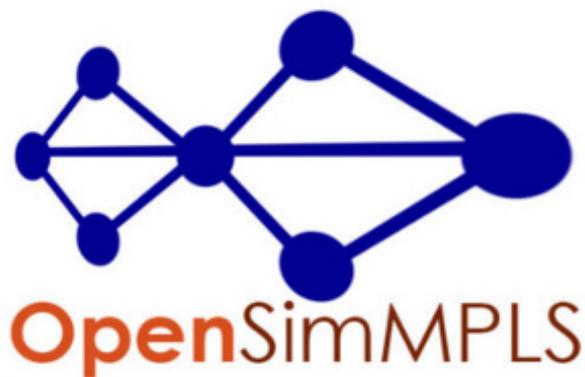


OpenSimMPLS

v2.0



Quick user guide

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Introduction

OpenSimMPLS is a MPLS network simulator, written in Java, portable and Multilanguage. It can simulate:

- Single-domain MPLS networks (use only LERs, LSRs, traffic generators and traffic sinks if you want to simulate this kind of networks).
- Single-domain MPLS networks that support Guarantee of Service (GoS) using active techniques (mix LERs, LSRs, active LERs, active LSRs, traffic generators and traffic sinks, as desired, if you want to simulate this kind of networks).

This guide is a little help so you can take your first steps with the simulator quickly. Therefore it is brief and schematic.

Requirements

You need to have installed in your operating system:

- Java 8.

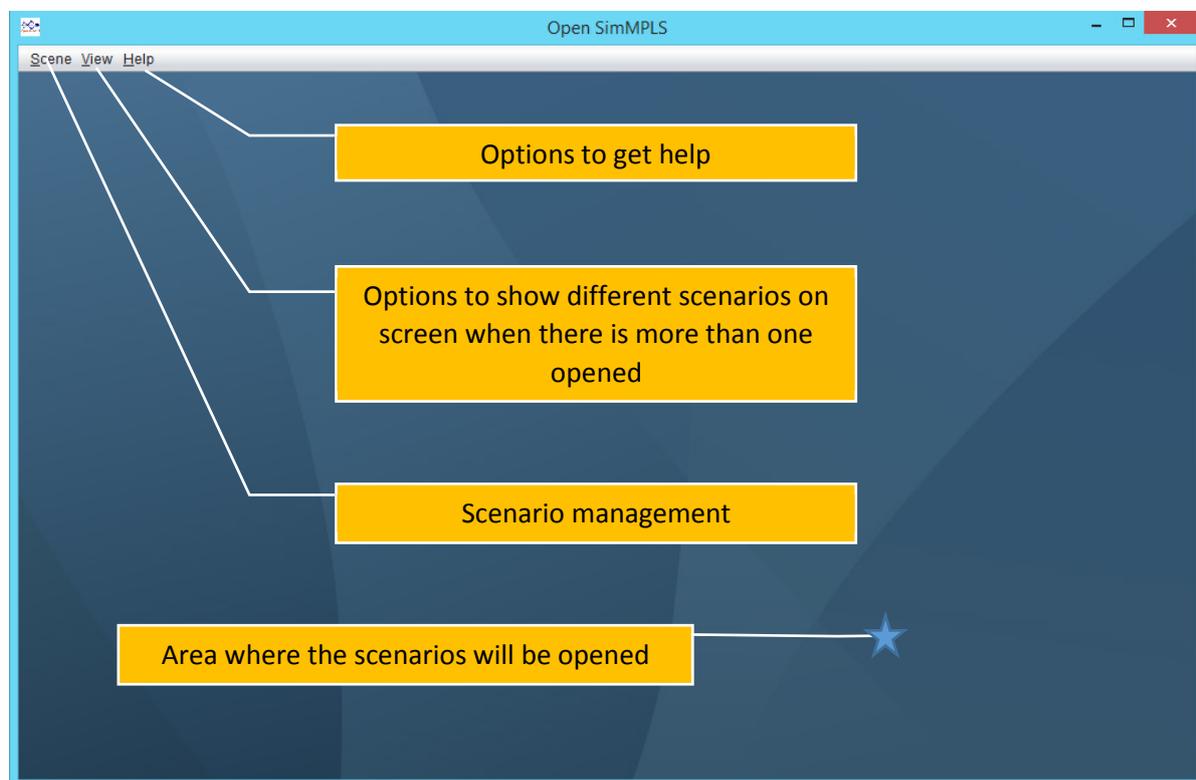
And, of course, have downloaded OpenSimMPLS v2.0, which you can do from the project page that you see in the header of this guide.

Starting OpenSimMPLS v2.0

Once downloaded, run the simulator with the following command:

```
java -jar openSimMPLS-bin-v2.0.jar
```

Main simulator interface

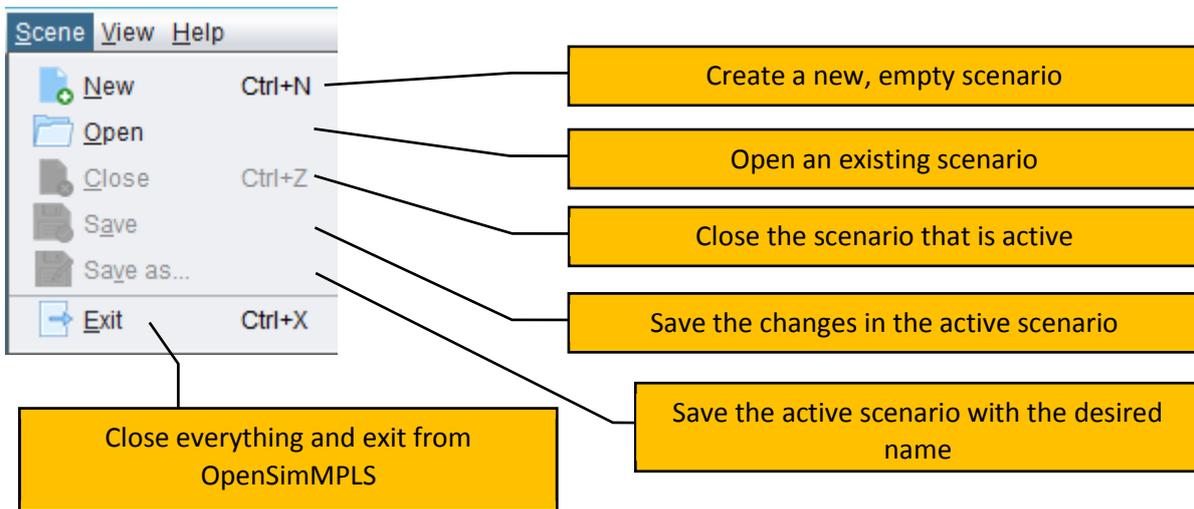


The initial window of the simulator appears only with a menu of options and a large space within which the different scenarios that are being designed or simulated will be displayed.

OpenSimMPLS allows you to keep more than one scenario open or running simultaneously.

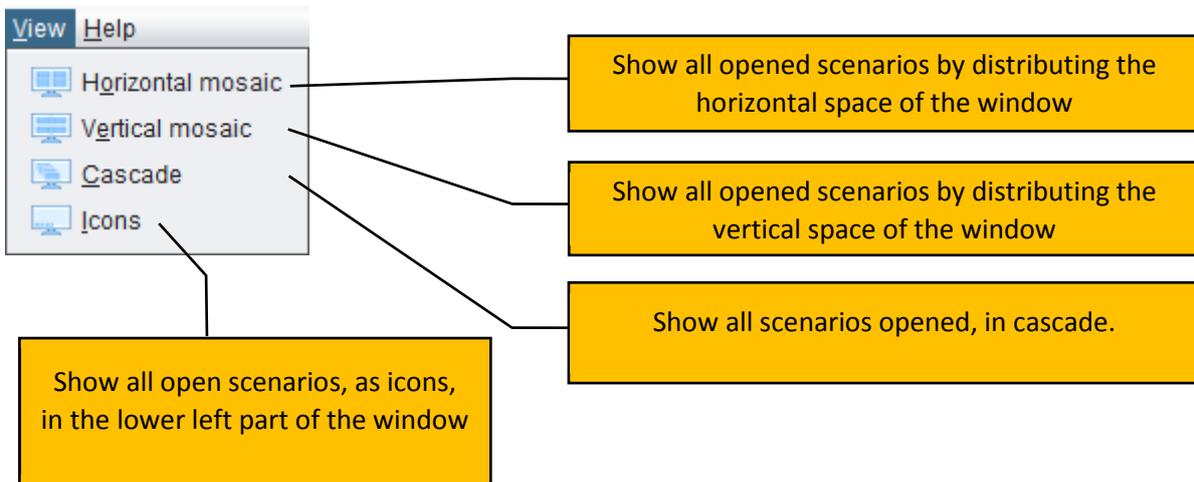
Scenario menu

Some of the options will only be active if there is a scenario opened.

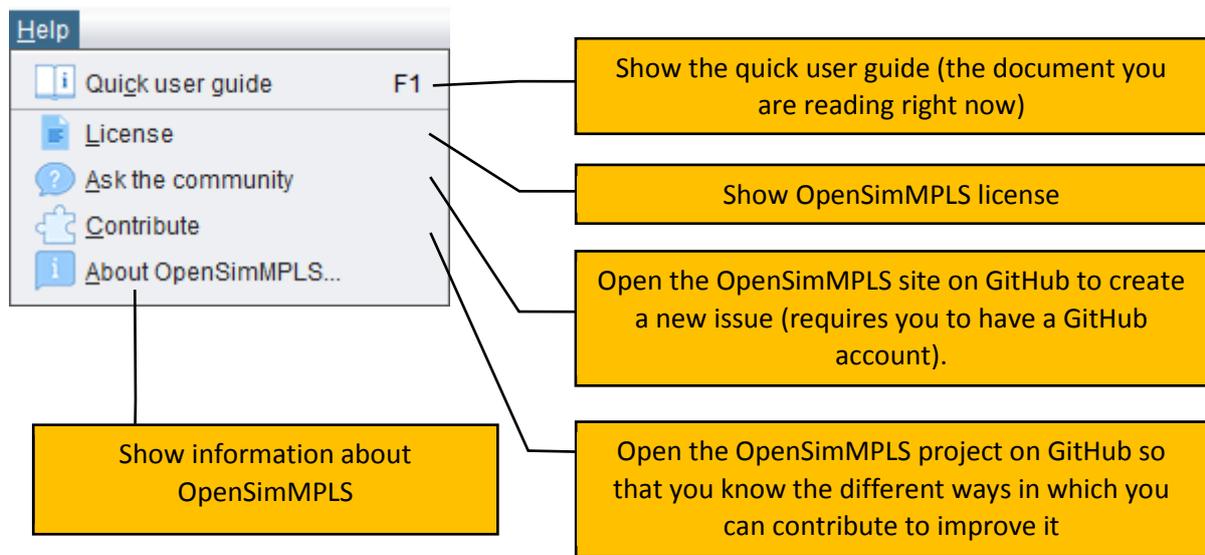


View menu

Some of the options will only be active if there is a scenario opened.

