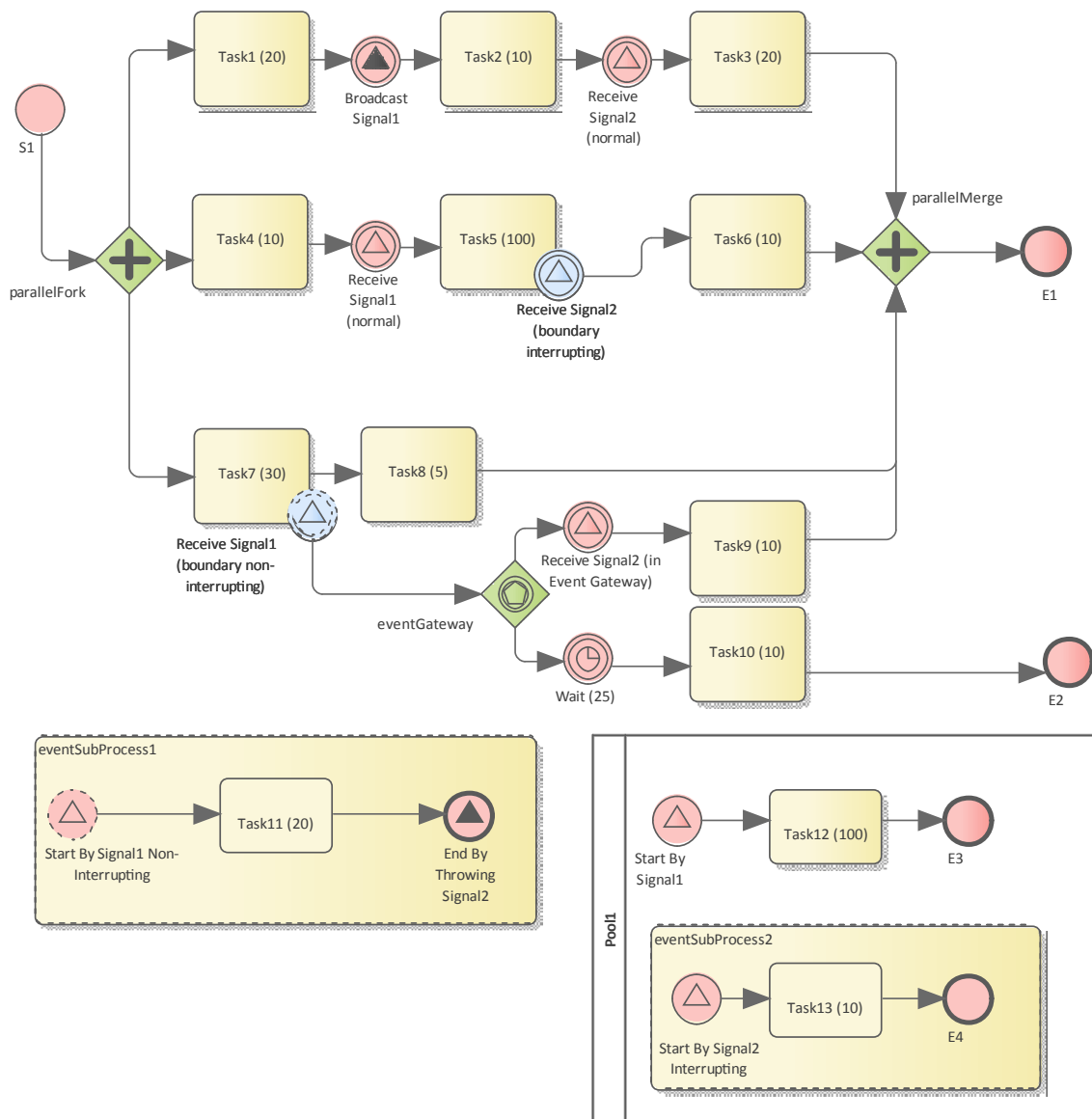
A Signal can be thrown from either a throwing Intermediate Event or a throwing End Event, and can be caught in a Start Event or a catching Intermediate Event (including a boundary Signal Event).

In this example, we demonstrate these Signal Events and their impact on the lifelines of tasks, via BPSim parameter settings.

- Start Signal Event:
  - *Start By Signal1* in top level process (Pool1)
  - *Start By Signal2* Interrupting in event sub-process *eventSubProcess2*
  - *Start By Signal1* Non Interrupting in event sub-process *eventSubprocess1*
- Throwing Intermediate Signal Event:
  - *Broadcast Signal1*
- Catching Intermediate Signal Event:
  - *Receive Signal1 (normal)*
  - *Receive Signal2 (normal)*
  - *Receive Signal2 (boundary Interrupting)*
  - *Receive Signal1 (boundary non-interrupting)*
  - *Receive Signal2 (in Event Gateway)*
- End Signal Event:
  - *End By Throwing Signal2*

## Create BPMN Model

In order to demonstrate the ability to communicate across processes via a Signal Event, we create a Collaboration model with a main Pool and a process in another Pool (*Pool1*).



### Create the Collaboration and main process

Create a new BPMN2.0 Collaboration diagram called *CollaborationForTestingSignalEvents*, (choose the option 'Create this diagram within a new Collaboration Model'). Right-click on the diagram name in the Browser window and select the 'Encapsulate Process' option.

A Pool *PoolMain* and a process *BusinessProcess\_PoolMain* are created, and these tags are set with the automatic values:

- *CollaborationForTestingSignalEvents.mainPool* is set to *PoolMain*
- *PoolMain.processRef* is set to *BusinessProcess\_PoolMain*

### Create the elements for the main process

Create a Start Event *S1* and add a Sequence Flow to a Fork Parallel Gateway *parallelFork*

Add Sequence Flows to:

- An Abstract Task *Task1 (20)* and then add this chain of Sequence Flows:
  - To a Throwing Intermediate Signal Event *Broadcast Signal1*
  - Then to an Abstract Task *Task2 (10)*
  - Then to a Catching Intermediate Signal Event *Receive Signal2 (normal)*
  - Then to an Abstract Task *Task3 (20)*

- Then to a Merge Parallel Gateway *parallelMerge*
- Then to an End Event *E1*
- An Abstract Task *Task4 (10)* and then add this chain of Sequence Flows:
  - To a Catching Intermediate Signal Event *Receive Signal1 (normal)*
  - Then to an Abstract Task *Task5 (100)*, on which you create a Boundary Interrupting Catching Intermediate Signal Event *Receive Signal2 (boundary interrupting)*
  - Then to an Abstract Task *Task6 (10)*
  - Then to the earlier Merge Parallel Gateway *parallelMerge*
- An Abstract Task *Task7 (30)*, and then add this chain of Sequence Flows:
  - To an Abstract Task *Task8 (5)*
  - Then to the earlier Merge Parallel Gateway *parallelMerge*

On *Task7 (30)*, create a Boundary Non-interrupting Catching Intermediate Signal Event *Receive Signal1 (boundary non-interrupting)*. Add a Sequence Flow to an Event Gateway *eventGateway*, and to that add Sequence Flows to:

