Chapter 7.4
Information Feedback Approach for Maintaining Service Quality in Supply Chain Management

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ABSTRACT

Maintaining the service quality in a supply chain has become a challenging task with increased complexity and number of players down the line. Often several supply chains cross over the common resources, calling for the sharing of resources and prioritization. This leads to the definition of pre-specified service quality as seen by the end user of the supply chain. In this chapter, a feedback mechanism that conveys the status of the supply line starting from the tail end is discussed. The advantages of using a predicted and shifted slippage or loss rate as the feedback signal are highlighted. Based on the feedback, the source is expected to change the rate of transfer of the commodity over the supply chain. With this, the resources would get utilized effectively, reducing the stranded time of the commodity down the line. The service quality in terms of delay and loss rate gets improved.

INTRODUCTION

The enormous business size in recent days call for distributed supply units to be located across the globe and connected through a sophisticated network. Throughout this work, these isolated business structures are referred to as mobile business units. They resemble the distributed computing environment in the sense that a time-bound, constraint-based command, signal, and information get exchanged among them.

In this work the concept of differential feedback is explored for the effective utilization of the information for the communication among the members of the supply chain. The model that translates individual behavior to the collective behavior of the chain is given. The resource contention for communication along the chain is addressed and the solution is modeled.

Maintaining a constant agreed ratio of defects or losses—quality of service (QoS)—in a supply chain is often tricky. The problem gets further complicated when the supply chain contains multiple source streams. In this work, a differential feedback-based model has been developed to predict the defects or losses. A shifted version of the same will be used as a feedback signal. Simulation results show that the number of defects observed at any point in the supply chain gets reduces with the shifted feedback signal. With the defects getting reduced, for a given demand at any point down the supply chain, the quantum of input may be reduced with differential feedback to achieve the same performance. The defense supply and deployment into the battlefield, the fair mixing of reactants in a chemical reaction chamber, and so forth stand as good examples.

The shifted feedback information from the end user or any other intermediate player in the line may be used to achieve some additional quality of service deadlines such as the absolute delay guarantee, fraction of the service loss, and so forth. The same would be agreed up on with the different units down the line, well in advance. Simulation results prove that the usage of shifted signals can stabilize the QoS and improve the service quality in terms of overall successful operations in a given time. This reduces the stranded time of the information or loss along the supply chain.

Analysis shows that a system exhibits self-similarity to maximize the entropy (Manjunath & Gurumurthy, 2005a). It is proved that, to maximize entropy, the system makes use of differential feedback of different degrees. They form various levels of abstraction and by and large carry redundant information (Manjunath & Gurumurthy, 2005a). The self-similar property has been exploited here to maintain the quality of service constraints

Because of abstraction and redundancy, even if a portion of the information is lost or if it is required to predict the future uncertainties with minimum available information, it can be repaired or re-synthesized using the available information.

The self-similar property of the component induces interesting properties into the system. This property may be used as lead-lag components in controlling the information transfer over the network. Closed-loop feedback is utilized to control the signals transferred over the network. Intermediate self-similar structures or switches may modulate feedback signals and control the system behavior.

In order to meet the real-time transfer of the signal, stringent service quality parameters are defined over the data transfers down the supply chain. This chapter provides techniques to meet these requirements with minimal resources. In-time flow of the commodities to the end user is the basic requirement in a supply chain. The tools and techniques used to meet this goal are different in different supply chains. The example of real-time transfer of information for the end user is considered throughout this chapter. The supply chain involves various routers, switches, and media in between. The goal is to get the real-time performance in the chain with minimal retransmissions. The concepts may be easily extended to any other form of supply chain.

A supply chain has four areas of decision: location, production, inventory, and transportation or distribution. It is known that the rate of production bears a direct relation with the rate of consumption. However, the other factors during the transportation, such as the influence of adjacent supply chains and the stranded time of commodities within the chain, need to be considered. In this chapter, these factors are explained in depth.

Simulation plays an important role in the modeling of a supply chain before it becomes operational. It provides a closer look at the issues that may crop up in a supply chain and handle them appropriately during the implementation.

Supply chains have to make two categories of decisions—he long-term strategic and short-term operational decisions. A lot of data is required for making decisions. A model-based approach is extremely helpful to reduce the sample size. The model consists of an auto regressive (AR) and a moving average (MA) part. The ARMA

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