PPS User Guide

Version v0.20.0-RC6

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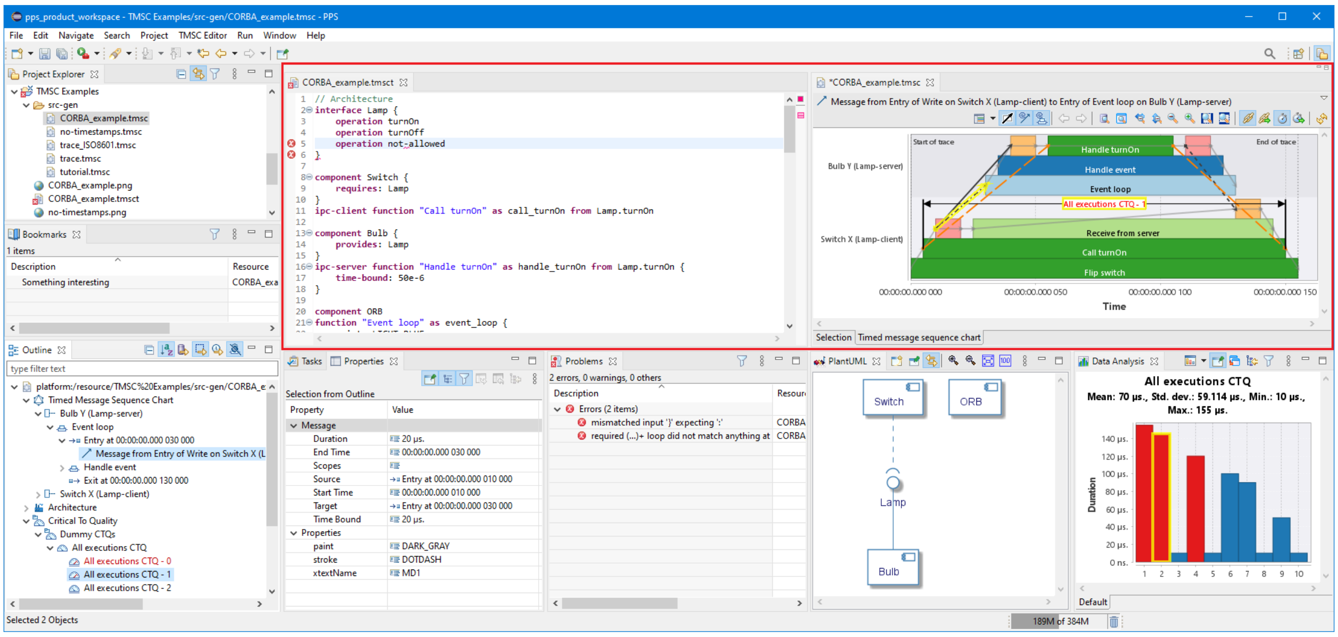
This user guide describes how to use the Platform Performance Suite (PPS). PPS provides insight in software execution over time and enables automatic performance diagnostics. Various generic analysis techniques like critical path, root-cause, outlier identification analysis can be applied to the Timed Message Sequence Chart (TMSC) model. The TMSC-models, as well as the results of the analysis, are presented to the user by various visualizations focusing on facilitating the diagnosis at specific abstraction levels.

Chapter 1. PPS Workbench

PPS is an Integrated Development Environment (IDE) based on Eclipse. For common information about the Eclipse Workbench, please read the Eclipse user guide. The figure below shows a screenshot of the PPS IDE with the most important editors and views for PPS. The remainder of this section explain these views.


pps_product_workspace - TMSC Examples/src-gen/CORBA_example.tmsc - PPS

File Edit Navigate Search Project TMSC Editor Run Window Help

Project Explorer

- TMSC Examples
  - src-gen
    - CORBA_example.tmsc
    - no-timestamps.tmsc
    - trace_ISO8601.tmsc
    - trace.tmsc
    - tutorial.tmsc
  - CORBA_example.png
  - CORBA_example.tmsct
  - no-timestamps.png

Bookmarks

1 items

Description	Resource
Something interesting	CORBA_exa

Outline

- platform:/resource/TMSC%20Examples/src-gen/CORBA_e
  - Timed Message Sequence Chart
    - Bulb Y (Lamp-server)
      - Event loop
        - Entry at 00:00:00.000 030 000
          - Message from Entry of Write on Switch X (L
        - Handle event
        - Exit at 00:00:00.000 130 000
    - Switch X (Lamp-client)
  - Architecture
  - Critical To Quality
    - Dummy CTQs
      - All executions CTQ
        - All executions CTQ - 0
        - All executions CTQ - 1
        - All executions CTQ - 2

CORBA_example.tmsct

```
// Architecture
interface Lamp {
    operation turnOn
    operation turnOff
    operation not-allowed
}

component Switch {
    requires: Lamp
}
ipc-client function "Call turnOn" as call_turnOn from Lamp.turnOn

component Bulb {
    provides: Lamp
}
ipc-server function "Handle turnOn" as handle_turnOn from Lamp.turnOn {
    time-bound: 50e-6
}

component ORB
function "Event loop" as event_loop {
```

*CORBA_example.tmsc

Message from Entry of Write on Switch X (Lamp-client) to Entry of Event loop on Bulb Y (Lamp-server)

Selection | Timed message sequence chart

Tasks | Properties

Selection from Outline

Property	Value
Message	
Duration	20 µs.
End Time	00:00:00.000 030 000
Scopes	
Source	Entry at 00:00:00.000 010 000
Start Time	00:00:00.000 010 000
Target	Entry at 00:00:00.000 030 000
Time Bound	20 µs.
Properties	
paint	DARK_GRAY
stroke	DOTDASH
xtextName	MD1

Problems

2 errors, 0 warnings, 0 others

Description	Resour
Errors (2 items)	
mismatched input '}' expecting ':'	CORBA
required (...)+ loop did not match anything at	CORBA

Data Analysis

All executions CTQ
Mean: 70 µs., Std. dev.: 59.114 µs., Min.: 10 µs., Max.: 155 µs.

Selected 2 Objects

189M of 384M

Figure 1. A screenshot of the PPS IDE

Project Explorer view

Within Eclipse, the files to work with are part of a project. The available projects are shown in the Project Explorer view. Each project is simply a directory on the hard disk, and can be expanded to show the files and directories it contains. By double clicking a file, it is opened in the editor area by the default editor that is associated with that file.

The files in the Project Explorer view support contextual actions by means of the Context menu. The supported actions for a file are explained in more detail in the section of the editor that is associated with that file.

Toggling the **[Link with Editor]** button in the *Project Explorer* view toolbar ties the view to always show the current file being edited.

Editor area

The editor area is marked as a red rectangle in a screenshot of the PPS IDE. In the screenshot, the editor area contains two editors side-by-side. By default editors will be opened stacked, but editors can be moved by means of dragging the tab of an editor to another location.

The left editor shows the TMSC textual editor and the right editor shows the TMSC graphical viewer, that both are explained in more detail in their corresponding sections.

Opening a textual editor and graphical viewer side-by-side is useful as the changes in the textual editor will be reflected in the graphical viewer upon save.

Bookmarks view

Bookmarks are a simple way to navigate to resources that are used frequently. The Bookmarks view displays all bookmarks in the Workbench.

Outline view

The Outline view displays an outline of a structured file that is currently open in the editor area, and lists structural elements. The contents of the Outline view are editor specific and therefore explained in more detail in the section of its editor.

Properties view

The Properties view displays property names and values for a selected item such as a `Message` in a screenshot of the PPS IDE. The contents of the Properties view are editor specific and therefore explained in more detail in the section of its editor.

By default the Properties view is stacked behind the Tasks view.

Problems view

As you work with resources in the workbench, various builders may automatically log problems, errors, or warnings in the Problems view. For example, when you save a textual TMSC file that contains syntax errors, those will be logged in the Problems view. When you double-click the icon for a problem, error, or warning, the editor for the associated resource automatically opens to the relevant place.

By default the Problems view is stacked behind the Tasks view.

PlantUML view

The plantuml library implements a DSL and renderer for many UML diagrams (class, sequence, objects, states, activities, …). See http://plantuml.com for more info about the DSL and renderer. The PlantUML view integrates plantuml's functionality into Eclipse and displays contextual UML diagrams for a selected item such as an `Architecture` in a screenshot of the PPS IDE. The contents of the PlantUML view are editor specific and therefore explained in more detail in the section of its editor.

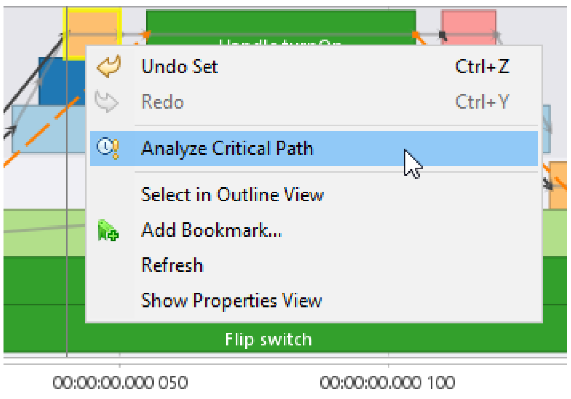
Data Analysis view

The Data Analysis view displays statistical information for a selected item such as a Time series viewer for a `metric instance` in a screenshot of the PPS IDE. The contents of the Data Analysis view are editor specific and therefore explained in more detail in the section of its editor.

By default the Data Analysis view is stacked behind the PlantUML view.

