Chapter 4
Fuzzy QoS Based OLSR Network

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ABSTRACT
Quality-of-Service (QoS) routing protocol is developed for mobile Ad Hoc Networks. MANET is a self configuring network of mobile devices connected by wireless links. Each device in the MANET is free to move independently in any direction; therefore, it changes links to other devices frequently. The proposed QoS-based routing in the Optimized Link State Routing (OLSR) protocol relates bandwidth and delay using a fuzzy logic algorithm. The path computations are examined and the reason behind the selection of bandwidth and delay metrics is discussed. The performance of the protocol is investigated by simulation. The results in FQOLSR indicate an improvement in mobile wireless networks compared with the existing QOLSR system.

INTRODUCTION
The routing protocols for the mobile Ad hoc networks (MANETs) (IETF, n.d.), such as OLSR (Tan, 2001), AODV (Clausen & Banerjee, 2003), DSR (Perkins, Royer, & Das, 2002), are designed without explicitly considering QoS of the routes they generate. Routing is primarily concerned with connectivity. Routing protocols such as OLSR usually characterize the network with a single metric such as hop-count or delay, and use the shortest–path algorithms for path computation. The use of single metric is that it can only be used for satisfying one criteria either maximize throughput or minimize delay. Hence the use of a mixed metric that can be generated based on multiple primitive metrics becomes attractive for the basis of possible improved routing decisions. QoS routing requires not only finding a route from a source to a destination, but a route that satisfies the end-to-end QoS requirement. The QoS requirement chosen are distinctively different routing metric and neither of these metrics is inferable from each other. These metrics should use separate rules for defining the best route (Tan, 2001). The value of a metric over any directed path $p = (i, j, k…q, r)$ can be any one of the following compositions.

- **Additive Metric**: Metric is additive if metric $(p) = met_{ij} + met_{jk} +…+ met_{qr}$. Delay, delay jitter, hop-count and cost follow the additive composition rule.
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- **Multiplicative Metric:** Metric is multiplicative if $\text{Metric} (p) = \text{met}_{ij} \times \text{met}_{jk} \times \ldots \times \text{met}_{qr}$. The probability of successful transmission follows the multiplicative composition rule.

- **Concave Metric:** Metric is concave if $\text{metric} (p) = \min \{\text{met}_{ij}, \text{met}_{jk}, \ldots, \text{met}_{qr}\}$. Bandwidth follows the concave composition rule.

The use of fuzzy logic greatly simplifies the process of associating two inputs through the use of the straightforward membership function and the linguistic types of fuzzy rules make the performance fine-tuning process. The output generated is able to give a good approximation on what is to be expected.

QoS is more difficult in Ad hoc networks than in other networks, because network topology changes as the nodes move. This paper aims at specifying in FQOLSR in Mobile Ad Hoc Networks. The implementation is done in limited available resources.

The author has proposed the FQOLSR protocol, which is an enhancement of the QOLSR routing protocol prescribed in Johnson and Maltz (1996). This paper is organized as follows. The next section presents the network parameters chosen. Existing system method to relate two metrics is presented, as well as the design of fuzzy logic algorithm. The author also describes FQOLSR protocol, which is an enhancement of the QOLSR routing protocol to support multiple-metric routing criteria. Therefore, the author validates the proposal by means of performance evaluation. Finally, the author presents the conclusion.

**QOS PARAMETERS**

Bandwidth, delay, delay jitter, queue and loss probability are among the network parameters that are qualified to be used in the computation of a single mixed metric. It is possible that all these parameters are used at once, but it will make the computation more complex. It is unnecessary due to the redundant information present between two (or more) of the network parameters (Tan, 2001).

Delay is a critical element in QoS for many applications. Some applications, like Voice Over IP (VOIP) and video conferencing, indeed have specific delay bound where quality is considered intolerable when this limit is exceeded. By taking into account, delay becomes an important starting point to consider. Link delay is an additive metric that can be used to estimate the delay along a particular route when summed together. However, the delay along a particular route is lower when compared to others does not necessarily mean that this particular route is better or have more available bandwidth than other routes (Tan, 2001).

In order to improve the accuracy of the measured delay, one more parameter is used to generate the single mixed metric. Bandwidth available on a link, considered as an important resource required by most applications in a quest to realize better QoS. The lower the link utilization, the more likely that packets can be transmitted with low queuing delay, even if the packet arrival rate might subject to large variation (Tan, 2001). In a wide-ranging traffic characteristic suggests that it is probably a good idea to associate two correlated metrics to produce a metric that can better describe the link state. An important point to note here is that the measured delay and utilization are not synchronous to each other (Tan, 2001).

Delay peaks after link utilization. Hence link utilization also has the advantage to be used as an indicator for the upcoming delay.

**EXISTING SYSTEM**

OLSR protocol is a routing protocol for mobile ad hoc networks. The routing table calculation followed in the existing systems is, in order to improve quality requirements in routing informa-