Customer-centric Network Upgrade Strategy: Maximizing Investment Benefits for Enhanced Service Quality

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Abstract

With the ever increasing demand for network resources, network operators and Internet Service Providers are under constant pressure to accommodate more network bandwidth and offer better service quality. In meeting customer expectations, an effective solution is to perform periodic network upgrades. Given a budget constraint, a sound network upgrade decision should maximize investment benefit. In this context, the amount of revenue generated is contingent to the degree of customer satisfaction. This paper presents a customer-centric approach in making network upgrade decisions, where customer satisfaction is the key evaluation criterion. Network performance is related to customer's perceived service quality and component upgrades are assessed based on their profitability. As demonstrated using a case scenario, our approach results in effective upgrade decisions that enhance service quality, improve customer satisfaction, and maximize revenue.

Keywords

service management, network upgrade, customer satisfaction, investment decision

1. Introduction

As networked applications become increasingly prevalent in daily business operations and home activities, the demand for network services is growing in leaps and bounds. While this trend affords great marketing potential for Internet Service Providers (ISPs) and network operators, it also exerts immense pressure on the suppliers to accommodate more network bandwidth and offer better service quality. In meeting customer expectations, an effective solution is to identify trouble spots in the network infrastructure and perform periodic upgrades. Ideally, every identified component should be replaced. Due to monetary constraints, only a subset of such upgrades is possible. Consequently, ISPs must make sound network upgrade decisions that maximize revenue given a limited budget.

The importance of sound investment decisions in network upgrading cannot be over emphasized, both because of its impact on service quality, and because of the potential cost involved. In practice, the network upgrade process is a long-term planning strategy consisting of three crucial steps: identification, assessment, and decision. Network components causing severe service difficulties should be identified, the effect of their upgrades

should be quantified as monetary benefits, and an upgrade decision that maximizes revenue should be determined. The entire process requires in-depth analysis of the underlying network infrastructure, the network performance, the characteristics of its supported service operations, and the customer behaviors. In this paper, we focus on regional networks, where the network size and service subscriber population are relatively small. Nevertheless, our approach is generally applicable to large scale networks. Current practice often produces ineffective investment decisions that do not achieve the desired level of service quality. We believe the inadequacy lies fundamentally at its network-centric view. When a component reaches some network performance threshold, it is tagged for potential upgrade, and the network infrastructure is scrutinized in terms of its QoS performance (e.g. delay, throughput, availability, etc.). While such an approach reflects the network status, it does not consider the customer's perception of service quality. More precisely, it does not link the performance of a component to its severity or scope of impact on the customer population. Our work departs from this network-centric paradigm by establishing customer satisfaction as the key evaluation criterion. Our approach is motivated by two observations: 1) an ISP's revenue is solely based on its customers' willingness to use its services; 2) an ISP maintains competitiveness in the market by meeting the customer expectations.

In our customer-centric approach, we first establish a linkage between customer satisfaction, service quality and network performance using an analytical framework: the metrics tree model. This affords us the possibility of identifying candidate replacement components that have the greatest impact on the customer population. We then evaluate the benefits of component upgrades as changes to customer satisfaction, and consequently changes in revenue. Finally, we formalize the upgrade decisions as a profitability-based optimization problem.

The remainder of this paper is organized as follows. Section 2 presents background and related works. Section 3 gives an overview of our approach. In Section 4, we establish the relation between network performance and customer satisfaction for the identification of candidate upgrade components. Section 5 assesses the monetary benefit of component upgrade. Section 6 presents the optimization model for making investment decision. The effectiveness of our approach is demonstrated in Section 7. Section 8 summarizes our approach and presents some future works.

2. Background and Related Works

The process of making investment decisions has been a traditional practice in business planning. The soundness of a decision is largely dependent on the ability to correctly analyze the status of the operations and the trend of market growth. In the context of the network service market, the basis for such in-depth analysis relies heavily on the information gathering capability of key service aspects: network performance, service operations, and customers. Existing works in Internet measurement offer rich reservoir of network statistics, ranging from statistical information collection from Management Information Base [3] (via SNMP [2]), monitored network QoS performance (e.g. RMON [4]), to actively measured end-to-end path information (e.g. via pinging). Today's routers are even

capable of keeping track of individual traffic flow information (e.g. Cisco's NetFlow [1]). At the service and customer level, customer access can be tracked by customer-side monitors, and service difficulties are recorded in the form of trouble-ticketing logs. Due to the lack of mapping between network performance and its impact on customers, trouble spots are currently identified on the basis of simple network QoS metrics (e.g. component utilization). Such identification does not reflect the customer's perception of a service, and adversely affects the outcome of the investment decisions. We observe that given a fixed budget, an investment decision that optimizes overall network performance is not necessarily the most profitable investment choice. In our customer-centric approach, we leverage the existing information gathering capabilities to establish a sensible mapping between the network QoS and customer satisfaction. This serves as our basis for assessing component upgrade benefits.

Some previous works, such as [6] and [8], emphasize the importance of analyzing both the customer and the network profiles in a business decision process. However, [6] does not offer any means of correlating the two. [8] highlights the importance of customer utility and devises a utility model based on customer's service preferences. The work assumes the existence of a mapping between the network performance and a customer's perceived service quality. Motivated by these previous attempts, our work provides a well-structured linkage between the network, the service, and the customer. The resulting mapping is specific to the underlying network infrastructure, the requirements of service operations, and the particular characteristics of each customer.

Using real option pricing, [9] tries to determine the best investment time for link capacity upgrades. Their work evaluates the profitability of an investment in terms of revenue generated from the network usage. To account for customer dissatisfaction due to congestion, a simple discount factor is associated with each congested link. In our work, revenues are estimated based on the customer's perception of service quality rather than the traffic volume. This approach elevates our analysis from the underlying networks to the services and customers, and leads to investment assessments emphasizing better service quality.

[7] proposes a revenue-based approach to component upgrade optimization given a fixed budget constraint. The profitability of each network component is estimated based on the amount of customer traffic it bears, with the assumption that previously unsatisfied customers are satisfied after the upgrade. Similarly, we establish the profitability of a network upgrade by analyzing customer traffic flows. In contrast, our approach attempts to estimate the benefit of an upgrade to the customers, taking into account key factors influencing a customer's perception of service quality: interdependencies among network components, the increase in traffic demand, and the behavior of customer access.

To a customer, his/her perception of service quality is only related to the network components bearing the customer traffic. Therefore, it is important to analyze the performance of customer traffic flows, rather than the network status as a whole. Considering the amount of customer flows generated over time (e.g. months), the issue of scalability should be considered. [5] demonstrates the effectiveness of tracking only frequently used flows to achieve better efficiency. In the same spirit, we utilize pruning to achieve better scalability in our customer flow analysis.

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