- A Catching Intermediate Signal Event *Receive Signal2 (in Event Gateway)*, and then this chain of Sequence Flows:
  - To an Abstract Task *Task9 (10)*
  - Then to the earlier Merge Parallel Gateway *parallelMerge*
- A Catching Intermediate Timer Event *Wait (25)*, and then this chain of Sequence Flows:
  - To an Abstract Task *Task10 (10)*
  - Then to an End Event *E2*

#### Create an Event sub-process (triggered by a non-interrupting Start Signal Event) in the main process

- Create an Activity *eventSubProcess1* and, in its 'Properties' dialog, set the 'Type' field to *subProcess* and change the attribute 'triggeredByEvent' to *true*
- Within *eventSubProcess1* create a Start Event *Start By Signal1 Non Interrupting* and, in its 'Properties' dialog, set the 'Type' field to *Event Sub-Process Non-Interrupting > Signal*
- Add a Sequence Flow to a target Abstract Task *Task11 (20)*
- Add a Sequence Flow to a target End Event *End By Throwing Signal2* and, in the element 'Properties' dialog, set the 'Type' field to *Signal*

#### Create another process

- From the Toolbox, drag and drop the 'Pool' icon onto the diagram and name the element *Pool1*
- Right-click on *Pool1* in the Browser window and select the 'Encapsulate Process' option; a process *BusinessProcess\_Pool1* is created and the tag 'Pool1.processRef' is set to *BusinessProcess\_Pool1*

#### Create the main process for *Pool1*


- Create a Signal Start Event *Start By Signal1*
- Add a Sequence Flow to a target Abstract Task *Task12 (100)*
- Add a Sequence Flow to a target End Event *E3*

#### Create an Event sub-process to interrupt *Pool1*

- Create an Activity *eventSubProcess2* and, in the 'Properties' dialog, set the 'Type' field to *subProcess*; change the attribute 'triggeredByEvent' to *true*
- Within *eventSubProcess2* create a Start Event *Start By Signal2 Interrupting* and, in the 'Properties' dialog, set the 'Type' field to *Event Sub-Process Interrupting > Signal*
- Add a Sequence Flow to a target Abstract Task *Task13 (10)*
- Add a Sequence Flow to a target End Event *E4*

#### Create the BPMN2.0 Signal Elements and configure for Signal Events

In the BPMN 2.0 Toolbox, expand the 'BPMN 2.0 - Types' page and drag the 'Signal' icon onto the diagram; name the element *Signal1*. Drag the icon onto the diagram again to create *Signal2*. These are root elements (which can be used by all processes) so they will be created directly under the model Package.

Double-click on each of the Signal Event elements and, in the 'Value' field for the 'signalRef' tag, click on the  button and browse to the appropriate Signal element.



*Tips: Alternatively, you can drag the Signal element from the Browser window and drop it on the Event elements in the diagram; a context menu displays, from which you select the 'set signalRef' option.*



- Set signalRef to 'Signal1' on:
  - *Broadcast Signal1*
  - *Start By Signal1* in top level process (*Pool1*)
  - *Start By Signal1 Non Interrupting* in Event sub-process *eventSubprocess1*
  - *Receive Signal1 (normal)*
  - *Receive Signal1 (boundary non-interrupting)*
- Set signalRef to 'Signal2' on:
  - *Start By Signal2 Interrupting* in Event sub-process *eventSubProcess2*
  - *Receive Signal2 (normal)*
  - *Receive Signal2 (boundary Interrupting)*
  - *Receive Signal2 (in Event Gateway)*

## Configure BPSim


In this section, we create the Configuration Artifact, specify the model Package and configure the parameter values of each element.

The configuration is quite simple because none of the Signal Events require any BPSim configurations. All we have to do is set the processing time for tasks so we can observe how processes, threads and tasks are started and interrupted.

Task	Description
Set up configuration	<ul style="list-style-type: none"> <li>Open the Configure BPSim window ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>Create an Artifact named 'SignalEvent Complete Example' (in the 'Select/Create Artifact' field, click on the  button and select its parent Package and click on the Add New button, then type in the element name and click on the Save button and the OK button)</li> </ul> <p>Then all the BPMN elements will be loaded in to the Configure BPSim window.</p>
Non-Signal Events	<ul style="list-style-type: none"> <li>In the element list on the left of the dialog, expand the 'StartEvent' group, then click on <i>SI</i> and on the 'Control' tab; click on the 'New Parameter' drop-down arrow and select 'Trigger Count', then type '1' in the 'Value' field</li> <li>Expand the 'IntermediateEvent' group, then click on <i>Wait (25)</i> and on the 'Control' tab; click on the 'New Parameter' drop-down arrow and select 'InterTriggerTimer', then click on the  button in the 'Value' field; select 'Constant' and 'Numeric', and type '25' in the 'Constant Numeric' field and 'seconds' in the 'TimeUnit' field</li> </ul>
Dummy variable for Process	<p>The simulation controller displays a list showing the runtime token count for each element. For example, 4 tokens have passed the Gateway element <i>parallelMerge</i> in a simulation. This is quite useful for certain statistics and analysis. However, it does not show WHEN <i>parallelMerge</i> was traversed during the simulation. In order to get the exact trace for a single token we use the property trace utility, which relies on property parameters. So we create a dummy parameter.</p>

	<p>In the 'Configuration BPSim' dialog, expand the 'BusinessProcess' group.</p> <ul style="list-style-type: none"> <li>Click on <i>BusinessProcess_Main</i> and on the 'Properties' tab, and overtype <i>New Property</i> with <i>dummyVariable</i>; in the 'Value' field, click on the  button and on 'Constant' and 'Numeric', and in the 'Constant Numeric' field type '0'</li> <li>Click on <i>BusinessProcess_Pool1</i> and perform exactly the same actions as for <i>BusinessProcess_Main</i></li> </ul>
Processing Time for Tasks	<p>Expand the 'Activity' group and for each Task element listed here: select the 'Time' tab, click on the 'New Parameter' drop-down arrow and select 'ProcessingTime', then click on the  button on the 'Value' column, select 'Constant' and 'Numeric', type the value as indicated into the 'Constant Numeric' field and select 'seconds' in the 'TimeUnit' field.</p> <ul style="list-style-type: none"> <li>Task1 (20): 20 seconds</li> <li>Task2 (10): 10 seconds</li> <li>Task3 (20): 20 seconds</li> <li>Task4 (10): 10 seconds</li> <li>Task5 (100): 100 seconds</li> <li>Task6 (10): 10 seconds</li> <li>Task7 (30): 30 seconds</li> <li>Task8 (5): 5 seconds</li> <li>Task9 (10): 10 seconds</li> <li>Task10 (10): 10 seconds</li> <li>Task11 (20): 20 seconds</li> <li>Task12 (100): 100 seconds</li> <li>Task13 (10): 10 seconds</li> </ul>

## Run Simulation

- On the 'Configure BPSim' dialog Toolbar, click on the 'Run' icon to open the 'BPSim Simulation Controller' dialog
- Click on the 'Run' icon drop-down arrow and select 'Standard Simulation'
- After simulation, click on the  button on the tool bar to display the 'BPSim PropertyParameter Values' dialog
- Click on the Query button and on the 'Group by Property' tab, and expand 'dummyVariable'

**BPSim PropertyParameter Values**

Trace for execution of 'SignalEvent Complete Example'

Token Number:  Range [0 ~ 0]

