Departament d'Enginyeria Telemàtica

entel

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Scalev v4.1

User Manual
scalev.upc.edu

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1. Introdution.

Scalev is a simulation tool developed within the SISCOM research group (Smart Services for Information Systems and Communication Networks, siscom.upc.edu) of the Network Engineering Department at the Universitat Politècnica de Catalunya. Its free distribution and use are permitted exclusively for educational purposes, and it can be downloaded from scalev.upc.edu. Its objective is to introduce students to the simulation of transmission systems at the device level, using a simple graphical interface where all parameters concerning each simulation are contained in a single simulator window.

The main features of Scalev are:

- Event-based simulator.
- Multiplatform (Programmed in Java).
- Ability to define 1 to 3 input traffic streams, with selectable distributions for inter-arrival time and packet length.
- Ability to assign input traffic streams to the same or different categories.
- Selection of the maximum number of packets the device can store per category.
- Single or multiple servers.
- Simple simulations and simulations with parameter sweeping.

2. Simulation scenario.

Figure 1 summarizes Scalev's simulation possibilities. As can be observed, up to three input traffic streams can be defined and assigned to up to three different categories.
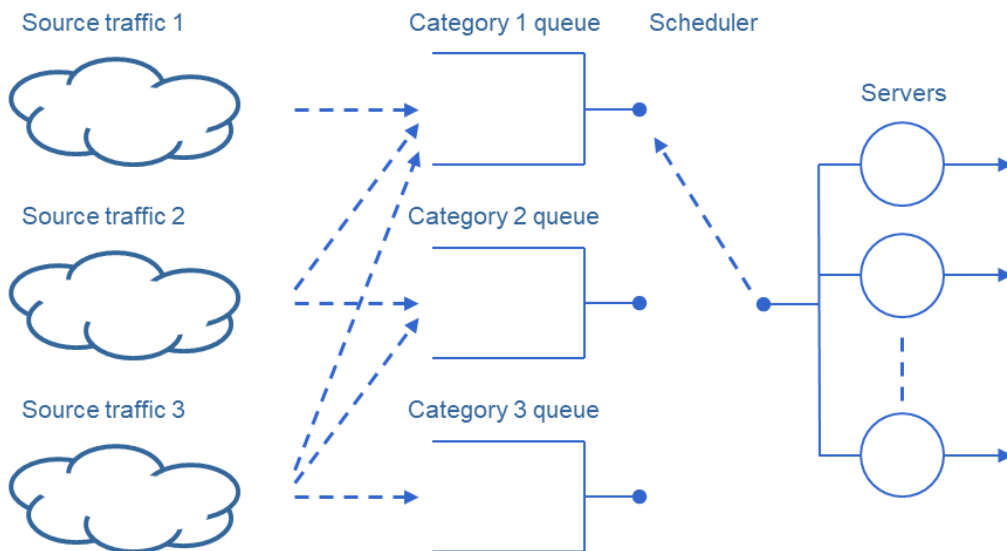

Figure 1. Simulation model.

Figure 2 shows a screenshot of the application's main window, where the mentioned selection possibilities can be observed.
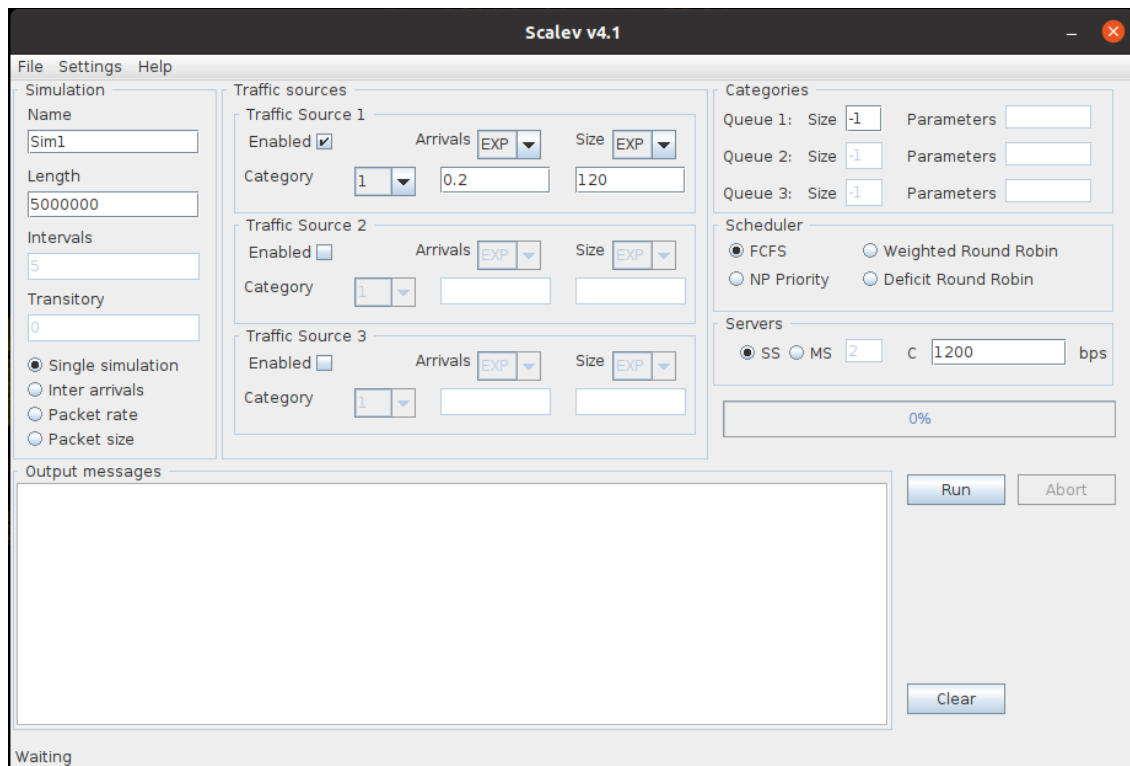

