

Warteschlangensimulator [unsaved model file]

File Edit View Elements Model Simulation Extras Help Quick access (Strg+E) Feedback

Load model Save model Model editor Simulation results Start animation Start simulation Parameter series Help

**Model**

**Erlang C comparison model**

Source Clients → Process station → Exit

This simple model can be fully described by the Erlang C formula.

Number of clients at the process station (current value and average over the complete run time)

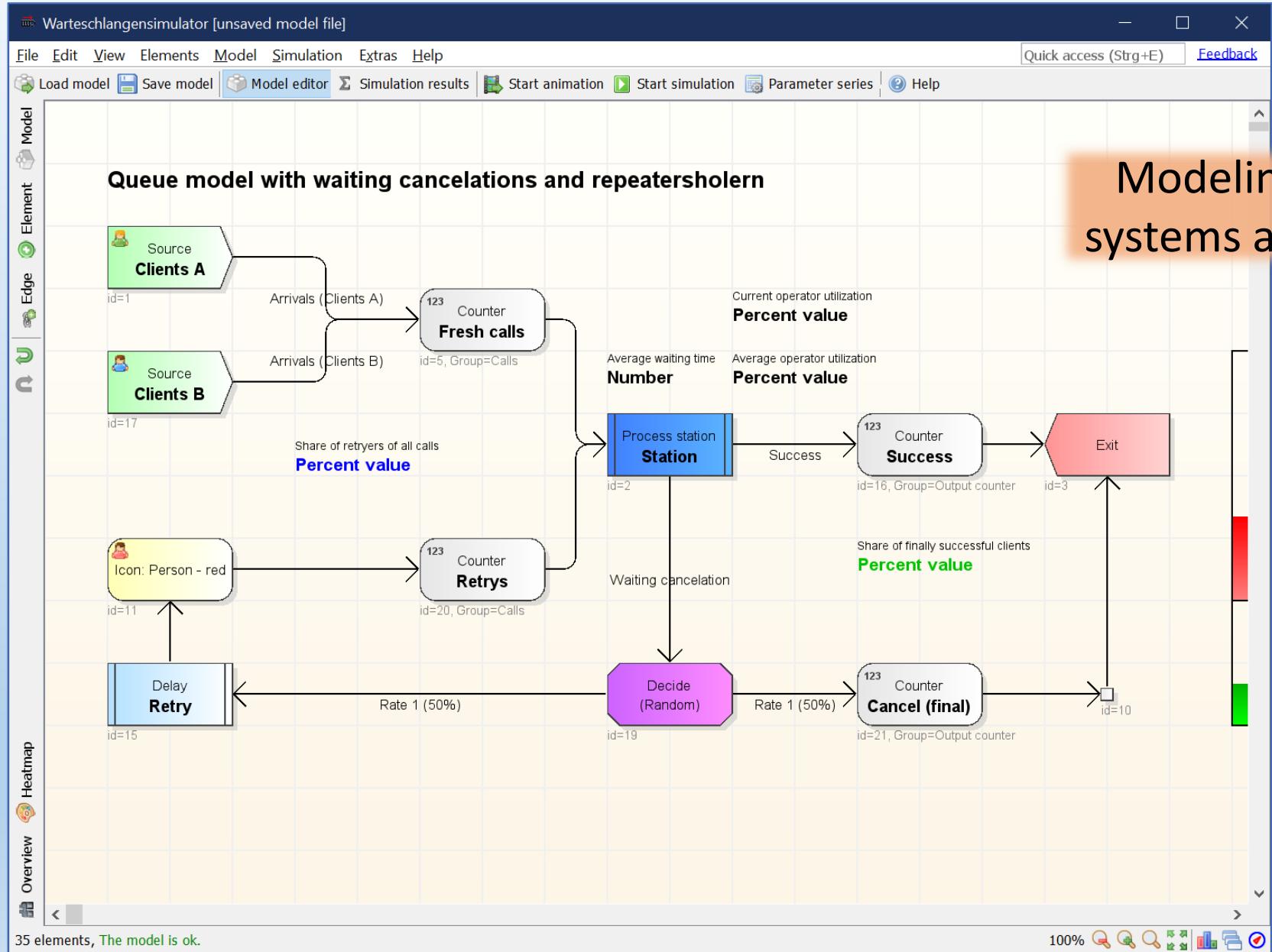
Fraction of time for the numbers of clients

(blue=0, green=1, red=2..10, orange=11...)

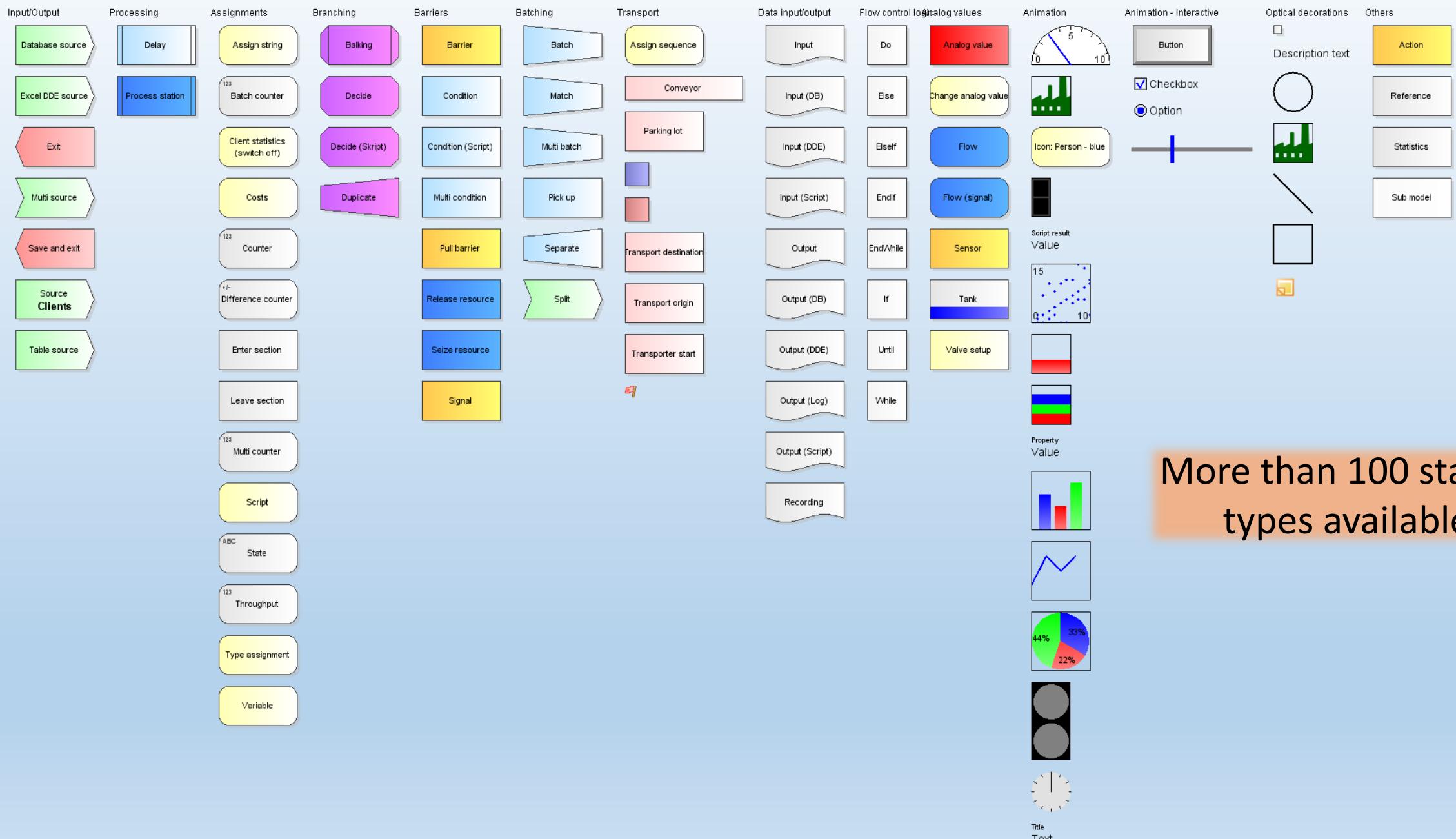
12 elements, The model is ok.

100%

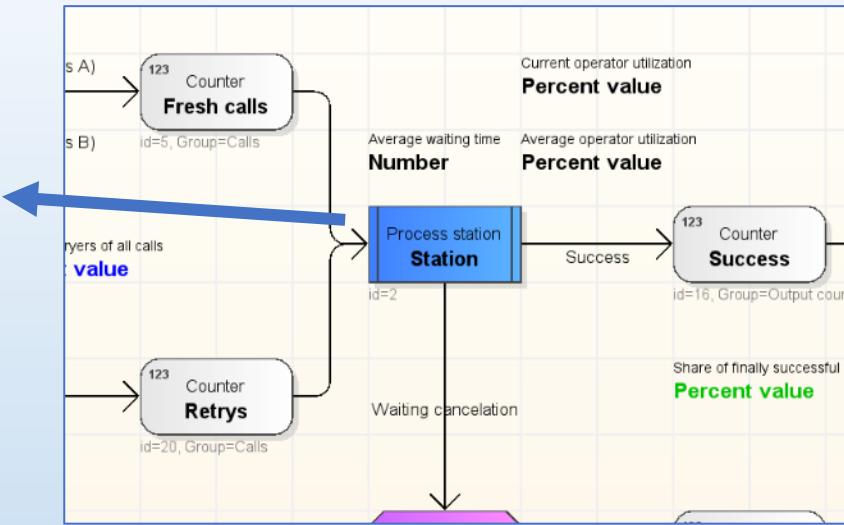
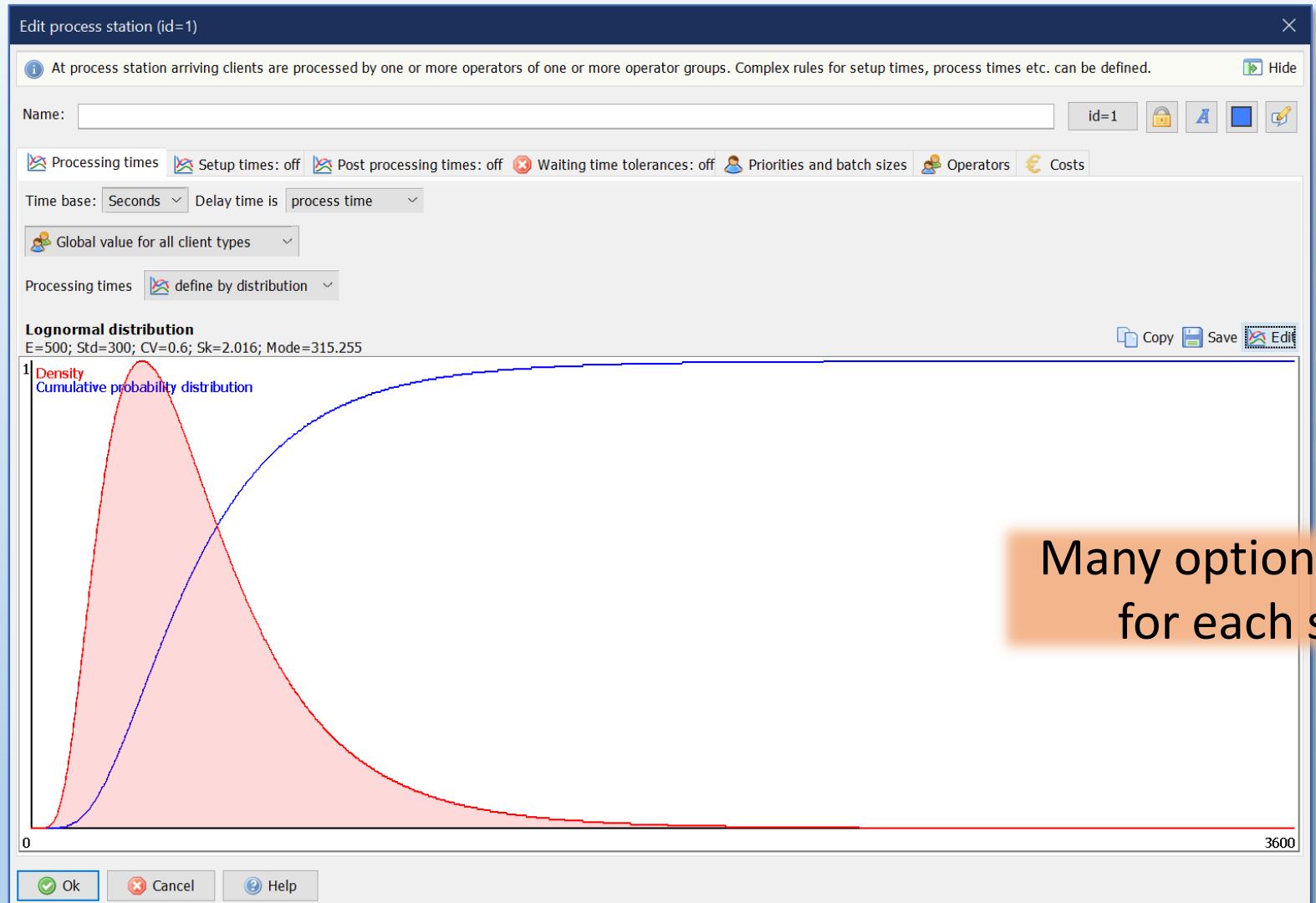
**Warteschlangensimulator**  
Fast and versatile event-driven  
stochastic simulator