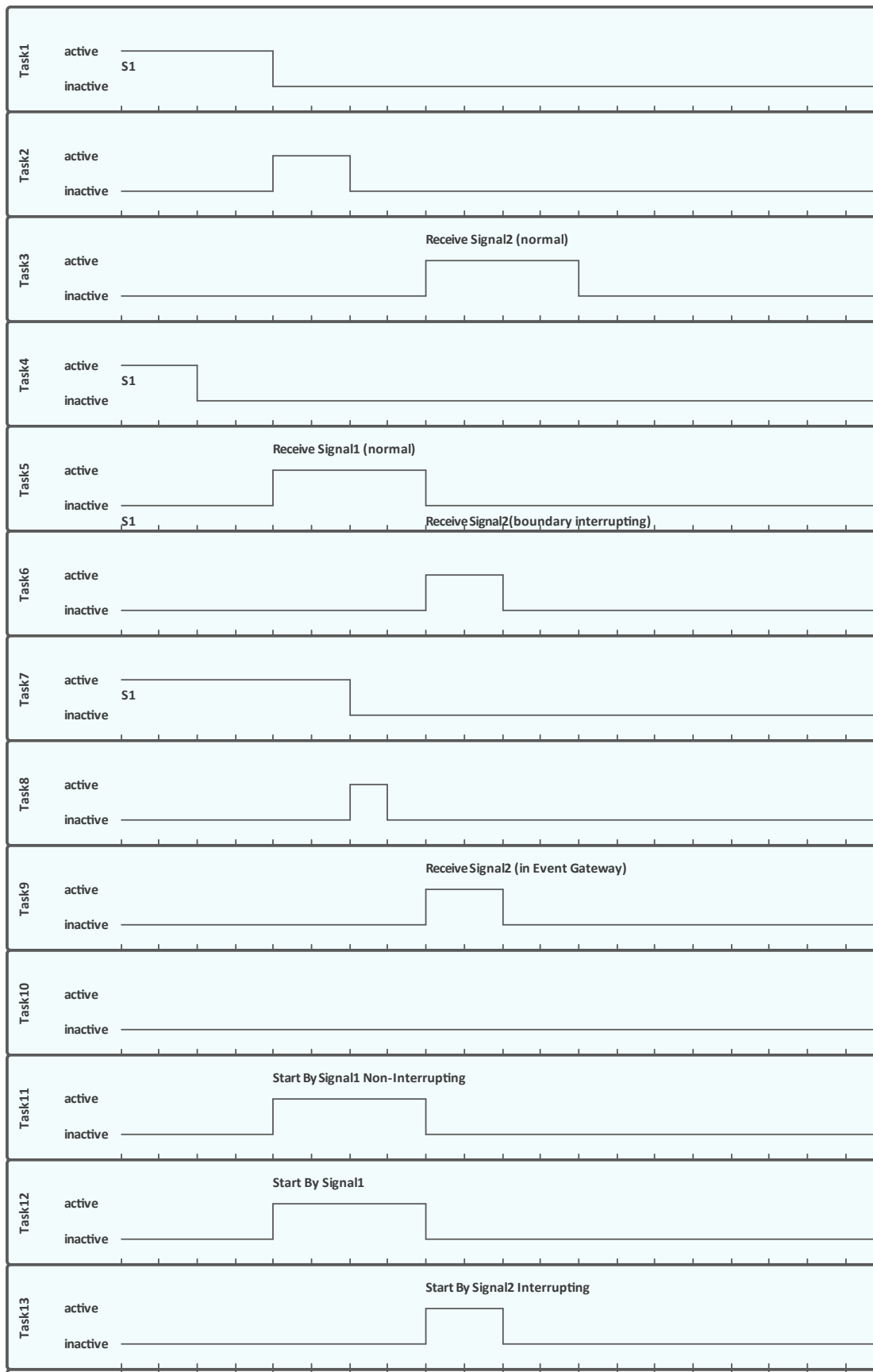
Group by Element Group by Property

Property	Min	Max
dummyVariable	0	0

Property	Value
dummyVariable	0
S1	0
parallelFork	0
Task7 (30)	0
Task4 (10)	0
Task1 (20)	0
Receive Signal1 (normal)	0
Broadcast Signal1	0
Task5 (100)	0
Start By Signal1 Non-Interrupting	0
Task11 (20)	0
eventGateway	0
Start By Signal1	0
Task12 (100)	0
Task2 (10)	0
Task8 (5)	0
Receive Signal2 (normal)	0
parallelMerge	0
End By Throwing Signal2	0
Task3 (20)	0
Task9 (10)	0
Task6 (10)	0
Start By Signal2 Interrupting	0
Task13 (10)	0
parallelMerge	0
parallelMerge	0
E4	0
parallelMerge	0
E1	0

## Analysis

From the direct results of the simulation it might not be obvious what has taken place; however, if we draw the lifeline for each task, it becomes quite clear.



- Task1, Task4 and Task7 started in parallel

- *Task2* started immediately after *Task1* finished (without stopping at the throwing event)
- At 20 seconds, *Signal1* was broadcast by the Throwing Intermediate Event *Broadcast Signal1* and:
  - *Receive Signal1 (normal)* was activated and *Task5* started
  - *Start By Signal1 Non-Interrupting* was activated and *Task11* in *eventSubProcess1* started
  - *Start By Signal1* was activated and *Task12* in *Pool1* started
- At 40 seconds, *Signal2* was broadcast by the End Event *End By Throwing Signal2* and:
  - *Receive Signal2 (normal)* was activated and *Task3* started
  - *Task5* was interrupted and *Task6* started
  - *Receive Signal2 (in Event Gateway)* was activated and *Task9* started
  - *Start By Signal2 Interrupting* was activated, and:
    - > The main process in *Pool1* was interrupted and *Task12* stopped
    - > *Task13* in *eventSubProcess2* started
- The *eventSubProcess2* inside *BusinessProcess\_Pool1* finished when *E4* was reached at 50 seconds
- The *BusinessProcess\_MainPool* finished when *E1* was reached at 60 seconds
- The Intermediate Timer Event *Wait (25)* did not get activated because the signal event in the Gateway was activated first; as a result, *Task10* was never started

Note: The actual running time for each task can be observed from the generated BPSimReport element, by:

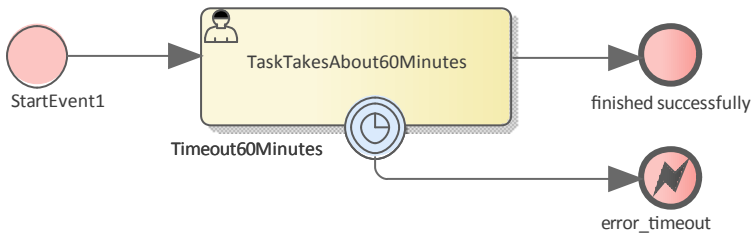
1. Double-clicking on the <<BPSimReport>> element.
2. Expanding the 'Time' group.
3. Expanding the task element.
4. Checking 'Total Time In Task'.

For example, for element *Task5 (100)*, although we set its processingTime to be 100 seconds, the **Total Time In Task** was 20 seconds, which was interrupted by *Receive Signal2 (boundary interrupting)* at 20 seconds.



