End-to-End Delay in Localized QoS Routing

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Abstract— Quality of service (QoS) routing has been proposed for supporting the requirements of network applications and satisfying connection constraints. A large amount of information needs to be exchanged periodically among routers. Therefore, in order to satisfy such requirements localized QoS routing algorithms have been proposed. This is where source nodes make routing decisions based on statistics collected locally. Using local information for routing avoids the overheads of exchanging global information with other nodes. In this paper we present a localized delay-based QoS routing (DBR) algorithm which relies on delay constraint that each path satisfies to make routing decisions. We also modify Credit Based Routing (CBR) so that this uses delay instead of bandwidth. The two localized algorithms and the commonly used global shortest path algorithm (Dijkstra's) are compared under different delay constraints and network topologies. We demonstrated through simulation that our scheme performs better than the modified CBR under different range of workloads and system parameters and outperforms the Dijkstra scheme in all network topologies, unless unrealistically small update intervals are used.

Keywords- Routing; Quality of Service; Localized Routing; Delay constraint.

I. INTRODUCTION

The concept of QoS routing has emerged from the fact that routers direct traffic from source to destination, depending on data types, network constraints and requirements to achieve network performance efficiency. It has been introduced to administer, monitor and improve the performance of networks. A lot of QoS algorithms [1] [2] [3] [4] are used to maximize network performance by balancing traffic distributed over multiple paths. Its major components include bandwidth, delay, jitter, cost, and loss probability in order to measure the end users' requirements, optimize network resource usage and balance traffic load.

The above QoS algorithms, which are source routing algorithms, depend on global network state information in order to make routing decisions. The global QoS network state needs to be exchanged periodically among routers. The efficiency of a routing algorithm depends on the accuracy of link state information [5], [6]. The balance between the frequency of update intervals and link state information is very important; the more update intervals of link state information the more accurate state information and vice versa. Such high levels of exchange may incur large communication and processing overheads.

However, packet switching networks provide good bandwidth sharing and data packets are transmitted with the least effort over the Internet. However, there is no guarantee for the application of the end-to-end delay, which is the sum of the delays at each hop along the path with intermediate nodes, and this may be required for real-time applications.

Localized QoS routing [7] [8] is proposed to achieve QoS guarantees and overcome the problem of using global network state information. Using such an approach, the source node makes its own routing decisions based on the information collected by monitoring the traffic generated from itself. Localized QoS routing does not need the global network state to be exchanged among network nodes because it infers the network state and avoids all the problems associated with it. In localized QoS routing each source node is required to first determine a set of candidate paths to each possible destination. It is not the intention of this paper to discuss this; however, more information about candidate path selection methods can be found in [9] and [10].

This paper proposes a delay based routing (DBR) which is a simple localized QoS routing algorithm that relies on average delay on the path in order to take routing decisions. We study other QoS routing schemes, such as the localized Credit Based Routing (CBR) proposed in [8] and [11]. We develop it using delay instead of bandwidth. We also use the global QoS routing scheme Shortest Path (Dijkstra) to compare their performance with our scheme in terms of flow blocking probability under different network loads and topologies.

II. RELEATED WORK

Although localized quality of service routing has been recently introduced as a new approach in the context of QoS routing, it is has previously only been studied using bandwidth metric in [7] and [8]. To the best of our knowledge, end-to-end delay has not been studied as the metric in localized quality of service routing algorithms. The two main localized quality of service routing algorithms that use bandwidth as the QoS metric are:

A. PSR

The Localized Proportional Sticky Routing (PSR) algorithm [7], which was the first localized QoS routing scheme. In this, each source node needs to maintain a set of candidate paths R. A path based on flow blocking probability and the load is proportionally distributed to the destination among the predefined paths. In PSR there are minimum hop (minhop) paths R^{min} and alternative paths R^{alt}, where $R = R^{min} \cup R^{alt}$. The PSR algorithm operates in two stages: proportional flow routing and computation of flow proportions. PSR proceeds in cycles of variable length, which form an observation period. Incoming flows are routed during each cycle along a path *r*, selected based on a flow proportion from a