Context menu

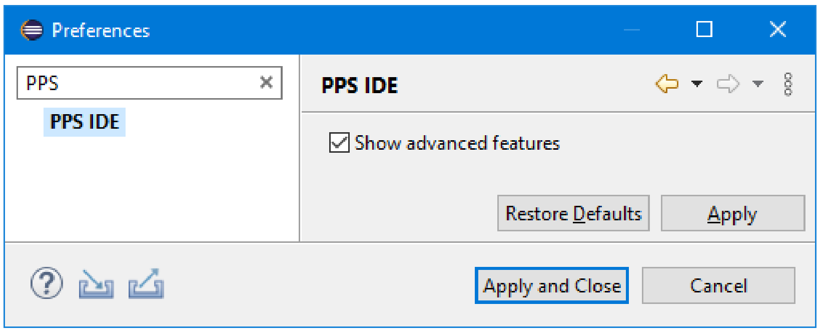
Many views in the PSS IDE support selection and with that, contextual actions based on the selection. The context menu can be visualized by right-clicking the mouse in any part of the view that has the selection. The context menu shows all available actions for both the view and its selection.



1.1. Preferences

Use the command Preferences dialog pages to set how you want Eclipse to operate. The menu path is **Window › Preferences** on Windows and Linux - on macOS the Preferences can be found in the **App** menu. The filter input at the left top can be used to easily navigate to the PPS settings.

The *'Show advanced features'* option enables experimental features in PPS. These features may be unstable, undocumented and might produce unexpected results. All editors should be closed and re-openend after changing this setting for the changes to take effect.



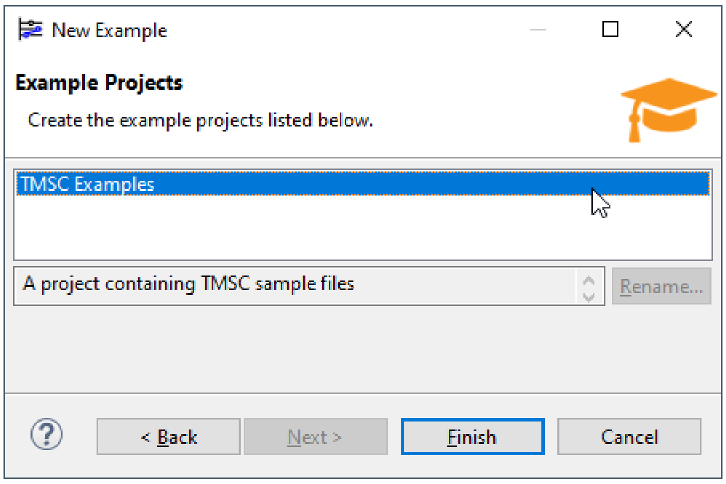
PPS IDE

☑ Show advanced features

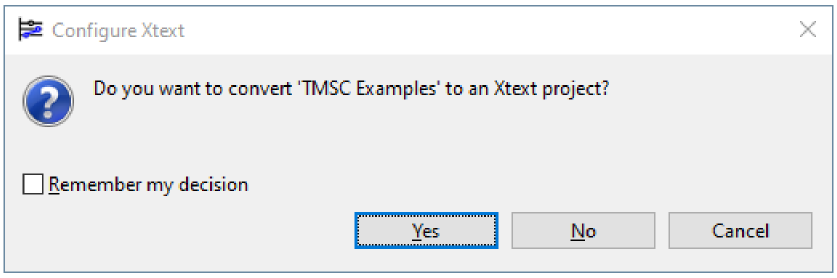
Chapter 2. TMSC textual editor

The TMSC textual syntax allows you to create small example traces, to explore, test or document PPS features. The textual syntax is not developed for large traces as it will suffer from scalability issues. For large traces a custom TMSC reconstructor should be implemented as documented in the PPS developer guide.

The TMSC textual editor provides syntax highlighting and code completion to support writing TMSCs. It also provides means to customize the visualization of the TMSC by e.g., defining colors for executions and dependencies. All features of the syntax are explained in the comment that are included in the `tutorial.tmsct` file that is part of the TMSC examples project as provided by PPS. Use the **File › New › Example...** menu and choose the `TMSC Examples Wizard` to add this TMSC examples project to your PPS workspace. Then click the **[Finish]** button to complete the import.


New Example
Example Projects
Create the example projects listed below.
TMSC Examples
A project containing TMSC sample files
Rename...
< Back
Next >
Finish
Cancel

During import the following question may pop up. You may want to check `Remember my descision`. Then click the **[Yes]** button to continue.

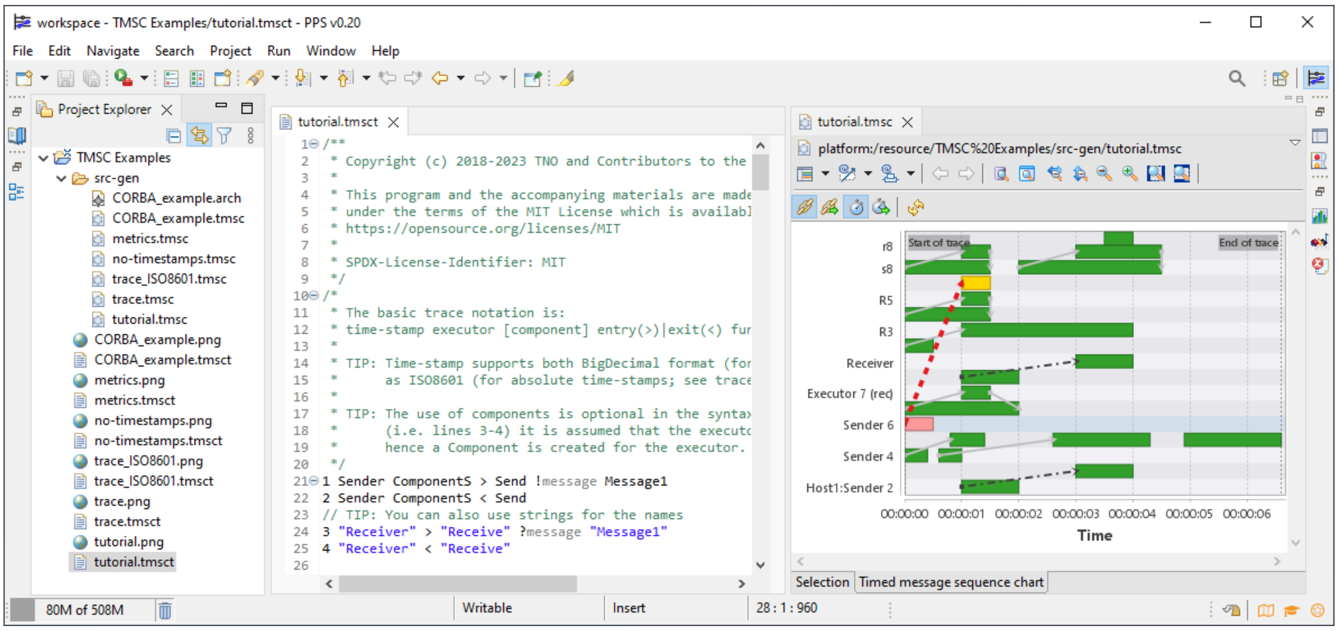


Do you want to convert 'TMSC Examples' to an Xtext project?

When the wizard is done, the `tutorial.tmsct` file is automatically opened in the editor area. Upon a save of a `*.tmsct` file, a `*.tmsc` file with the same name is automatically generated in the `src-gen` folder within the project. This TMSC file can be opened with the TMSC graphical viewer.

Toggling the **[Link with Editor]** button in the *Project Explorer* view toolbar ties the view to always show the current file being edited.

In the screenshot below, the editor area contains the TMSC textual editor and the TMSC graphical viewer side-by-side. By default editors will be opened stacked, but editors can be moved by means of dragging the tab of an editor to another location. Opening a textual editor and graphical viewer side-by-side is useful as the changes in the textual editor will be reflected in the graphical viewer upon save.



```
/**
 * Copyright (c) 2018-2023 TNO and Contributors to the
 *
 * This program and the accompanying materials are made
 * under the terms of the MIT License which is availabl
 * https://opensource.org/licenses/MIT
 *
 * SPDX-License-Identifier: MIT
 */
/*
 * The basic trace notation is:
 * time-stamp executor [component] entry(>)|exit(<) fur
 *
 * TIP: Time-stamp supports both BigDecimal format (for
 *      as ISO8601 (for absolute time-stamps; see trace
 *
 * TIP: The use of components is optional in the syntax
 *      (i.e. lines 3-4) it is assumed that the executo
 *      hence a Component is created for the executor.
 */
1 Sender ComponentS > Send !message Message1
2 Sender ComponentS < Send
// TIP: You can also use strings for the names
3 "Receiver" > "Receive" ?message "Message1"
4 "Receiver" < "Receive"
```

2.1. Project Explorer view

The `tmsct` file extension is associated with the TMSC textual editor.

Chapter 3. TMSC graphical viewer

The runtime behavior and timing of software applications can be visualized using Timed Message Sequence Charts (TMSC). Various generic analysis techniques like critical path, root-cause, outlier identification analysis can be applied to the TMSC model. To learn more about Timed Message Sequence Charts, please read section Timed Message Sequence Charts.