# Timer Event - Boundary



## Create BPMN Model



- Create a Start Event *StartEvent1*
- Add a Sequence Flow to a target userTask *TaskTakesAbout60Minutes*
- Add a Sequence Flow to a target End Event *finished successfully*
- Create an Intermediate Event, dragging the icon from the Toolbox and dropping it onto *TaskTakesAbout60Minutes*; select 'Edge-Mounted' and 'Timer' from the automatic menus, and call the element *Timeout60Minutes*
- Add a Sequence Flow to a target End Event (Error) *error\_timeout*


## Configure BPSim

In this section, we create the Configuration Artifact, identify the parent Package and set the parameter values of each element.

Objects	Action
Create Artifact and Package	<ul style="list-style-type: none"> <li>• Open the 'Configure BPSim' dialog ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>• Create an Artifact named 'IntermediateEvent - Boundary - Timer - TruncatedNormal' (in the 'Select/Create Artifact' field, click on the  button and select its parent Package, click on the Add New button, then type in the element name and click on the Save button and the OK button)</li> </ul> <p>Then all the BPMN elements will be loaded in to the 'Configure BPSim' dialog.</p>
StartEvent1	<p>In the element list on the left of the dialog, expand the 'StartEvent' group and click on <i>StartEvent1</i>.</p> <ul style="list-style-type: none"> <li>• Click on the 'Control' tab</li> <li>• Click on the 'New Parameter' drop-down arrow and select 'TriggerCount'</li> <li>• In the 'Value' field type '100'</li> </ul>
TaskTakesAbout60Minutes	<p>In the element list on the left of the dialog, expand the 'Activity' group and click on <i>TaskTakesAbout60Minutes</i>.</p> <ul style="list-style-type: none"> <li>• Click on the 'Time' tab</li> <li>• Click on the 'New Parameter' drop-down arrow and select 'ProcessingTime'</li> <li>• In the 'Value' field click on the  button and select 'Distribution' and 'TruncatedNormal'</li> </ul>

	<ul style="list-style-type: none"> <li>• In the 'Mean' field type '50'</li> <li>• In the 'StandardDeviation' field type '10'</li> <li>• In the 'Min' field type '0'</li> <li>• In the 'Max' field type '1000'</li> <li>• Click on the OK button</li> </ul>
Timeout60Minutes	<p>In the element list on the left of the dialog, expand the 'IntermediateEvent' group and click on <i>Timeout60Minutes</i>.</p> <ul style="list-style-type: none"> <li>• Click on the 'Control' tab</li> <li>• Click on the 'New Parameter' drop-down arrow and select 'InterTriggerTimer'</li> <li>• Set the value to '000:000:000 001:00:00' (that is, 1 hour)</li> </ul>

## Run Simulation

- On the Configure BPSim window toolbar, click on the 'Run' icon to open the 'BPSim Simulation Controller' dialog
- Click on the 'Run' icon drop-down arrow and select 'Standard Simulation'
- After simulation, click on the  button on the tool bar to display the 'BPSim PropertyParameter Values' dialog
- Click on the Query button and on the 'Group by Property' tab, and expand 'dummyVariable'

On simulation, we get this result:

BPSim Simulation Controller : IntermediateEvent - Boundary - Timer - TruncatedNormal	
Type	Message
Info	Export BPMN Model - Succeeded.
Info	Loading BPMN Model - Succeeded.
Info	Simulation Engine Initialized
Info	Simulation Started.
Info	Simulation Finished.
Info	Simulation Result Generated.
Element	Runtime Value
Token Status	
<<StartEvent>>StartEvent1	100
<<Activity>>TaskTakesAbout60Minutes	100
<<EndEvent>>finished successfully	93
<<EndEvent>>error_timeout	7

## Analysis

Since the ProcessingTime of *TaskTakesAbout60Minutes* was set as a distribution value, it turns out that:

- 93 out of 100 finished in 1 hour, so the normal flow to *finished successfully* takes effect
- 7 out of 100 finished in more than 1 hour, so the exception flow to *error\_timeout* takes effect

**Other Configurations**

In the example folder, there are two other Business Process Simulation Artifacts that set the ProcessingTime as a constant value of 50 minutes and 80 minutes, other settings remain the same.

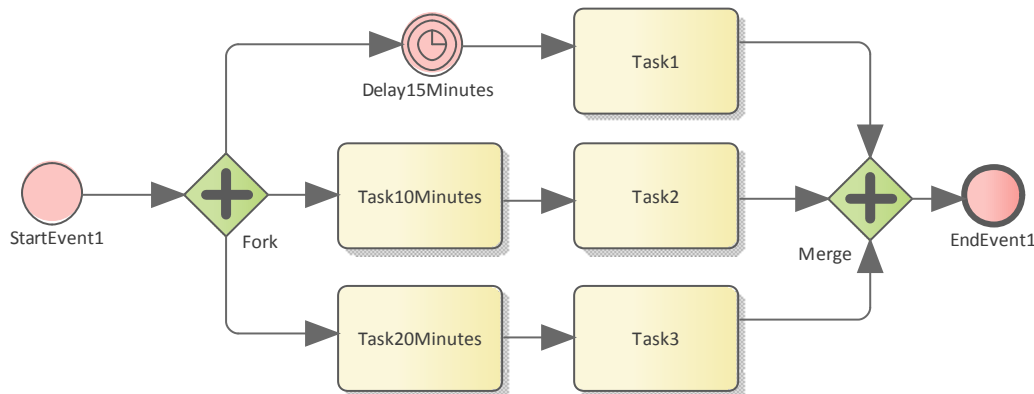
**Run simulation on these two Artifacts:**

- ProcessingTime configured to be 50 minutes always finishes in normal flow
- ProcessingTime configured to be 80 minutes always finishes in exception flow

## Timer Event - Standalone Intermediate Event

When a Timer Intermediate Event is used within the normal sequence flow as a standalone element, it acts as a delay mechanism.


### Create BPMN Model




- Create a Start Event called *StartEvent1*
- Add a Sequence Flow to a target Parallel Gateway called *Fork*
- Add Sequence Flows to:
  - A Standalone Timer Intermediate Event called *Delay15Minutes*, and from that a Sequence Flow to an Activity called *Task1*
  - An Activity called *Task10Minutes*, and from that a Sequence Flow to an Activity called *Task2*
  - An Activity called *Task20Minutes*, and from that a Sequence Flow to an Activity called *Task3*
- From *Task1*, *Task2* and *Task3* create Sequence Flows to a Merge Parallel Gateway called *Merge*
- Add a Sequence Flow to a target EndEvent called *EndEvent1*


### Configure BPSim

In this section, we create the Configuration Artifact, specify the model Package and configure the parameter values of each element.

