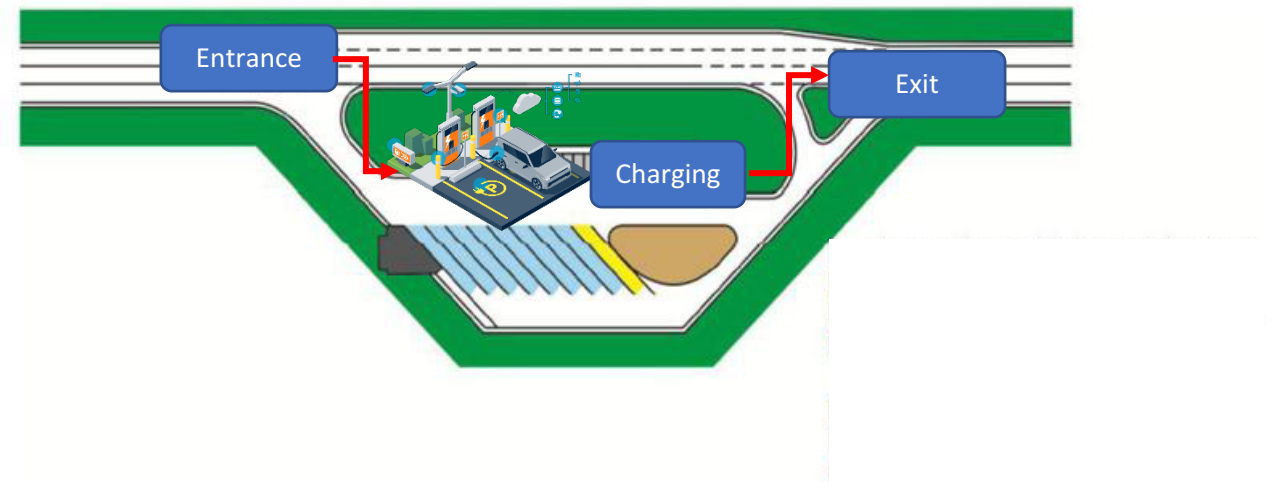
Performance modelling of an electric car charging facility.

Let us consider an electric car charging facility inside a rest area. The process of charging can be considered as a three stages process, each one characterized by a First Come First Served queue and its service time. Cars first have to reach the facility passing through a small road, then they can queue to use a charger, and finally they reach the exit through another small road.



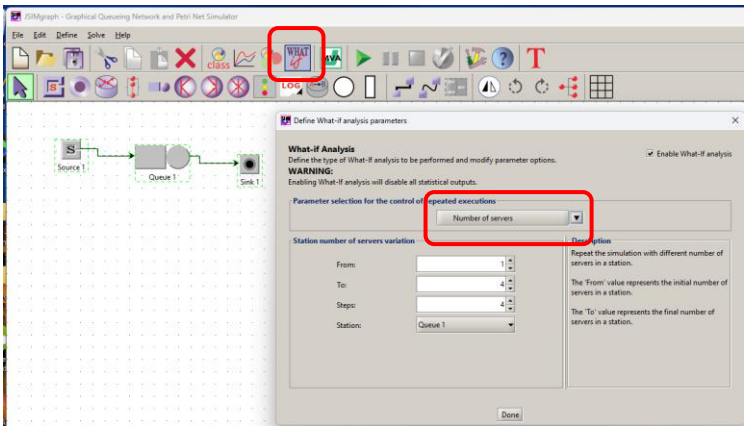
Each stage is characterized by its own service time distribution, and the entire system can be considered as a tandem network. The charging process can be considered as a multiple server queuing station. The parameters of the system are the following:

Inter-arrival time distribution	Hyper-exponential with: $\lambda_1 = 0.01$ cars per minute $\lambda_2 = 0.2$ cars per minute $p_1 = 0.12$
Passing through the entrance	Exponential, with 1 minute average
Charging vehicle	Erlang distribution, with 4 phases and 38 minutes of average
Passing through the exit	Exponential, with 2.5 minutes average

The study aims at determining which is minimum number of charging stations (servers in the queue modelling the charging process) to have an average response time less than one hour, with a confidence level or 99.5%, and a maximum relative error of 1%.

Questions:

1. Add a Picture of your queueing network model.
2. Add a plot of the average time as function of the number of servers. Hint: JMT can perform a *What-if* analysis on the number of servers.



3. Which is the minimum number of charging station required to achieve the goal?
4. Which is 90th percentile of the response time distribution for the optimal scenario. Hint: this should be computed by performing a separate simulation considering only the scenario with the optimal configuration, since *Statistics* are not available when the *What-if* analysis is enabled.

Please enter the answers, together with a ZIP file containing the .jsimg files of your model, renamed with PPTX extension, in the following form:

https://forms.office.com/Pages/ResponsePage.aspx?id=K3EXCvNtXUKAjjCd8ope67-7CBR7gDJEgHF_krAEqPhUQVBBQ1lETjRFQVIxTk1QSFJJN0FBT1ZHTC4u

The deadline is **Midnight, 11/10/2025**