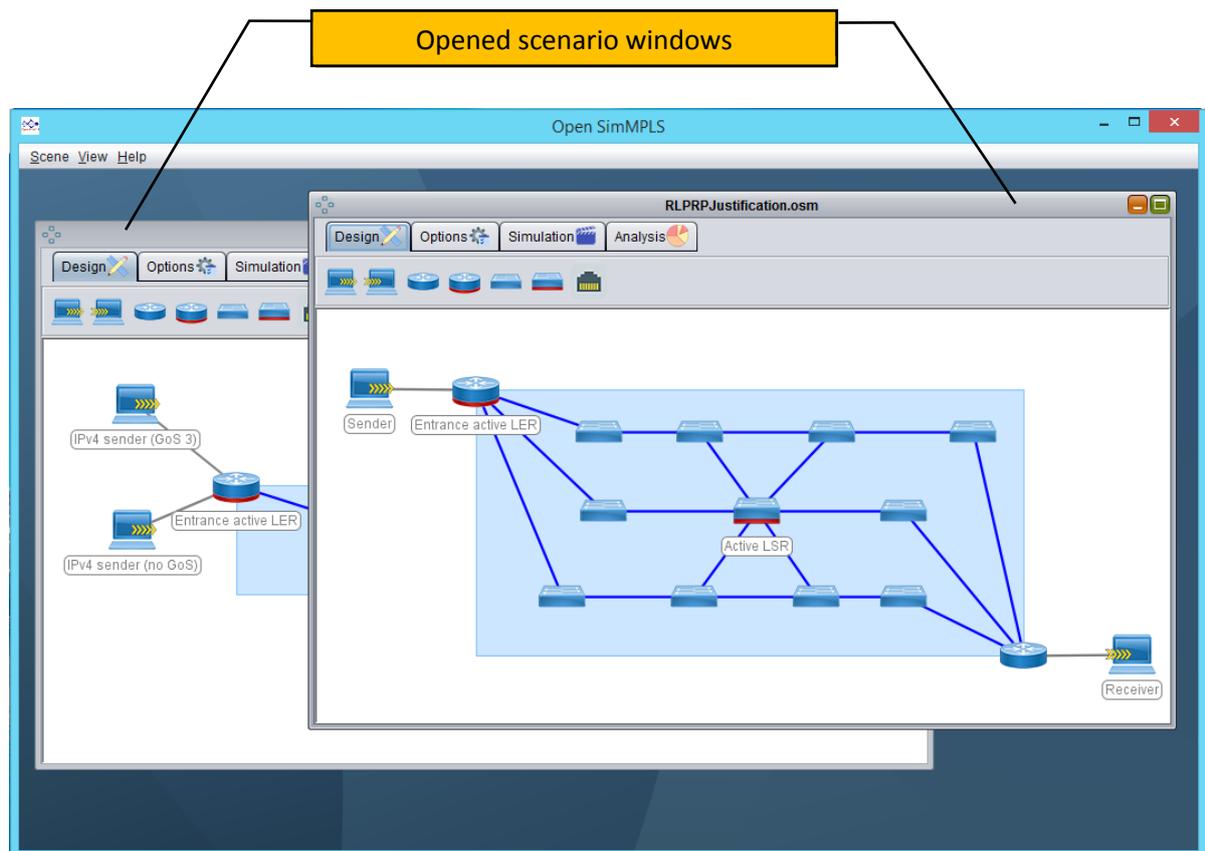


Help menu



Scenario window

Each scenario has its own window within the simulator. This is where all the action happens and where all the OpenSimMPLS functionality is. Each open scenario is independent of the other open scenarios.

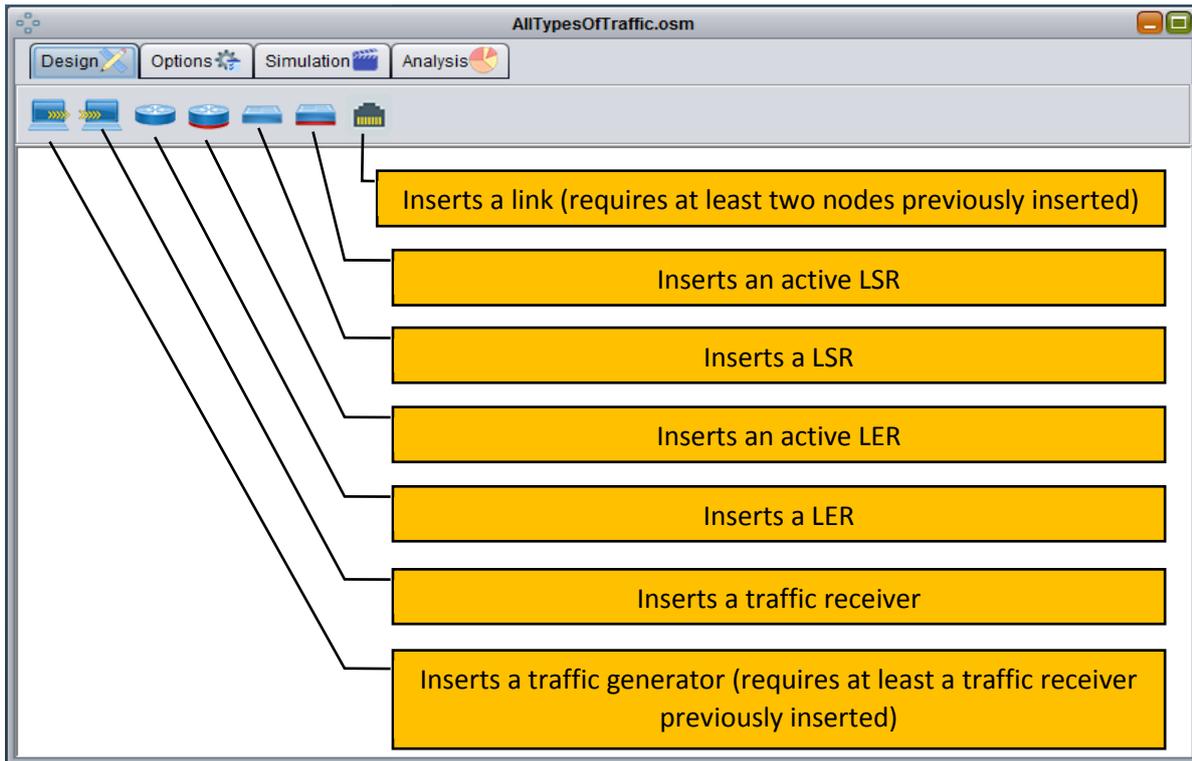


The scenario window has four tabs that will guide you through the simulation process. Follow them in the order in which they appear:

1. **Scenario design.** Configure the topology, the elements, the links and the configuration all of them. It also defines the type of traffic you want to generate and who will receive it.
2. **Options.** Put a title and describe your scenario. In addition, select the duration of the simulation and the grain of it.
3. **Simulation.** Put your scenario to work and interact with the simulation in real time.
4. **Analysis.** Select elements of the topology and see statistical information about them. Observe what has happened throughout the time of the simulation.

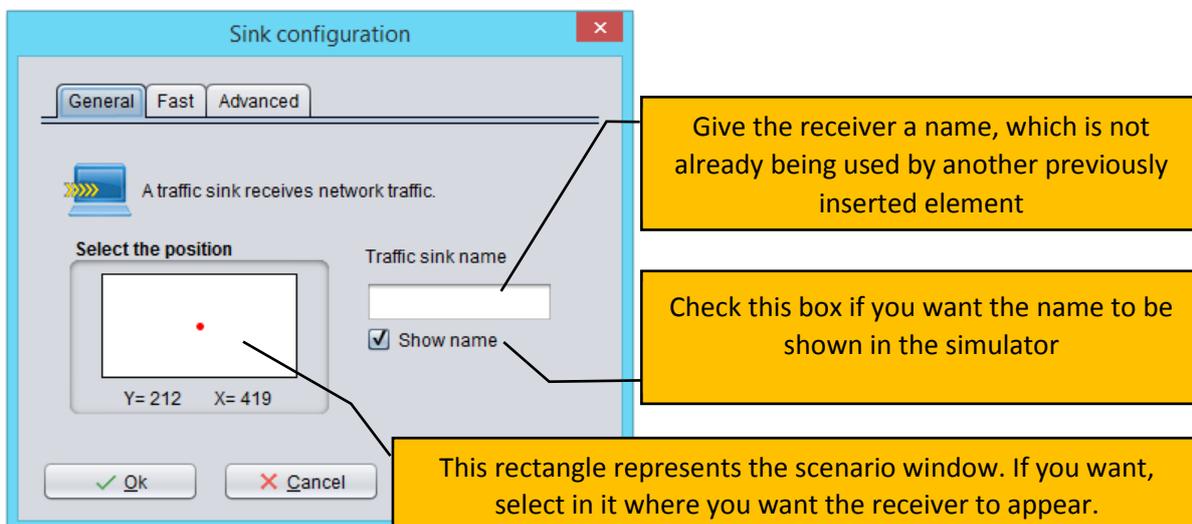
Step 1. Scenario design

To design the scenario, select the Design tab.

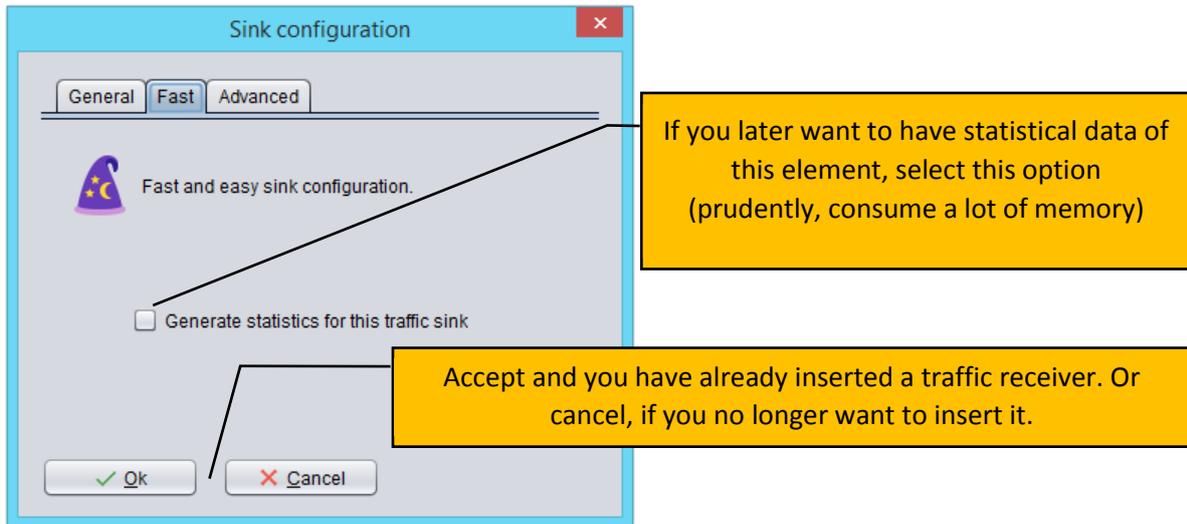


Traffic sinks insertion and configuration

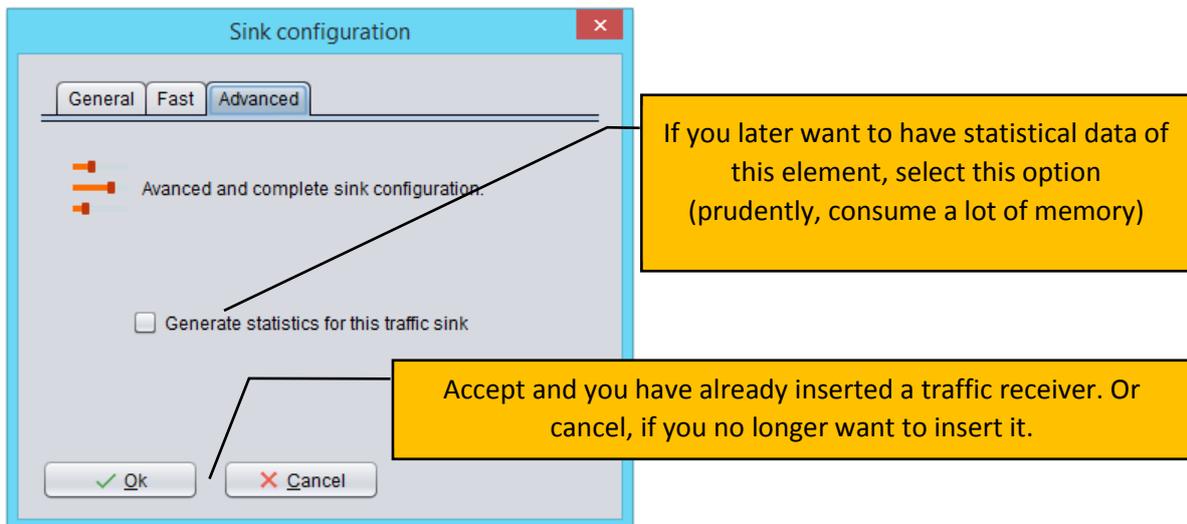
When we insert a traffic receiver, its configuration window appears, with three tabs: general configuration, quick configuration or advanced configuration (to choose).