Object	Action
Create Artifact and Package	<ul style="list-style-type: none"> <li>• Open the 'Configure BPSim' dialog ('Simulate &gt; Process Analysis &gt; BPSim &gt; Open BPSim Manager')</li> <li>• Create an Artifact named 'IntermediateEvent - Standalone - Timer' (in the 'Select/Create Artifact' field, click on the  button and select its parent Package and click on the Add New button, then type in the element name and click on the Save button and the OK button)</li> </ul> <p>Then all the BPMN elements will be loaded in to the 'Configure BPSim' dialog.</p>
StartEvent1	<ul style="list-style-type: none"> <li>• In the element list on the left of the dialog, expand the 'StartEvent' group, then click on <i>StartEvent1</i> and on the 'Control' tab</li> <li>• Click on the 'New Parameter' drop-down arrow and select 'Trigger Count', then</li> </ul>

	<p>type 'I' in the 'Value' field</p> <ul style="list-style-type: none"> <li>Click on the 'Properties' tab</li> <li>Overtyping <i>New Property</i> with <i>dummyProperty</i>; in the 'Value' field, click on the  button and on 'Constant' and 'Numeric', and in the 'Constant Numeric' field type '0'</li> </ul> <p>With this property, the 'Property Trace' dialog will be able to show the sequence of element flows during simulation.</p>
Delay15Minutes	<ul style="list-style-type: none"> <li>In the element list on the left of the dialog, expand the 'IntermediateEvent' group, then click on <i>Delay15Minutes</i> and on the 'Control' tab</li> <li>Click on the 'New Parameter' drop-down arrow and select 'InterTriggerTimer', then set the 'Value' field to 15 minutes ('000:000:000 000:15:00')</li> </ul>
Task10Minutes	<ul style="list-style-type: none"> <li>In the element list on the left of the dialog, expand the 'Activity' group, then click on <i>Task10Minutes</i> and on the 'Time' tab</li> <li>Click on the 'New Parameter' drop-down arrow and select 'ProcessingTime', then set the 'Value' field to 10 minutes ('000:000:000 000:10:00')</li> </ul>
Task20Minutes	<ul style="list-style-type: none"> <li>In the element list on the left of the dialog, expand the 'Activity' group, then click on <i>Task20Minutes</i> and on the 'Time' tab</li> <li>Click on the 'New Parameter' drop-down arrow and select 'ProcessingTime', then set the 'Value' field to 20 minutes ('000:000:000 000:20:00')</li> </ul>

## Run Simulation

- On the 'Configure BPSim' dialog Toolbar, click on the 'Run' icon to open the 'BPSim Simulation Controller' dialog
- Click on the 'Run' icon drop-down arrow and select 'Standard Simulation'
- After simulation, click on the  button on the tool bar to display the 'BPSim PropertyParameter Values' dialog
- Click on the Query button and on the 'Group by Property' tab

**BPSim PropertyParameter Values**

Trace for execution of 'IntermediateEvent - Standalone - Timer'

Property	Min	Max
dummyProperty	0	0

Token Number: 0 Range [0 ~ 0] Query

Group by Element Group by Property

Property	Value
dummyProperty	
StartEvent1	0
Fork	0
Delay15Minutes	0
Task20Minutes	0
Task10Minutes	0
Task2	0
Merge	0
Task1	0
Merge	0
Task3	0
Merge	0
EndEvent1	0

### Analysis

The *Fork* Parallel Gateway will activate the outgoing Sequence Flows simultaneously (the order is undefined and not important). However, we would expect the order of the Tasks to be exactly:

- *Task2*
- *Task1*
- *Task3*

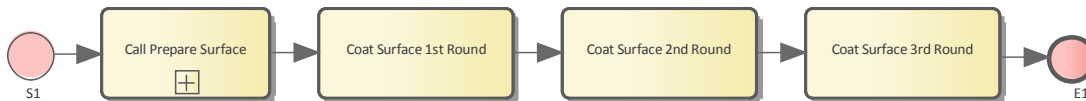
This order is determined by the BPSim parameters set on two of the Activities (ProcessingTime) and the Timer Intermediate Event (InterTriggerTimer). The sequence shown in the 'BPSim PropertyParameter Values' dialog confirms that *Task2* comes ahead of *Task1*, which comes ahead of *Task3*.

## Paint Wall Process Simulation (Call Activity)

This is a simple example to simulate the process of painting a wall. We define the main process as preparing the surface and then painting it three times. Preparing the surface is further divided into tasks such as sanding and cleaning.

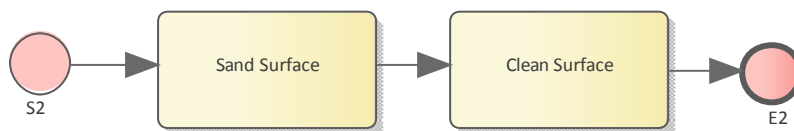
We assume that applying each of the three coats of paint is the same process, except that the time randomly spent on each coat might be different.

### Create BPMN Model



#### Create the main process - Paint Wall Process

- Create a Start Event called *S1*
- Add a Sequence Flow to a target callProcessActivity called *Call Prepare Surface*
- Add a Sequence Flow to a target callGlobalTaskActivity called *Coat Surface 1st Round*
- Add a Sequence Flow to a target callGlobalTaskActivity called *Coat Surface 2nd Round*
- Add a Sequence Flow to a target callGlobalTaskActivity called *Coat Surface 3rd Round*
- Add a Sequence Flow to a target End Event called *E1*



#### Create the re-used process - Prepare Surface Process

- Create a Start Event called *S2*
- Add a Sequence Flow to a target Abstract Task called *Sand Surface*
- Add a Sequence Flow to a target Abstract Task called *Clean Surface*
- Add a Sequence Flow to a target End Event called *E2*

#### Set Global Task and re-used process to call Activities

- Create a Global Task Activity called *Coat Surface*
- Double-click on each of *Coat Surface 1st Round*, *Coat Surface 2nd Round* and *Coat Surface 3rd Round*, and set the tag 'calledActivityRef' to *Coat Surface*

*Tip: You can also drag the Global Task 'Coat Surface' from the Browser window and drop it on the Call Activity element, clicking the 'set calledActivityRef' option on the context menu.*

- Double-click on *Call Prepare Surface* and set the tag 'calledActivityRef' to *Prepare Surface Process*


*Tip: You can also drag the process 'Prepare Surface Process' from the Browser window and drop it on the Call Activity element, clicking the 'set calledActivityRef' option on the context menu.*

### Configure BPSim

- Open the 'Configure BPSim' dialog ('Simulate > Process Analysis > BPSim > Open BPSim Manager')

- Create a Business Process Simulation Artifact named *Paint Wall Simulation*
- Select the Package containing the corresponding BPMN 2.0 model

All of the BPMN elements will be loaded in to the 'Configure BPSim' dialog.

Object	Activity
Fixed Scaling Time	<p>On the left hand panel of the Configure BPSim window, expand the 'Activity' group, then:</p> <ul style="list-style-type: none"> <li>• Click on <i>Sand Surface</i> and on the 'Time' tab, then click on the 'New Parameter' drop-down arrow and select 'Processing Time'; in the 'Value' field, change the setting to 000:000:000 000:30:00 (that is, 30 minutes)</li> <li>• Click on <i>Clean Surface</i> and on the 'Time' tab, then click on the 'New Parameter' drop-down arrow and select 'Processing Time'; in the 'Value' field, change the setting to 000:000:000 000:10:00, (that is, 10 minutes)</li> </ul>
Random Coating Time	<p>On the left hand panel of the Configure BPSim window, expand the 'GlobalTask' group, then:</p> <ul style="list-style-type: none"> <li>• Click on <i>Coat Surface</i></li> <li>• Click on the 'Time' tab, then click on the 'New Parameter' drop-down arrow and select 'Processing Time'</li> <li>• In the 'Value' field click on the  button, and on the parameter dialog click on the 'Distribution' tab and on 'Poisson'</li> <li>• In the 'Mean' field type '10', then click on the OK button</li> </ul> <p>With this setting, the mean value of the random numbers generated by the Poisson distribution is 10. If you prefer, you can choose other types of distribution.</p>
TriggerCount on S1	<p>On the left hand panel of the Configure BPSim window, expand the 'Start Event' group, then:</p> <ul style="list-style-type: none"> <li>• Click on <i>S1</i></li> <li>• Click on the 'Control' tab, then click on the 'New Parameter' drop-down arrow and select 'TriggerCount'</li> <li>• In the 'Value' field type '1'</li> </ul>

## Run Simulation

- From the 'Configure BPSim' dialog toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button and select 'Standard Simulation'
- When the simulation is complete, it provides this result:



BPSim Simulation Controller : Paint Wall Simulation	
Type	Message
Info	Verifying Simulation Environment.
Info	Simulation Environment Verified.
Info	Loading BPMN Model - Succeeded.
Info	Simulation Engine Initialized
Info	Simulation Started.
Info	Simulation Finished.
Info	Simulation Result Generated.