The TMSC `*.tmsc` or `*.tmscz` files can be viewed by using the TMSC graphical viewer. By double clicking on a TMSC file, this viewer opens. After opening the viewer, the viewer starts loading the model. Once the model is loaded, the viewer is filled with the data from the model. The editor features various views, each with a different purpose, namely:

- Project Explorer View (detached)
- Outline View (detached)
- Selection View (tab)
- Timed Message Sequence Chart View (tab)
- PlantUML View (detached)
- Data Analysis View (detached)

3.1. Timed Message Sequence Charts

The runtime behavior and timing of software applications can be visualized using Timed Message Sequence Charts (TMSC). In a TMSC, executors are shown on as horizontal swimlanes, and (real) time is shown along the horizontal axis. The labels of the executors are shown on the vertical axis. An executor is a single threaded computational resource with run-to-completion semantics. The function calls that are executed by an executor are shown as bars within its swimlane and are called executions. The bars are labeled with the function name. Nested function call executions are drawn as stacked bars, resulting in a call stack. Arrows between the bars denote the data and control flow dependencies. The arrows indicate where executors are communicating with each other. Section Relations to (Message) Sequence Charts and Flame Graphs compares TMSCs to similar representations.

Section TMSC view shows an example visualization.

3.1.1. Relations to (Message) Sequence Charts and Flame Graphs

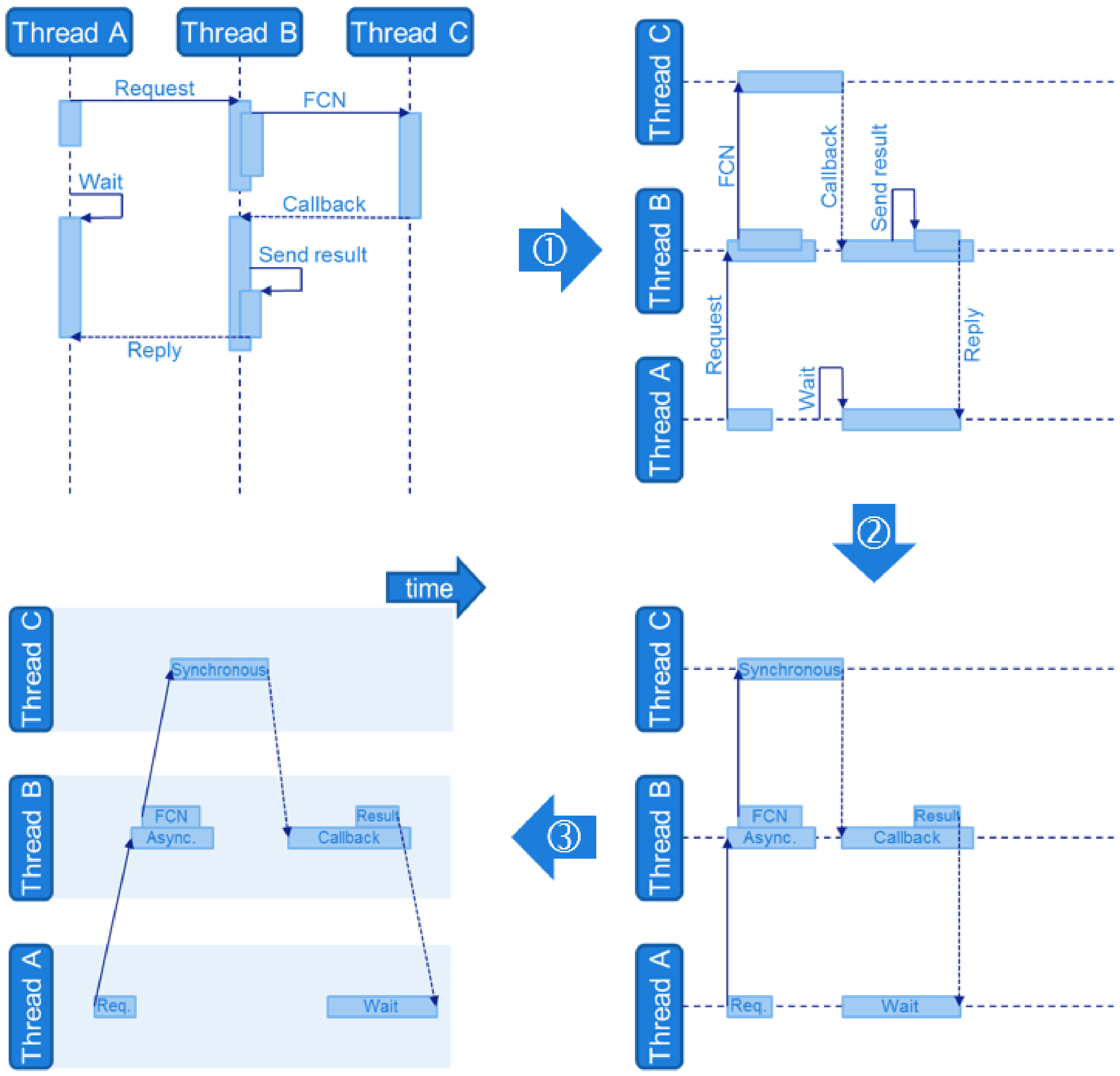
To give some more intuition about Timed Message Sequence Charts, they are compared to similar representations.

Timed Message Sequence Charts are similar to UML Sequence Diagrams and SDL Message Sequence Charts. The main differences are:

- The horizontal axis and vertical axis are swapped such that life-lines are positioned horizontally, and the vertical axis shows the life-line labels.
- The life-lines represent autonomous execution entries, similar as in SDL.

- Life-lines are shown as swim-lanes.
- Arrows represent asynchronous messages, i.e. the sending executor continues execution directly.
- Overlapping executions are drawn as stacked boxes, instead of overlapping boxes.
- Labels are shown inside the executions, instead of on the arrows.
- The horizontal axis shows the (real) time, such that the length of an execution represents the actual duration of that execution, and the distance between the start and the end of an arrow represent the latency of message passing.
- Fragments, such as loops, alternatives and references, are not allowed in Timed Message Sequence Charts.

These differences are illustrated with the picture below.



Timed Message Sequence Charts are also similar to Call Charts or Flame Charts. It can be argued that Timed Message Sequence Charts have a Flame Chart for each executor. These Flame Chart are connected by arrows to show inter-executor relations. Note that, Flame Charts should not be confused with Flame Graphs, Flame Graphs put the alphabet on the horizontal axis instead of the time, see Brendan Gregg’s pages.

3.1.2. On Activities and Paths

TODO

TMSC projection

TODO

3.1.3. Critical Path Analysis

The TMSC also allows more advanced analysis like critical path analysis. Critical path analysis is always applied on the full TMSC.

A transitive reduction is applied on the TMSC before the analysis is performed. In short this means that all path segments which are superfluous are removed.

Critical path analysis to an event can be applied by following the TMSC dependencies in their opposite direction, only taking the route of dependencies with the shortest duration.

The description above is a very simplistic summary of a much more sophisticated algorithm as described in this paper: Inferring Timed Message Sequence Charts from execution traces of large-scale component-based software systems. The algorithm as described in the paper is used as base for implementation.

3.1.4. Metric Analysis

The TMSC metric analysis allows to validate whether timing requirements are met for predefined metrics. Currently, metrics and their budgets can be defined programmatically by means of implementing an extension point as described in the PPS developer guide. When a metric is analyzed, this results in a sequence of metric instances, one for every occurrence found. Each metric instance has a duration and all metric instances are analyzed to mark instances that exceed their budget.

3.1.5. Root cause analysis

> The functionality as described in this section still needs to be formalized in a paper. This section will be updated when the paper is available.

> Please read section On Activities and Paths prior to this section.

Automatic root cause analysis can automatically detect if a metric instance was delayed by either resource contention and or service contention. This section explains the detection algorithm on a high level.

Service contention

Service contention basically means that an activity cannot execute as fast as possible because it is delayed by another activity which uses the same services. To detect this, two ingredients are needed: the critical path and the activity TMSC, both between the start and end of a metric instance. We can now say that all critical TMSC dependencies which are not part of the activity TMSC are caused by *service contention*.

Resource contention

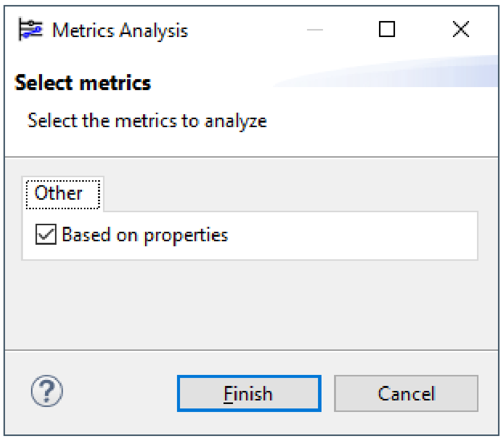
Resource contention basically means that an execution within an activty takes more time than normal, but what is 'normal'. For metric instances multiple instances can be found within a trace. Typically these metric instances execute the same software functions in the same sequence, what we call repetitive behavior. We can use this repetitive behavior to determine the 'normal' execution time for each function within a metric instance. Outlier detection based on the interquartile range, with a multiplicand of 3.0, is used to detect *resource contention*.

