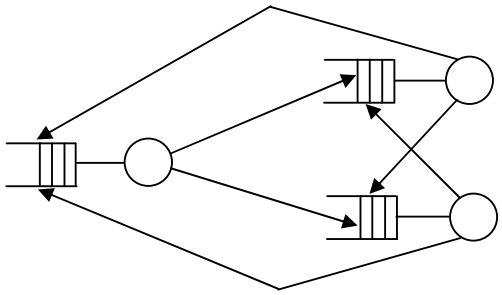
QUESIM Queueing Network Example

Problem specification

Two special-purpose machines are desired to be operational at all times. The machines break down according to an exponential distribution with mean failure rate 1 per hour. Upon breakdown, a machine has a probability 0.75 that it can be repaired locally by a single repairman who works according to a normal distribution with average duration 1 hour, standard deviation 20 min. If it cannot be repaired locally, the machine must be repaired by a specialist, who works according to a triangular distribution, with most likely duration 20 min, minimum 10 min, maximum 40 min. Further, after completing local service, there is a probability 1/3 that a machine will also require the special service. After the special service, there is a probability 1/5 that a machine will also require a final touch by the local repairman, whose time is in this case normal with mean 15 min, standard deviation 3 min. For both normally distributed service times we consider only values in the range $\pm 3\sigma$. The system can be viewed as a queueing network with the following topology where the first server represents the normal operation; the queue is made of the spare machine(s) (if any).



We want to find the following:

- Average number of operational machines
- Utilization of the two maintainers
- Average waiting time for both local repairman and the specialist
- Probability that both machines are operational
- Probability that no machine is operational

There are two possible improvements to the above system that have approximately the same cost. Either rent a third machine to be used as a backup (any of the two original machines can be replaced by the third one in case of a failure). The other option is to employ another repairman for local repairs. Find which option is better provided the criterion is the probability that at least one machine is operational.

Optimization results:

Case	P[at least one machine is operational]	
Now	71%	
3 machines	79%	better !
2 repairmen	76%	