STRATEGIC IDLING AND DYNAMIC SCHEDULING IN OPEN-SHOP SERVICE NETWORK: CASE STUDY AND ANALYSIS

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ABSTRACT

In Open-shop service networks customers would like to obtain service from a set of stations, most of them without a specific order. This paper is motivated by XYZ (not the real name), a company in the healthcare service industry that operates a stochastic open shop network where the stations of the networks administer medical tests that customers can take within several hours of the same day. According to senior management of XYZ there are two types of complaints about the service that customers of XYZ experience. One is with respect to the total time that customers spend in the system; the other is with respect to the long waiting time at a specific station. In fact the company believes that customers get upset when they wait more than 20 minutes for a particular station (such customers appear on the computer screen of the schedulers with red faces).

We focus in this paper on two types of service levels: the more traditional macro-level measures such as minimizing total waiting time or total system time (waiting plus service times) or minimizing total tardiness, and the "micro-level" measure of reducing excessive long waits at any individual workstation within the process. The only paper we are aware of that discusses systematically and analytically micro service level is [1] where a strategic idling (SI) scheduling policy is suggested.

The idea behind SI is that when a downstream station is very congested operating the upstream station in a normal rate may increase the congestion at the downstream station. Instead, idling the upstream station until the downstream station is less congested could be beneficial. Therefore while work-conserving policies are optimal for macro-level measures, scheduling policies with SI might be helpful for the micro-level measure. In [1] we showed the benefits of SI for the two stations in tandem network where customers arrive to the network according to a Poisson process and services at the stations are exponentially distributed. In the current paper we examine whether similar ideas can be applied to a much more complex environment of a stochastic open shop network.

There was no official policy of using SI in XYZ. However using the empirical data we found statistical evidence that SI is in fact used by the schedulers to effectively manage the micro-level measure. This SI was done using only intuition of the schedulers of XYZ. We provide in this paper an efficient way to combine the SI and Dynamic Scheduling Policies (DSPs) so that the resulting policies can simultaneously address both macro- and micro-level measures.

For deciding which customer should be assigned to the next freed-up station we use 6 DSPs that include among others rules such as: "Longest System time first" and "Longest Current Waiting time first". In all of the 6 DSPs used the station that is just freed-up and has the highest remaining workload is assigned to a waiting customer.

Since the stochastic open-shop networks are very difficult to analyze analytically, we developed two simulation models. The first simulation model is based on the empirical data (ED) for arrivals and service times. We compared the micro and macro service levels for the following policies: ED; ED with no idling; the six DSPs with no idling and the six DSPs with SI. The main findings are: (1) ED with no idling results in better macro service levels than ED but with much worse micro-level performance, (2) The DSPs with no idling are much better than ED in their macro service levels but perform worse on micro-level than ED, (3) The DSPs with SI result in worse (but not by a lot) macro service levels than those without idling but are much better than the DSPs without SI and quite close to the ED policy in the micro-level performance. The second simulation model is based on randomly generated open-shop networks aiming to show benefits of using SI with DSPs for general networks. The results obtained with the second simulation are in line with those of the first model and show that combining DSPs with SI is a promising strategy in general stochastic open-shop environments.

REFERENCES

[1] O. Baron, O. Berman, D. Krass and J. Wang. Using strategic idleness to improve customer service experience in service networks. *Operations Research*, 2014, *62*(1), 123-140.