If you want, you can use the quick settings to have something to try if you're in a hurry. Or if you want to configure all the parameters, use the advanced settings. It does not make sense to use both tabs.

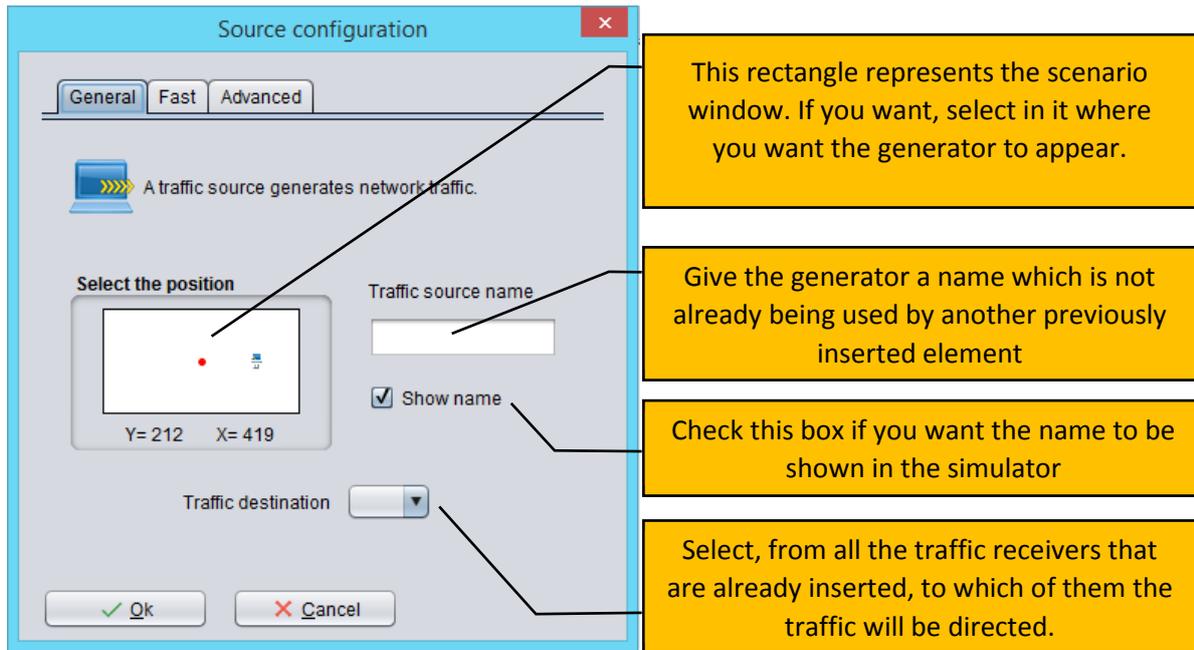


In the case of the traffic receiver, the advanced configuration and quick configuration are the same. There is not much to configure.



Traffic generators insertion and configuration

When we insert a traffic generator, its configuration window appears, with three tabs: general configuration and quick configuration or advanced configuration (to choose).



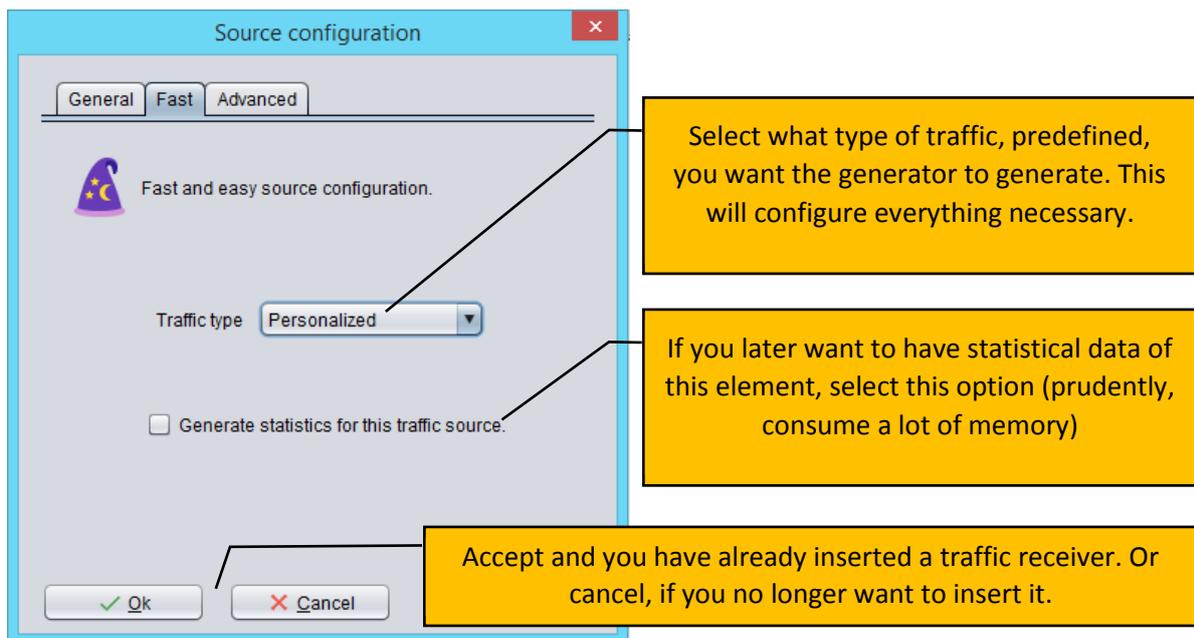
This rectangle represents the scenario window. If you want, select in it where you want the generator to appear.

Give the generator a name which is not already being used by another previously inserted element

Check this box if you want the name to be shown in the simulator

Select, from all the traffic receivers that are already inserted, to which of them the traffic will be directed.

If you want, you can use the quick settings to have something to try if you're in a hurry. Or if you want to configure all the parameters, use the advanced settings. It does not make sense to use both tabs.

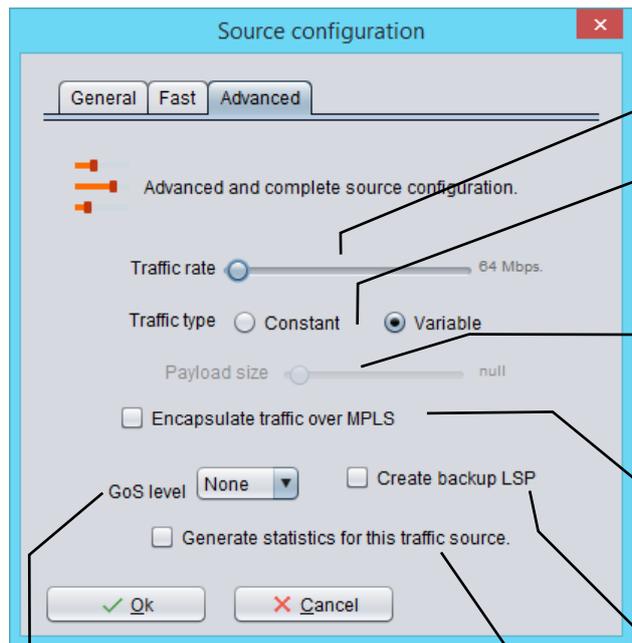


Select what type of traffic, predefined, you want the generator to generate. This will configure everything necessary.

If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)

Accept and you have already inserted a traffic receiver. Or cancel, if you no longer want to insert it.

In the case of the traffic receiver, the advanced configuration allows defining all aspects of the traffic that you want to generate.



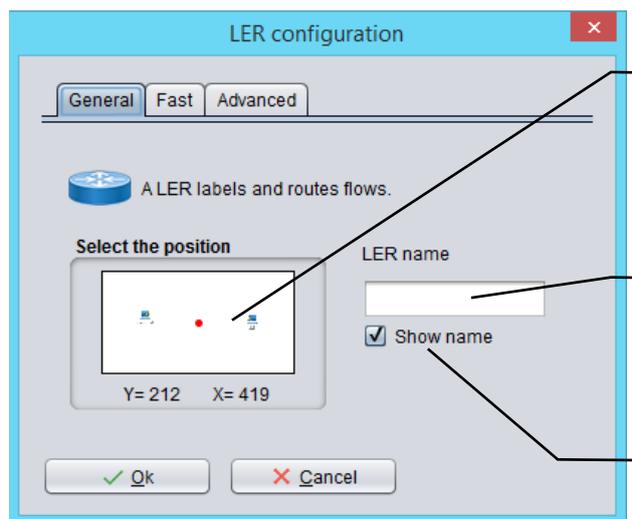
The screenshot shows the 'Source configuration' dialog box with three tabs: 'General', 'Fast', and 'Advanced'. The 'Advanced' tab is selected. The dialog contains the following elements: a 'Traffic rate' slider set to 64 Mbps; 'Traffic type' radio buttons for 'Constant' and 'Variable' (selected); a 'Payload size' slider set to 'null'; an unchecked checkbox for 'Encapsulate traffic over MPLS'; a 'GoS level' dropdown menu set to 'None'; an unchecked checkbox for 'Create backup LSP'; and an unchecked checkbox for 'Generate statistics for this traffic source'. At the bottom are 'Ok' and 'Cancel' buttons.

Annotations (yellow boxes):

- Choose the number of megabits per second you want to generate (points to Traffic rate slider).
- You can generate constant traffic (with the size you choose) or variable (following statistics from the Abilene Network). (points to Traffic type radio buttons).
- For constant traffic, select the size of the payload of the packets, in octets. (points to Payload size slider).
- By default it will generate IPv4 traffic. Check this box if you want to generate MPLS traffic. (points to Encapsulate traffic over MPLS checkbox).
- You can request that an additional backup LSP be pre-established for traffic by checking this box. (points to Create backup LSP checkbox).
- If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory) (points to Generate statistics for this traffic source checkbox).
- Select the level of Service Guarantee (GoS) you want for traffic. Higher level for more important traffic. (points to GoS level dropdown menu).

LERs insertion and configuration

When we insert an LER, its configuration window appears, with three tabs: general configuration and quick configuration or advanced configuration (to choose).

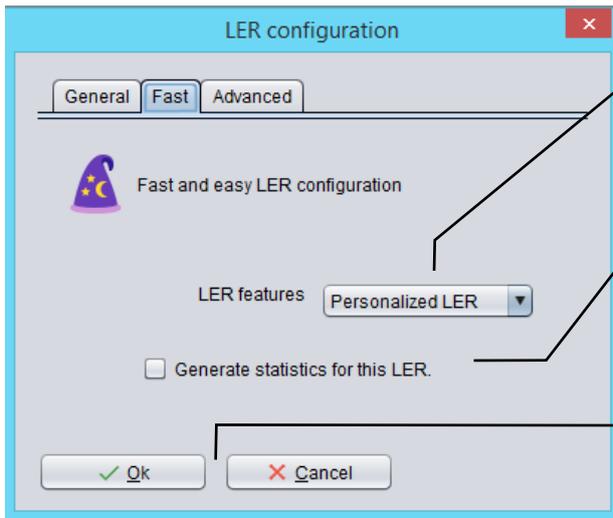


The screenshot shows the 'LER configuration' dialog box with three tabs: 'General', 'Fast', and 'Advanced'. The 'General' tab is selected. The dialog contains the following elements: a router icon and the text 'A LER labels and routes flows.'; a 'Select the position' section with a small map showing a red dot and coordinates 'Y= 212 X= 419'; an 'LER name' text input field; and a checked checkbox for 'Show name'. At the bottom are 'Ok' and 'Cancel' buttons.