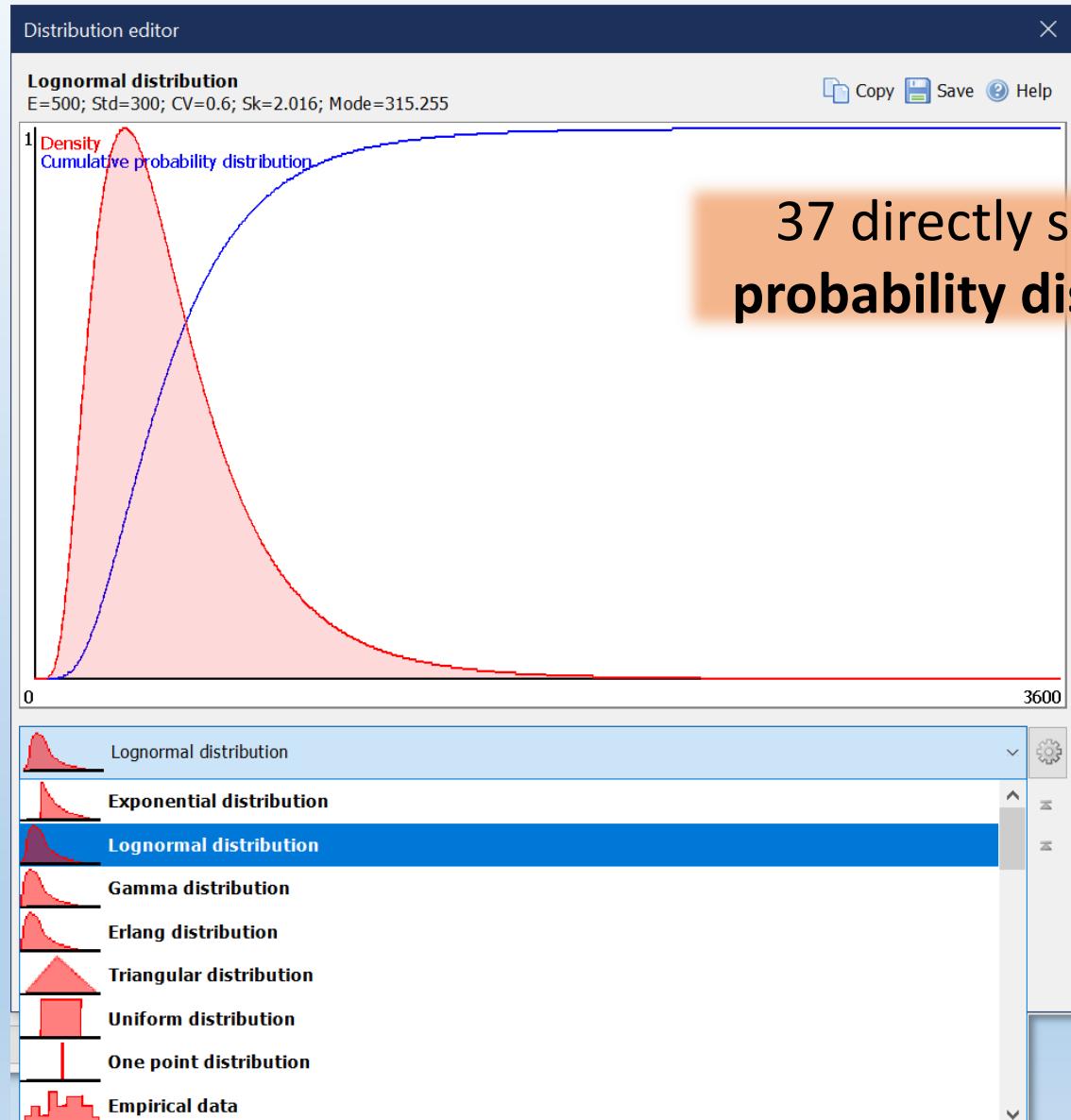
# Modeling queueing systems as **flow charts**



More than 100 station types available

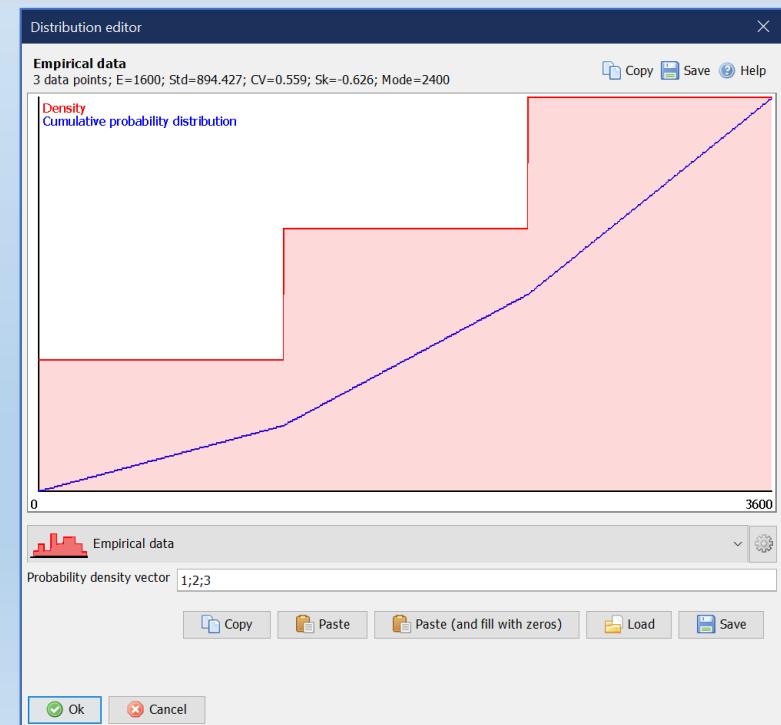


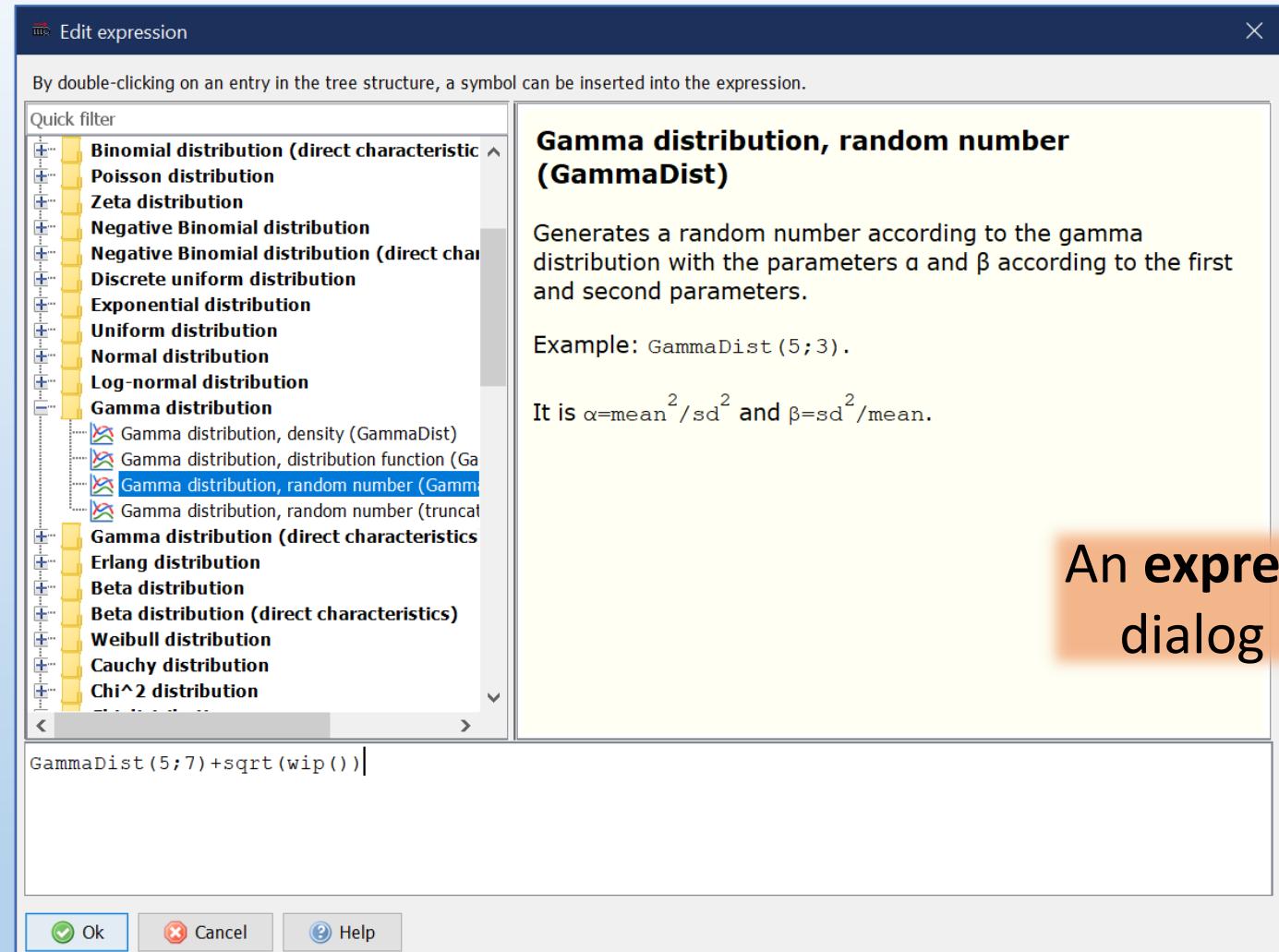
Many optional settings  
for each station



37 directly selectable  
probability distributions

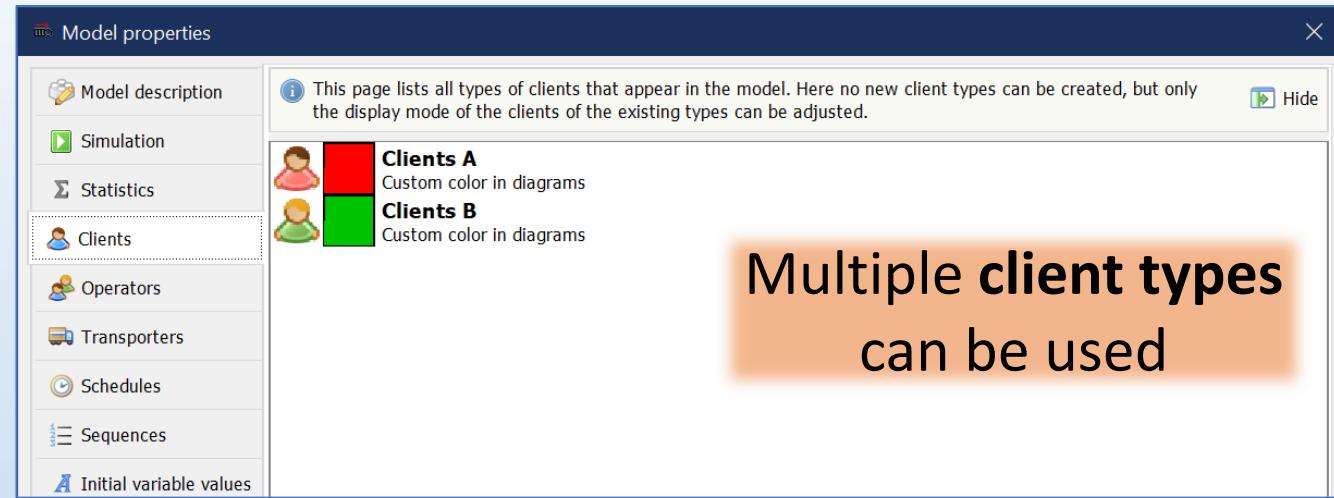
... including the option to use  
loaded empirical data





Calculation expressions  
can also be used

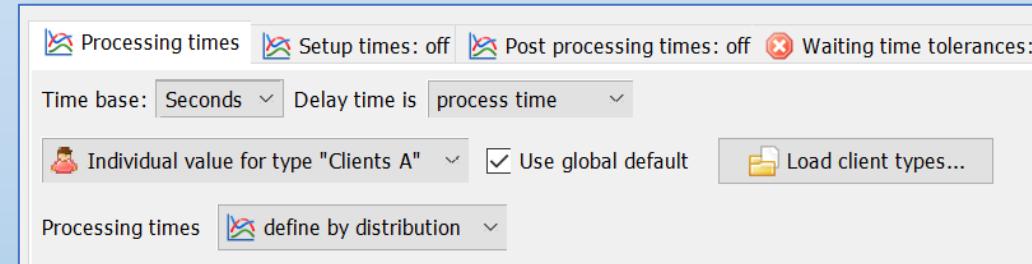
An expression builder  
dialog is available