Element	Runtime Value
Token Status	
<<StartEvent>> S1	1
<<StartEvent>> S2	1
<<Activity>> Scale Surface	1
<<Activity>> Clean Surface	1
<<EndEvent>> E2	1
<<GlobalTask>> Coat Surface(<<Activity>> Coat Surface 1st Round)	1
<<GlobalTask>> Coat Surface(<<Activity>> Coat Surface 2nd Round)	1
<<GlobalTask>> Coat Surface(<<Activity>> Coat Surface 3rd Round)	1
<<EndEvent>> E1	1

### Flow Analysis

For the only token started on *S1*, we can see from the 'BPSim Simulation Controller' dialog how the flow develops:

- When reaching the callProcessActivity, the called process is activated; so we have *S2 ~ E2*
- When reaching a callGlobalTaskActivity, the called Global Task is activated - the notation reads: *GlobalTask name (called activity name)*; the global *Coat Surface* was called three times:
  - *Coat Surface(Coat Surface 1st Round)*
  - *Coat Surface(Coat Surface 2nd Round)*
  - *Coat Surface(Coat Surface 3rd Round)*


### Time Analysis

Click on the  button on the 'BPMN Simulation Controller' dialog toolbar. The 'BPMN Simulation Report View' displays:

The screenshot shows the 'BPMN Simulation Report View' window. The title bar is yellow. Below it is a toolbar with icons for report actions. The main area is a table with a yellow header row. The table has two columns: 'Item' and 'Sum Of Processing time'. The 'Item' column contains a hierarchical tree structure of simulation elements. The 'Sum Of Processing time' column contains numerical values. A search filter 'Paint Wall Simulation- R...' is applied to the 'Sum Of Processing time' column.

Item	Sum Of Processing time
Time	
<<GlobalTask>> Coat Surface	
Sum Of Processing Time	30.00
<<GlobalTask>> Coat Surface(<<Activity>> Coat Surface 2nd Round)	
Sum Of Processing Time	10.00
<<GlobalTask>> Coat Surface(<<Activity>> Coat Surface 3rd Round)	
Sum Of Processing Time	12.00
<<GlobalTask>> Coat Surface(<<Activity>> Coat Surface 1st Round)	
Sum Of Processing Time	8.00
<<BusinessProcess>> Paint Wall Process	
Sum Of Processing Time	70.00
<<BusinessProcess>> Scale Surface Process	
Sum Of Processing Time	40.00
<<BusinessProcess>> Scale Surface Process(<<Activity>> Call Scale Surface)	
Sum Of Processing Time	40.00
<<Activity>> Scale Surface	
Sum Of Processing Time	30.00
<<Activity>> Clean Surface	
Sum Of Processing Time	10.00

*Tips: Type a text string in the Filter bar to show only the records containing that text string in that column field.*

After expanding the report (click on the  button on the 'Report View' toolbar), the report displays as shown in the example, from which we can make this analysis:

- *Coat Surface 1st Round* took 8 minutes; *Coat Surface 2nd Round* took 10 minutes; *Coat Surface 3rd Round* took 12 minutes - the figures 8, 10, 12 are randomly generated by the Poisson(10) distribution; what is important here is that each call instance of the Global Task has its own values
- *Coat Surface* has a total time collected from all instances:  $8 + 10 + 12 = 30$
- The Call Activity *Call Prepare Surface* took 40 minutes, composed of *Sand Surface* (30 minutes) and *Clean Surface* (10 minutes)
- The Sum Of Processing Time for *Paint Wall Process* is 70 minutes, composed of the four Call Activities:  $40 + 8 + 10 + 12 = 70$

## Customized Simulation

We can configure a 'Result Request' on BPMN elements to customize the simulation report so that we only report on the parameters we are interested in.

### Configure Result Request

- On the left hand side of the 'Configure BPSim' dialog, expand the 'Activity' group, then click on *Coat Surface 1st Round* and on the 'Time' tab
- In the lower panel on the right of the dialog, click on 'ProcessingTime', click on the drop-down arrow in the 'Result

Request' field and select the checkbox against 'sum'; click on the OK button

- Repeat these steps for the Activities *Call Prepare Surface*, *Coat Surface 2nd Round*, *Coat Surface 3rd Round*
- Expand the 'Business Process' group and repeat these steps for *Paint Wall Process*


### Run Simulation

- On the 'Configure BPSim' dialog toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button drop-down arrow and select, in this case, 'Customized Simulation'

### Flow Analysis

The Flow Analysis is exactly the same as for a Standard Simulation.

### Time Analysis

On the 'BPSim Simulation Controller' dialog toolbar, click on the  button; the 'BPMN Simulation Report View' displays.

BPMN Simulation Report View	
Paint Wall Simulation- Result	
Item	
Time	
Coat Surface 2nd Round	
ProcessingTime	
Sum of Instance 0	10.00
Coat Surface 3rd Round	
ProcessingTime	
Sum of Instance 0	12.00
Paint Wall Process	
ProcessingTime	
Sum of Instance 0	70.00
Call Scale Surface	
ProcessingTime	
Sum of Instance 0	40.00
Coat Surface 1st Round	
ProcessingTime	
Sum of Instance 0	8.00

The Time Analysis is the same as for a Standard Simulation; however, the report only contains the 'sum' results we requested.

Note: Currently, in the Time Analysis, we can not request ProcessingTime either on the called process itself or on the Activities contained by the called process. If you have this requirement, use the Standard Simulation.

## BPSim Cost Parameters

BPSim 1.0 provides the means to set cost parameters and receive cost statistics from process simulation experiments. BPSim provides a framework to determine **variable** costs according to two parameters, both related to the level of activity performed in the simulated process. These parameters are:

- Completion cost ('Fixed Cost' in the BPSim specification) - The cost incurred whenever an operation is completed; this cost can be related to Task, Process, Sub-Process, Call Activity or Resource elements
- Time cost ('Unit Cost' in the BPSim specification) - The cost incurred whenever a task, process, sub-process, call activity or resource is busy for a period of time

The cost parameters are supported on Activities, resources and processes.

