Evaluating The First Mover’s Advantage in Announcing Real-Time Delay Information

Introduction

Advances in internet-based technology have enabled service providers to disseminate real-time delay estimates to customers who are strategic and delay-sensitive. However, the propensity to pioneer such technology could vary among different service providers; for example due to risk aversion with respect to adopting unproven technology, or unwillingness to invest in infrastructure. In a market with two service providers who compete for market share, we investigate whether one of the service providers (the technology leader $L$) should begin to announce her real-time delay information, knowing her competitor (the follower $F$) could opt to respond. From $L$’s viewpoint, it is crucial to evaluate the impact of delay announcements on her market share---an important question that has not been addressed in the delay announcement literature.

We cast this leader-follower setting as a sequential queueing game. We find that $L$'s optimal action depends crucially on the relative service capacities of the service providers: $L$'s delay announcements improve, in equilibrium, her market share when she is not the higher-capacity service provider; otherwise, initiating delay announcements erodes her market share. The implication of the results we uncover is that service providers with higher service capacities (compared to their competitor) should expect market share erosion from real-time delay broadcast. For a lower-capacity service provider, delay announcements can be considered a strategic remedy for capacity shortage.

Model and Analysis

We consider two single-server service providers, $L$ and $F$, with potentially unequal exponential service times. Delay-sensitive customers arrive as a Poisson stream and patronize the service provider with whom they expect to encounter a shorter queue delay. In the status-quo, neither $L$ nor $F$ makes real-time delay announcements and customers route based on their beliefs about the service providers' delays, which results in equal delays at $L$ and $F$. Employing this delay-equalizing routing, we endogenously determine the arrival rates to $L$ and $F$, and therefore,
the status-quo market share. Naturally, the service provider with higher service capacity has a higher status-quo market share.

Service provider $L$, the Leader, is evaluating whether making real-time delay announcements can increase her market share with respect to the status-quo. Being the leader, $L$ might expect to accrue immediate short-term benefits from such an action. However, the short-time benefits (if any) might not sustain in the long term as $F$, the Follower, could respond after realizing (or anticipating) a potential market share loss. Therefore, $L$ must account for $F$'s possible response to evaluate the long-term effects of real-time delay announcements. Accordingly, we model $L$'s decision as a sequential game: $L$ anticipates $F$’s best response if she opts to initiate real-time delay announcements and compares the resulting market share to her status-quo market share. Then, she opts to announce if this market share is a (weak) improvement over the status-quo, and opts not to otherwise.

We demarcate two information regimes that arise within our strategic framework:

- In Regime 1, $F$ opts not to respond to $L$; therefore, $L$ announces real-time delay information, while only the historical average delay information is available for $F$. We propose a mechanism by which this historical average delay is updated at regular intervals that we call *updating periods*. In each period, customers make a routing decision based on the most recent available information, i.e., the real-time delay for $L$ and the latest historical average delay for $F$.

- In Regime 2, $F$ responds to $L$ with a one-period lag after which both $L$ and $F$ announce real-time delay information. In this regime, the system is akin to the Join the Shortest Queue system.

Since $F$ is not the technology leader, we do not consider the possibility of her initiating delay announcements.

**Analysis of Regime 1**

We prove that in Regime 1, $L$’s market share improves in the short-term (the period in which she first initiates making real-time delay announcements). We characterize conditions under which this improvement is sustained in the long term. For other cases, we evaluate the long-term performance numerically. We find that when $L$ is not the higher-capacity service provider, her long-term market share in Regime 1 is higher than her status-quo market share.
share: delay announcements serve to counteract her status-quo disadvantage. However, when she is the higher-capacity service provider, the results are mixed: By signaling to customers when she is relatively busy, she may sometimes lose the advantage of uncertainty that she benefited from in the status-quo.

Analysis of Regime 2

Through numerical analysis, we find that $L$ experiences a (weak) market share improvement when she is not the higher-capacity service provider, and a degradation otherwise: Unlike in Regime 1, announcing is always a losing proposition for a higher-capacity service provider $L$ in Regime 2, because $F$ can now erode her status-quo market share disadvantage by signaling to customers when she is relatively free.

Game Outcome

Using the analysis of Regimes 1 and 2, we find the outcome of the sequential game as follows:

- **$L$ is the higher-capacity service provider:** $F$ always responds to $L$ initiating real-time delay announcements, resulting in a performance degradation at $L$. Since a higher-capacity service provider is worse off in Regime 2 than in the status-quo a higher-capacity leader $L$ must not initiate announcements.

- **$L$ is not the higher-capacity service provider:** $F$ responds to $L$ initiating real-time delay announcements under some parameter settings. However, $L$ is always (weakly) better off than in the status-quo regardless of $F$’s action. Hence, a lower-capacity technology leader $L$ should initiate announcements.

Conclusions

Our work uncovers an effect of announcing real-time delay information that has not been noted previously: For a market-share sensitive service provider, announcing real-time delay information is a good idea only if she does not have higher service capacity than her competitor. Thus, higher-capacity service providers must exercise caution before initiating real-time delay announcements to prevent market share erosion. On the other hand, for a lower-capacity service provider, announcing delay information can be considered a strategic remedy for capacity shortage. We find numerically that our results are robust to multi-server service providers and to the case when a fraction of customers is loyal to one or the other service provider.