Annotations (yellow boxes):

- This rectangle represents the scenario window. If you want, select in it where you want the LER to appear. (points to the 'Select the position' map).
- Give the LER a name which is not already being used by another previously inserted element (points to the 'LER name' input field).
- Check this box if you want the name to be shown in the simulator (points to the 'Show name' checkbox).

If you want, you can use the quick settings to have something to try if you're in a hurry. Or if you want to configure all the parameters, use the advanced settings. It does not make sense to use both tabs.

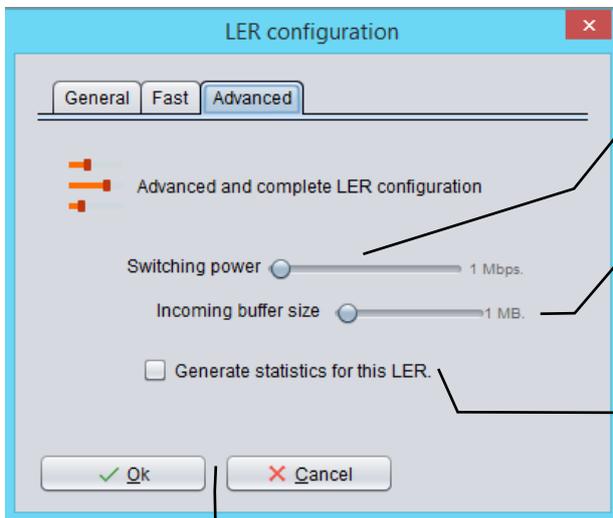


Select what type of LER, predefined. This will configure everything necessary.

If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)

Accept and you have already inserted an LER. Or cancel, if you no longer want to insert it.

In the case of the LER, the advanced configuration allows defining all aspects of the hardware required.



Choose the number of megabits per second that the LER can process

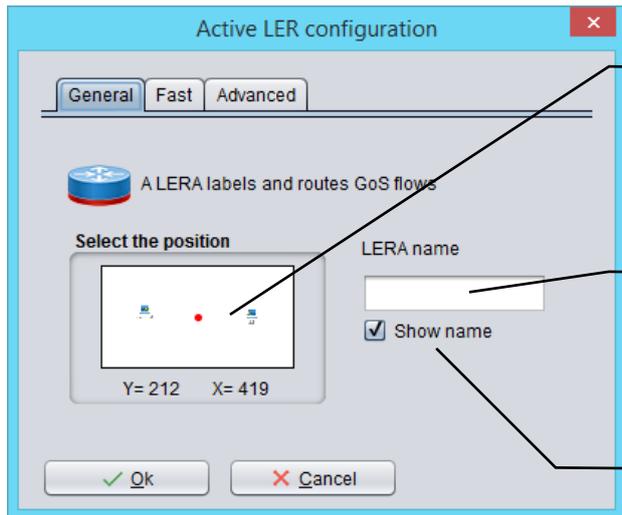
Choose the size of the input buffer of the LER, in Megabytes

If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)

Accept and you have already inserted an LER. Or cancel, if you no longer want to insert it.

Active LERs insertion and configuration

When we insert an active LER, its configuration window appears, with three tabs: general configuration and quick configuration or advanced configuration (to choose).

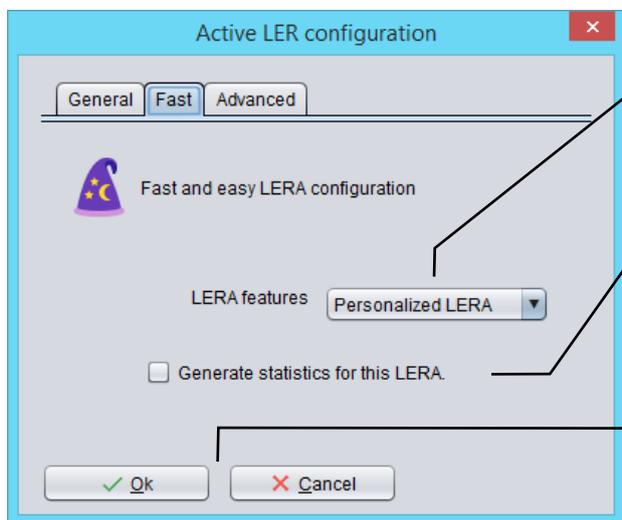


This rectangle represents the scenario window. If you want, select in it where you want the active LER to appear.

Give the active LER a name which is not already being used by another previously inserted element

Check this box if you want the name to be shown in the simulator

If you want, you can use the quick settings to have something to try if you're in a hurry. Or if you want to configure all the parameters, use the advanced settings. It does not make sense to use both tabs.

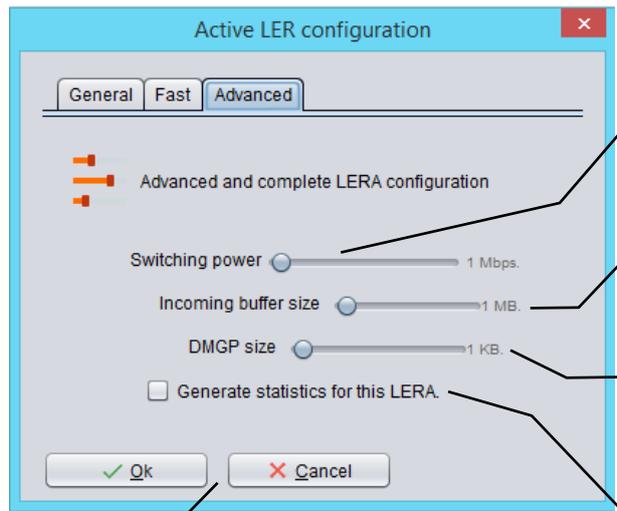


Select what type of LER is active, predefined. This will configure everything

If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)

Accept and you have already inserted an active LER. Or cancel, if you no longer want to insert it.

In the case of the active LER, the advanced configuration allows defining all the necessary hardware aspects.



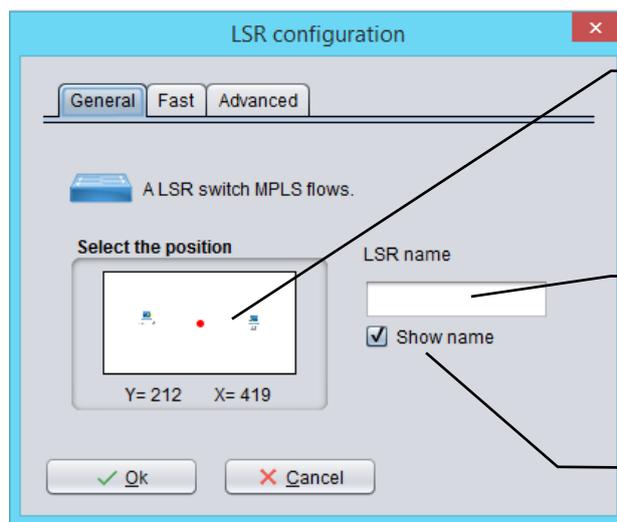
The screenshot shows the 'Active LER configuration' dialog box with three tabs: 'General', 'Fast', and 'Advanced'. The 'Advanced' tab is selected. It contains several sliders: 'Switching power' (set to 1 Mbps), 'Incoming buffer size' (set to 1 MB), and 'DMGP size' (set to 1 KB). There is also a checkbox for 'Generate statistics for this LERA.' and 'Ok'/'Cancel' buttons at the bottom.

Annotations:

- Choose the number of megabits per second that the active LER can process (points to the 'Switching power' slider).
- Choose the size of the input buffer of the active LER, in Megabytes (points to the 'Incoming buffer size' slider).
- Choose the size of the DMGP in Kilobytes. Larger DMGP allows you to recover more packets locally. (points to the 'DMGP size' slider).
- If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory) (points to the 'Generate statistics for this LERA' checkbox).
- Accept and you have already inserted an active LER. Or cancel, if you no longer want to insert it. (points to the 'Ok' button).

LSRs insertion and configuration

When we insert an LSR, its configuration window appears, with three tabs: general configuration and quick configuration or advanced configuration (to choose).

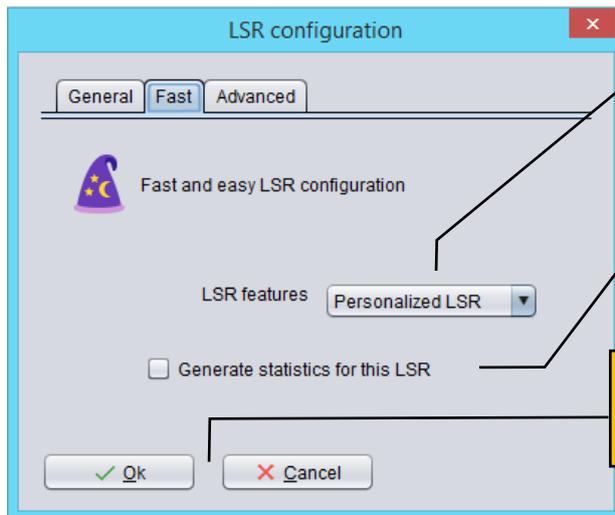


The screenshot shows the 'LSR configuration' dialog box with three tabs: 'General', 'Fast', and 'Advanced'. The 'General' tab is selected. It features a 'Select the position' section with a small grid showing a red dot at coordinates Y=212 and X=419. There is also an 'LSR name' text field, a 'Show name' checkbox (checked), and 'Ok'/'Cancel' buttons at the bottom.

Annotations:

- This rectangle represents the scenario window. If you want, select in it where you want the LSR to appear. (points to the 'Select the position' grid).
- Give the LSR a name which is not already being used by another previously inserted element (points to the 'LSR name' text field).
- Check this box if you want the name to be shown in the simulator (points to the 'Show name' checkbox).

If you want, you can use the quick settings to have something to try if you're in a hurry. Or if you want to configure all the parameters, use the advanced settings. It does not make sense to use both tabs.

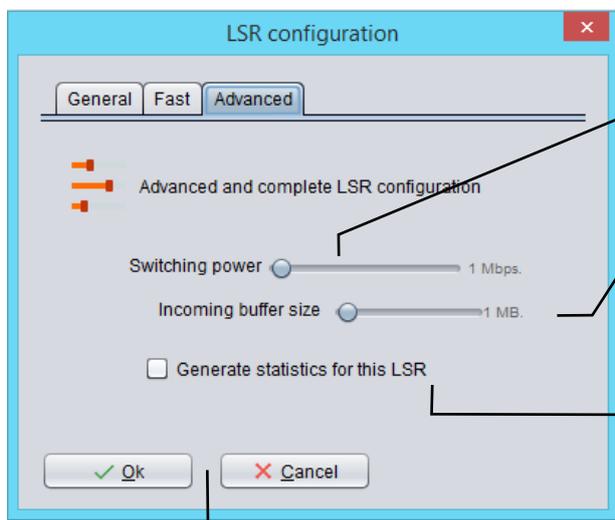


Select what type of LSR, predefined. This will configure everything necessary.

If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)

Accept and you have already inserted an LSR. Or cancel, if you no longer want to insert it.

In the case of the LSR, the advanced configuration allows defining all aspects of the hardware required.