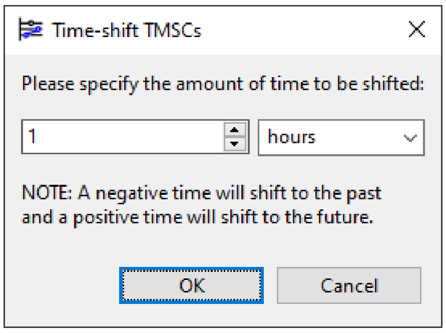
3.1.6. Slack Analysis

TODO

3.2. Project Explorer view

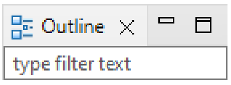
The `tmsc` and `tmscz` file extensions are associated with the TMSC graphical viewer. These files support the following contextual actions:

Icon	Action	Description
	[Analyze metrics...]	Starts metric analysis for the selected TMSC, please read section Metric Analysis for more information. When clicked, a wizard is presented to select the metrics to analyse. When done, the analyzed metrics and their resolved instances are saved in the TMSC. When the TMSC is opened in the TMSC graphical viewer the metrics and their resolved instances are visible in the Outline view. ⚠ This item is only visible if metrics are available.  Metrics Analysis — **Select metrics** — Select the metrics to analyze — Other: ☑ Based on properties — Finish — Cancel

Icon	Action	Description
	[Time-shift…]	The time-shift function can be used to correct all times in a TMSC file by applying an offset. When clicked, a dialog is presented to specify the amount of time to shift. Please close the TMSC graphical viewer for the selected TMSCs before applying a time-offset to avoid unresponsiveness of the IDE.  Time-shift TMSCs Please specify the amount of time to be shifted: 1 hours NOTE: A negative time will shift to the past and a positive time will shift to the future. OK Cancel

3.3. Outline view

The *Outline* view supports dynamic filtering of its elements, by means of entering a search pattern in its filter text box.

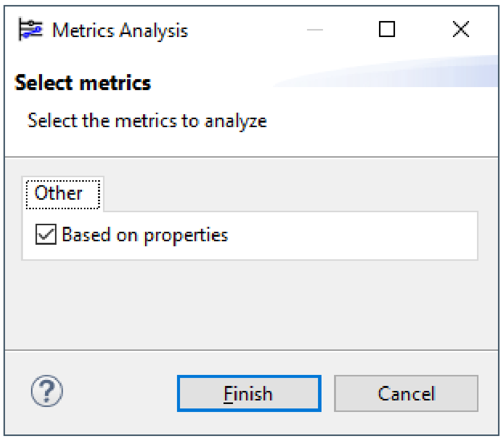


The *Outline* view shows the model in a tree view. Clicking an element in the tree selects the element and shows the details of that element in the *Properties* view.

By selecting elements in the tree both the resource and time context of an editor view can be reduced, see also Section dynamic inclusion filtering. With reduction of the resource context is meant that the editor area will show only content which is related to the selected *Outline* elements. For example, when a life-line is selected, the TMSC view view will only show this life-line and the life-lines that it directly communicates with. This feature is active if the **[Push Context]** toggle bottom is selected.

When the **[Push Time Range]** toggle button is selected, the editor area will automatically show the time range which includes the time context for the selected *Outline* elements.

The model elements in the content outline tree support the following contextual actions:

Elements	Icon	Action	Description
TMSC		**[Analyze metrics…]**	Starts metric analysis for the selected TMSC, please read section Metric Analysis for more information. When clicked, a wizard is presented to select the metrics to analyze. When done, the analyzed metrics and their resolved instances are visible in the Outline view and can be saved using the **File › Save** menu. This item is only visible if metrics are available.  Metrics Analysis **Select metrics** Select the metrics to analyze Other ☑ Based on properties
TMSC Scoped-TMSC		**[Analyze slack]**	Performs slack analysis on the selected TMSC, read section Slack Analysis for more information. When done, the rendering strategy is changed to the slack rendering strategy to show the calculated slack.
Scoped-TMSC		**[Save as TMSC]**	Saves the scoped TMSC, including its child scopes, into a new file, retaining only the elements of the TMSC that are required to store the scoped TMSC. This allows the user to only store a small portion of a larger TMSC.
Metric Metric-Instance		**[Add metric annotations to TMSC]**	Adds measurement annotations for the selected metric instances to the TMSC chart.

Elements	Icon	Action	Description
Dependency Execution Event Measurement Metric-Instance		**[Analyze critical path]**	Performs critical path analysis on the selected element, read section Critical Path Analysis for more information. If a measurement or metric instance is selected, the critical path analysis run from the end until the start-time of the interval. In other cases the critical path analysis starts at the start of the selected element and only stops at the end of the critical path. When done, the rendering strategy is changed to the critical path rendering strategy to show the critical path. The critical path is also visible in the Outline view as Scoped TMSC and can be saved using the **File › Save** menu.
Metric-Instance (*exceeding budget*)		**[Analyze root cause]**	Performs root-cause analysis on the selected metric instance, read section Root cause analysis for more information. When done, the rendering strategy is changed to the critical path rendering strategy to show the root cause analysis results. The results are also visible in the Outline view as Scoped TMSC and can be saved using the **File › Save** menu.

3.4. Selection view

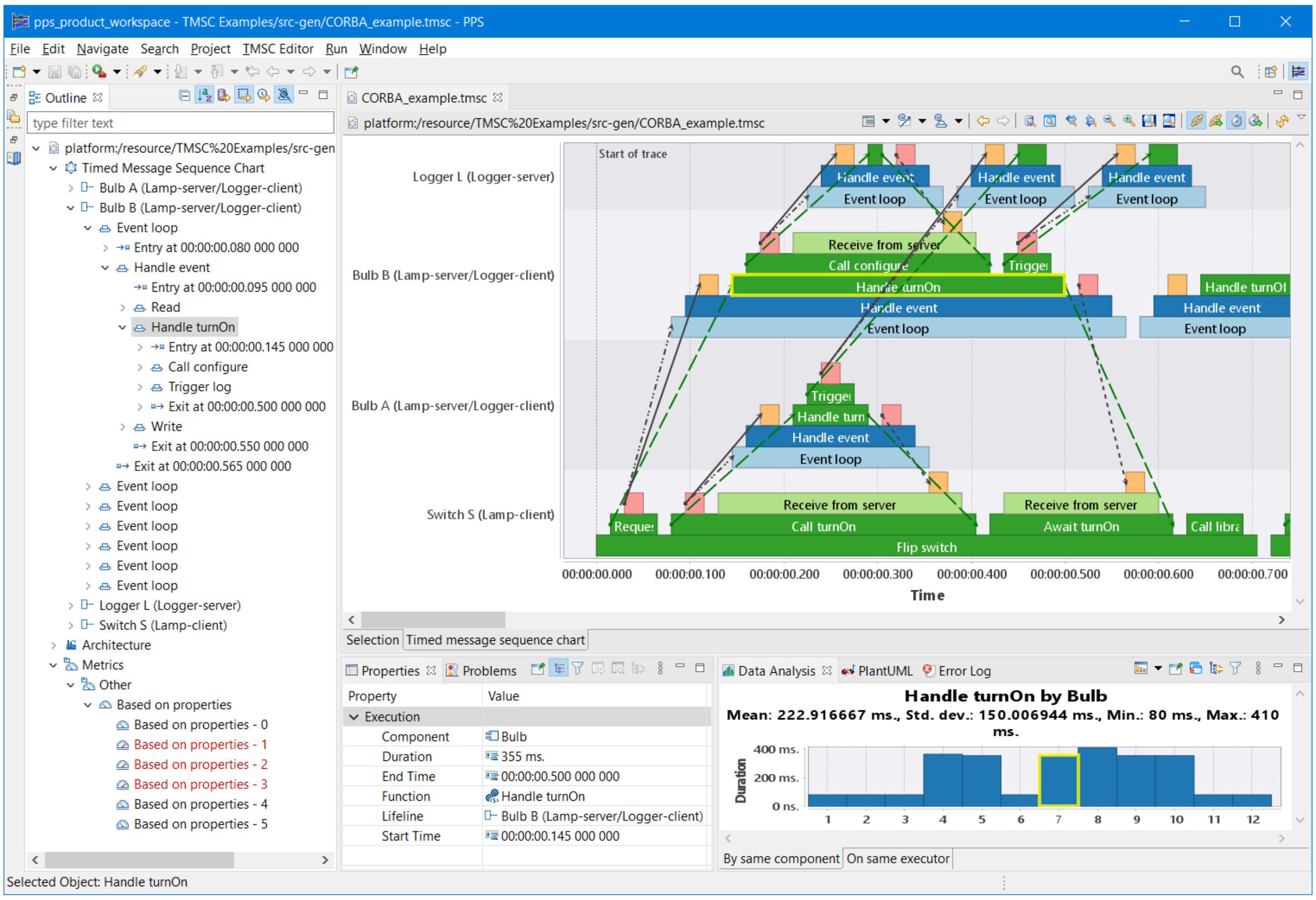
The *Selection* view tab is similar to the *Outline* view. It shows the model in a tree view. Clicking an element in the tree selects the element and shows the details of that element in the *Properties* view.

This view supports dynamic filtering based on the *Outline* view selection (see section dynamic inclusion filtering) to filter elements of interest.

3.5. Timed message sequence chart view

In a TMSC, the life-line of an executor is shown on as a horizontal swimlane, and (real) time is shown along the horizontal axis. The executor labels are shown on the vertical axis. The function calls that are executed by an executor are shown as bars within the swimlane. The bars are labeled with their execution name. Nested function call executions are drawn as stacked bars, resulting in a call stack. Arrows between the bars denote the data and/or control flow dependencies. The arrows indicate where executors are communicating with each other.

Due to dynamic inclusion filtering some executors might not be shown; however, the visible executors might communicate with this hidden executors. Communication text balloons are shown in this case, depending on the selected dependencies visibility. The arrow from/to the balloon indicates the data flow of the communication and the text in the balloon describes the other side.



