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Área: Arquitetura, Sistemas e Redes
Sistemas Móveis (SIMOV)

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Basics of OPNET

This document presents the basics of OPNET Modeler. The content of this document is mainly transcript from the OPNET documentation [www.opnet.com].

1.Introduction

The OPNET simulator (OPNET Modeler) is very large and powerful simulation tool. The development work started in 1986 by MIL3 Inc. (nowadays OPNET Technologies Inc.). Originally the software was developed for the needs of military, but it has grown to be a world leading commercial network simulation tool. OPNET is quite expensive for commercial usage but there are also free licenses for educational purposes.

2.Modeling Overview

OPNET provides a comprehensive development environment supporting the modeling of communication networks and distributed systems. Both behaviour and performance of modeled systems can be analyzed by performing discrete event simulations. The OPNET environment incorporates tools for all phases of a study, including model design, simulation, data collection, and data analysis.

OPNET can be used as a platform to develop models of a wide range of systems. Some examples of possible applications are listed below with specific mention of supporting features:

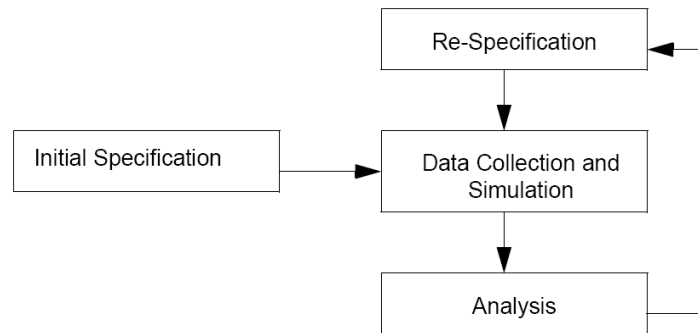
- Standards-based LAN and WAN performance modelling;
- Internetwork planning;
- Research and development in communications architectures and protocols;
- Distributed sensor and control networks, on-board systems;
- Resource sizing;
- Mobile packet radio networks;
- Satellite networks.

3.OPNET Architecture

OPNET provides a comprehensive development environment for modeling and performance-evaluation of communication networks and distributed systems.

The package consists of a number of tools, each one focusing on particular aspects of the modeling task. These tools fall into three major categories that correspond to the three phases of modeling and simulation projects: Specification, Data Collection and Simulation, and Analysis.

These phases are necessarily performed in sequence. They generally form a cycle, with a return to Specification following Analysis. Specification is actually divided into two parts: initial specification and re-specification, with only the latter belonging to the cycle, as illustrated in the following figure.



3.1. Model Specification

Model specification is the task of developing a representation of the system that is to be studied. OPNET supports the concept of model reuse so that most models are based on lower level models developed beforehand and stored in model libraries.

OPNET Models are structured hierarchically, in a manner that parallels real network systems. Specialized editors address issues at different levels of the hierarchy. This provides an intuitive modeling environment and also permits re-use of lower level models.

OPNET supports model specification with a number of tools, called editors, which capture the characteristics of a modeled system's behaviour:

- Project Editor—Develop network models. Network models are made up of subnets and node models. This editor also includes basic simulation and analysis capabilities.
- Node Editor—Develop node models. Node models are objects in a network model. Node models are made up of modules with process models. Modules may also include parameter models.
- Process Editor—Develop process models. Process models control module behavior and may reference parameter models.

3.2. Data Collection and Simulation

The objective of most modeling efforts is to obtain measures of a system's performance or to make observations concerning a system's behavior. OPNET supports these activities by creating an executable model of the system.

Provided that the model is sufficiently representative of the actual system, OPNET allows realistic estimates of performance and behavior to be obtained by executing simulations. Several mechanisms are provided to collect the desired data from one or more simulations of a system.