Choose the number of megabits per second that the LSR will be able to process

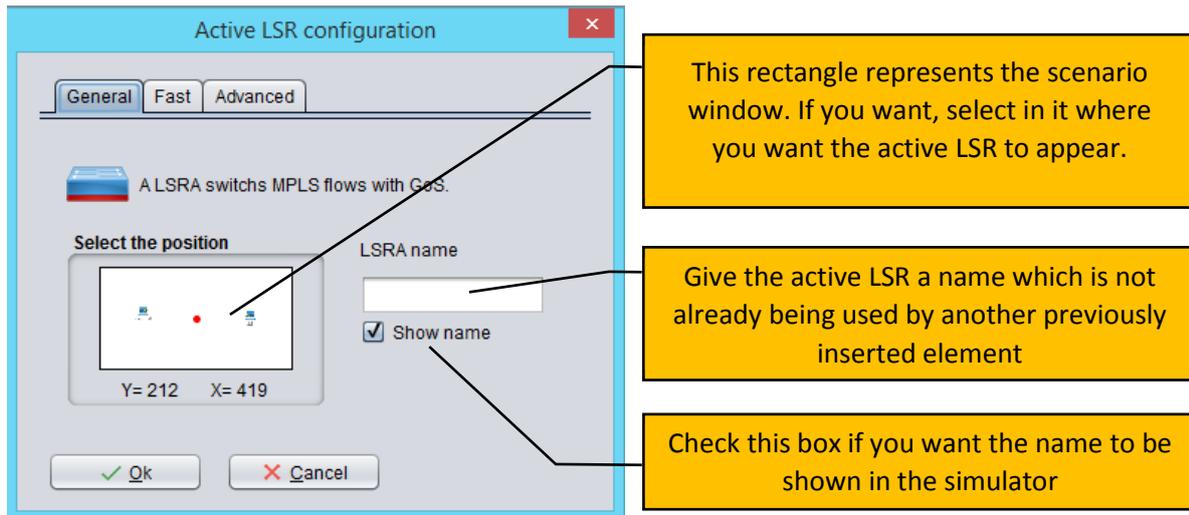
Choose the size of the LSR input buffer, in Megabytes

If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)

Accept and you have already inserted an LSR. Or cancel, if you no longer want to insert it.

Active LSRs insertion and configuration

When we insert an active LSR, its configuration window appears, with three tabs: general configuration and quick configuration or advanced configuration (to choose).

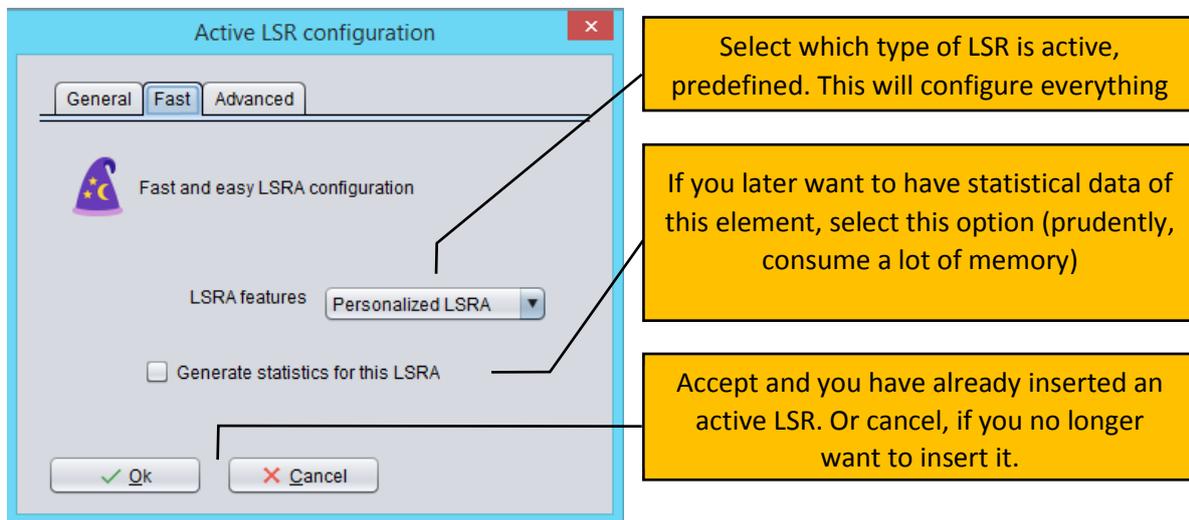


This rectangle represents the scenario window. If you want, select in it where you want the active LSR to appear.

Give the active LSR a name which is not already being used by another previously inserted element

Check this box if you want the name to be shown in the simulator

If you want, you can use the quick settings to have something to try if you're in a hurry. Or if you want to configure all the parameters, use the advanced settings. It does not make sense to use both tabs.

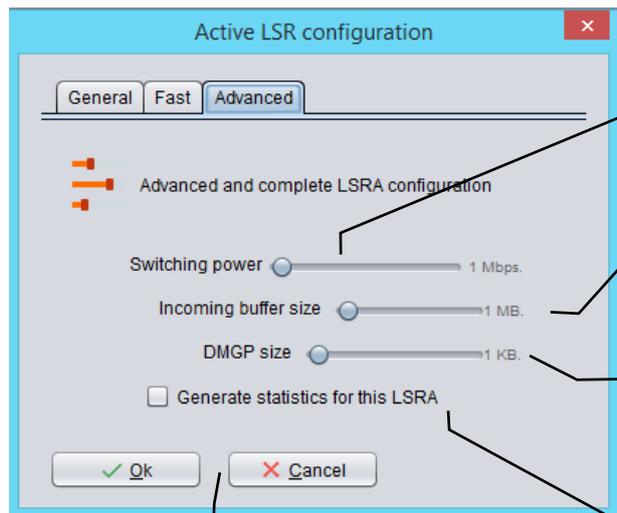


Select which type of LSR is active, predefined. This will configure everything

If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)

Accept and you have already inserted an active LSR. Or cancel, if you no longer want to insert it.

In the case of the active LSR, the advanced configuration allows defining all the necessary hardware aspects.



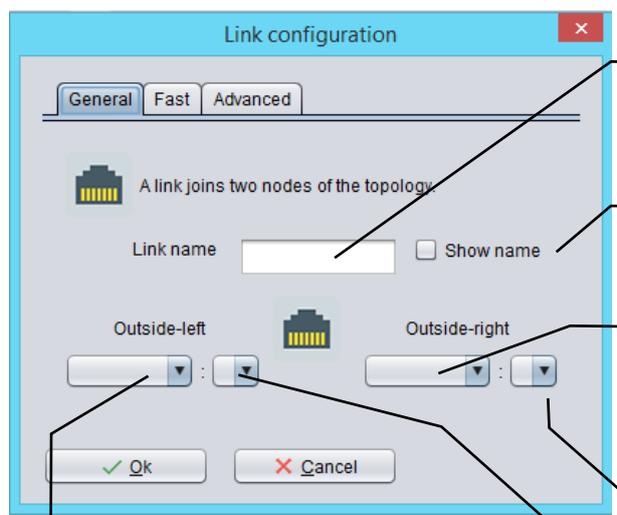
The 'Active LSR configuration' dialog box has three tabs: 'General', 'Fast', and 'Advanced'. The 'Advanced' tab is selected. It contains the following settings:

- Switching power:** A slider set to 1 Mbps. Callout: "Choose the number of megabits per second that the active LSR can process".
- Incoming buffer size:** A slider set to 1 MB. Callout: "Choose the size of the input buffer of the active LSR, in Megabytes".
- DMGP size:** A slider set to 1 KB. Callout: "Choose the size of the DMGP in Kilobytes. Larger DMGP allows you to recover more packets locally."
- Generate statistics for this LSRA:** An unchecked checkbox. Callout: "If you later want to have statistical data of this element, select this option (prudently, consume a lot of memory)".

At the bottom are 'Ok' and 'Cancel' buttons. Callout: "Accept and you have already inserted an active LSR. Or cancel, if you no longer want to insert it."

Links insertion and configuration

When we insert a link, its configuration window appears, with three tabs: general configuration and quick configuration or advanced configuration (to choose).

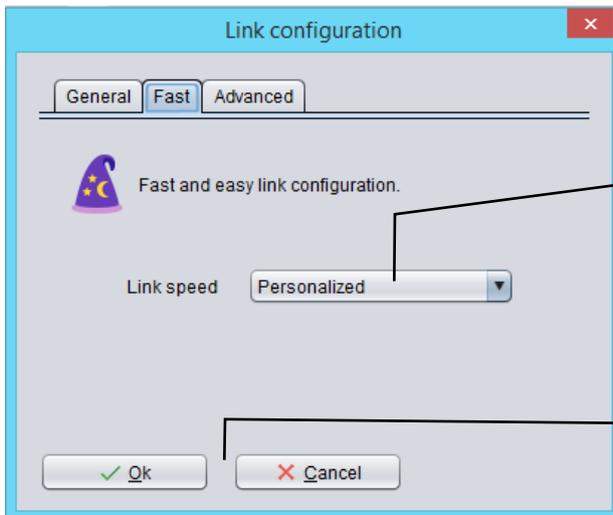


The 'Link configuration' dialog box has three tabs: 'General', 'Fast', and 'Advanced'. The 'General' tab is selected. It contains the following settings:

- Link name:** A text input field. Callout: "Give the link a name which is not already being used by another previously inserted element".
- Show name:** An unchecked checkbox. Callout: "Check this box if you want the name to be shown in the simulator".
- Outside-left:** A dropdown menu. Callout: "Here appear the nodes already inserted and with free ports. Select one."
- Outside-right:** A dropdown menu. Callout: "Once the head end is selected, the rest nodes appear here, if they are not already linked with the head end and as long as they have free ports. Select one tail end."
- Port selection:** Two dropdown menus (one for each side) to select specific ports. Callouts: "Select which port on the tail end the link will connect to." and "Select to which port on the head end the link will connect."

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

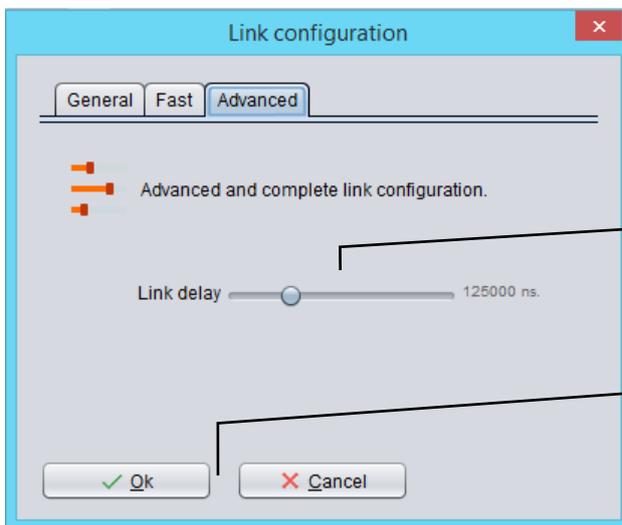
If you want, you can use the quick settings to have something to try if you're in a hurry. Or if you want to configure all the parameters, use the advanced settings. It does not make sense to use both tabs.



Select which type of LSR is active, predefined. This will configure everything necessary.

Accept and you have already inserted a link. Or cancel, if you no longer want to insert it.

In the case of the active LSR, the advanced configuration allows defining all the necessary hardware aspects.