- platform:/resource/TMSC%20Examples/src-gen
  - Timed Message Sequence Chart
    - Bulb A (Lamp-server/Logger-client)
    - Bulb B (Lamp-server/Logger-client)
      - Event loop
        - Entry at 00:00:00.080 000 000
        - Handle event
          - Entry at 00:00:00.095 000 000
          - Read
          - Handle turnOn
            - Entry at 00:00:00.145 000 000
            - Call configure
            - Trigger log
            - Exit at 00:00:00.500 000 000
          - Write
          - Exit at 00:00:00.550 000 000
        - Exit at 00:00:00.565 000 000
      - Event loop
      - Event loop
      - Event loop
      - Event loop
      - Event loop
      - Event loop
    - Logger L (Logger-server)
    - Switch S (Lamp-client)
  - Architecture
  - Metrics
    - Other
      - Based on properties
        - Based on properties - 0
        - Based on properties - 1
        - Based on properties - 2
        - Based on properties - 3
        - Based on properties - 4
        - Based on properties - 5

Property	Value
Execution	
Component	Bulb
Duration	355 ms.
End Time	00:00:00.500 000 000
Function	Handle turnOn
Lifeline	Bulb B (Lamp-server/Logger-client)
Start Time	00:00:00.145 000 000

It is possible to select executions or dependencies by clicking on them, also see section Selection in Chart. Selected elements are shown with a thicker yellow border. Once selected, the details of the execution can be seen in the *Properties* view and in the Data Analysis view.

By default, the *Properties* view displays normal properties. To view expert properties click the **[Show Advanced Properties]** button to reveal them.

The *Timed message sequence chart* view tab supports some common functions to support analysis of its data, like:

- Dynamic filtering based on the *Outline* view selection, see Section dynamic inclusion filtering.
- Select executions and dependencies by clicking on them, see section Selection in Chart. Once selected, details can be seen in the *Properties* view and in the Data Analysis view.
- Measuring the time between executions, see Section Measure Time.
- Synchronize the current visible time window with all other supported editors, see Section Synchronize Timing.
- Place a bookmark at a specific area within a file.

- Saving a snapshot of the chart, see Section Export chart to PNG file.
- Panning and zooming, see Section Panning and Zooming.

On top of these common functions, the *TMSC* tab has the following additional action bar buttons.

Icon	Action	Description
▼	**[Select Rendering Strategy]**	Changes the appearance of the TMSC depending on the analysis that is applied to the TMSC. Please read section Rendering strategies for more information. Please note that the icon depends on the current selection and therefore might be different than illustrated here.
▼	**[Select Dependencies Visibility]**	Show all dependencies. Hide communication text balloons on dependencies. Also hide dependencies that cross the current visible area of the chart. In other words, dependencies that do not start or end within the visible area. Hide all dependencies.
▼	**[Select Executions Visibility]**	Show all executions. Hide communication text balloons on executions. Hide all executions.
	[Optimize]	"Optimize" the life-line order of the TMSC view. This groups the life-lines by minimizing the distance in the graph of messages for the visible time range. The button moves the life-lines only when pressed. When the time range is moved, the optimization action can be re-applied.

3.5.1. Rendering strategies

Rendering strategies allow to visualize TMSCs from different viewpoints to support tailored user feedback for different analyses. When just viewing a TMSC, different colors and strokes for executions and dependencies might help the user to better understand their domain, whereas for, e.g., critical path analysis it is important that the dependencies on the critical path are highlighted. The rendering strategies in PPS are flexible and extendible (as described in the developer guide).

Performing an analysis may change the applied rendering strategy. Please use the rendering strategy toolbar button to go back to the previous rendering strategy if needed.

Icon	Name	Description
	[Based on properties]	This rendering strategy is typically used together with the TMSC textual editor. This strategy will render the TMSC elements based on properties that are added to the TMSC model. Please read the comments that are included in the `tutorial.tmsct` for more information.

Icon	Name	Description
	[Critical Path]	This strategy is used to show the Critical Path Analysis and Root cause analysis results. To learn more about these analyses and how to interpret their results, please read their corresponding sections. All executions are grayed-out as the analysis results focus on paths. The critical dependencies are rendered as thicker arrows where: • Blue: The critical path behaves as expected or no outliers where found during root-cause analysis. • Yellow: The dependency has an abnormal duration, but did not cause the metric instance to exceed its budget. • Red: The dependency caused the metric instance to exceed its budget.
	[Default]	This is the default rendering strategy and can be used to render any TMSC. This strategy shows all elements except life-line segments and projected dependencies. No color strategy is applied for executions, messages are dark-gray and other dependencies are light-gray.
	[Slack]	This strategy is used to show the Slack Analysis result. To learn more about this analysis and how to interpret its results, please read the corresponding section. The strategy shows the TMSC using the default rendering strategy and adds annotations for events that indicate how much slack is allowed before that point in software becomes critical.

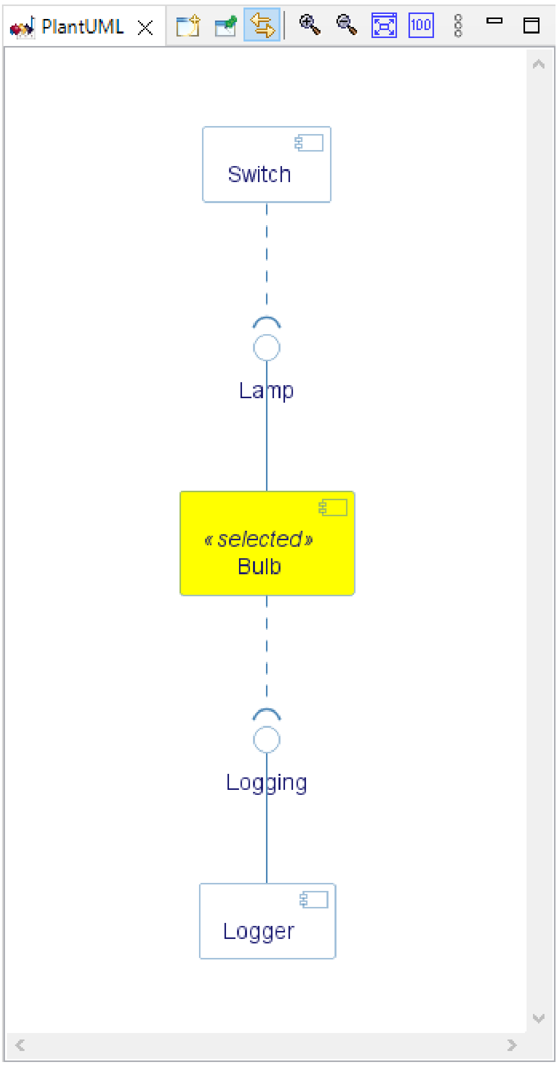
3.6. PlantUML view

PPS includes the PlantUML Eclipse Plugin to show UML diagrams for some architecture elements in the runtime architecture of a TMSC.

When an interface is selected in the Outline view, the interface and the components that are requiring or providing the interface are shown in a component diagram.

When a component is selected in the Outline view, the component, its required and provided interfaces and the components that respectively provide or require those interfaces are shown in a component diagram.

The selected architecture element is rendered in yellow as illustrated in the figure at the right.



3.7. Data Analysis view

To open the Data Analysis view, click the **Window** › **Show View** › **Data Analysis** menu.

This view can be used to perform analysis on TMSC elements like executions, messages or metrics. By selecting an element, it can be analyzed in detail. All comparable occurrences of the element will be collected and analyzed in the selected chart. What makes an element comparable, depends on the type of the element. For executions, their function and either component or executor are considered.

Apart from the standard analysis of a single element, there is also the possibility to analyze measurements. To access this function, the user must first perform a time measurement for two executions. By selecting the measurement, the execution pair can be analyzed in detail. All occurrences of execution pairs for the selected measurement will be collected and analyzed in the selected chart.

The charts in the *Data Analysis* view support some common functions to support analysis of their data, like:

- Panning and zooming, see Section Panning and Zooming.

- Saving a snapshot of the chart, see Section Export chart to PNG file.

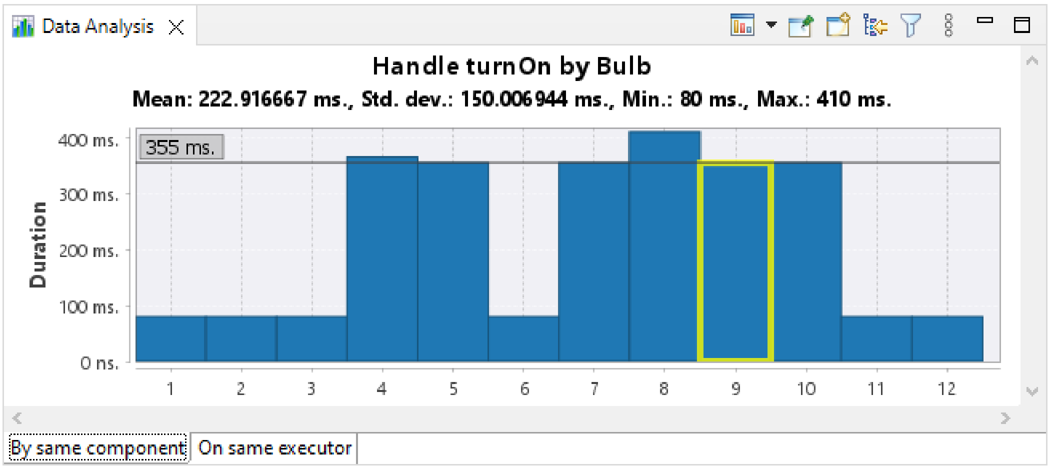
On top of these common functions, the *Data Analysis* view has the following additional action bar buttons.

Icon	Action	Description
📊 ▼	**[Select Data Analysis Type]**	Two types of charts are available for analyzing the data, please read their corresponding sections for more information: 📊 Time series 📶 Histogram
🗗	**[New Data Analysis View]**	If pushed, it opens another instance of the *Data Analysis* view. The other instance can be used to, for instance, view both the time series and histogram at the same time, or to keep one of the views pinned to a selection.
📌	**[Pin to selection]**	If pushed, this Data Analysis view is pinned to the current selection.

