Professor Hur's Ph.D. Dissertation

The Effect of Positively Correlated Arrivals on the Single Server Queue

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The appropriateness of independence assumptions in queueing theory should be doubted at least in applications such as modern manufacturing or telecommunication systems. Simplifying independence assumptions may lead to a poor estimate of performance. In this research, we investigated the effects of dependency in the arrival processes on queueing measures.

We use a Markov renewal process as an arrival process because of its wide applicability.

In order to extract the pure effect of dependency on the queueing performances, we introduced a specific form of a Markov renewal arrival process, which allows us to change dependency without simultaneously changing the marginal distributions.

With this process we can see the individual or joint effect of the parameters of arrival process, by which the effect of correlation is clear.

The effect of four main parameters are studied:

(a) intensity in the Markov renewal jump process,

(b) differences in the mean interarrival times in the underlying Markov renewal process,

(c) variability in the point processes underlying the Markov renewal process,

(d) the number of states of underlying Markov chain.

As for the parameter in (a), we find that the largest jump intensity, which corresponds to the ``least dependent" arrival process, provides a lower bound of mean waiting time. The smallest jump intensity which corresponds to the ``most dependent" case, gives an upper bound. A joint effect of (a) and (b) seems to be the most serious. The mean queue length can be made arbitrarily large (even with traffic intensity fixed smaller than one), by making (a) small enough and (b) large enough.

We find that the correlation coefficient may not be a good measure for dependency, since a higher correlation coefficient in the arrival stream does not always imply a larger mean queue length. This result is obtained through the parameter in (c).

A larger number of states (d) of the underlying Markov chain makes the correlation coefficient in the arrival process larger under some assumptions.

A numerical study shows, under heavy traffic and low jump intensity, this parameter has a remarkable influence on the queueing behavior. This effect, however, does not look significant when the traffic intensity is low and jump intensity is high.