3.3. Analysis

The third phase of the simulation project involves examining the results collected during simulation. Typically, much of the data collected by simulation runs is placed in output scalar and output vector files. OPNET provides basic access to this data in the Project Editor and more advanced capabilities in the Analysis Tool, which is essentially a graphing and numerical processing environment.

4. Create a Project

When creating a new network model, you must first create a new **project** and **scenario**. A project is a group of related scenarios that each explores a different aspect of the network. Projects can contain multiple scenarios.

After you create a new project, the **Startup Wizard** automatically appears. The Startup Wizard lets you define certain aspects of the network environment.

To use the **Startup Wizard** to set up a new scenario, do the following:

- 1.If Modeler is not already running, start it. Building the network
- 2.Select File > New...
- 3.Select Project from the pull-down menu and click OK.

4. Name the project and scenario, as follows:

- 4.1. Name the project <project name>
- 4.2. Name the scenario <scenario name>.
- 4.3. Click OK.

↳ The **Startup Wizard** opens.

5. Enter the values in the dialog boxes of the Startup Wizard.

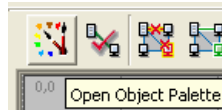
Dialog Box Name	Value
5.1 Initial Topology	Select the default value: Create empty scenario
5.2 Choose Network Scale	Select <....>. Select the Use metrics units checkbox
5.3 Specify Size	Select the size for the network
5.4 Select Technologies	Select <...>
5.5 Review	Check values, then click Finish

↳ A workspace of the size you specified is created. The **object palette** you specified opens in a separate window.

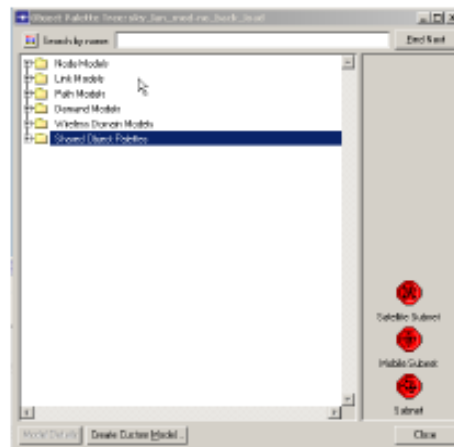
5. Create a specific Object Palette

Modeler's full set of node and link models would be overwhelming to work with all at once, so the object palette can be configured to show only a specific subset, or model list. You can use the standard model lists, adapt them for your own needs, or make your own list.

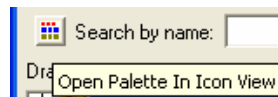
1. Open the Object Palette dialog box, if it is not, through a click in the Click the Object Palette Icon, or click on Open Object Palette under the Topology menu.



↳ The Object Palette dialog box opens.