▽	**[Filter Outliers]**	If pushed, a dialog is shown that allows to remove outliers from the current data set. The following outlier detection algorithms are supported:
		
		Interquartile range
		From Wikipedia: The interquartile range is often used to find outliers in data. Outliers here are defined as observations that fall below `Q1 − "multiplicitant"*IQR` or above `Q3 + "multiplicitant"*IQR`, where a multiplicitant of 1.5 is used to detect mild outliers and 3 is used for extreme outliers.
		
		Sigma test
		From Brendan Gregg: This identifies the presence of outliers based on their distance from the bulk of the data, and should be relatively easy to understand.
		First, calculate the max sigma:
		`maxσ = (max(x) − μ) / σ`
		This is how far the max is above the mean, μ, in units of standard deviation, σ (sigma). The sigma test is then:
		`outliers = (maxσ >= "threshold")`
		If any measurement exceeds "threshold" standard deviations, we can say that the sample contains outliers.
		
		Range
		Outliers here are defined as observations that fall below `"min"` or above `"max"`

3.7.1. Time series viewer

This chart displays the durations for all comparable elements for the selected element, including the element itself. A description for the selected element is displayed in the title of the chart. Statistical information can be found just below the title of the chart: mean, standard deviation, minimum and maximum.



Every occurrence will be visualized as a vertical bar, with the height being equal to the duration. The occurrences are ordered 'as is', just like the order in the original data set. The originally selected element is also selected in the bar chart.

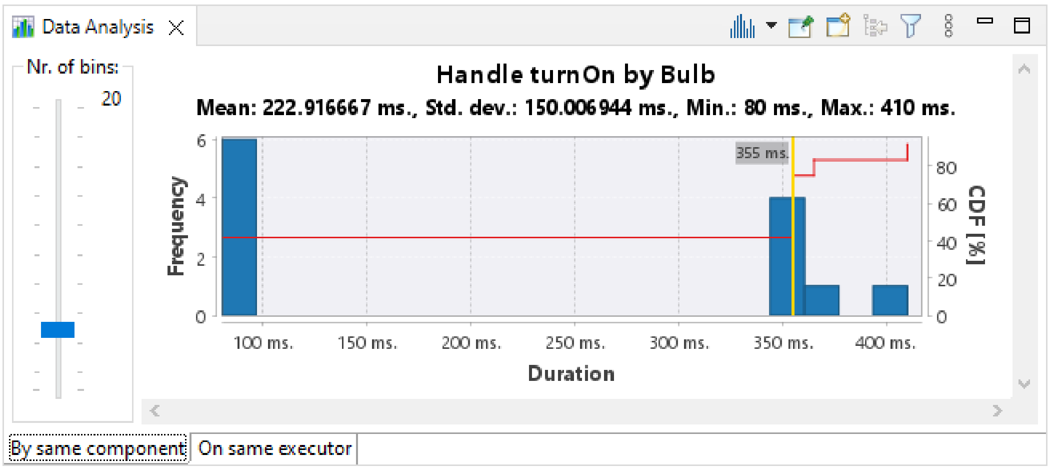
> If a metric is selected, the durations of its instances will be visualized, where red bars denote instances that exceed the metric budget.

On top of the common *Data Analysis* functions, the *Time Series Chart* view also supports selection and the following additional action bar buttons.

Icon	Action	Description
	[Locate value]	If pushed, the current selection of the Data Analysis view is synchronized to the Outline view of the TMSC graphical viewer. Depending on the content outline settings the selection may also be pushed to the active viewer.

3.7.2. Histogram viewer

This chart displays a histogram of the durations for all comparable elements for the selected element, including the element itself. A description for the selected element is displayed in the title of the chart. Additional statistical information can be found just below the title of the chart: mean, standard deviation, minimum and maximum.



The width of the duration intervals on the x-axis can be adjusted by the user using the 'Nr. of bins' slider. The duration of the originally selected element is shown as a vertical, yellow marker. The red line shows the Cumulative Distribution Function (CDF) which shows the probability that the duration will take a value less than or equal to x. <<<

Chapter 4. Common Viewer Functionality

This chapter describes functionality that is commonly available for viewers in PPS.

4.1. Panning and Zooming

The chart viewers supports zooming and panning, as follows:

Zooming, using the mouse

- To zoom in, click in the chart area and drag towards the right and downwards. A rectangle shows the selected area. Once the mouse is released, the chart is zoomed in, only showing the selected area.
  - Hold the `Ctrl` key while clicking and dragging to zoom horizontally only.
  - Hold the `Ctrl` + `Shift` keys while clicking and dragging to zoom vertically only.
- To zoom out, click in the chart area and drag to the left. Release the mouse to zoom all the way out, to show the entire chart.
  - Hold the `Ctrl` key while clicking and dragging to zoom out horizontally only.
  - Hold the `Ctrl` + `Shift` keys while clicking and dragging to zoom out vertically only.

Zooming, using the mouse wheel

Scroll up to zoom in and scroll down to zoom out. The location of the mouse will be used as focus area, meaning that the chart will be zoomed in or out around that point.

- Hold the `Ctrl` key while scrolling with mouse wheel to zoom horizontally.
- Hold the `Ctrl` + `Shift` keys while scrolling with mouse wheel to zoom vertically.

Zooming, using the keyboard

First click somewhere in the chart to activate keyboard focus. While holding the `Ctrl` key, the arrow keys can be used to zoom the chart in or out. Both the normal arrow keys as well as the arrow keys on the numpad can be used.

- Use the `→` or `←` key to zoom in or out horizontally.
- Use the `▯` or `▯` key to zoom in or out vertically.

In addition to the arrow keys, also 'browser style' zooming is supported.
While holding the `Ctrl` key:

- Use the `+` key to zoom in both horizontally as vertically.
- Use the `-` key to zoom out both horizontally as vertically.
- Use the `0` key to zoom all the way out, showing the entire chart.

Panning, using the scroll bars

- Use the vertical scroll bar or mouse wheel to scroll vertically.
- Use the horizontal scroll bar to scroll horizontally.

Panning, using the mouse

Hold the `Alt` key while clicking and dragging the chart in the direction to pan.

Panning, using the keyboard

First click somewhere in the chart to activate keyboard focus. The arrow keys can be used to pan the chart in the desired direction. Both the normal arrow keys as well as the arrow keys on the numpad can be used.

Right click on the chart to show a menu with even more options.

Furthermore, the action bar for time based views show additional buttons to zoom.

Icon	Action	Description
🔍	**[Zoom to fit all the data in the data set]**	Zoom out to show all the data in the current view. ℹ This action can take much time as PPS typically works with large data sets.
🔍	**[Zoom to fit all content]**	Zoom out to show as much content as possible (considering performance) in the current view.
🔍	**[Zoom to fit all content horizontally]**	Zoom out to horizontally show as much content as possible (considering performance) in the current view.
🔍	**[Zoom to fit all content vertically]**	Zoom out to vertically show as much content as possible (considering performance) in the current view.
🔍	**[Zoom out]**	Zoom out a bit.
🔍	**[Zoom in]**	Zoom in a bit.
🔍	**[Zoom to current selection]**	This will zoom the view to show the active selection only. ℹ Only available if Selection in Chart is available for this viewer.
🔍	**[Zoom to fit the time of the current selection]**	This will zoom the view to show the time range for the active selection. ℹ Only available if Selection in Chart is available for this viewer.
🔍	**[Zoom to fit the height of the current selection]**	This will zoom the view to show the height for the active selection. ℹ Only available if Selection in Chart is available for this viewer.

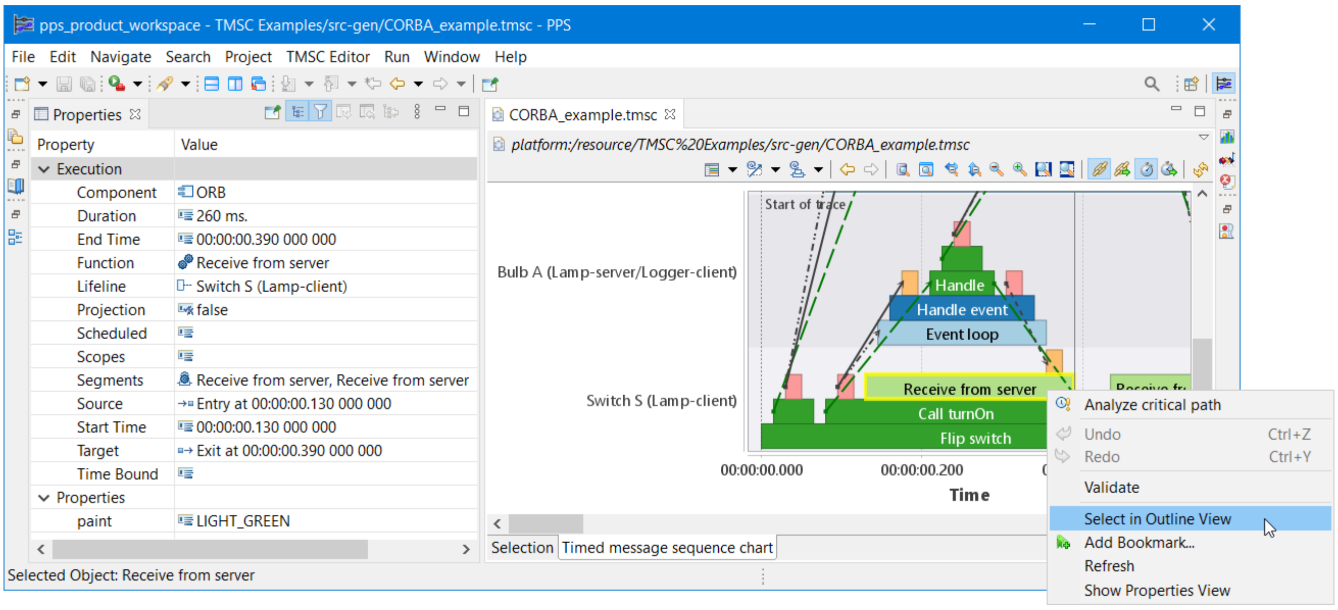
Icon	Action	Description
⇦	**[Back]**	This will navigate back to the previous visible area in the navigation history. The navigation history will be automatically cleared when new input is set to the chart.
⇨	**[Forward]**	This will navigate forward to the next visible area in the navigation history. The navigation history will be automatically cleared when new input is set to the chart.