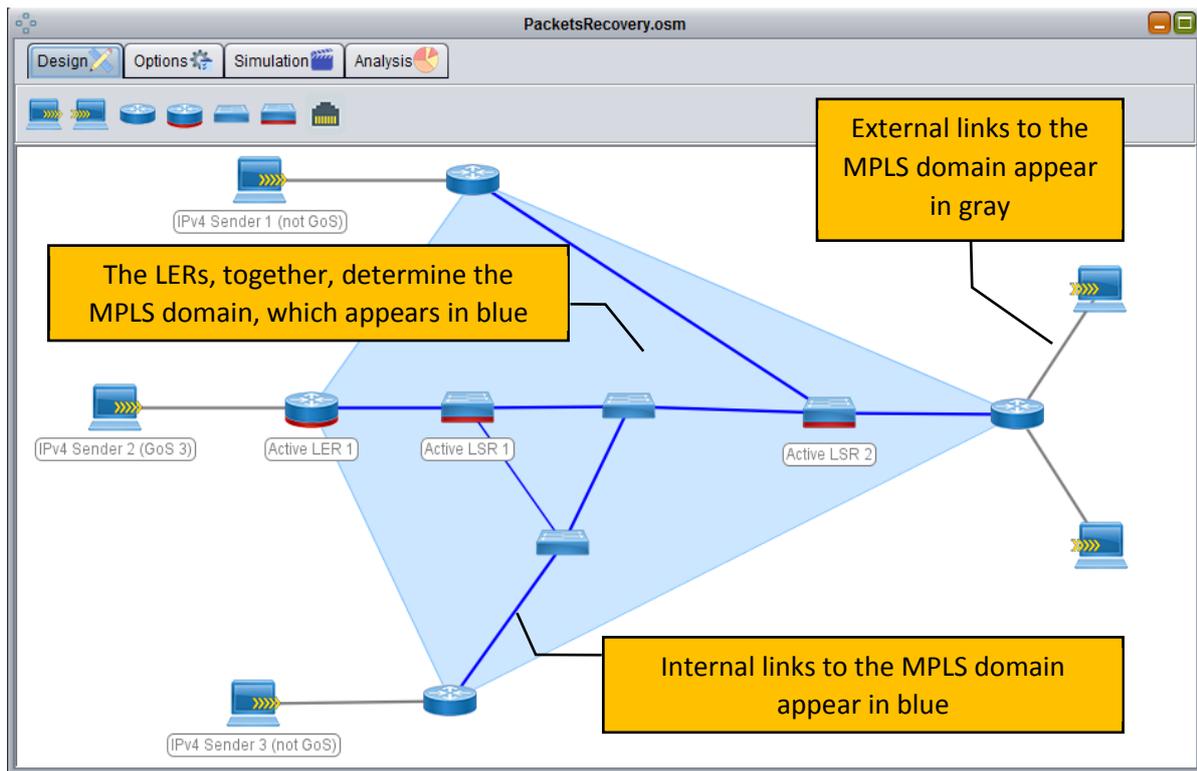


Define the delay, in nanoseconds, that you want the link to have.

Accept and you have already inserted a link. Or cancel, if you no longer want to insert it.

Design finishing

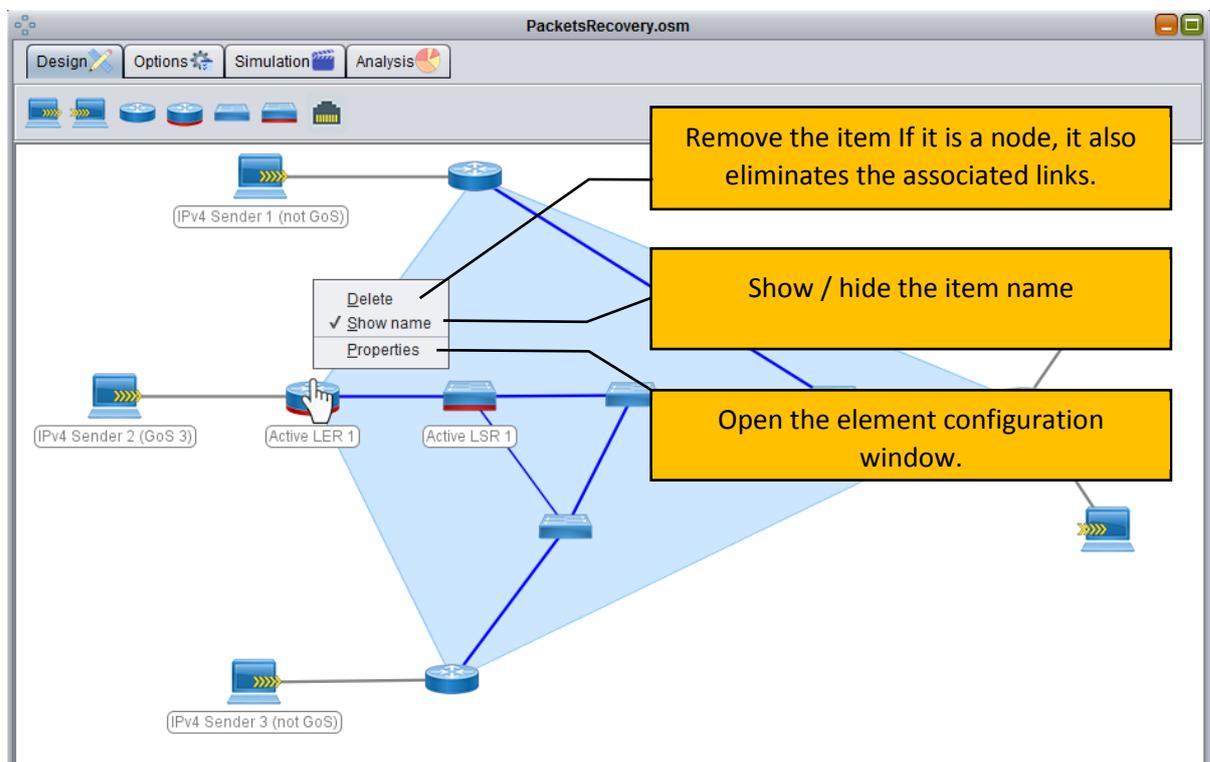
Repeat the process of inserting elements as many times as necessary until you have designed the desired topology. The following figure shows an example of how a completely designed scenario would look.



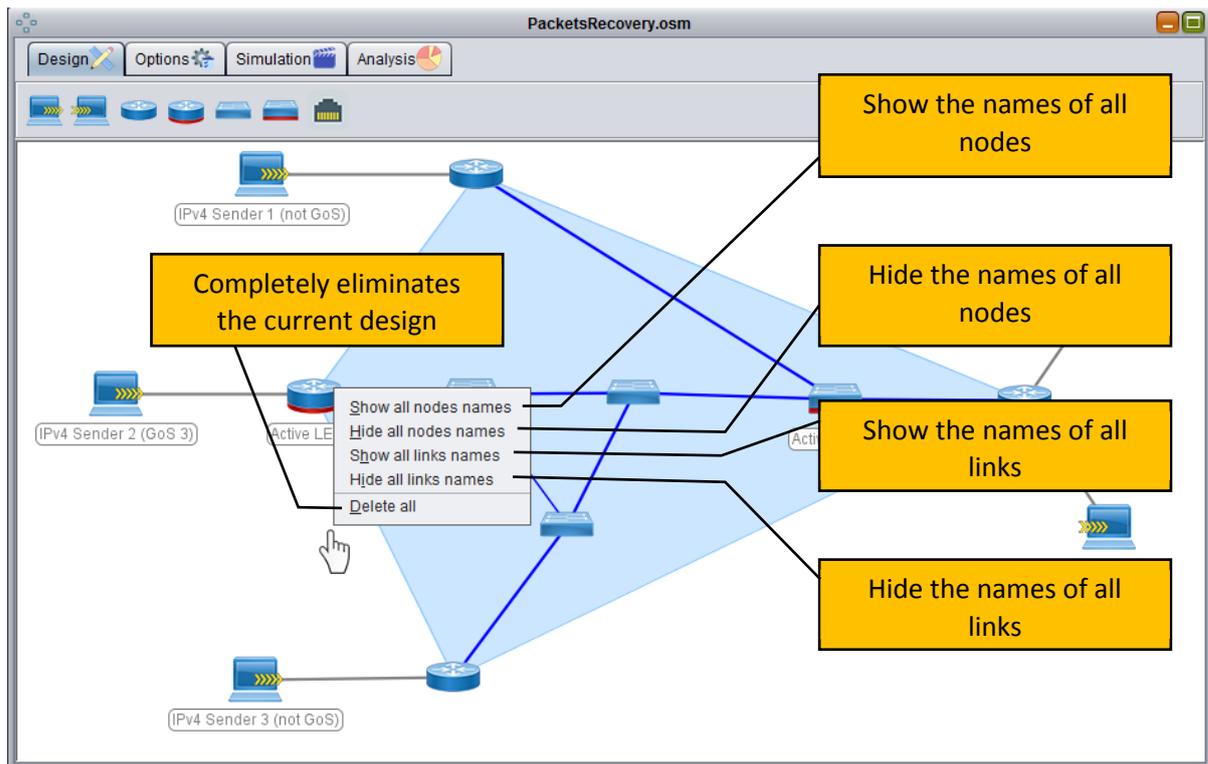
Design editing

At any time, the design can be edited: change the settings, delete inserted elements, and so on. For example:

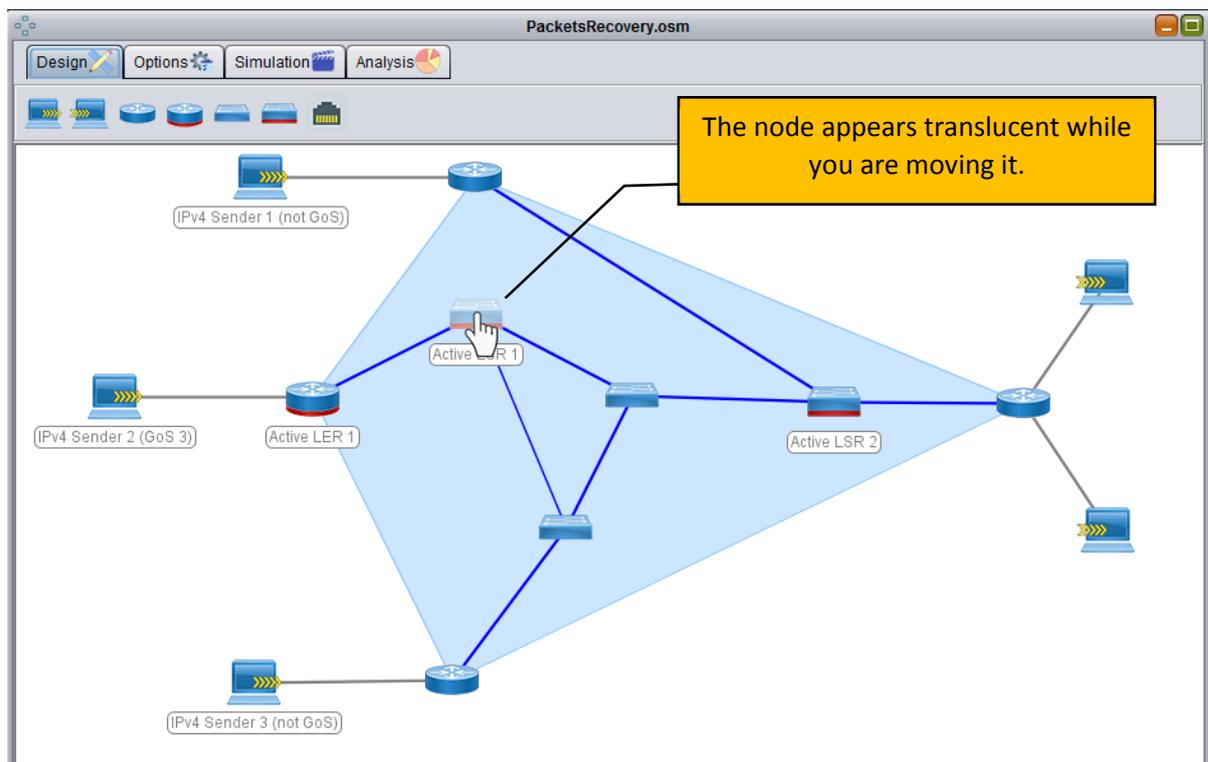
- A right click on an element (node or link) shows options on that element.



- A right click on the background of the design space shows global options on the design.



- You can drag the nodes with the main mouse button to place them where you want.



Step 2. Scenario information and timing parameters

To define the duration and basic data of the scenario, select the "Options" tab. In this tab you can define several aspects such as, for example, data about the scenario (author, title, description) or the duration of the simulation and its granularity.