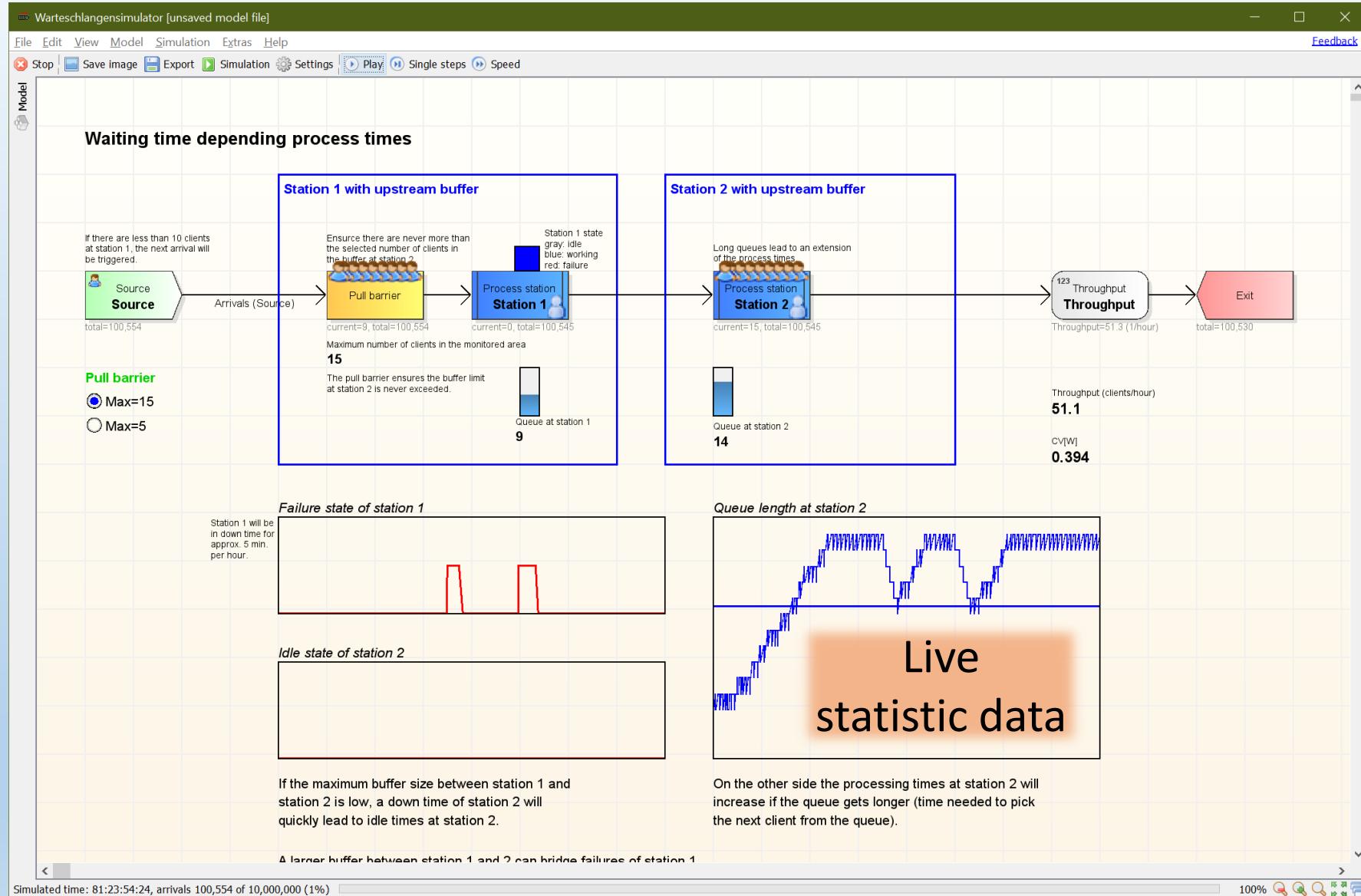


Multiple client types  
can be used



Each type can have an  
individual parameters

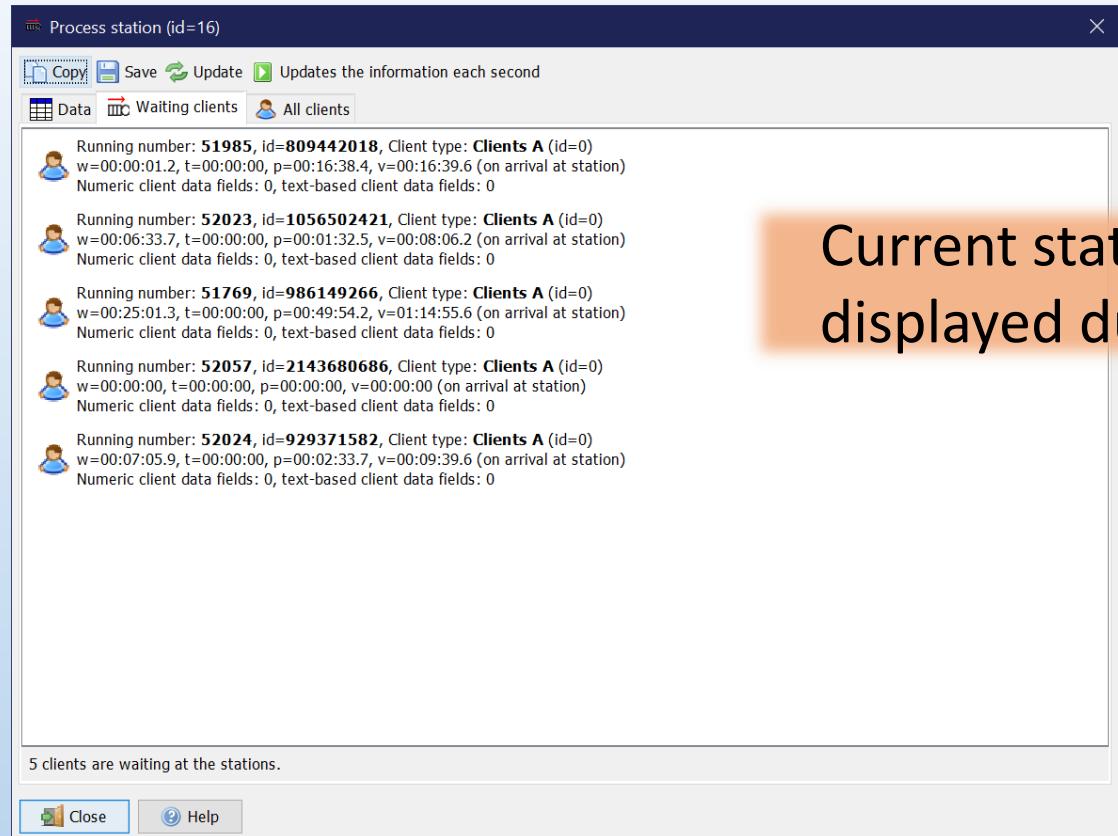




## Animation of models

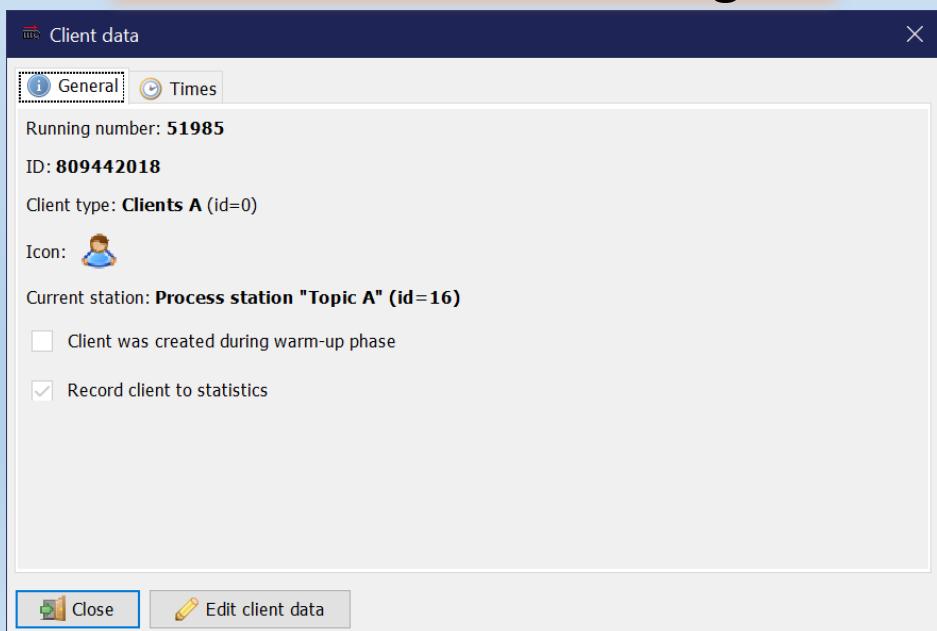
... which can be recorded as videos

Live statistic data



Current station data can be displayed during animation

... and also changed while animation is running



The screenshot shows the Warteschlangensimulator software interface. The main window title is "Warteschlangensimulator [unsaved model file]". The menu bar includes File, Edit, View, Elements, Model, Simulation, Extras, Help, Quick access (Strg+E), and Feedback. Below the menu is a toolbar with icons for Load statistics, Save statistics, Model editor, Simulation results, Start animation, Start simulation, Parameter series, Model for these results, and Help.

The left sidebar is titled "Simulation results" and contains a tree view of results categories:

- Fast access
- Dashboard
- Results overview (Text) (selected)
- Notes on the results (Text)
- Model overview
- Arrivals and leavings
- Clients at the stations
  - Number of clients at the stations (Text)
  - Number of clients at the stations (total)
  - Number of clients at the stations (by c)
  - Number of clients in the queues (Table)
  - Number of clients in the queues (by cli)
  - Number of clients in service process (T)
  - Number of clients in service process (b)
- Distributions by state
- Times of the clients
  - Waiting, transfer and processing times
  - Waiting, transfer and processing times
  - Ratio of waiting to process times (Graphic)
  - Distributions by time
- Times at the stations
  - Waiting, transfer and process times at
  - Waiting, transfer and process times at
  - Flow factors at the stations (Table)
  - Waiting times at the stations (Graphics)
  - Process times at the stations (Graphics)
  - Residence times at the stations (Graphics)
  - Flow factors at the stations (Graphics)
  - Waiting, transfer and process times by
  - Waiting, transfer and process times by
  - Flow factors by client types (Table)
  - Waiting times by client types (Graphics)
  - Process times by client types (Graphics)
  - Residence times by client types (Graphics)
  - Flow factors by client types (Graphics)
- Distributions by time
- Resource utilization
  - Resource utilization (Text)

The main content area is titled "Results overview" and displays the "Simulation model" section with the name "Waiting time depending process times", simulated clients (10,000,341), and a link to "details". It also lists sections for "Average number of clients", "Average number of clients in the queues (by stations)", "Average number of clients in service process (by stations)", and "Times by clients", each with their respective descriptions and data.

Full statistic recording  
without explicit configuration

**Results overview**

**Simulation model**  
Name: Waiting time depending process times  
Simulated clients: 10,000,341

**Average number of clients**

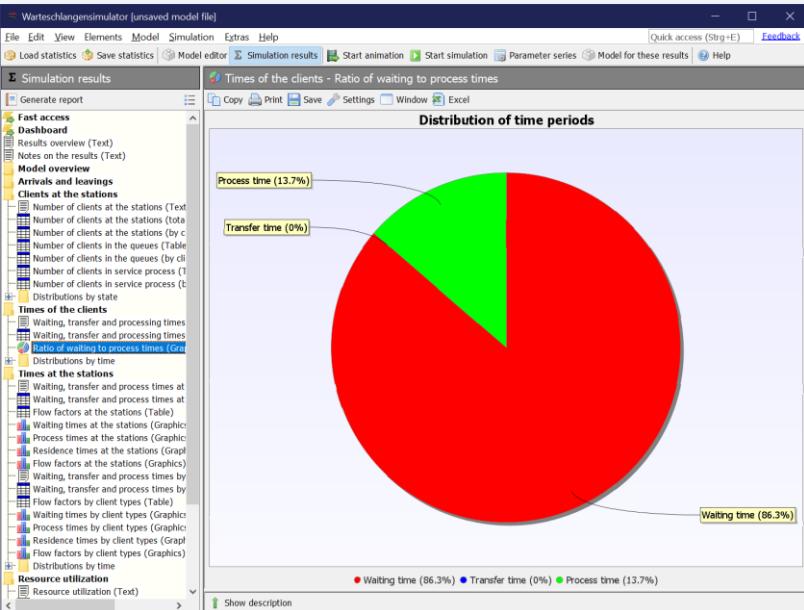
**Average number of clients (by station) E[N]**  
Clients in system: 13.127  
Clients at Process station "Station 1" (id=2):  $E[N]=1.025$   
Clients at Process station "Station 2" (id=10):  $E[N]=3.127$   
Clients at Pull barrier (id=9):  $E[N]=8.127$

**Average number of clients in the queues (by stations) E[NQ]**  
Clients in system (waiting): 11.334  
Clients in queue at Process station "Station 1" (id=2):  $E[NQ]=1.025$   
Clients in queue at Process station "Station 2" (id=10):  $E[NQ]=2.183$   
Clients in queue at Pull barrier (id=9):  $E[NQ]=8.127$

**Times by clients**

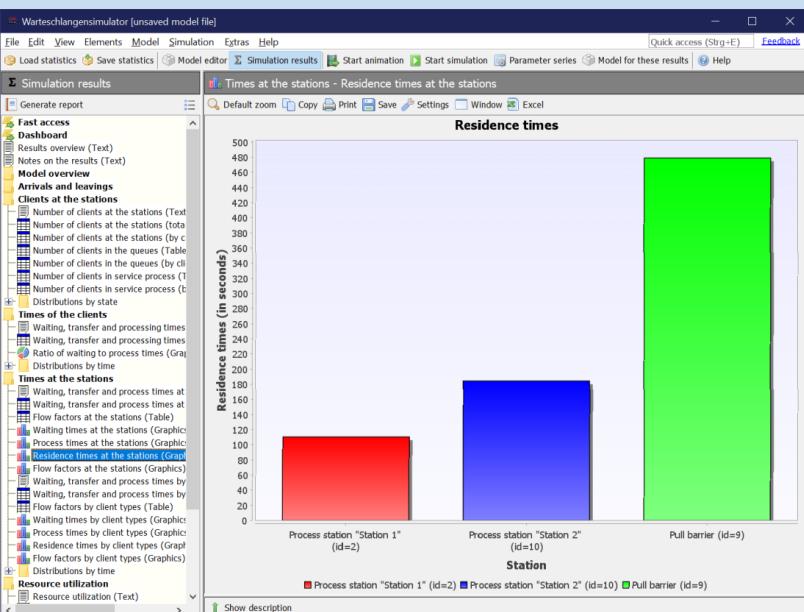
**Waiting times by client types E[W]**  
Average:  $E[W]=00:11:08.027$  (668.027)