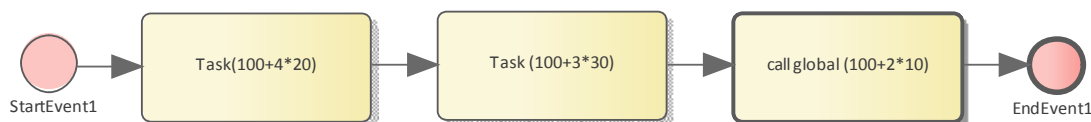
- Activity - Completion cost is incurred whenever an Activity finishes; Time cost (Unit Cost \* Time) is incurred whenever an activity finishes
- Resource - Completion cost is incurred whenever each involved resource finishes an activity; Time cost (Unit Cost \* Time) is incurred whenever each involved resource finishes an activity
- Process - Completion cost is incurred whenever a process finishes; Time cost (Unit Cost \* Time) is incurred whenever a process finishes

Those costs that are known without the need for simulation - for example, overall labor employment costs - are not supported by BPSim.

In this topic, we discuss two examples that demonstrate the configuration and simulation of cost parameters.

- Set Cost on Activity
- Set Cost on Resource

### Set Cost Parameters on Activity




### Create the BPMN Model (Activities)

- In the Browser window, create a *StartEvent1*, a *GlobalTask1*, two *AbstractTasks*, and an *EndEvent1*
- Ctrl+drag the elements from the Browser window onto a diagram, pasting *GlobalTask1* as an Invocation (Call Activity) called *call global (100+2\*10)*
- Give the elements names and connect them with Sequence Flows; the two *AbstractTasks* should be called:
  - *Task (100+3\*30)* and
  - *Task (100+4\*20)*



### BPSim Configuration

Create a Business Process Simulation configuration Artifact in the diagram, right-click on it and select the 'Configure BPSim' option. Set the configuration to link to the Package containing the BPMN model elements and configure these BPSim parameters as indicated.

Parameter	Settings
	<ul style="list-style-type: none"> <li>• Click on the 'Scenario' tab and, for the 'Time Unit' parameter, click on the</li> </ul>

Scenario Parameters	<p>'Value' drop-down arrow and select 'hours'</p> <ul style="list-style-type: none"> <li>In the 'Value' field for the 'Duration' parameter, set the value to '0001 00:00:00' (1 day)</li> </ul> <p>This Time Unit is used to calculate the Time Cost (Time cost = Unit Cost * Time), so make sure the Unit Cost is based on the correct Time Unit.</p>
Control Parameters	<ul style="list-style-type: none"> <li>On the left side of the dialog, expand the 'StartEvent' group and click on <i>StartEvent1</i></li> <li>Click on the 'New Parameter' drop-down arrow and select 'TriggerCount'</li> <li>In the 'Value' field type '1'</li> </ul>
Time Parameters	<p>On the left side of the dialog, expand the 'Activities' group.</p> <ul style="list-style-type: none"> <li>Click on <i>Task(100+4*20)</i> and on the 'Time' tab, then click on the 'New Parameter' drop-down arrow and select 'ProcessingTime'; set the 'Value' field to '000:000:000 004:00:00' (4 hours)</li> <li>Click on <i>Task(100+3*30)</i> and do the same, setting the 'Value' field to '000:000:000 003:00:00' (3 hours)</li> </ul> <p>Expand the 'GlobalTask' group.</p> <ul style="list-style-type: none"> <li>Click on <i>GlobalTask1</i> and do the same, setting the 'Value' field to '000:000:000 002:00:00' (2 hours)</li> </ul>
Cost Parameters	<ul style="list-style-type: none"> <li>Click on <i>Task(100+4*20)</i> and on the 'Cost' tab, then click on the 'New Parameter' drop-down arrow and select: <ul style="list-style-type: none"> <li>'FixedCost' - in the 'Value' field click on the  button, select the 'Constant' tab and 'Floating', and in the 'Constant Floating' field type '100'; click on the OK button</li> <li>'UnitCost' - do the same, setting the 'Constant Floating' field to '20'</li> </ul> </li> <li>Click on <i>Task(100+3*30)</i> and do the same, setting: <ul style="list-style-type: none"> <li>'FixedCost' to '100'</li> <li>'UnitCost' to '30'</li> </ul> </li> <li>Click on <i>GlobalTask1</i> and do the same, setting: <ul style="list-style-type: none"> <li>'FixedCost' to '100'</li> <li>'UnitCost' to '10'</li> </ul> </li> <li>Expand the 'BusinessProcess' group, click on <i>BPSim Cost</i> and do the same, setting: <ul style="list-style-type: none"> <li>'FixedCost' to '50'</li> <li>'UnitCost' to '5'</li> </ul> </li> </ul>

## Simulation

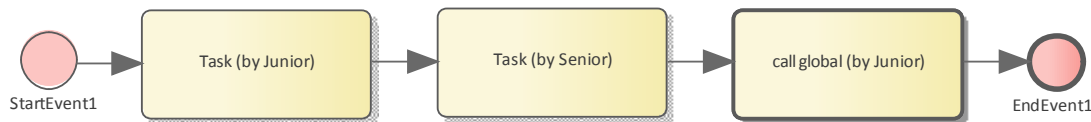
- From the 'Configure BPSim' dialog toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button and select 'Standard Simulation'
- When the simulation is complete, click on the  button on the 'BPMN Simulation Controller' dialog toolbar; the 'BPMN Simulation Report View' displays
- Filter the report by clicking on the  button and selecting 'Show only Non-Empty Items'

BPMN Simulation Report View	
Item	CostOnActivitySimulation- Result
Time	
Control	
Resource	
Cost	
<<Activity>>Task (100+3*30)	
Total Completion Cost	100.00
Total Time Cost	90.00
<<Activity>>call global (100+2*10)	
Total Completion Cost	100.00
Total Time Cost	20.00
<<Activity>>Task(100+4*20)	
Total Completion Cost	100.00
Total Time Cost	80.00
<<GlobalTask>>GlobalTask1	
Total Completion Cost	100.00
Total Time Cost	20.00
<<GlobalTask>>GlobalTask1(<<Activity>>call global (100+2*10))	
Total Completion Cost	100.00
Total Time Cost	20.00
<<BusinessProcess>>BPSim Cost	
Total Completion Cost	50.00
Total Time Cost	45.00

## Analysis

Activity	Analysis
Task(100+4*20)	<ul style="list-style-type: none"> <li>Total Completion Cost is 100, matching the FixedCost (100) setting in BPSim</li> <li>Total Time Cost is 80, calculated as ProcessingTime (4 hours) * UnitCost (20/hour)</li> </ul>
Task(100+3*30)	<ul style="list-style-type: none"> <li>Total Completion Cost is 100, matching the FixedCost (100) setting in BPSim</li> <li>Total Time Cost is 90, calculated as ProcessingTime (3 hours) * UnitCost (30/hour)</li> </ul>
call global (100+2*10)	<ul style="list-style-type: none"> <li>Total Completion Cost is 100, matching the FixedCost (100) on <i>GlobalTask1</i> setting in BPSim</li> <li>Total Time Cost is 20, calculated as ProcessingTime (2 hours) * UnitCost (10/hour) on <i>GlobalTask1</i></li> </ul>
BPSim Cost process	<ul style="list-style-type: none"> <li>Total Completion Cost is 50, matching the FixedCost (50) setting in BPSim</li> <li>Total Time Cost is 45, calculated as Total ProcessingTime of all tasks (4 + 3 + 2 = 9 hours) * UnitCost (5/hour)</li> </ul>

## Set Cost Parameters on Resource




## Create the BPMN Model (Resources)

- In the Browser window create a *StartEvent1*, a *GlobalTask1*, two abstractTasks called *Task (by Junior)* and *Task (by Senior)*, and an *EndEvent1*
- Ctrl+drag the elements from the Browser window onto a diagram, pasting *GlobalTask1* as an Invocation (Call Activity) named *call global (by Junior)*
- Connect the elements with Sequence Flows
- Create two BPMN2.0 Resource elements: *Junior Developer* and *Senior Developer*



## BPSim Configuration

Create a Business Process Simulation configuration Artifact in the diagram, right-click on it and select the 'Configure BPSim' option, then set the configuration to link to the Package containing the BPMN model elements and configure these BPSim parameters as indicated.