The screenshot shows the 'PacketsRecovery.osm' interface with four tabs: Design, Options, Simulation, and Analysis. The 'Design' tab is active, showing 'Scenario information' and 'Simulation timing parameters'. Callouts explain the fields: 'Give your scenario a title' points to the 'Scene title' field; 'Put your data here (name, surname, email ...)' points to the 'Scene author' field; 'Describe the scenario. What do you intend to simulate in it?' points to the 'Description' field; and 'Choose the duration of the simulation. It will be the sum of the milliseconds and nanoseconds that you choose' points to the 'Duration' slider. A larger callout explains: 'The simulation is done through discrete events. The duration of these events is defined in this point. You will not be able to analyze with a finer grain than what you define here. Lower values allow finer simulations (and that consume more resources). Higher values, the opposite. The smallest possible value is the smallest delay of the links in the scenario you designed.' This callout also points to the 'Tick length' slider.

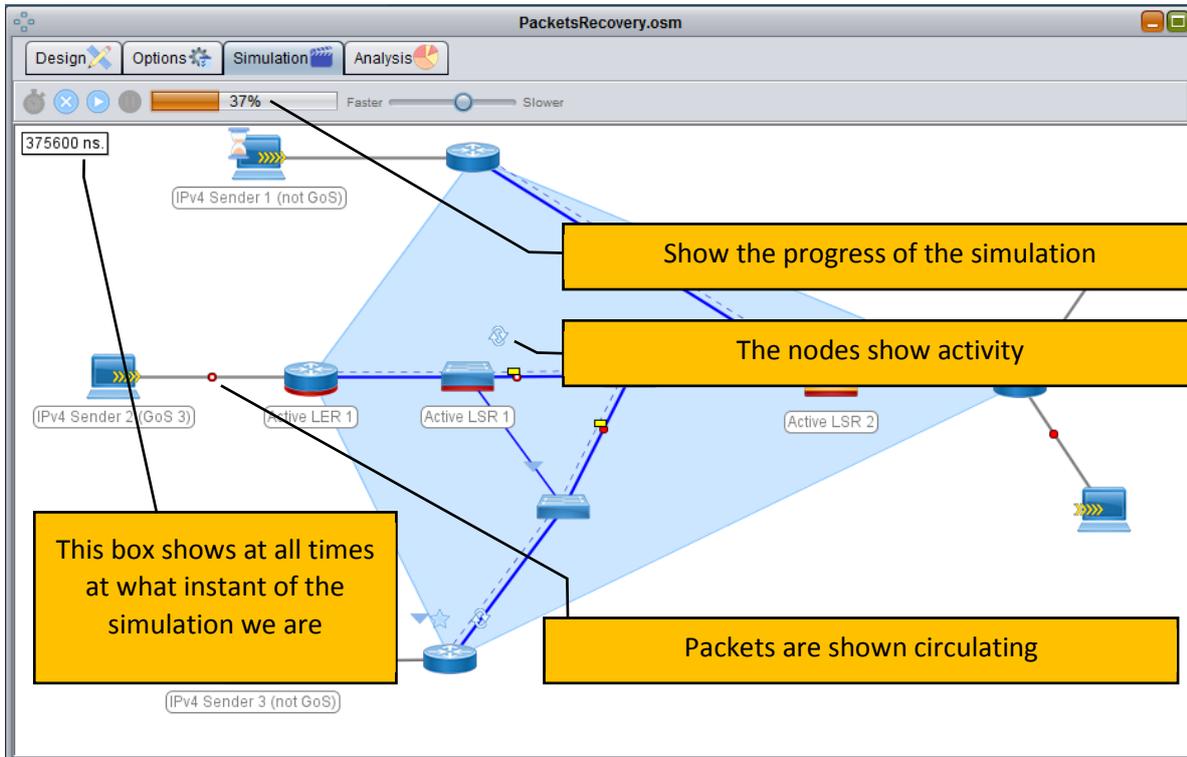
Step 3. Simulation execution

When everything is configured in the "Design" and "Options" tabs, it is usual to go to the "Simulation" tab, where the designed scenario can be put into operation.

The screenshot shows the 'PacketsRecovery.osm' interface with the 'Simulation' tab active. It displays a network diagram with three IPv4 senders (two 'not GoS' and one 'GoS 3') and two 'Active LSR 1' nodes. A progress bar at the top shows '0%' and a speed control slider between 'Faster' and 'Slower'. Callouts explain the controls: 'Accelerates or slows down the simulation' points to the speed slider; 'Show the progress of the simulation' points to the progress bar; 'Pause the simulation' points to a red square button; 'Resumes the simulation if it is paused' points to a green square button; 'Stops/finishes the simulation' points to a red square button; and 'Start the simulation' points to a blue square button.

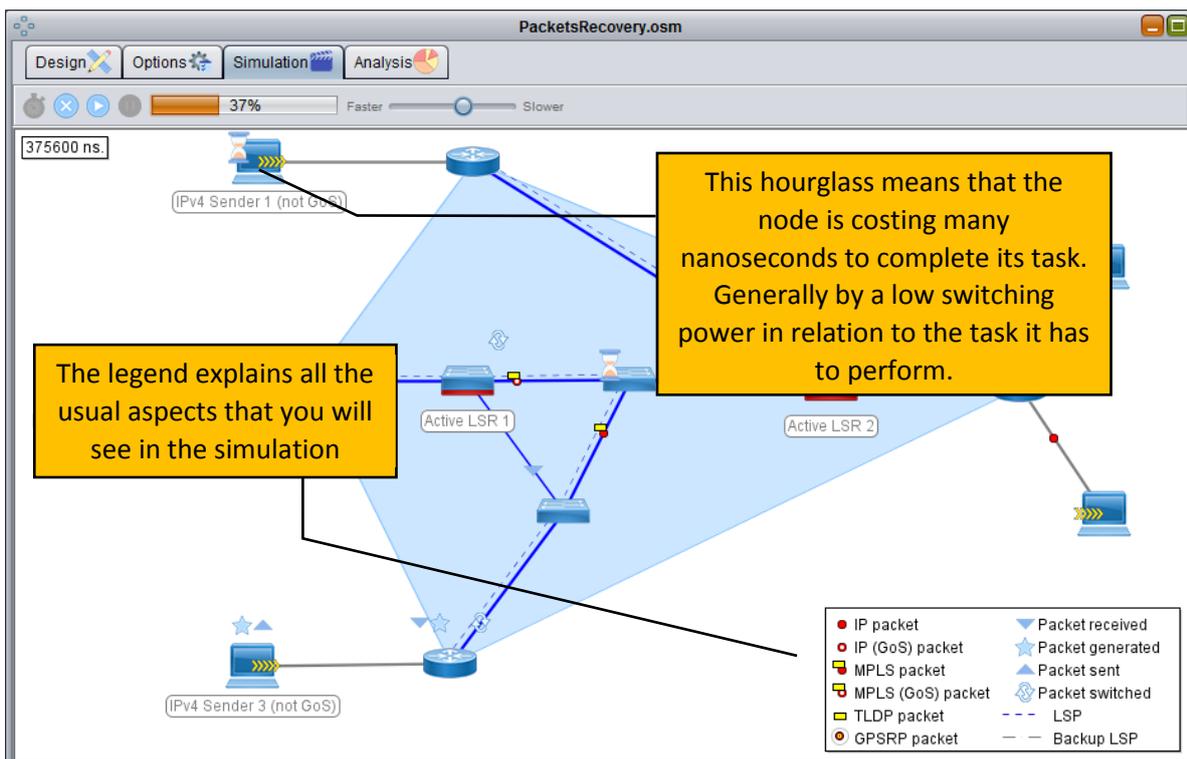
Start simulation

When the simulation starts, all the elements of the scenario begin to work in unison with the parameters that have been configured for them.



Understanding the simulation

You can see a legend that explains all the symbols that you can see in the simulation. To make this legend appear, you must click with the main mouse button in the background of the simulation panel (click again to hide it).