**Process times by client types E[S]**  
Average:  $E[S]=00:01:45.646$  (105.646)

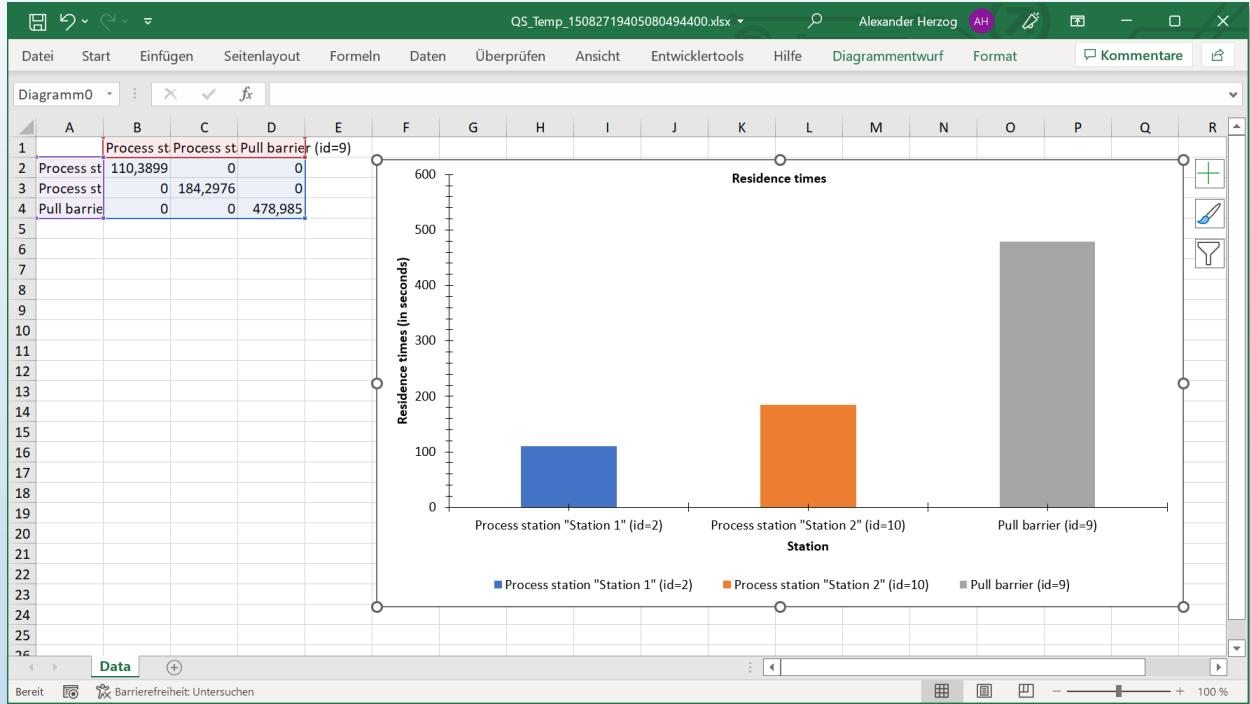
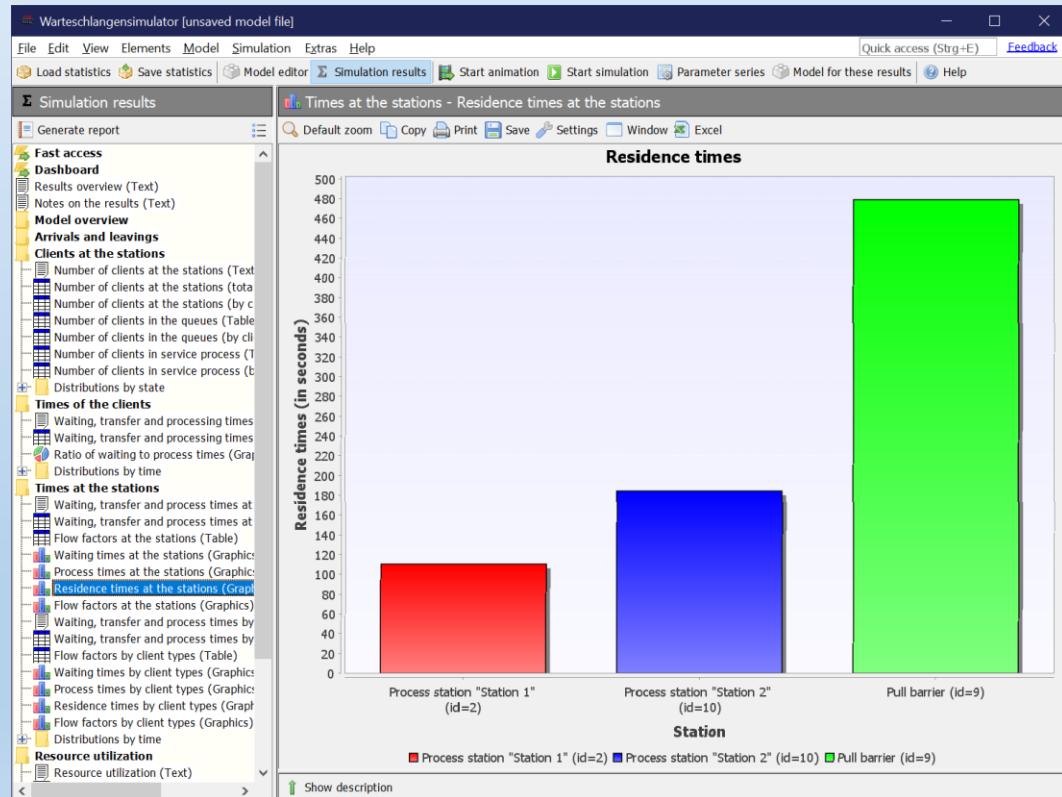


**Clients at the stations - Number of clients at the stations (by client types) (total)**

Station	E[N]	Std[N]	Var[N]	CV[N]	Sk[N]	Kurt[N]	Min[N]	Max[N]	10% Quantile[N]	25% Quantile[N]
Process station "Station 1" (id=2) - Source	1.025	1.346	1.812	0.719	0.853	-0.284	0	5	1	1
Process station "Station 2" (id=10) - Source	3.127	1.346	1.812	0.43	-0.853	-0.284	0	5	1	2
Pull barrier (id=9) - Source	8.127	1.346	1.812	0.166	-0.853	-0.284	5	10	6	7
Throughput *Throughput* (id=21) - Source	0	0	0	0	0	0	0	0	0	0



# Results available as texts, tables and charts



Excel export of tables  
and charts available

Warteschlangensimulator [unsaved model file]

File Edit View Elements Model Simulation Extras Help Quick access (Strg+E) Feedback

Load statistics Save statistics Model editor Simulation results Start animation Start simulation Parameter series Model for these results Help

**Simulation results**

Generate report

Copy Print Save All None Save tables

- Results overview (Text)
- Notes on the results (Text)
- Model overview - Model overview (Text)
- Model overview - Model overview (Graphics)
- Model overview - Station descriptions (Text)
- Arrivals and leavings - Arrivals at the stations (Text)
- Arrivals and leavings - Leavings from the stations (Text)
- Arrivals and leavings - Number of arrivals (Table)
- Arrivals and leavings - Inter-arrival times at the system - Inter-arrival times (Text)
- Arrivals and leavings - Inter-arrival times at the system - Inter-arrival times (Table)
- Arrivals and leavings - Inter-arrival times at the system - Distributions by time - Distribution of the inter-arrival times (Table)
- Arrivals and leavings - Inter-arrival times at the system - Distributions by time - Distribution of the inter-arrival times (Graphics)
- Arrivals and leavings - Inter-departure times from the system - Inter-departure times (Text)
- Arrivals and leavings - Inter-departure times from the system - Distributions by time - Distribution of the inter-departure times (Table)
- Arrivals and leavings - Inter-departure times from the system - Distributions by time - Distribution of the inter-departure times (Graphics)
- Arrivals and leavings - Inter-arrival times at the stations - Inter-arrival times (Table)
- Arrivals and leavings - Inter-arrival times at the stations - Inter-arrival times (Graphics)
- Arrivals and leavings - Inter-arrival times at the stations - Inter-arrival times by client types (Table)
- Arrivals and leavings - Inter-arrival times at the stations - Distributions by time - Distribution of the inter-arrival times (Table)
- Arrivals and leavings - Inter-arrival times at the stations - Distributions by time - Distribution of the inter-arrival times (Graphics)
- Arrivals and leavings - Inter-arrival times at the stations - Distributions by time - Distribution of the inter-arrival times by client types (Table)
- Arrivals and leavings - Inter-arrival times at the stations - Distributions by time - Distribution of the inter-arrival times by client types (Graphics)
- Arrivals and leavings - Inter-departure times at the stations - Inter-departure times (Table)
- Arrivals and leavings - Inter-departure times at the stations - Inter-departure times by batches (Table)
- Arrivals and leavings - Inter-departure times at the stations - Inter-departure times (Graphics)
- Arrivals and leavings - Inter-departure times at the stations - Inter-departure times by batches (Graphics)
- Arrivals and leavings - Inter-departure times at the stations - Inter-departure times by client types (Table)
- Arrivals and leavings - Inter-departure times at the stations - Inter-departure times by client types (Graphics)
- Arrivals and leavings - Inter-departure times at the stations - Distributions by time - Distribution of the inter-departure times (Table)
- Arrivals and leavings - Inter-departure times at the stations - Distributions by time - Distribution of the inter-departure times by batches (Tab..)
- Arrivals and leavings - Inter-departure times at the stations - Distributions by time - Distribution of the inter-departure times (Graphics)
- Arrivals and leavings - Inter-departure times at the stations - Distributions by time - Distribution of the inter-departure times by batches (Graph..)
- Arrivals and leavings - Inter-departure times at the stations - Distributions by time - Distribution of the inter-departure times by client types (..)
- Arrivals and leavings - Inter-departure times at the stations - Distributions by time - Distribution of the inter-departure times by client types (..)
- Clients at the stations - Number of clients at the stations (Text)
- Clients at the stations - Number of clients at the stations (total) (Table)
- Clients at the stations - Number of clients at the stations (by client types) (total) (Table)

Generate report

# Report generator

supporting docx, pdf, tex and html

html Reports can be saved as interactive web viewers

Waiting time depending process times - Statistics

Results overview (Text)

Results overview

Simulation model

Name: Waiting time depending process times  
Simulated clients: 10.000,341

Average number of clients

Average number of clients (by station) E[N]

Clients in system: 13.127  
Clients in queue at Process station "Station 1" (id=2): E[N]=1.073  
Clients in queue at Process station "Station 2" (id=10): E[N]=2.137  
Clients in Full barrier (id=9): E[N]=0.127

Average number of clients in the queues (by stations) E[NQ]

Clients in system (waiting): 11.33  
Clients in queue at Process station "Station 1" (id=2): E[NQ]=1.025  
Clients in queue at Process station "Station 2" (id=10): E[NQ]=2.183  
Clients in queue at Full barrier (id=9): E[NQ]=0.127

Average number of clients in service process (by stations) E[NS]

Clients in system in service process: 1.179  
Clients in service process at Process station "Station 1" (id=2): E[NS]=0.846  
Clients in service process at Process station "Station 2" (id=10): E[NS]=0.944

Times by clients

Waiting times by client types E[W]

Average: E[W]=00:11:00.027 (668.027)

Process times by client types E[S]

Average: E[S]=00:01:45.046 (105.646)

Residence times by client types E[V]

Average: E[V]=00:12:53.073 (773.073)

Flow factors by client type

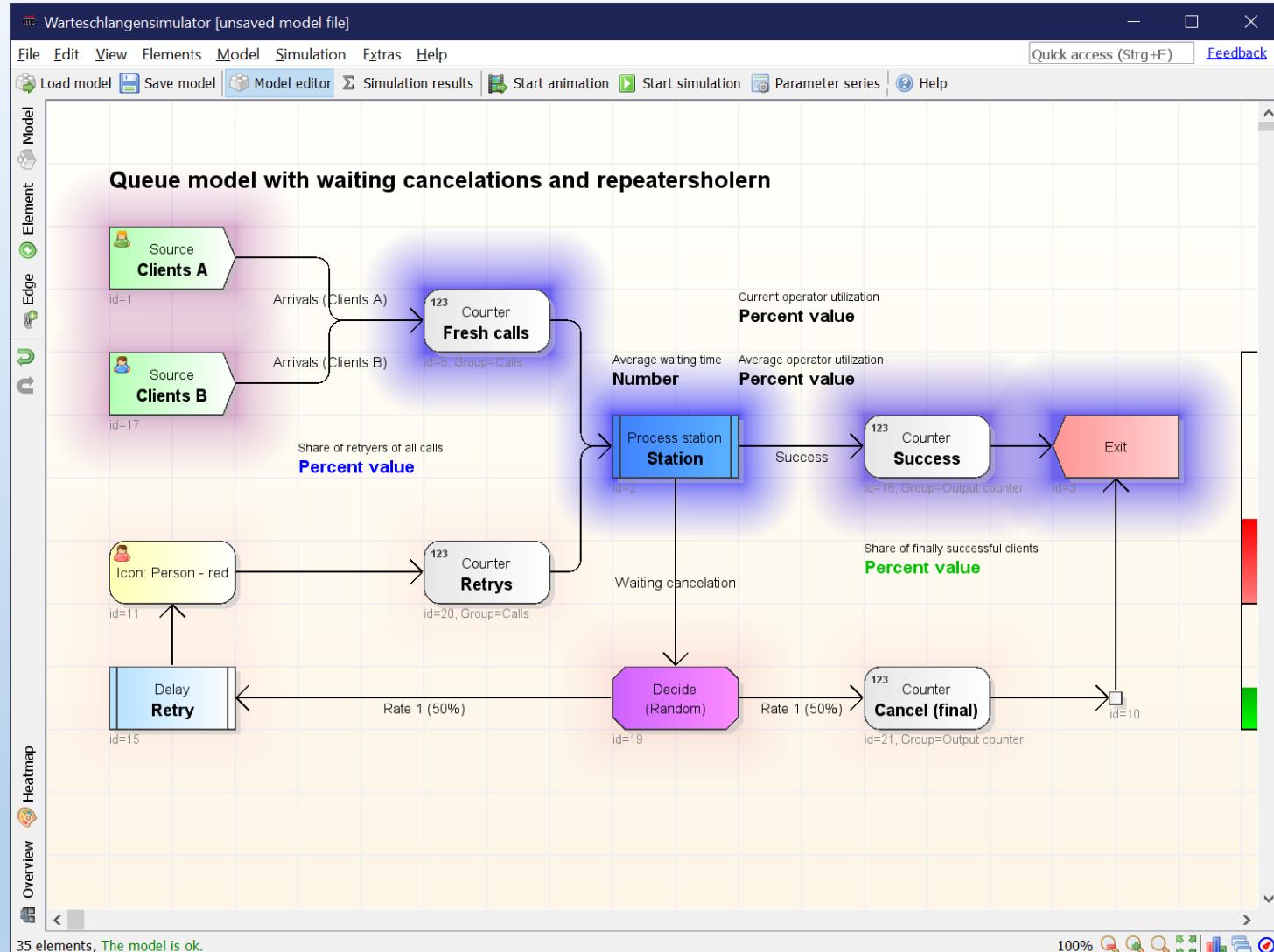
Average: 7.323

Times by stations

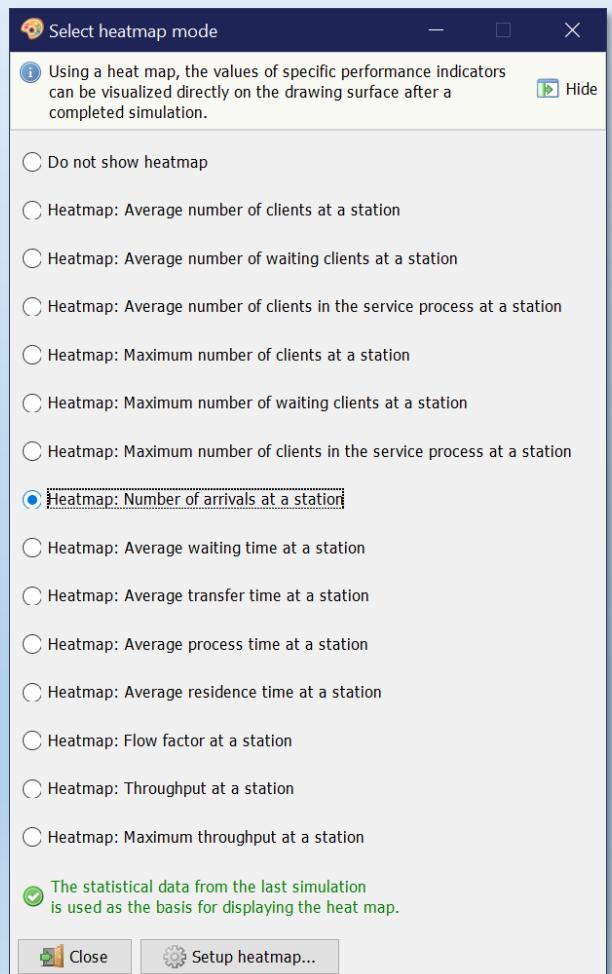
Waiting times by stations E[W]