4.2. Selection in Chart

It is possible to select some of the items in a chart by clicking on them. If an item supports selection and is selected, it is shown with a thicker yellow border. Once selected, the details of the item can be seen in the *Properties* view.

By default, the *Properties* view displays normal properties. To view expert properties click the **[Show Advanced Properties]** button to reveal them.

A context menu is available to select the current chart selection in the *Outline* view. This might be helpful for views that support dynamic inclusion filtering.



Property	Value
Execution	
Component	ORB
Duration	260 ms.
End Time	00:00:00.390 000 000
Function	Receive from server
Lifeline	Switch S (Lamp-client)
Projection	false
Scheduled	
Scopes	
Segments	Receive from server, Receive from server
Source	Entry at 00:00:00.130 000 000
Start Time	00:00:00.130 000 000
Target	Exit at 00:00:00.390 000 000
Time Bound	
Properties	
paint	LIGHT_GREEN

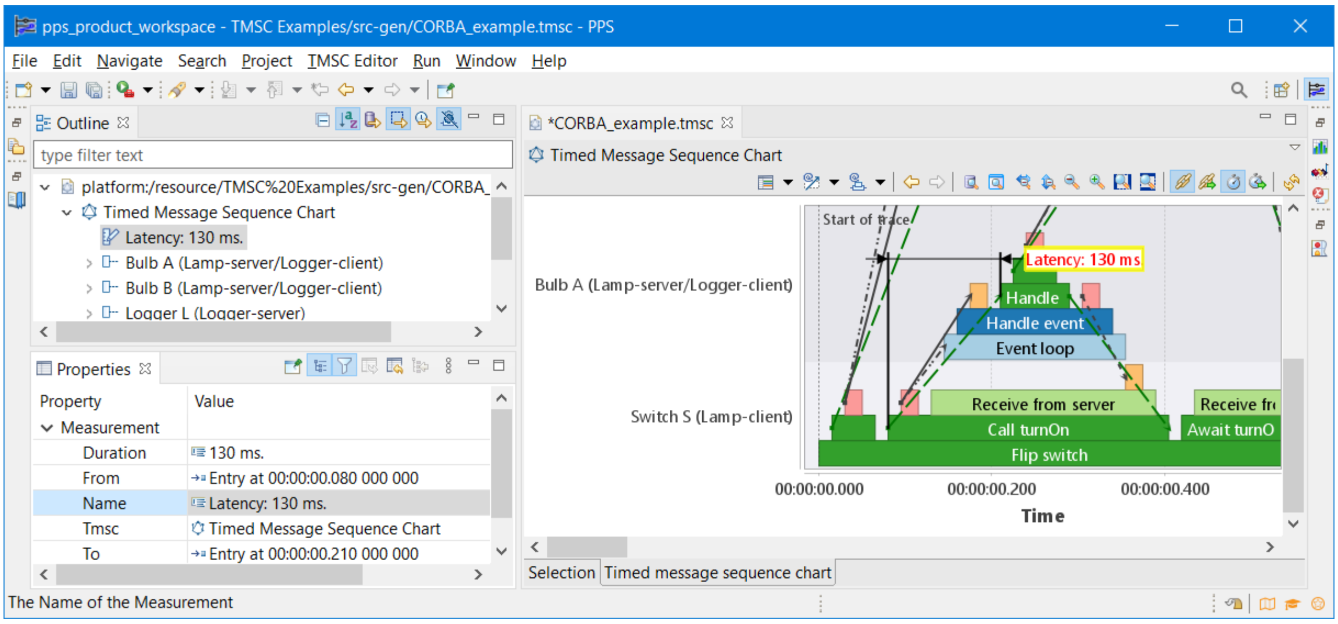
Selected Object: Receive from server

4.3. Measure Time

It is possible to measure the time between for instance the start of one task, and the termination of another task in a chart. While hovering over a task, a gray vertical support line is shown. While hovering over the first half of the task, it is shown at the creation of the task. While hovering over the second half of the task, it is shown at the termination of the task. Hold down the `Alt` key while such a support line is shown, and left click it, to keep the support line fixed at that moment in time. Then hover to move the support line to another end point of a task and again left click while holding the `Alt` key. An annotation is then shown that visually and textually shows the time between the two support lines. The measurement is also added to the model and as shown in the *Outline* view and the dirty (*) state of the editor. The user can choose to save the measurement or to undo the operation by using the **Edit › Undo** menu.

To change the text of the measurement annotation, please select the annotation and edit the *Name* in the *Properties View*.

To delete a measurement annotation, please select the annotation and either hit the `Del` key or use the ✖ **Delete** context menu.


pps_product_workspace - TMSC Examples/src-gen/CORBA_example.tmsc - PPS
File Edit Navigate Search Project TMSC Editor Run Window Help
Outline
type filter text
platform:/resource/TMSC%20Examples/src-gen/CORBA_
Timed Message Sequence Chart
Latency: 130 ms.
Bulb A (Lamp-server/Logger-client)
Bulb B (Lamp-server/Logger-client)
Logger L (Logger-server)
Properties
*CORBA_example.tmsc
Timed Message Sequence Chart
Start of trace
Latency: 130 ms
Bulb A (Lamp-server/Logger-client)
Handle
Handle event
Event loop
Switch S (Lamp-client)
Receive from server
Receive fr
Call turnOn
Await turnO
Flip switch
00:00:00.000
00:00:00.200
00:00:00.400
Time
Selection
Timed message sequence chart
The Name of the Measurement

Property	Value
Measurement	
Duration	130 ms.
From	Entry at 00:00:00.080 000 000
Name	Latency: 130 ms.
Tmsc	Timed Message Sequence Chart
To	Entry at 00:00:00.210 000 000

4.4. Export chart to PNG file

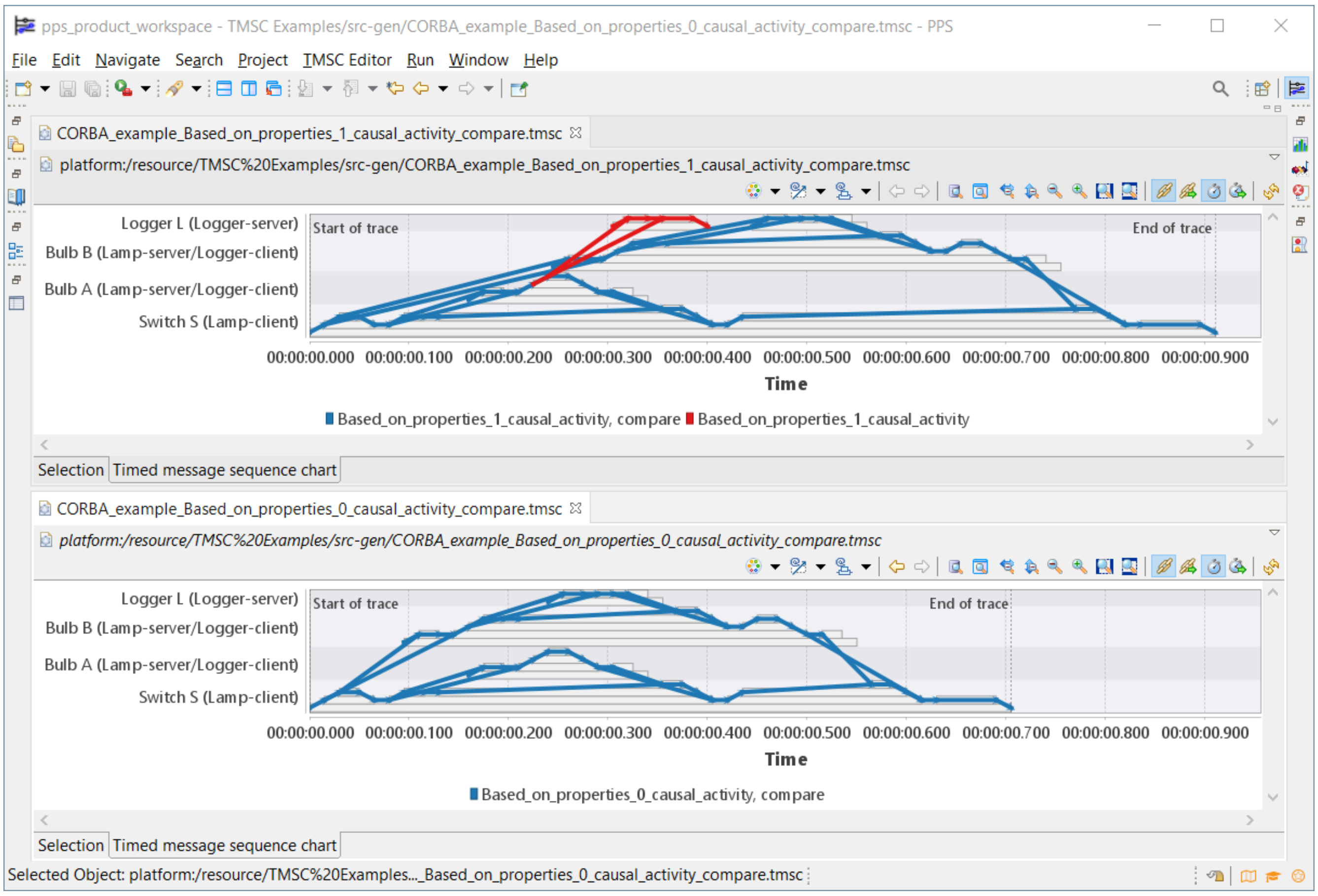
It is possible to save a snapshot of a chart by clicking the **[Export As Image]** from the view menu (small triangle ▾ or 3-dots ⋮ button at the right top of the view). The action will open a save dialog which allows you to select the location and the name of the exported PNG file.

