Verifying Little's Law on Discrete Event Simulation

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Abstract

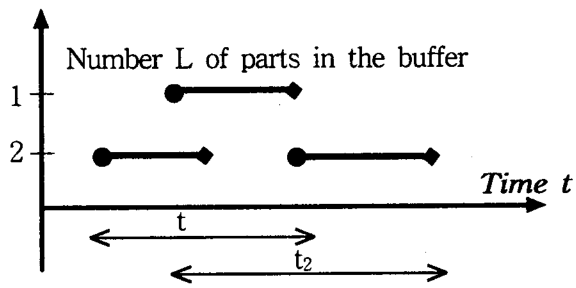
MQL(Mean Queue Length) is one of the key factors to evaluate a system. MQL can be easily calculated by a well-known formula, Little's Law. Little's Law is a fundamental theorem of the queueng theory. We will give an easy example for a given statistics collection period T. Let $L(t)$ be the number of parts present in a buffer. The Mean Queue Length is defined by

$$L = \frac{1}{T} \cdot \int_0^T L(t)dt$$

If t_j denotes the time of the jth part spent in the buffer, then it is easily seen that

$$L = \frac{1}{T} \cdot \sum_{j=1}^{N} t_j ,$$

where N is the number of entrances of parts into the buffer under consideration. In other words, this sum is taken for all movable elements. Note that t_j is not equal to the processing time of a part, since there is possibly a waiting time of the part. The following figure shows the validity of the above formula in case of 2 movable elements :



If the processing time is equal to the time t_j spent the part on the buffer, then Mean Queue Length can be determined by the utilization, which is defined by

$$utilzation = \frac{\sum t_j}{capacity * T}$$

Therefore, $L = buffer.capacity \times buffer.utilization$. This equation holds only if the parts are never blocked(*waiting*) on the buffer. In the model Little's Law this is ensured by vanishing of the processing time of the drain.

We had built a model to analyze EMSs(Electric Monorail Systems) in a car-body shop of "D" -car manufacturer using **SIMPLE++™**. The arrival rate $\lambda := \frac{N}{T}$ can easily modelled by the interarrival time(attribute *interval*) of the basic building block "**source**". The mean time spent a part in the buffer is

$$W = \frac{1}{N} \cdot \sum_{j=1}^{N} t_j$$

In case of finite many parts (customers) Little's Law $L = \lambda \cdot W$ can easily verify.

The model *MeanQueueLength* shows how the values L can be determined in the model. Waiting parts on/before the buffer are allowed.