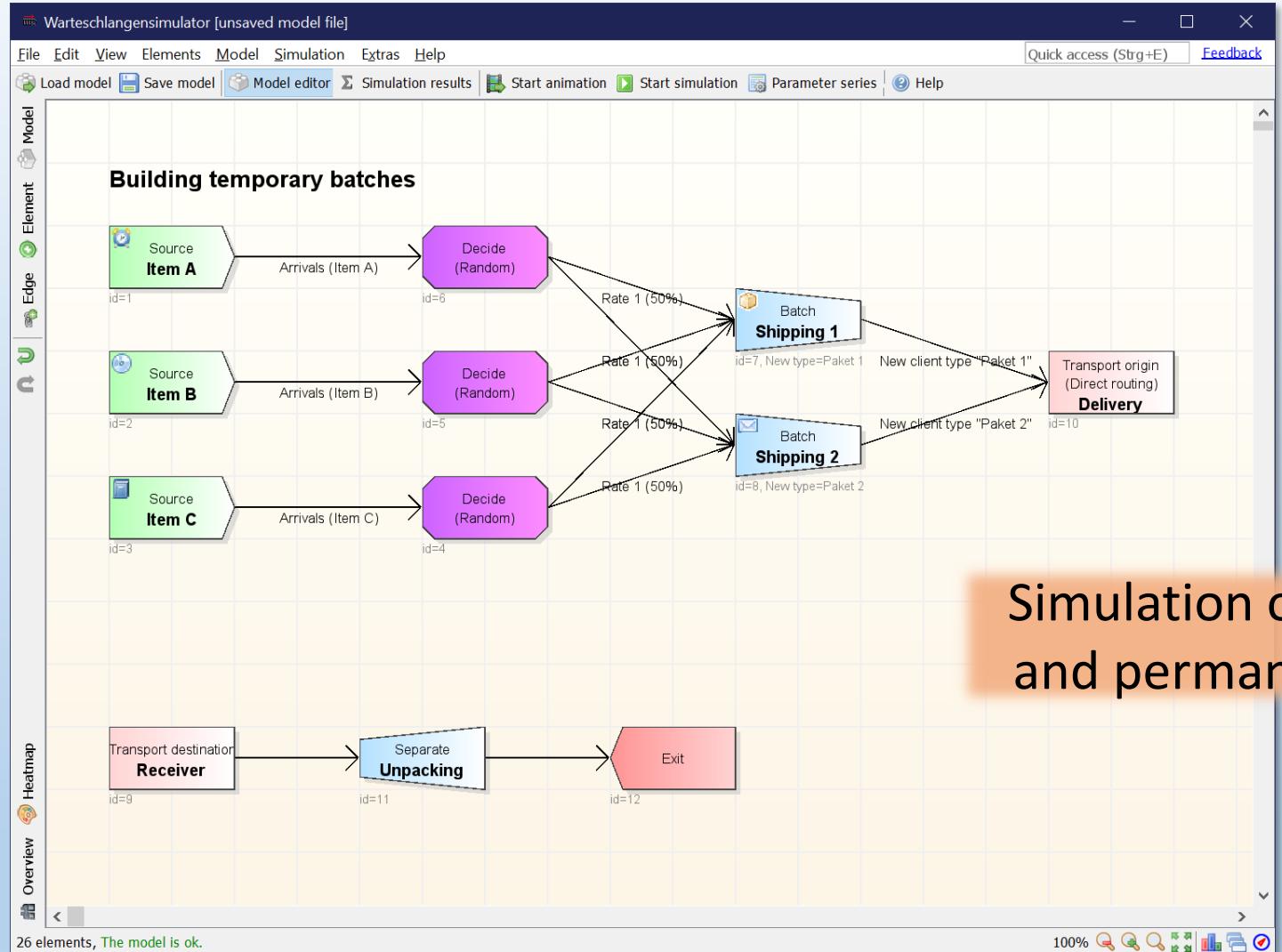
Process station "Station 1" (id=2): E[W]=00:01:00.389 (60.389)  
Process station "Station 2" (id=10): E[W]=00:02:08.653 (128.653)  
Full barrier (id=9): E[W]=00:07:58.985 (478.985)

Process times by stations E[S]

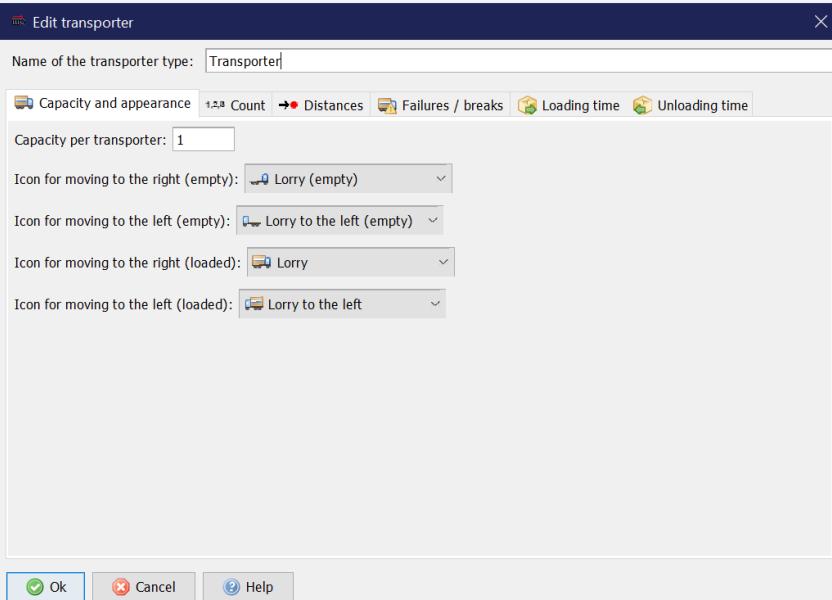
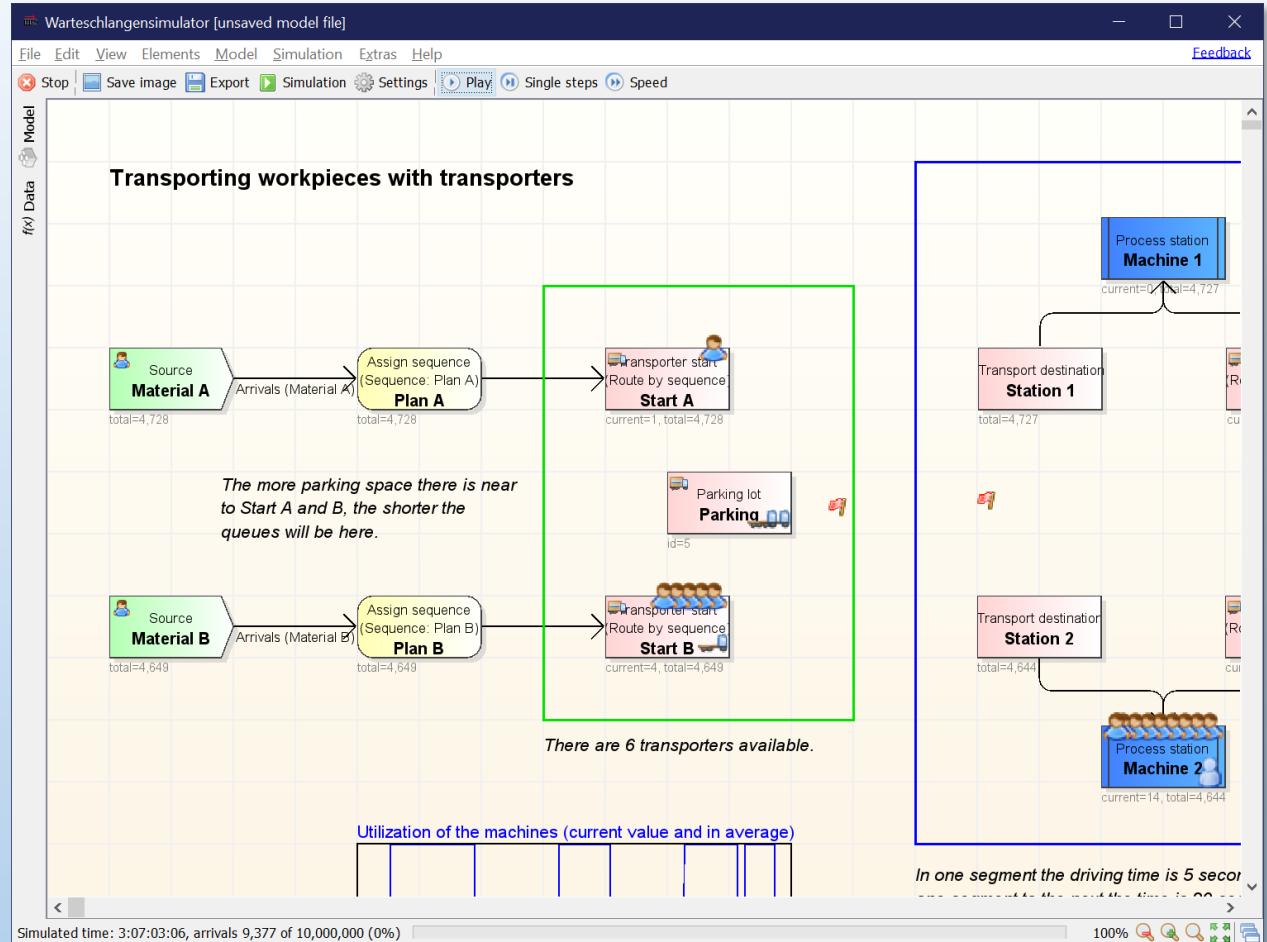