The PNG is saved with the same resolution and size as currently displayed.

4.5. Synchronize Timing

The time range in open viewers can be synchronized, so that multiple aspects on a time range as shown in the different viewers, can be analyzed simultaneously. When one editor is zoomed or scrolled, the other editors remain synchronized. This is especially helpful when editors are positioned above or 'on top of' each other. As in that case, the margins to the left and right of the time range will be synchronized as well, such that the time ranges have the same width in the viewers. The data for corresponding points in time are then vertically aligned, making it easy to correlate the data from the different viewers.

> Time range synchronization only works if the ranges of two viewers overlap. If the current visible range of a viewer is outside the range of another editor, time range synchronization behavior is unpredictable.


pps_product_workspace - TMSC Examples/src-gen/CORBA_example_Based_on_properties_0_causal_activity_compare.tmsc - PPS
File Edit Navigate Search Project TMSC Editor Run Window Help
CORBA_example_Based_on_properties_1_causal_activity_compare.tmsc
platform:/resource/TMSC%20Examples/src-gen/CORBA_example_Based_on_properties_1_causal_activity_compare.tmsc
Logger L (Logger-server)
Bulb B (Lamp-server/Logger-client)
Bulb A (Lamp-server/Logger-client)
Switch S (Lamp-client)
Start of trace
End of trace
00:00:00.000 00:00:00.100 00:00:00.200 00:00:00.300 00:00:00.400 00:00:00.500 00:00:00.600 00:00:00.700 00:00:00.800 00:00:00.900
Time
Based_on_properties_1_causal_activity, compare
Based_on_properties_1_causal_activity
Selection
Timed message sequence chart
CORBA_example_Based_on_properties_0_causal_activity_compare.tmsc
platform:/resource/TMSC%20Examples/src-gen/CORBA_example_Based_on_properties_0_causal_activity_compare.tmsc
Logger L (Logger-server)
Bulb B (Lamp-server/Logger-client)
Bulb A (Lamp-server/Logger-client)
Switch S (Lamp-client)
Start of trace
End of trace
00:00:00.000 00:00:00.100 00:00:00.200 00:00:00.300 00:00:00.400 00:00:00.500 00:00:00.600 00:00:00.700 00:00:00.800 00:00:00.900
Time
Based_on_properties_0_causal_activity, compare
Selection
Timed message sequence chart
Selected Object: platform:/resource/TMSC%20Examples..._Based_on_properties_0_causal_activity_compare.tmsc

Only PPS viewers that have a time range (typically the x-axis) support time range and margin width (the width taken by the margin labels, margin ticks, etc) synchronization. If a viewer supports time range and margin width synchronization, some buttons will be present in the toolbar of the viewer.

Icon	Action	Description
	[Synchronize Time Range]	If pushed, the current time range of the editor/view is explicitly synchronized to all other supported editors/views that have time range synchronization enabled.
	[Enable Time Range Synchronization]	If checked, the editor/view will participate in time range synchronization. If not checked, changes to the time range of the editor/view will not be automatically synchronized to any other editors/views, and the editor/view will not be synchronized to time range changes of other editors/views.

Icon	Action	Description
	[Synchronize Margin Width]	If pushed, the current margin width of the editor/view is explicitly synchronized to all other supported editors/views that have margin width synchronization enabled.
	[Enable Margin Width Synchronization]	If checked, the editor/view will participate in margin width synchronization. If not checked, changes to the margin width of the editor/view will not be automatically synchronized to any other editors/views, and the editor/view will not be synchronized to margin width changes of other editors/views.

Currently, PPS viewers do not support manually changing the margin width. As such, the margin width is only synchronized by explicit request, using the **[Synchronize Margin Width]** toolbar button (). To reset the margin width of an editor/view, click the **[Refresh]** toolbar button ().

Disabling time range and margin width synchronization can be useful when dealing with large traces. Zooming in to a specific part of a trace while having time range synchronization enabled may lead to performance issues. To mitigate this, disable time range synchronization on a view, zoom in to the time range of interest within that view, re-enable time range synchronization for the view, and press the **[Synchronize Time Range]** toolbar button () to explicitly synchronize the new time range to the other views. That way, the other views are only updated once.

Time range and margin width synchronization are performed per workbench window. If you open a second workbench window, the editors/views within each workbench window are synchronized. Editors/views across different workbench windows are not synchronized. This is helpful when looking at different traces in separate workbench windows.

4.6. Splitting and cloning editors

Some editors have multiple tabs, where each tab has a different view on the same data. It can be useful to have multiple editors on the same data, to show different views on the same data, at the same time. To support this, editors can be split and cloned.

When an editor has the focus, the following toolbar buttons are present in the toolbar:

Icon	Action	Description
	[Toggle Split Editor (Horizontal)]	If pushed, the editor is split into two parts, each shown horizontally, one above the other. Splitting horizontally while already split vertically, changes the vertical split into a horizontal split. Splitting horizontally while already split horizontally, undoes the horizontal split.

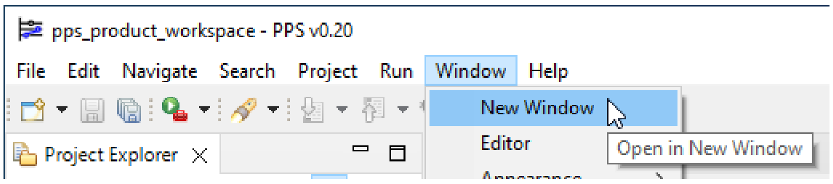
Icon	Action	Description
▦	**[Toggle Split Editor (Vertical)]**	If pushed, the editor is split into two parts, each shown vertically, one besides the other. Splitting vertically while already split horizontally, changes the horizontal split into a vertical split. Splitting vertically while already split vertically, undoes the vertical split.
▨	**[Clone Editor]**	If pushed, the editor is cloned. A second instance of the editor is then available that can be used independently of the original editor.

When splitting, the two editors remain bound together, and can only be moved together. The split can later be undone. When cloning, the two editors can be independently moved, closed, etc.

Putting two editors below each other can be especially useful when applying timing synchronization to the views of those editors.

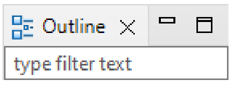
4.7. Multiple workbench windows

By default the Eclipse IDE opens with one window, called the *workbench* window. Working with traces, various editors may be opened, typically on data that is related. When working with with multiple traces, especially when using multiple monitors, it can be of benefit to open a second workbench window. In this second workbench window, editors for a different trace can be opened, and analyzed. This keeps the editors/data for one trace in one window, separate from the editors/data of the other trace in the other window. The data for the different traces in the workbench windows on the different monitors can then for instance be compared. Also, timing synchronization is applied per workbench window. To open a new workbench window, click the **Window › New Window** menu.



4.8. Dynamic Inclusion Filtering

Typically PPS works with large data sets. This complicates focussing on relevant data and the following functions therefore have been added to the *Outline* view.

Icon	Action	Description
	**[type filter text]**	Dynamic filtering of its elements, by means of entering a search pattern in its filter text box. The pattern may contain '*' for 0 and many characters and '?' for exactly one character. Literal '*' and '?' characters must be escaped in the pattern e.g., '*' means literal '*', etc. Escaping any other character (including the escape character itself), just results in that character in the pattern. e.g., '\a' means 'a' and '\\' means '\'
	[Push Context]	If checked and one or more elements are selected, the selected elements are set as input for the active editor. The editor will threat this input as it context and show the most relevant information accordingly.
	[Push Selection]	If checked and one or more elements are selected, the selected elements are also highlighted in the active editor.
	[Push Time Range]	If checked and one or more elements are selected, the time range to show these elements is calculated and is set to the active editor.

Chapter 5. Release Notes

The release notes of the Platform Performance Suite (PPS) are listed below, in reverse chronological order.

5.1. PPS v0.20

This release prepares PPS to be open sourced.

The highlights of this release are:

- TMSC meta-model changes, see developer guide for more information:
  - Added `Host` concept to the deployed architecture life-cycle phase.
  - `Executions` are not `Dependencies` anymore.
  - Added `ITimeRange` interface to support time-based selections.
- This release also includes many bug fixes and improvements.

5.2. PPS v0.0.3

The highlights of this release are:

- Upgrade from Eclipse 2020-06 to Eclipse 2021-12, see New and Noteworthy for more information.
- Reuse common libraries from Eclipse TRACE4CPS™ and Eclipse LSAT™
- PPS RCP now packages a JavaSE-11 JRE
- This release also includes many bug fixes and improvements.

5.3. PPS v0.0.2

This release of PPS adds the feature of defining, resolving and analyzing metric instances in a TMSC. When a metric instance exceeds its budget, a detailed root cause analysis can be performed to diagnose which task(s) caused this.

5.4. PPS v0.0.1

This first release of PPS includes a TMSC graphical viewer that is supported by a textual syntax.