Figure 2. Scalev main window.

As can be observed in the figure, the following values can be selected:

- Number of input traffic streams between 1 and 3. For each stream, the following values can be chosen separately:
    - Distribution and mean value of the inter-arrival time (seconds).
    - Distribution and mean value of the packet size (bits).
    - Assigned category.
- Simulation Name.
- Simulation length (Duration). Its unit of measurement depends on the type of simulation, as will be seen later.
- Intervals. This value is selectable only in sweeping simulations. The simulator will divide the total simulation into a number of intervals, the value of which the user assigns in this field. The quotient of the simulation length and the number of intervals must be an integer.
- Transient. This value is selectable only in multi-server simulations. During the period between the start of the simulation and the value selected in this field, the simulator does not take measurements.
- Scheduler Type (FCFS, Non-Preemption Priority, Weighted Round Robin, or Deficit Round Robin).
- Maximum Number of Packets that can be stored per category. If an infinite queue capacity is desired, the value -1 must be entered.

- Parameters associated with each category. These parameters depend on the selected scheduler:

  - FCFS and NP Priority: Do not require parameters.
  - Weighted Round Robin: Number of packets transmitted from the category in each cycle.
  - Deficit Round Robin: Number of bits assigned per cycle to each category.
- Number of Servers.
- Server Capacity (bits per second).

3. Simple simulation.

Scalev allows for two types of simulations: simple simulations and simulations with parameter sweeping.

In simple simulations, a single simulation is performed with the selected parameters. It's possible to assign a name and a length (duration) to the simulation. In the case of simple simulations, the length is measured in bit times. For example, if a channel capacity of 1200 bps has been assigned, and a value of 5000000 has been entered for the simulation length, this length will be equivalent to:

$$5000000 \frac{1}{1200} = 4166.67 \; seconds = 1.16 \; hours$$

Once the simulation is executed, various results files will be available. The names and location of these files are selected using the *Directories* option in the *Settings* menu. As can be observed in Figure 3, the user enters the directory where they want the files to be saved, and separately, the name for each of them. The application adds the .txt extension to the name entered.
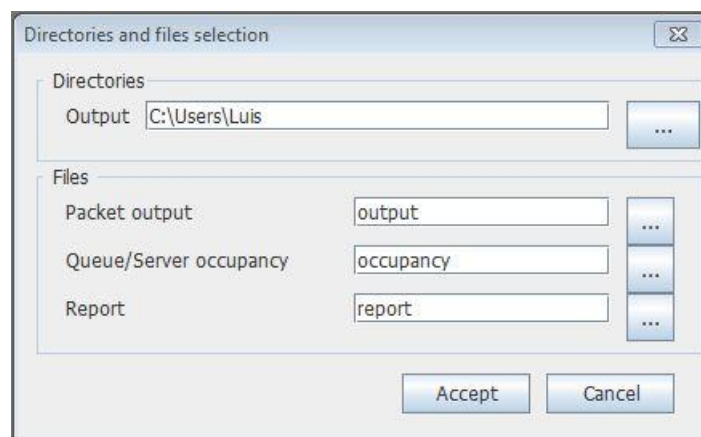

Figure 3. Directory and files name selection for the result files.

3.1 Simulation report.

In this file, the simulation report is obtained. To the name introduced by the user for this file, the application adds the simulation name. Figure 4 shows an example of a report obtained after a simulation performed with the parameters from Figure 2. As can be observed, the following information appears:

- Global Simulation Parameters (Name, start time, length, etc.).
- Parameters selected for the input traffic streams.
- Parameters selected for the categories.
- Simulation Results:
  - For each input traffic stream: Mean values for channel utilization, transmission, transfer, and waiting times, total number of packets served, total number of packets lost, and loss probability.
  - For each input category: In addition to the above results, the mean number of packets in the queue, in the server, and the sum of both are included.