## Visualizing simulation results as heatmaps

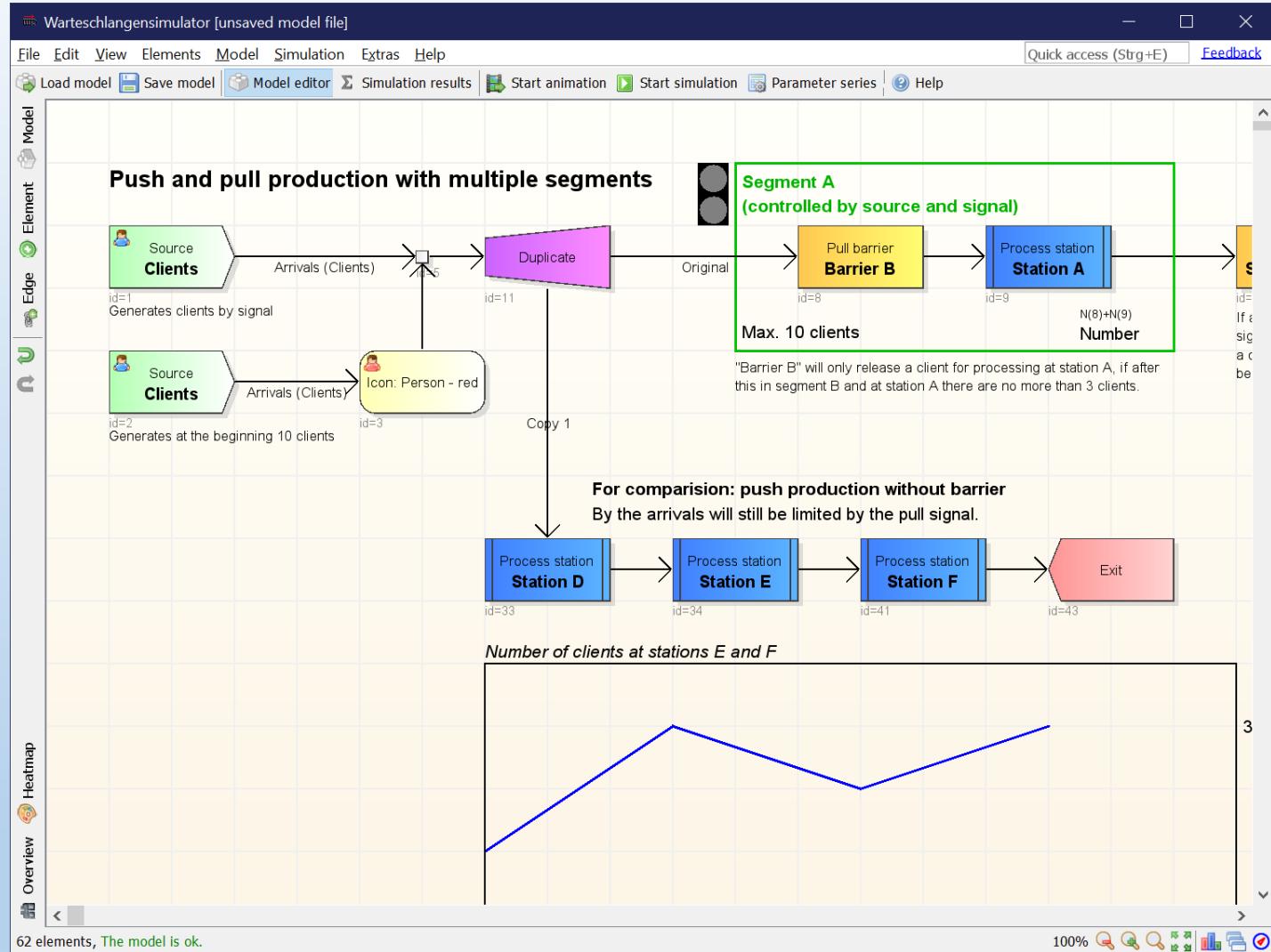




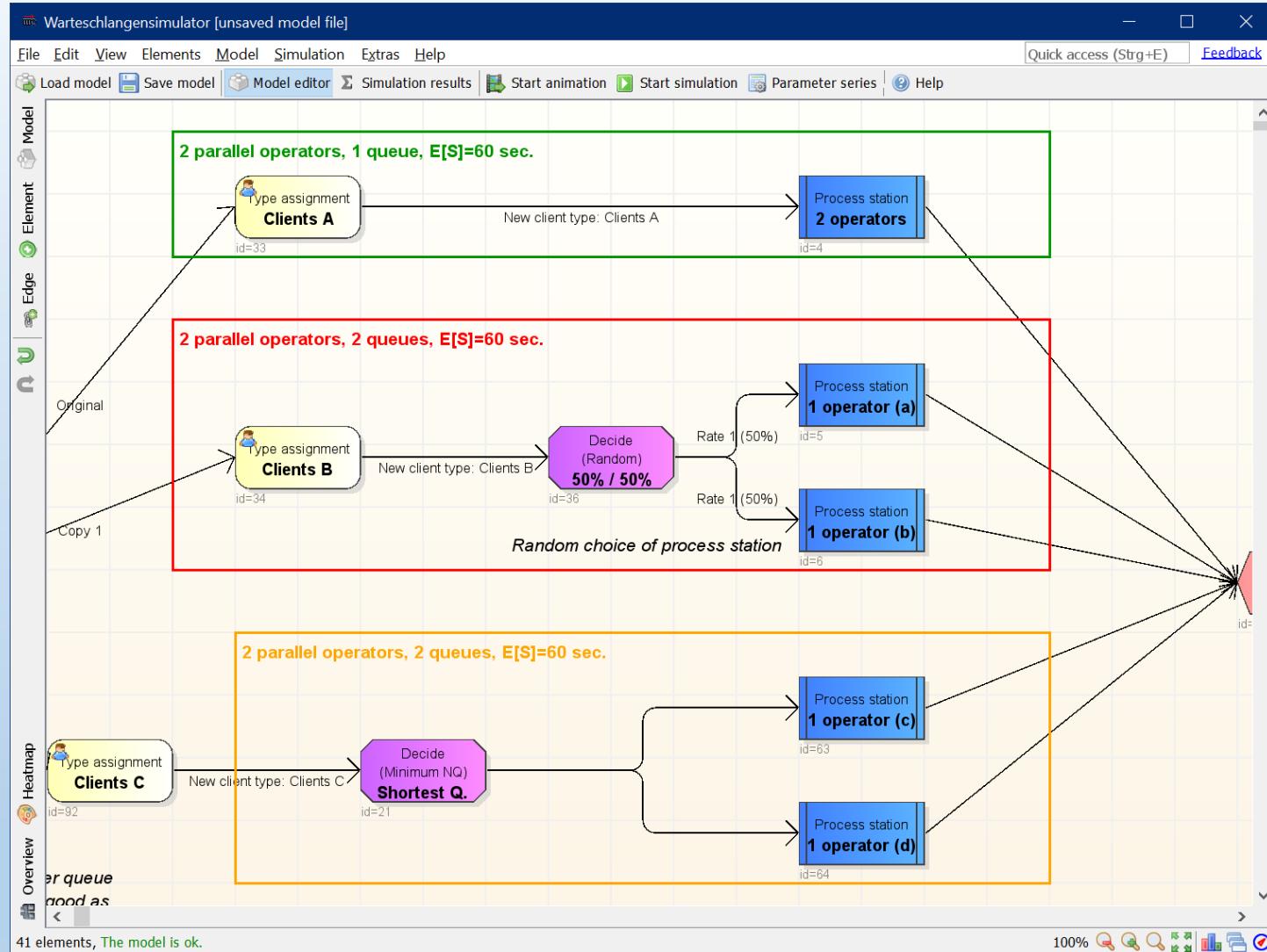
Simulation of temporary  
and permanent batches



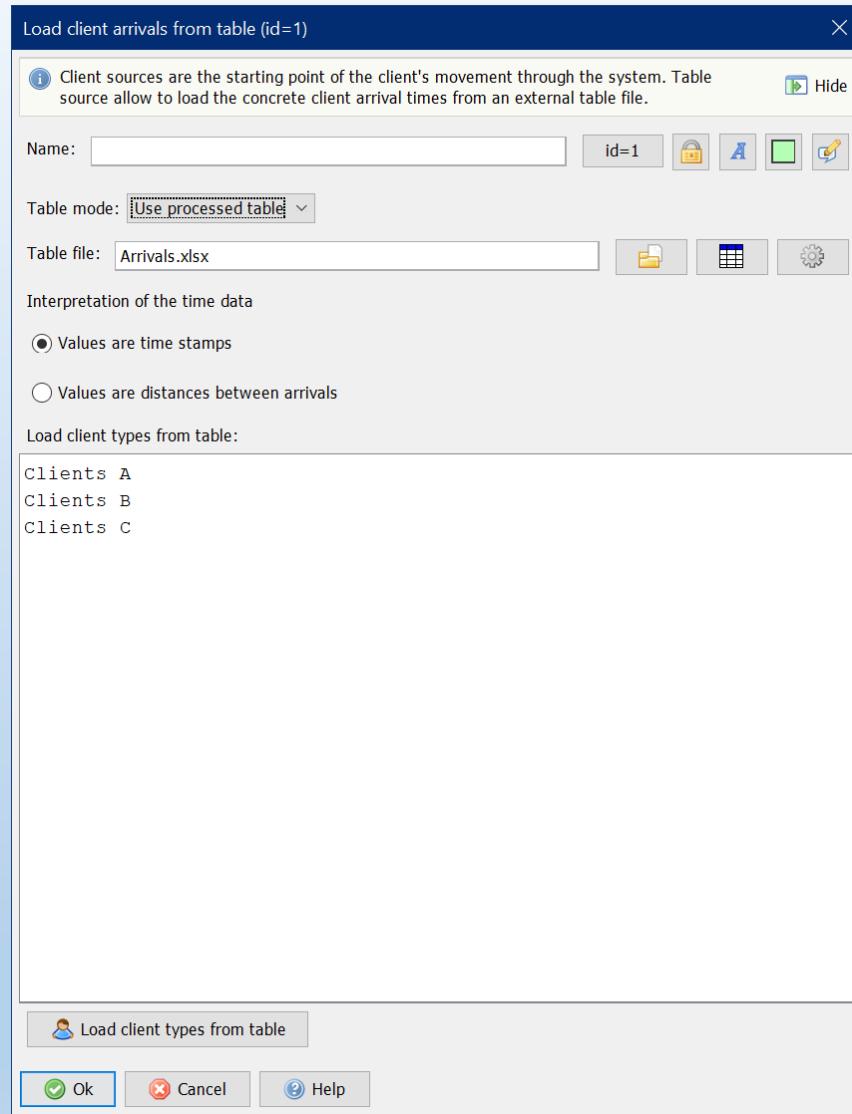
Simulation of transport processes using transporters



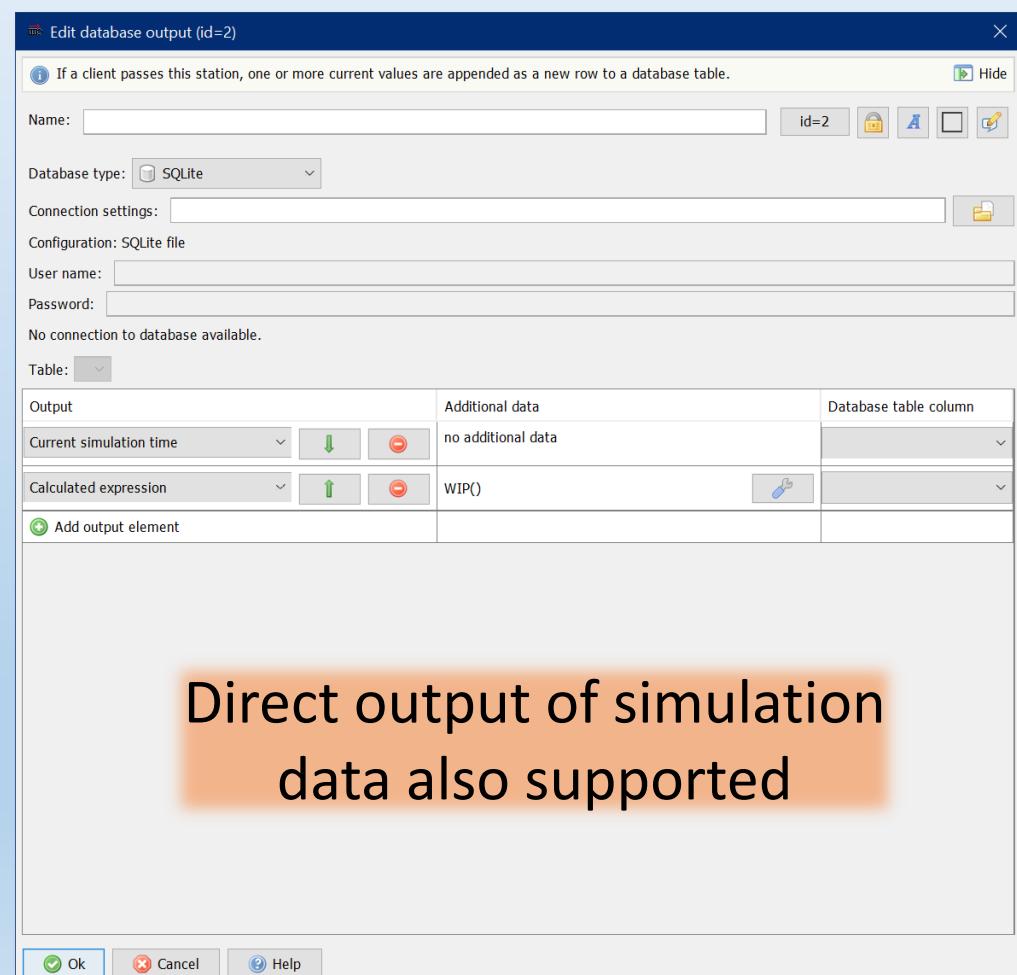
**Push/pull production – and any other kind of condition-based barriers, signals etc.**



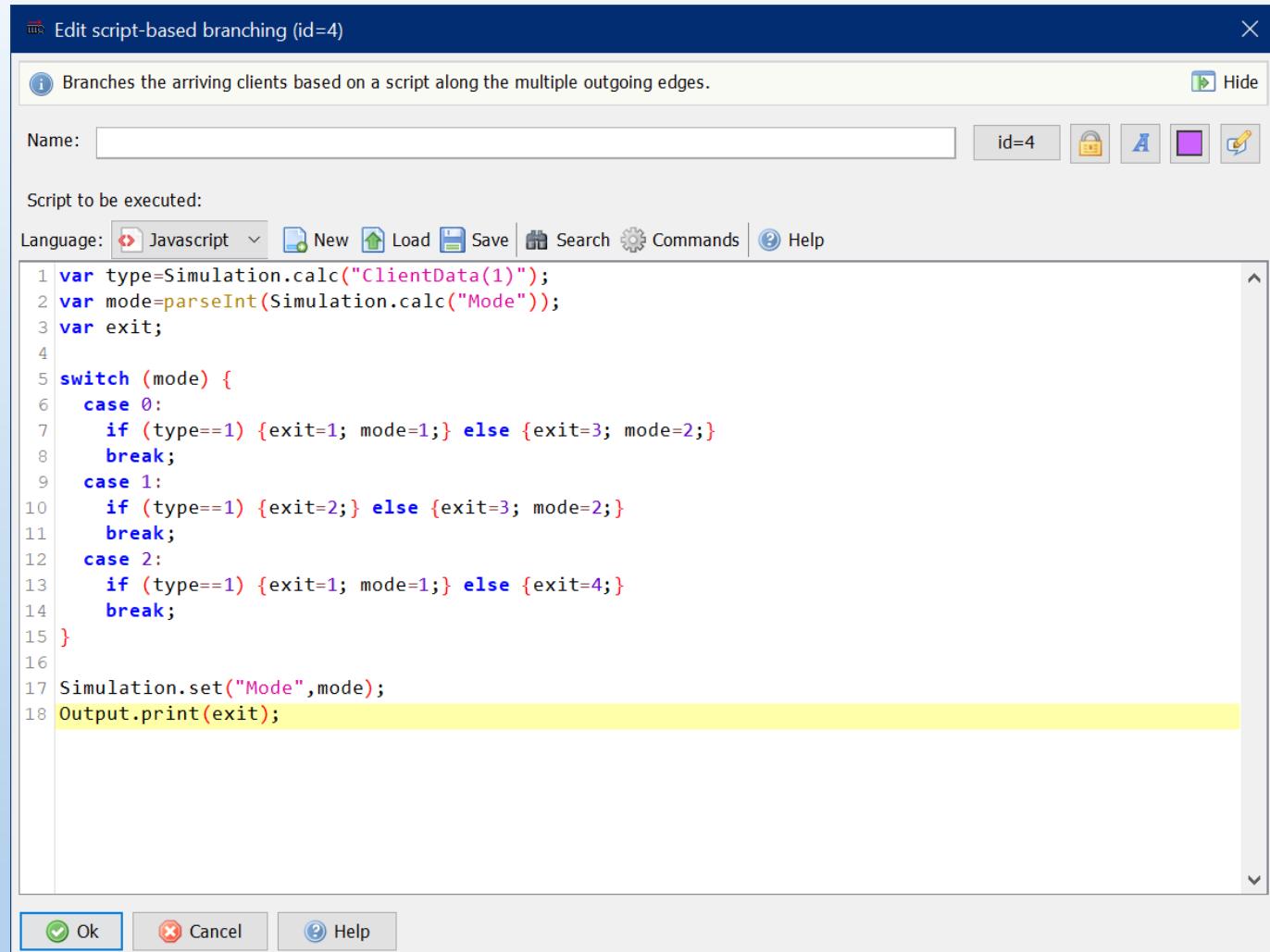
**Branching clients by conditions,  
by chance, script-based, etc.**