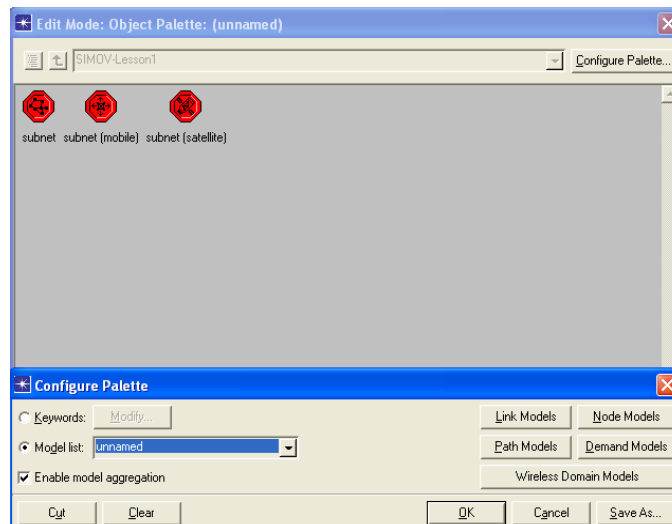


2. Click in the Open Palette in Icon View.

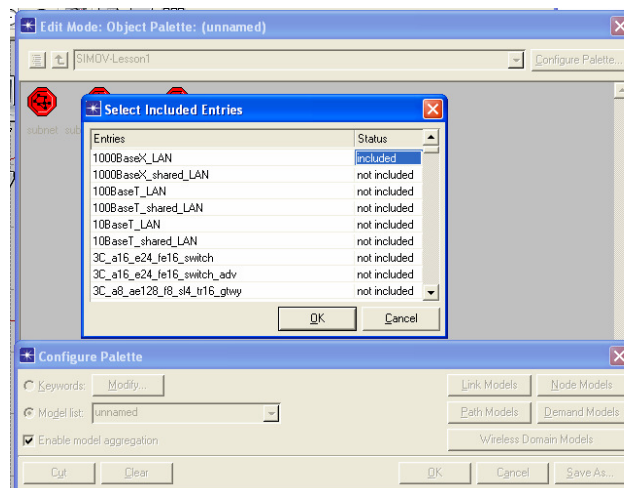


3. Click the **Configure Palette** button.

↳ The **Configure Palette** dialog box opens.

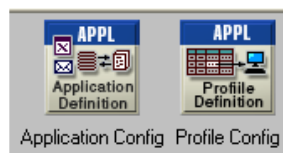


4. Click the Clear button to clear the **Object Palette**.
 5. In order to add Node Models to the **Object Palette** click the Node Models button.
- ↳ The **Select Included Entries** dialog box opens.



6. Change the entries status to "included" for including in the Object Palette.
7. Click OK to include and close the Select Included Entries dialog box.
8. Save the Object Palette.

6. Configuring Applications



It is a good idea to define the profiles and applications that will be used by the network devices before you begin constructing the network. You define the profiles in the **profile definition object** and applications in the **application definition object**.

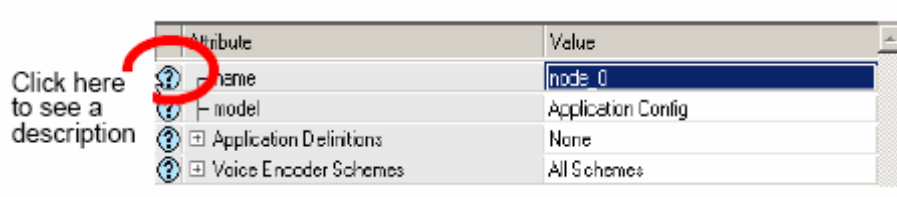
- A **profile** is applied to a workstation, server, or LAN. It specifies the applications used by a particular group of users. You might have one profile for Marketing (heavy use of email; light use of file transfer) and another profile for Engineering (light use of email; heavy use of file transfer).
- An **application** may be any of the common applications (email, file transfer) or a custom application you define. Eight common ("standard") applications are already

defined: Database Access, Email, File Transfer, File Print, Telnet Session, Video conferencing, Voice over IP Call, and Web Browsing.

6.1. To Configure the Application Configuration Object

Follow these steps.

1. Open the object palette if it is not already open.
2. Drag an **Application Config** object to the project workspace.
3. Right-click on the new object and select **Edit Attributes**.
 - ↳ The Attributes dialog box opens.
4. Click on the question mark next to the name attribute to see a description of the attribute.
 - Close the attribute description dialog box when done.
5. Set the name attribute to <...>.

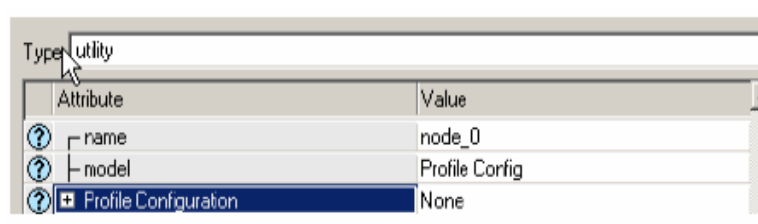


6. Change the **Application Definitions** attribute to **Default** by clicking in the attribute's Value column and selecting **Default** from the drop-down list.
 - ↳ Selecting **Default** configures the application definition object to make 16 pre-configured applications available for use. These applications are different configurations of the eight standard applications mentioned earlier. Now you will be able to include these applications in the profile you are about to create.
7. Click **OK** to accept the changes and close the **Attributes** dialog box.