Parameter	Setting
Scenario Parameters	<ul style="list-style-type: none"> <li>• Click on the 'Scenario' tab and, for the 'Time Unit' parameter, click on the 'Value' drop-down arrow and select 'hours'</li> <li>• In the 'Value' field for the 'Duration' parameter, set the value to '0001 00:00:00' (1 day)</li> </ul> <p>This Time Unit is used to calculate the Time Cost (Time cost = Unit Cost * Time), so make sure that the Unit Cost is based on the correct Time Unit.</p>
Control Parameters	<ul style="list-style-type: none"> <li>• On the left side of the dialog, expand the 'StartEvent' group and click on <i>StartEvent1</i></li> <li>• Click on the 'New Parameter' drop-down arrow and select 'TriggerCount'</li> <li>• In the 'Value' field type '1'</li> </ul>
Time Parameters	<p>On the left side of the dialog, expand the 'Activities' group.</p> <ul style="list-style-type: none"> <li>• Click on <i>Task (by Junior)</i> and on the 'Time' tab, then click on the 'New Parameter' drop-down arrow and select 'ProcessingTime'; set the 'Value' field to '000:000:000 004:00:00' (4 hours)</li> <li>• Click on <i>Task (by Senior)</i> and do the same, setting the 'Value' field to '000:000:000 003:00:00' (3 hours)</li> </ul> <p>Expand the 'GlobalTask' group.</p> <ul style="list-style-type: none"> <li>• Click on <i>GlobalTask1</i> and do the same, setting the 'Value' field to '000:000:000 002:00:00' (2 hours)</li> </ul>
Resource Parameters	On the left of the dialog, expand the 'Resource' group.

	<ul style="list-style-type: none"> <li>Click on <i>Junior Developer</i> and on the 'Resource' tab, then click on the 'New Parameter' drop-down arrow and select 'Quantity'; in the 'Value' field type '10'</li> <li>Click on <i>Senior Developer</i> and do the same, typing '5' in the 'Value' field</li> </ul> <p><b>Assign Resource to Activities</b></p> <p>On the left of the dialog, expand the 'Activity' group and click on:</p> <ul style="list-style-type: none"> <li><i>Task (by Junior)</i> and on the 'Resource Role' tab, then - if the 'Resource Roles defined in BPMN' panel is empty - click on the Add Resource Role button, choose 'Junior Developer' and type '1' in the 'Quantity' field; check that the 'Resource Selection Expression for Activity' panel now contains:  <code>bpsim::getResource('Junior Developer', 1)</code></li> <li><i>call global (by Junior)</i> and do exactly the same thing</li> <li><i>Task (by Senior)</i> and do the same thing, selecting 'Senior Developer' and setting 'Quantity' to '1'; the 'Resource Selection Expression for Activity' panel should contain:  <code>bpsim::getResource('Senior Developer', 1)</code></li> </ul>
Cost Parameters	<ul style="list-style-type: none"> <li>Click on <i>Junior Developer</i> and on the 'Cost' tab, then click on the 'New Parameter' drop-down arrow and select: <ul style="list-style-type: none"> <li>'FixedCost' - in the 'Value' field click on the  button, select the 'Constant' tab and 'Floating', then in the 'Constant Floating' field type '100' and in the 'CurrencyUnit' field type 'AUD'; click on the OK button</li> <li>'UnitCost' - do the same, setting the 'Constant Floating' field to '20'</li> </ul> </li> <li>Click on <i>Senior Developer</i> and do the same, setting: <ul style="list-style-type: none"> <li>'FixedCost' to '100'</li> <li>'UnitCost' to '30'</li> </ul> </li> </ul>

## Simulation

- From the Configure BPSim window toolbar, click on the Run button; the 'BPSim Simulation Controller' dialog displays
- Click on the Run button and select 'Standard Simulation'
- When the simulation is complete, click on the  button on the 'BPMN Simulation Controller' dialog toolbar; the 'BPMN Simulation Report View' displays
- Filter the report by clicking on the  button and selecting 'Show only Non-Empty Items'



BPMN Simulation Report View	
Item	CostOnResourceSimulation- Result
▷ Time	
▷ Control	
▷ Resource	
▾ Cost	
▾ <<Resource>> Senior Developer	
Total Completion Cost	100.00
Total Time Cost	90.00
▾ <<Resource>> Junior Developer	
Total Completion Cost	200.00
Total Time Cost	120.00


## Analysis

Resource	Results
Junior Developer	<ul style="list-style-type: none"> <li>Total Completion Cost is '200', calculated as FixedCost (100) * number of Activities involved (2)</li> <li>Total Time Cost is '120', calculated as ProcessingTime (4 + 2 = 6 hours) * UnitCost (20/hour)</li> </ul>
Senior Developer	<ul style="list-style-type: none"> <li>Total Completion Cost is '100', calculated as FixedCost (100) * number of Activities involved (1)</li> <li>Total Time Cost is '90', calculated as ProcessingTime (3 hours) * UnitCost (30/hour)</li> </ul>

## Export a BPSim Configuration


When you have defined a BPSim Configuration in a model, you can export it to an XMI file to be imported into other projects. The BPMN 2.0 model on which the configuration is based is also exported with the configuration. This binds the model to the appropriate BPSim Configuration when you import the XMI file into another project.

### Access

Ribbon	Publish > Model Exchange > Export-XML > Export XML for Current Package : Publish
Context Menu	On a diagram or in the Browser window, right-click on the Business Process Simulation Artifact   Export BPSim Configuration
Keyboard Shortcuts	Ctrl+Alt+E : Publish
Other	Toolbar of Configure BPSim window    Export icon

### Publish Model Package

The process of exporting a BPSim configuration and its model uses the 'Publish Model Package' dialog for publishing a model to an XMI file.

Option	Description
Package	Defaults to the name of the Package containing the Business Process Simulation Artifact.
Filename	Type in or browse for (click on the  icon) the file path and XML filename into which to export the model.
XML Type	Select 'BPMN 2.0 XML'.
Export	Click on this button to export the configuration and BPMN 2.0 model. The export is complete when a confirmation message displays in the 'Progress' field.
Format XML Output	Defaults to selected; leave selected.
View XML	If you want to examine the exported XML, click on this button.

### Notes

- To import the model from XMI into a new project, select the target Package in the new project and select the 'Publish > Model Exchange > Import XML > Import Package from XMI' ribbon option