3.2 Packets output file.

One file of this type of results file is generated for each input traffic stream and one for each category. To the name entered by the user, the application automatically adds the simulation name and the necessary suffixes. For example, if a simulation named Sim1 has been performed, with two input traffic streams and two categories, and the user has entered "output" as the name, the following files will be available upon completion of the simulation:

- output_Sim1_source_1.txt
- output_Sim1_source_2.txt
- output_Sim1_category_1.txt
- output_Sim1_category_2.txt

In each of these files, the following information is stored (tab-separated) every time a packet is transmitted:

- Packet Identifier (number assigned by the simulator as an index to each packet generated).
- Arrival Time.
- Service Time.
- Transfer Time.
- Waiting Time.

3.3 Waiting queues and servers output file.

One file of this type of results file is generated for each category. As in the previous case, the application automatically adds the necessary suffixes. For example, if a simulation named Sim1 has been performed with two categories, and the user has entered "occupancy" as the name, the following files will be available upon completion of the simulation:

- occupancy_Sim1_1.txt

- occupancy_Sim1_2.txt

In each of these files, the following information is stored (tab-separated) for every arrival or service completion instant of a packet:

- Time Instant at which the event occurs.
- Number of packets of this category in its waiting queue.
- Number of packets of this category in the server or servers.

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*****************************************************
******          SCALEV SIMULATION REPORT      ******
*****************************************************

GLOBAL PARAMETERS

Simulation name: Sim1
Start time: Mon Jan 09 15:38:56 CET 2023
Simulation length: 5000000
Traffic sources number: 1
Traffic categories number: 1
Scheduler type: First Come First Served
Server capacity: 1200
Number of servers: 1
Transitory: 0

TRAFFIC PARAMETERS

        Traffic number: 1
        Arrivals distribution: EXPONENTIAL
        Arrivals average: 0.2
        Length distribution: EXPONENTIAL
        Length average: 120.0
        Category: 1
        Theoric utilization: 0.5

CATEGORY PARAMETERS

        Category number: 1
        Queue size: -1
        Scheduler parameters: No parameters needed

SIMULATION RESULTS

        TRAFFIC SOURCES

        Traffic source number: 1
        Simulated utilization (carried): 0.5001429906770078
        Transmision time: 0.09987851049554299
        Transference time: 0.19921195565353525
        Wait time: 0.09933344515799226
        Total number of served packets: 20866
        Total number of lost packets: 0
        Loss probability: 0.0


        CATEGORIES

        Category number: 1
        Simulated utilization (carried): 0.5001429906770078
        Transmision time: 0.09987851049554299
        Transference time: 0.19921195565353525
        Wait time: 0.09933344515799226
        Packet number in queue: 0.49741356863532515
        Packet number in server: 0.5001429906770073
        Packet number in system: 0.9975565593123324
        Served packets: 20866
        Lost packets: 0
        Loss probability: 0.0