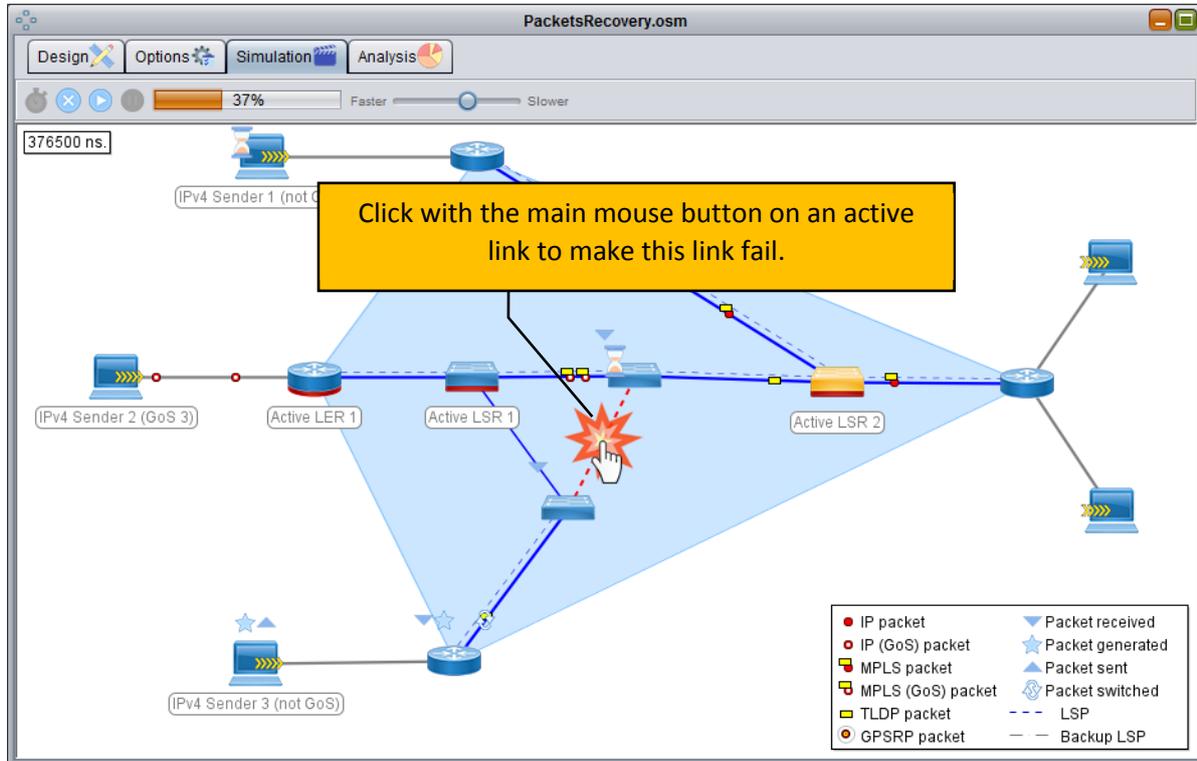


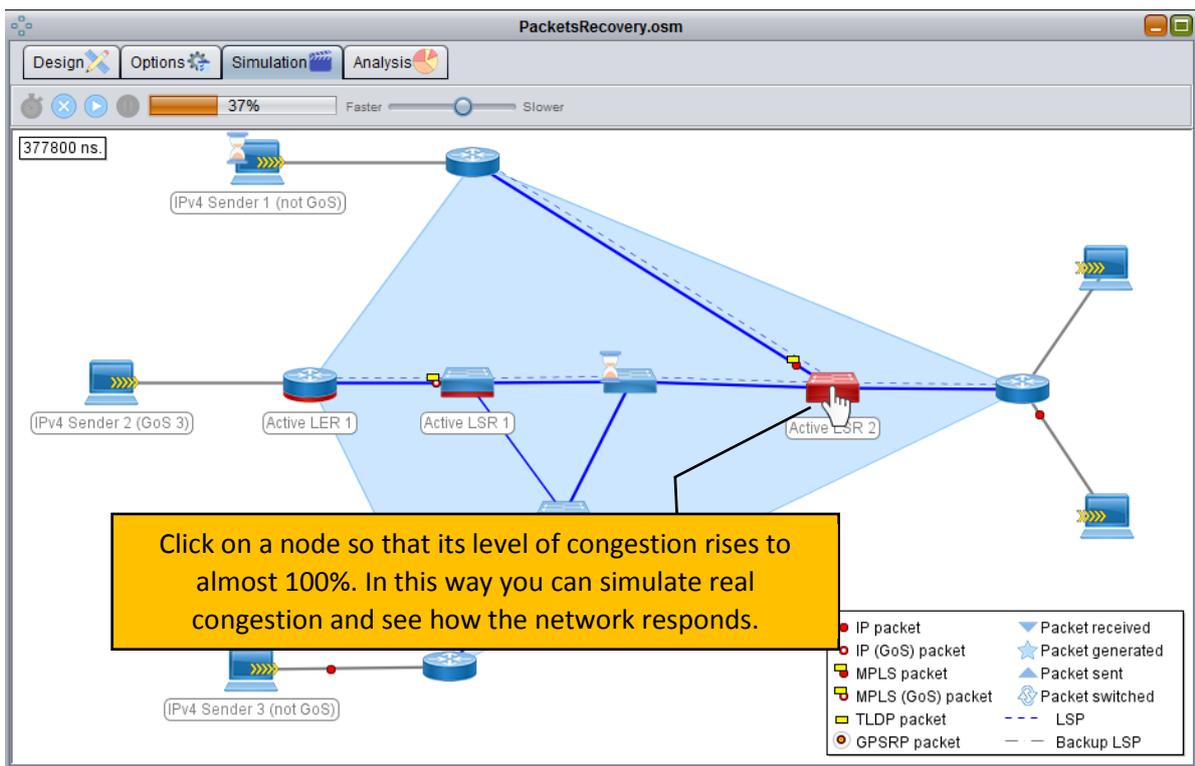
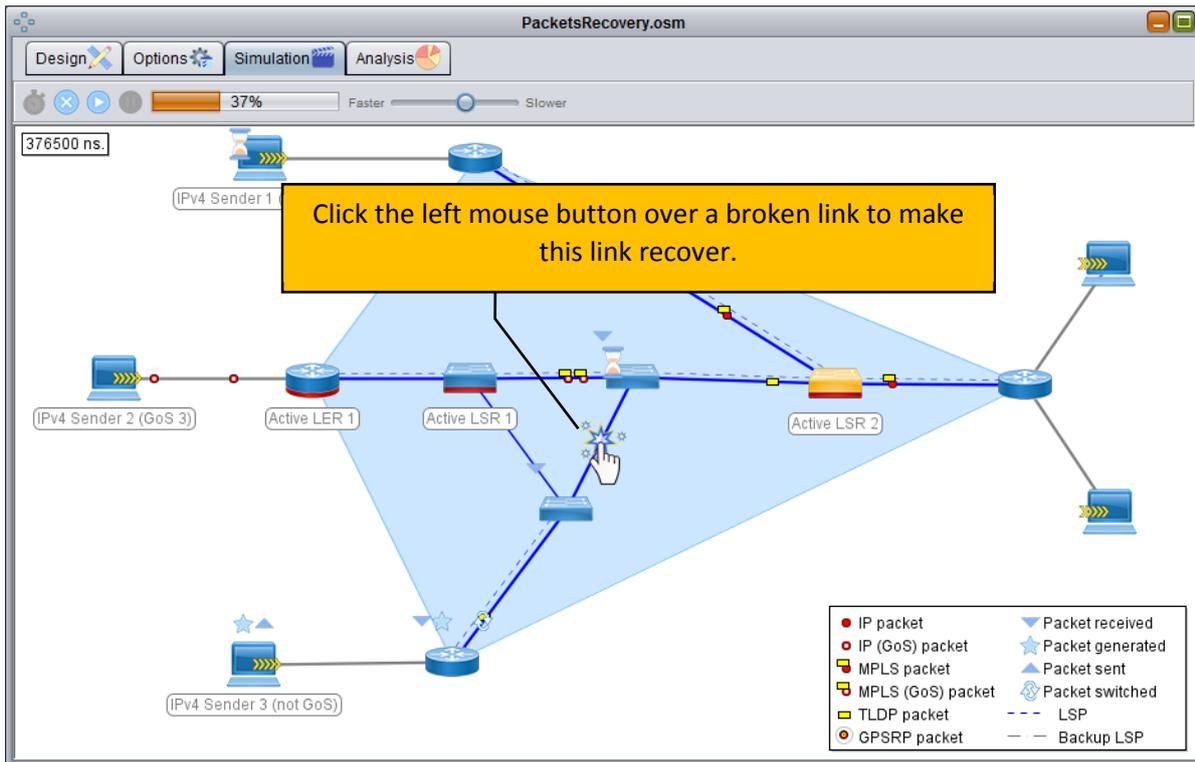
Interacting with the simulation

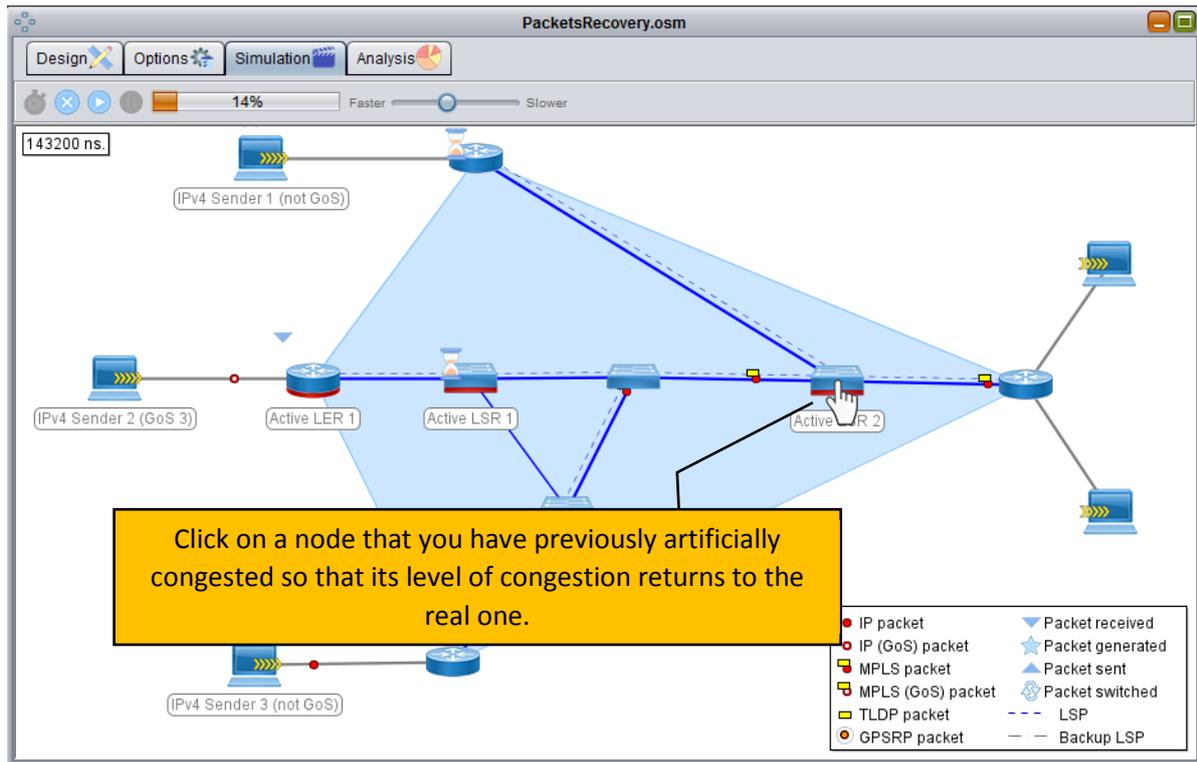
You can interact with the simulation in two ways:

- Manually causing congestion in a node.
- Making a link fail.

The simulation will adjust to the disasters you cause. This way you can analyze what happens in situations that could happen in reality.







Step 4. Analyzing the simulation

After finishing the simulation (or while it is running) you can go to the "Analysis" tab to see the statistics of those elements that you have configured to generate them.

Selection of the element to analyze

Select an element to show its statistics

- Active LER 1
- Active LSR 1
- Active LSR 2

Recovering packet via GPSRP

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Three IPv4 flows (one is GoS tagged) arrives to Active LSR 2, that became congested and start discarding packets. This LER will start recovering ONLY GoS packets through Active LSR 1 or Entrance active LER. The rest of the traffic is not recovered.

Select from this drop-down the element of your scenario that you want to analyze. If you did not configure an item to generate statistics in the "Design" tab, it will not appear here

The information about the scenario that you configured in the "Options" tab

Statistical analysis

The screenshot shows the 'Analysis' tab of the 'PacketsRecovery.osm' simulation. The selected element is 'Active LSR 2'. A yellow callout box explains that charts vary in number and information based on the selected element and are shown in real time if the simulation is not finished. The 'Incoming packets' chart shows a blue line increasing from 0 to approximately 800 over 400,000 ns, with a green line remaining near 0. The 'Outgoing packets' chart shows a blue line increasing from 0 to approximately 90 over 400,000 ns, with a green line increasing to about 60 and then plateauing. A 'Selected node' callout points to the 'Active LSR 2' element.

Exporting charts

The graphics can be exported in PNG format to illustrate your work, practices ... in short, to reuse them where you see fit. You can also copy them to the clipboard and paste them directly elsewhere.

This screenshot is similar to the previous one but shows a context menu over the 'Incoming packets' chart. The menu options are 'Copy', 'Save as', and 'PNG...'. A yellow callout box explains that clicking with the right mouse button allows saving the selected graphic in PNG format or copying it to the clipboard. The 'Incoming packets' chart shows a blue line increasing from 0 to approximately 1,200 over 600,000 ns, with a green line increasing to about 200. The 'Outgoing packets' chart shows a blue line increasing from 0 to approximately 110 over 600,000 ns, with a green line increasing to about 90.

Contribute

OpenSimMPLS is open source software. It is used by professionals and universities around the world (in more than 130 countries). It is a simulator in operation since 2004. Its maintenance is expensive in terms of time so, if you can contribute to its evolution/use, my family will thank you. There are many ways to collaborate.

Teachers

As a teacher, you use this simulator in your practices regarding communication networks. You can contribute a lot:

- Contribute the **teaching units** you use, to teachers from other parts of the world. It is not necessary to provide the solutions, but the statements, the scenarios you use and the purpose of the practical session.
- **Encourage your students to contribute**, instilling in them from the beginning in class a collaborative culture and respect for the work of others. Not only will they learn more about MPLS networks, but they will learn to work with repositories of software versions, pull requests and collaborate on software development projects.

Students

The students are very active. You are the people who directly use the simulator and, therefore, those who most discover their shortcomings. You can contribute a lot:

- **Contribute the scenarios that you develop** in your class practices.
- Contribute with **source code to repair bugs** or add new functionality.
- **Translate the simulator into other languages**. It is currently translated into Spanish and English, but any other language will be welcome. Together with them, Chinese and Arabic would allow practically anyone to understand it.
- **Build community**. Go to the OpenSimMPLS repository on GitHub: detect bugs, file issues for them, help answering questions from other users of the simulator, and so on.

Researchers

Most researchers use OpenSimMPLS as the basis to develop your own techniques. You can contribute a lot in this regard:

- **Source code of algorithms or novel techniques** for the simulator. If it's already done, why not bring it?

Professionals/developers

Professionals who use this simulator, get an economic benefit. I do not need financial resources, but time. **If your company uses this simulator, ask it to sponsor a few hours of your dedication to improve it**. It is the best way for you to have a simulator that is not obsolete.

Thanks for, at least, thinking about it 😊