## Using external data for client arrivals and parameters in simulation process



Direct output of simulation data also supported



Scripts can be used for  
modelling complex  
control strategies

Supported languages:  
Javascript and Java

Warteschlangensimulator [unsaved model file]

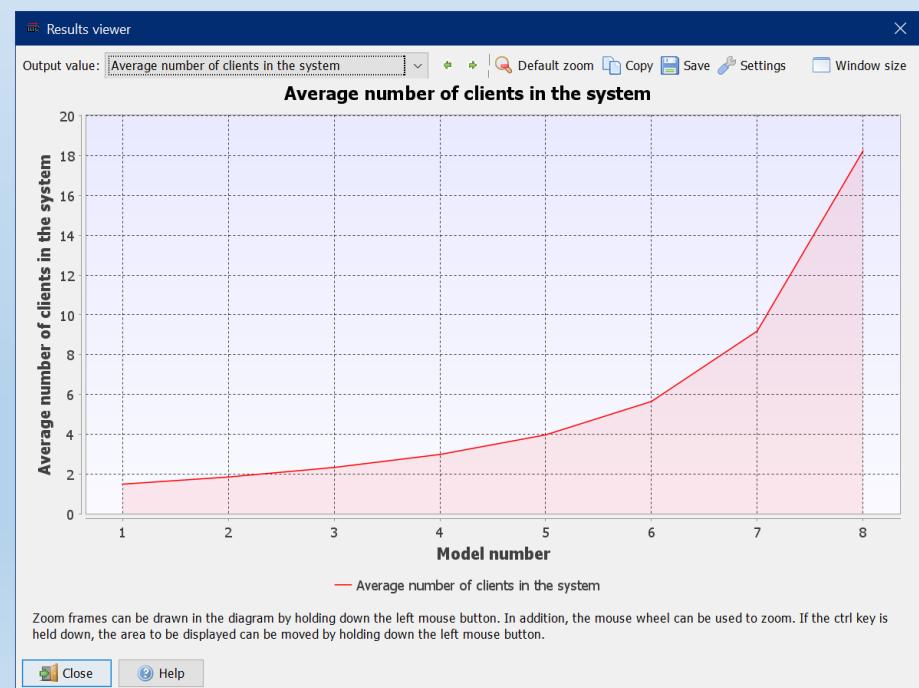
File Edit View Elements Model Simulation Extras Help

New Load Save Templates Base model Input parameters Output values Start simulation Process results Close Help

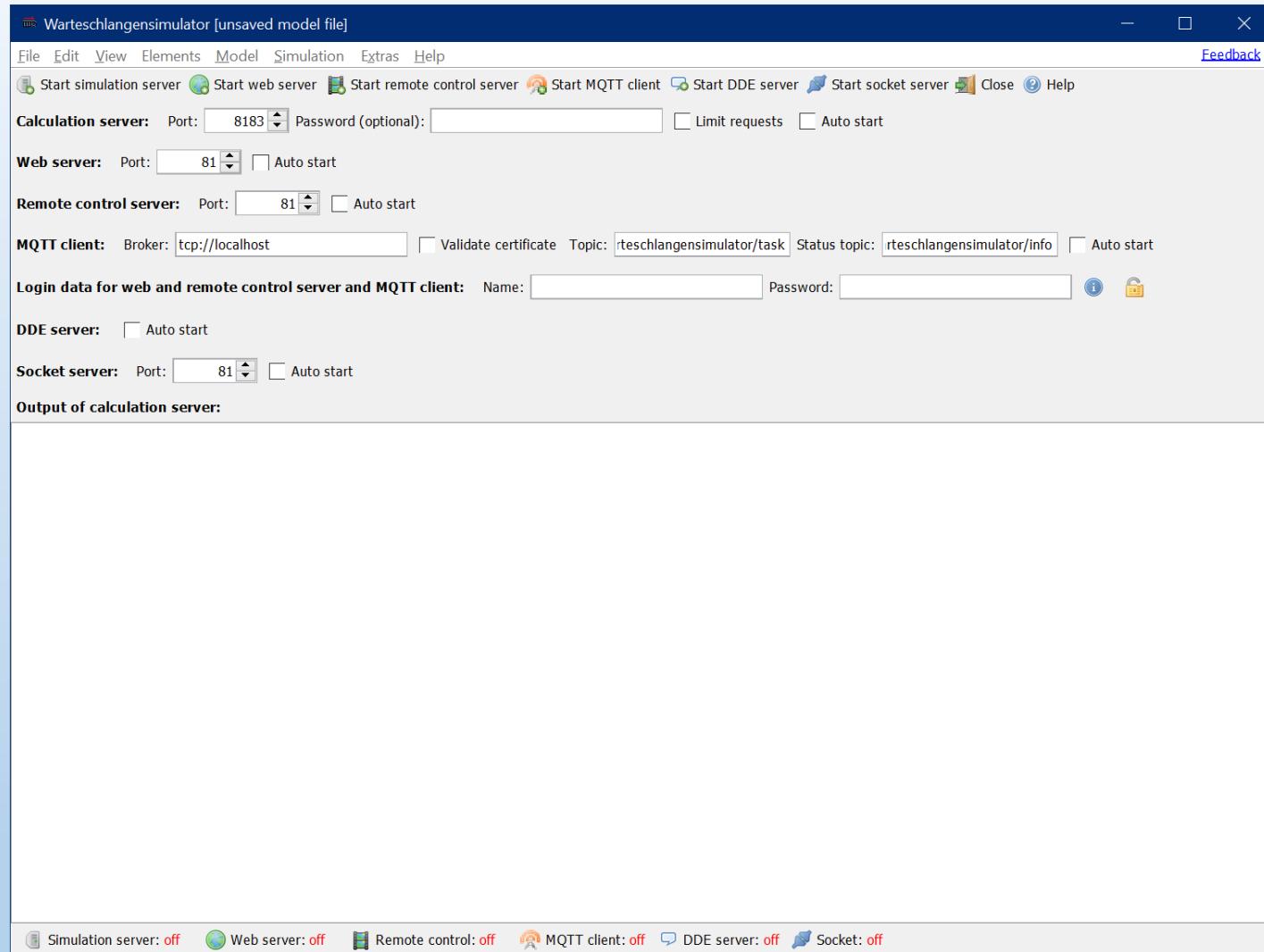
Model	Input parameter Average service time	Output value Average number of clients in the system	Output value Average number of waiting clients in the system	Output value Waiting time for all clients	Output value Process time for all clients	Output value Resource utilization - Operators group	Control
Parameter series 1	60	1.5	0.9	00:01:30	00:01:00	60.006%	
Parameter series 2	65	1.86	1.209	00:02:00.8	00:01:05	65.067%	
Parameter series 3	70	2.34	1.64	00:02:43.9	00:01:10	70.033%	
Parameter series 4	75	2.992	2.241	00:03:44.1	00:01:15	75.055%	
Parameter series 5	80	3.976	3.176	00:05:17.8	00:01:20	79.943%	
Parameter series 6	85	5.654	4.804	00:08:00.3	00:01:24.9	84.97%	
Parameter series 7	90	9.19	8.29	00:13:48.7	00:01:30	90.069%	
Parameter series 8	95	18.233	17.285	00:28:50.4	00:01:34.9	94.831%	

Simulation step 6: Simulation of model Parameter series 6  
 Simulation step 7: Simulation of model Parameter series 7  
 Simulation step 8: Simulation of model Parameter series 8  
 The simulation of the parameter series was finished after 8 steps.  
 Total simulation time: 6 seconds, simulation time per steps: 1 seconds.

# Fast and easy creation of parameter studies

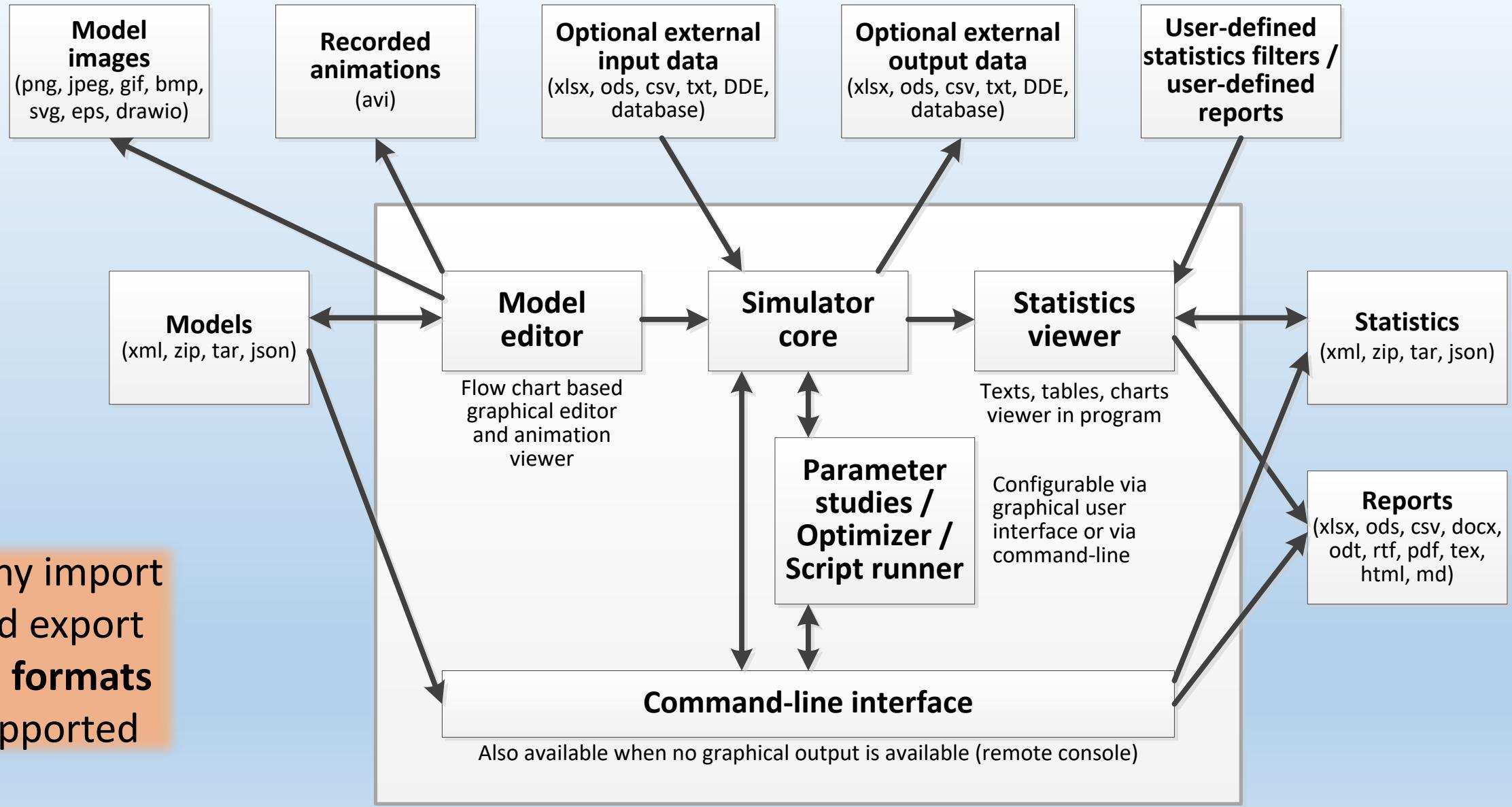


## **Optimizer** also built-in



Command-line and  
server operation available

Simulator can be used on  
Linux-based HPC systems



Warteschlangensimulator [unsaved model file]

File Edit View Elements Model Simulation Extras Help

Load statistics Save statistics Model editor Simulation results Start animation Start simulation Parameter series Model for these results Help

### Simulation results

- Generate report
- Fast access
- Dashboard
- Results overview (Text)
- Erlang-C comparison (Text)
- Model overview
- Arrivals and leavings
- Clients at the stations
  - Number of clients at the stations (Text)
  - Number of clients at the stations (total) (Table)
  - Number of clients at the stations (by client) (Table)
  - Number of clients in the queues (Table)
  - Number of clients in the queues (by client) (Table)
  - Number of clients in service process (Table)
  - Number of clients in service process (by client) (Table)
  - Distributions by state
- Times of the clients
  - Waiting, transfer and processing times of clients (Table)
  - Waiting, transfer and processing times of clients (Graphic)
  - Ratio of waiting to process times (Graphic)
  - Distributions by time
- Times at the stations
  - Waiting, transfer and process times at the stations (Table)
  - Waiting, transfer and process times at the stations (Graphic)
  - Distributions by time
- Resource utilization
  - Resource utilization (Text)
  - Resource utilization (Table)
  - Resource utilization and failures (Graphics)
  - Resource utilization and failures (Graphics)
- System data (Text)
- Arrivals per Thread
- Generate report

System data

Copy Print Save Search Settings Window Word

**System data**

Used simulator version: 5.1.0  
Run date of the simulation: 7/7/22, 12:58 PM  
Threads: 24  
Simulation computer: Windows 10 (amd64), OpenJDK 64-Bit Server VM (18.0.1)  
Author of the model: Alexander Herzog  
User (simulation run): Alexander Herzog