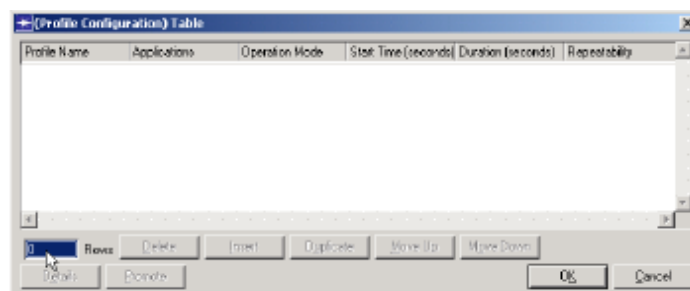
6.2. To Configure the Profile Configuration Object

Follow these steps.

1. Drag a Profile Config object from the object palette to the project workspace.
2. Right-click on the object and select Edit Attributes.
3. Set the **name** attribute to <...>.
4. Change the **Profile Configuration** attribute by clicking in its Value column and selecting Edit... from the drop-down list.



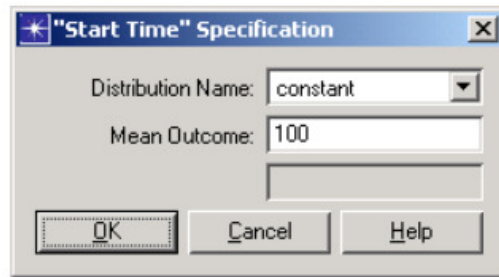
- ↳ The Profile Configuration dialog box appears.



6.2.1. To Define a New Profile and Add It to the Table

Follow these steps.

1. Change the number of rows to **1**.
2. Name the new profile <...> by clicking in the Profile Name column of the first row.
3. Skip the next column, Application. We'll configure the other attributes first and come back to this one later.
4. Change the **Operation Mode** to **Simultaneous**.
5. Click in the profile's **Start Time (seconds)** cell to open the Start Time Specification dialog box.
6. Select **constant** from the **Distribution Name** pull-down menu.

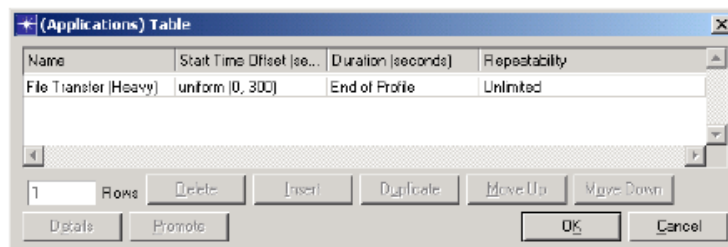


7. Set Mean Outcome to 100, then click OK to close the Start Time Specification dialog box.
 - ↳ The Start Time attribute has a value of **constant (100)**.

Do not close the profile configuration attribute dialog box.

You will be modeling FTP performance. That application should be included in the profile.