End time: Mon Jan 09 15:38:58 CET 2023

*****************************************************
******              END OF REPORT             ******
*****************************************************
```

Figure 4. Simulation report example.

4. Multiple Simulations with Input Parameter Sweeping.

Scalev allows for the execution of multiple simulations by performing a sweeping of one of the input parameters of traffic source 1. For example, if the parameter selected for sweeping is the inter-arrival time, a different simulation will be performed for each of the possible values supplied for that parameter. The remaining values stay the same across all simulations. The user must provide the initial value of the parameter to be varied, the final value, and the increment, separated by the character ":". Figure 5 shows a screenshot requesting a sweeping simulation of the inter-arrival time between 0.2 and 0.9 seconds with increments of 0.1.

The length of each simulation of this type is measured in the number of packets transmitted from traffic source 1. In the case of Figure 5, each of the multiple simulations will run until 500,000 packets have been transmitted from traffic source 1.
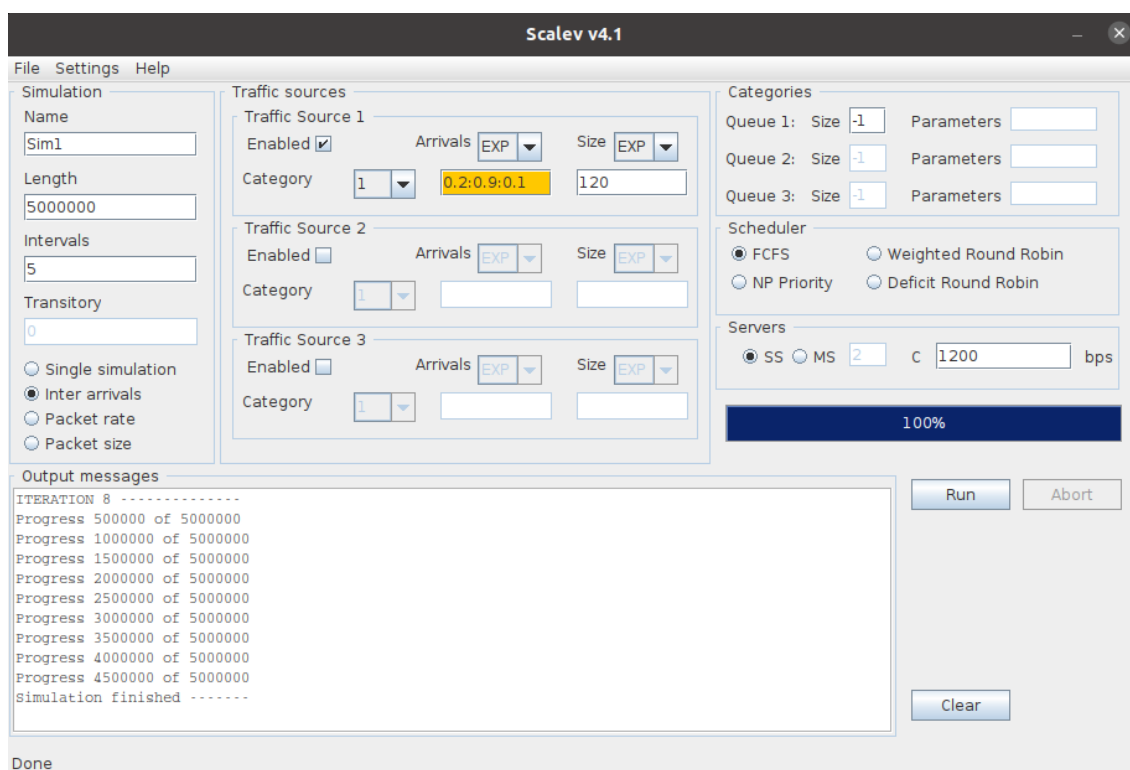

Figure 5. Simulation with sweeping of the inter-arrival time parameter.

On the other hand, the measurements calculated in each of these multiple simulations are taken by intervals. In this way, a confidence interval is added to some of the metrics offered by the simulator. In this version of the simulator, this interval is provided for 95% confidence. The provided value must be added to and subtracted from the mean value to obtain the confidence interval. The number of intervals is selectable by the user, with the only condition that it must be a divisor of the total simulation length. For example, in the case of Figure 5, 5 intervals will be taken, with 1,000,000 packets from traffic stream 1 in each one.

4.1 Types of Simulation.

Sweeping simulations can be performed on the following parameters:

- **Inter-arrival time (s).** The corresponding field is highlighted with an orange background.
- **Arrival Rate (pkts/s).** The corresponding field is highlighted with a green background, indicating that the parameter the simulator now requests is the inverse of what is requested on other occasions. The arrival rate (pkts/sec) is requested instead of the inter-arrival time (sec/pkt). Note, furthermore, that this only applies to traffic stream 1. For the rest of the traffic streams, if they are used, the parameter to be entered continues to be the inter-arrival time (sec/pkt).
- **Packet Length (bits).** The corresponding field is highlighted with an orange background.

4.2 Results file.

In this type of simulation, only the main report is generated as a results file. Its format is different from the one obtained with simple simulations. It is a file composed of several rows and several columns. Each row shows the results of one of the individual simulations, i.e., for a specific value of the variable parameter. For each simulation (each row), the following information is provided in each of the columns:

- Value taken by the variable parameter.
- Theoretical utilization for each traffic source (in as many columns as necessary, depending on the number of traffic sources in the simulation. This also applies to all results that follow).
- Simulated utilization.
- Mean Transmission Time.
- Mean Transfer Time.
- Confidence Interval of the Mean Transfer Time.
- Mean Waiting Time.
- Total Number of Packets Served.
- Total Number of Packets Lost.
- Loss Probability.
- Confidence Interval of the Loss Probability.
- Simulated utilization for each category (in as many columns as necessary, depending on the number of categories in the simulation. This also applies to all results that follow):
- Mean Transmission Time.
- Mean Transfer Time.
- Confidence Interval of the Mean Transfer Time.
- Mean Waiting Time.
- Mean Number of Packets in Queue.
- Confidence Interval of the Mean Number of Packets in Queue.
- Mean Number of Packets in Server.
- Mean Number of Packets in the System.
- Total Number of Packets Served.
- Total Number of Packets Lost.
- Loss Probability.
- Confidence Interval of the Loss Probability.