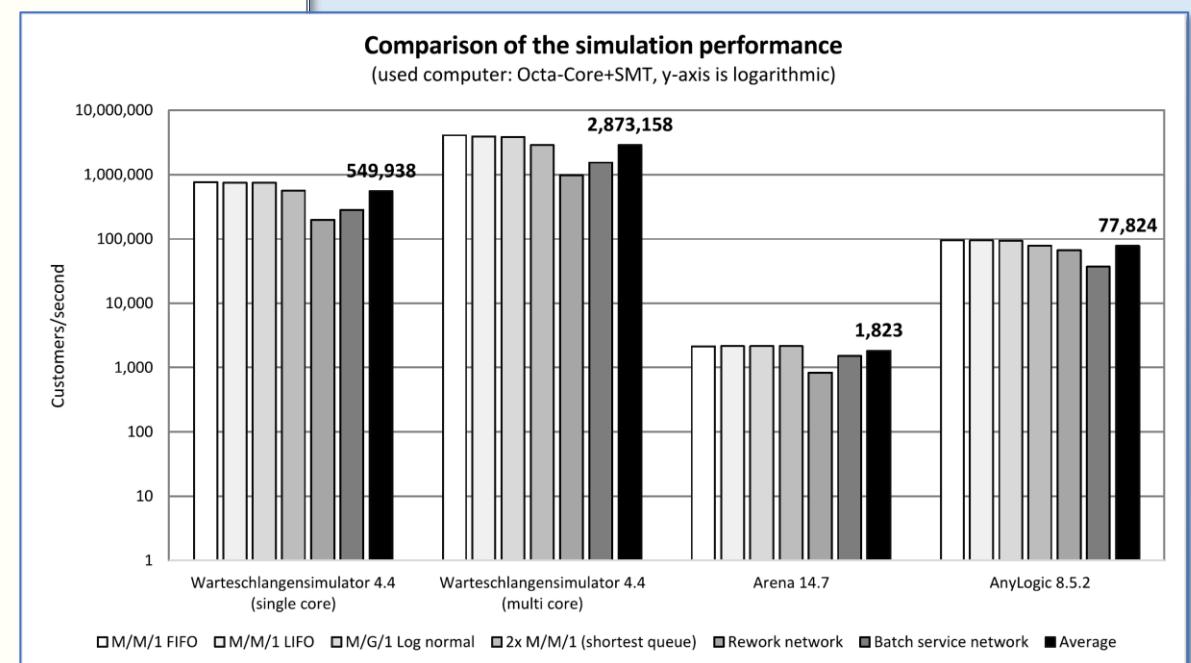
Needed simulation time: 525 ms  
Relative runtime difference between fastest and slowest thread: 1.156%  
Maximum relative difference in simulated clients between the threads: 4.326%  
The simulation was ran in NUMA-aware memory mode.

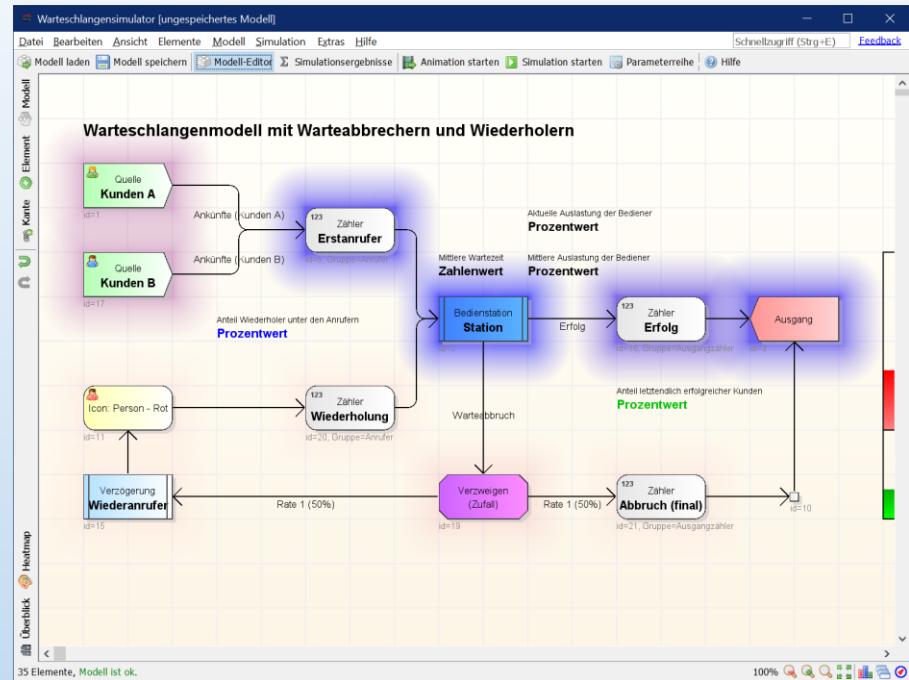
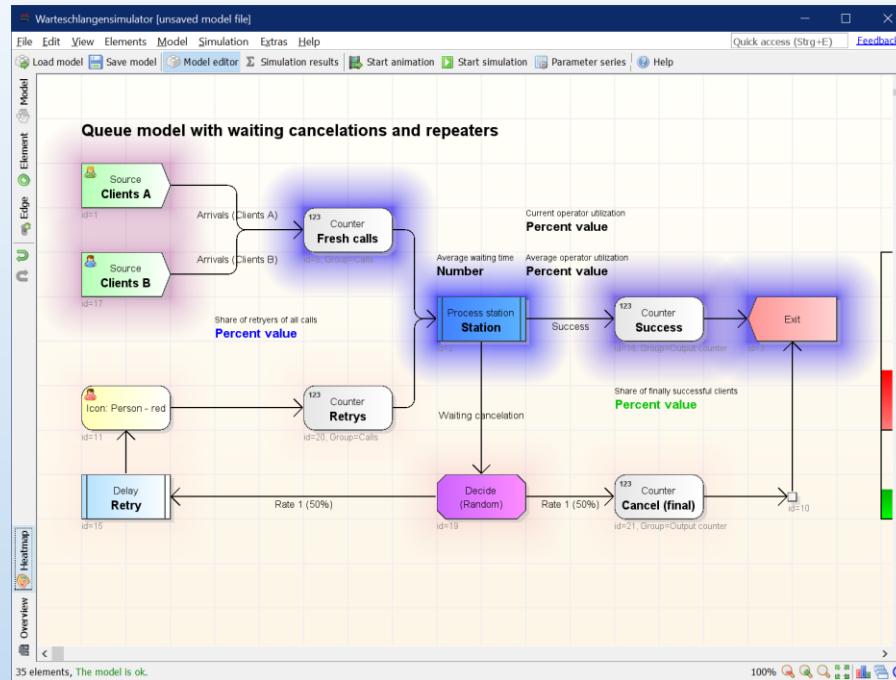
Simulated client arrivals (without warm-up phase): 5,000,133  
Clients per second: 9,524,062  
Needed calculation time per client (\*): 2.52  $\mu$ s

Simulated events: 18,600,181  
Events per second: 35,428,916  
Needed calculation time per event (\*): 677 ns

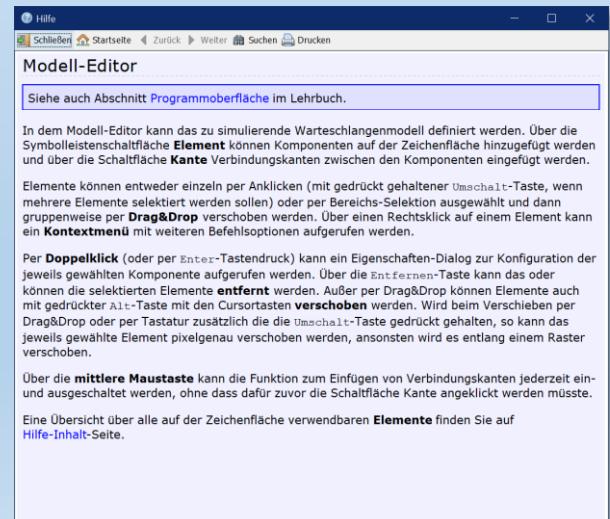
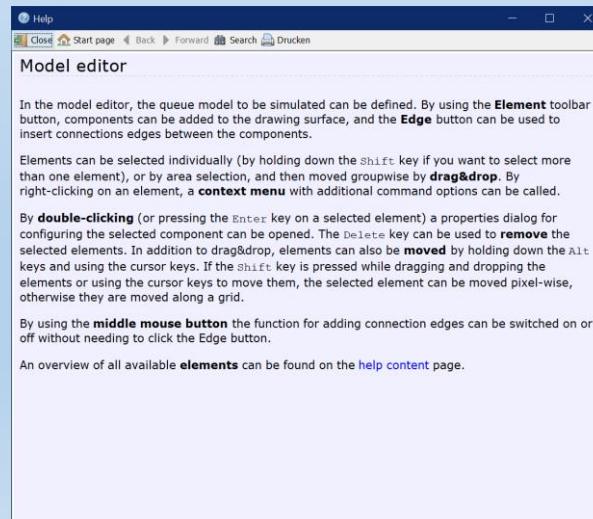
The data marked with (\*) indicate the real computing time on a CPU core.

Fast simulation  
supporting multi-core CPUs





User-interface and full documentation available in  
**English and German**



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| ● Commercial use | ● License and copyright notice | ● Liability     |
| ● Distribution   | ● State changes                | ● Trademark use |
| ● Modification   |                                | ● Warranty      |
| ● Patent use     |                                |                 |
| ● Private use    |                                |                 |

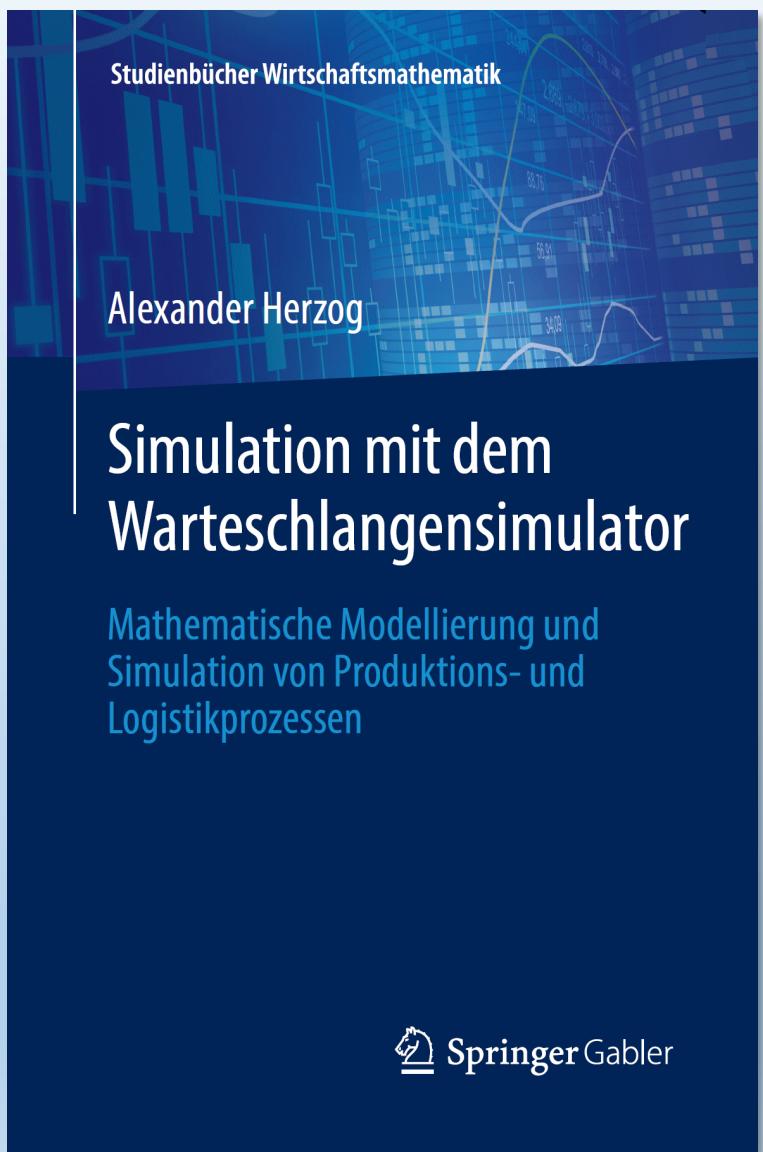





Available as OpenSource  
on GitHub

The screenshot shows the GitHub repository page for 'A-Herzog / Warteschlangensimulator'. The page includes a navigation bar with links for Product, Team, Enterprise, Explore, Marketplace, Pricing, Search, Sign in, and Sign up. Below the navigation is a header for 'A-Herzog / Warteschlangensimulator' with a public status, notifications (0), forks (5), stars (13), and a dropdown menu. The main content area shows the 'Releases / 5.1.0' section for 'Warteschlangensimulator - Version 5.1'. It displays a release note from A-Herzog dated 07 Mar 2022, mentioning 102 commits since the master branch. It highlights three assets: 'Installer for Windows', 'Zip archive for Linux and MacOS and for portable use', and 'Linux AppImage'. A note states that a Java runtime environment version 8 or higher is required. The 'Assets' section lists six files: Simulator.zip, SimulatorSetup.exe, SimulatorSetup.sig, Warteschlangensimulator-glibc2.3-x86\_64.AppImage, Source code (zip), and Source code (tar.gz). Each asset has a download link, file size (e.g., 120 MB, 512 Bytes), and a timestamp (07 Mar 2022).

Windows installer and zip  
file archive (for Windows  
and Linux) available



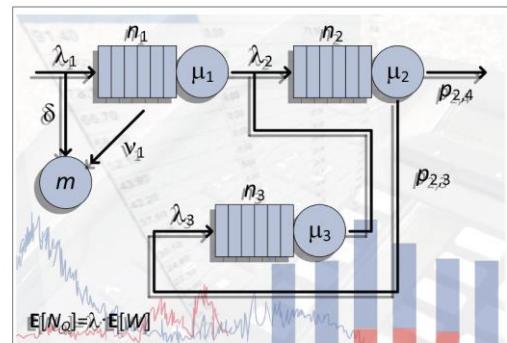
## Textbook

(in German language)

... but tutorials,  
references, online help  
etc. directly built-in in  
Warteschlangensimulator

Short introduction to  
Warteschlangensimulator

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This tutorial refers to version 5.1.0 of Warteschlangensimulator.  
Download address: <https://github.com/A-Herzog/Warteschlangensimulator/>