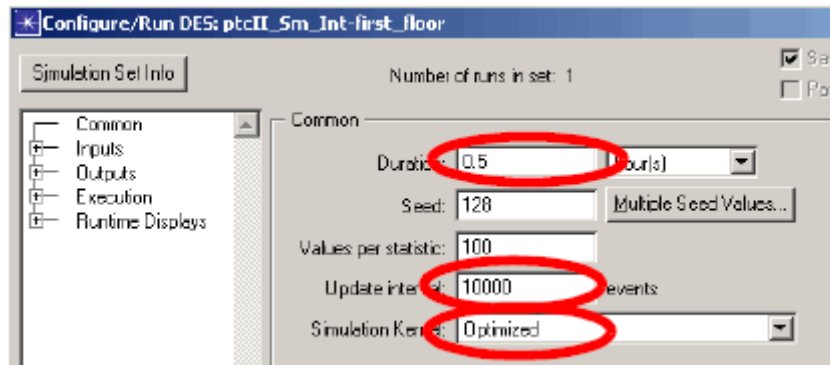
1. Click in the Applications column and choose **Edit...** from the pop-up menu.
 - ↳ The **Applications** dialog box appears.
2. Change the number of rows to **1**.
3. Set the **Name** to **File Transfer (Heavy)** by clicking in the cell and selecting the application from the drop-down list. The contents of the drop-down list are controlled by the Applications Configuration object. When you selected **Default** as the value for the **Application Definitions** attribute in this object, you enabled this list of applications. Note that the list includes 16 entries, a heavy and light version for each of the eight standard applications.
4. Set the **Start Time Offset** to **uniform (0, 300)**.
 - 4.1. Verify that the **Distribution Name** is **uniform**.
 - 4.2. Set the **Minimum Outcome** to **0**.
 - 4.3. Set the **Maximum Outcome** to **300**, then click **OK**.
5. Verify that the completed dialog box looks like this:



6. Click OK to close the Applications Table dialog box.
7. Click OK to close the Profile Configuration Table, then click OK again to close the Attributes dialog box.

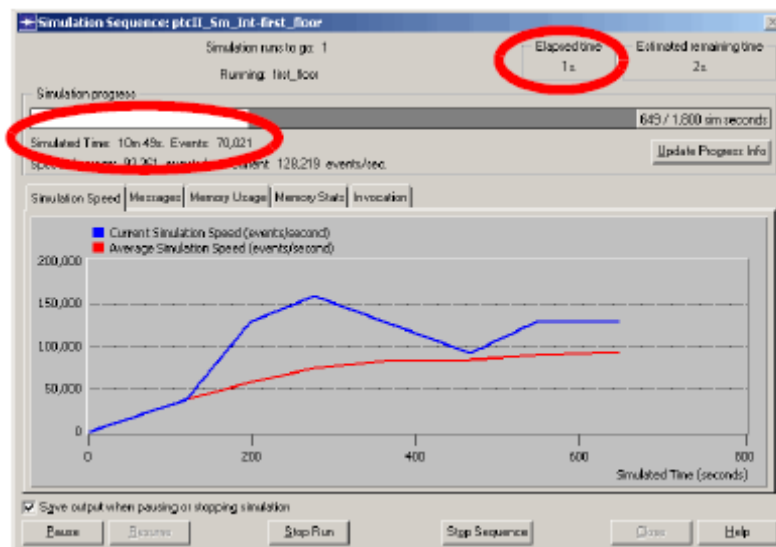
7.To run a simulation

- 1.Select DES > Configure/Run Discrete Event Simulation....You can also open the Configure Discrete Event Simulation dialog box by clicking on the Configure/Run Discrete Event Simulation (DES) toolbar button. 29



- 2.Type **0.5** in the **Duration:** field to simulate one-half hour of network activity.
- 3.Type **10000** (events) in the **Update interval:** field to specify how often the simulation calculates events/second data. In this case, the simulation calculates and displays events/second data at 10,000-event intervals. The default setting for this is 500,000 for larger network simulations.
- 4.Set the Simulation Kernel to **Optimized**.You can use one of two types of kernels to run your simulation. The development kernel collects simulation data you can use to debug your models, but the optimized kernel runs faster.
- 5.Click the **Run** button to begin the simulation. While the simulation runs, a dialog box appears showing the simulation's progress. The dialog box below shows that, in 1 second of elapsed (actual) time, Modeler has simulated 10 minutes and 49 seconds of network time. The entire simulation should take less than one minute to complete—the elapsed time varies according to the speed of your computer.

Elapsed Time: Number of seconds the simulation has run



Simulated Time: Minutes of network time

- 6.When the simulation finishes, the contents of the Messages tab appears. Click the Close button in the Simulation Sequence dialog box.
- 7.If your simulation does not complete, if no results were collected, or if the results vary significantly from those shown, you will have to troubleshoot your simulation.

8. Drag objects from Object Palette to Workspace

When you want set up a scenario, you must drag the object (node, links and etc) from Object Palette.

1. Find the specific object in the palette and drag it into the workspace
2. Right-click to turn off object creation.

9. Collecting Statistics

You can collect statistics from individual nodes in your network (**object statistics**) or from the entire network (**global statistics**).

9.1. Object statistics

1. Right-click on the object node and select Choose Individual DES Statistics from the server's Object pop-up menu.
 - ↳ The Choose Results dialog box for selected object appears. The Choose Results dialog box hierarchically organizes the statistics you may collect.
2.

9.2. Global statistics

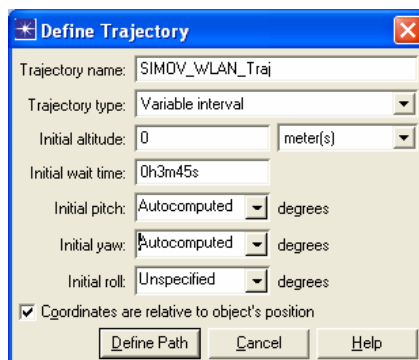
Global statistics can be used to gather information about the network as a whole. For example, you can find out the delay for the entire network by collecting the global **Delay** statistic:

1. Right-click in the workspace (but not on an object) and select Choose Individual DES Statistics from the Workspace pop-up menu.
2. Expand the Global Statistics hierarchy.
3.

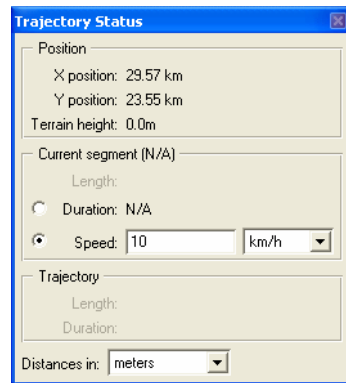
10. Define Trajectory to Mobile Node

10.1. To specify a trajectory for a mobile node

1. Choose **Topology > Define Trajectory....**
2. In the Define Trajectory dialog box, specify the attributes as shown, and then click on the **Define Path** button:
 - Trajectory name:
 - Trajectory type: **Variable interval**
 - Altitude: **0.0 meters**
 - Check the Coordinates are relative to object's position



When you click on the **Define Path** button in the Define Trajectory dialog box, the dialog box closes; next, the Trajectory Status dialog box displays and your cursor changes to a line in the Project Editor.



10.2. Draw the mobile node's trajectory

1. Left-click on the left edge of the node to begin the trajectory.
 2. Left-click on the grid at the (x, y) position (where x is the horizontal position and y is the vertical position).
 3. Right-click and select Complete trajectory definition to end the trajectory.
 - ↳ The trajectory disappears from the screen because it has not yet been referenced by a mobile node.
- You need to assign this trajectory to the node in the following steps:
4. Right-click on the node and select Edit Attributes.
 5. Change the trajectory attribute to <...>
 6. Click OK to close the dialog box.
- ↳ The trajectory is visible as a coloured arrow in the Project Editor.

10.3. Editing a trajectory

1. Right-click on the trajectory line and select Edit Trajectory.
 - ↳ The Edit Trajectory Information dialog box displays.
2. Edit the X and Y values for each row.
3. Make sure the Coordinates are relative to object's position box is NOT checked.
4. Click OK to close the dialog box and to overwrite the existing file.
5. Save the project with the default name.