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Support Qos Routing, Accurate State Information in Manet

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Abstract: To support QoS routing, accurate state information (such as energy level and queue length) should be available and manageable. But due to bandwidth constraints, communication costs, high loss rate and the dynamic topology of MANETs, getting and keeping up-to-date state information is a very complex task, if at all feasible. In this work, we use Optimized Link State Routing (OLSR) as the underlying routing protocol. This research reports the quantification of state information accuracy under different traffic rates. State information accuracy is defined as how far off is the believed QoS-related state information from its actual value. The results show that state information is inaccurate, especially under high traffic rates. Tuning the OLSR protocol parameters has no noticeable impact on inaccuracy levels. Based on our inaccuracy level analysis, we proposed three additional techniques for the energy level metric and two techniques for the queue length metric as an attempt to reduce inaccuracies. We compare the different techniques against each other and against the basic OLSR. For energy level, two of our proposed techniques have shown significant improvements in inaccuracy levels. On the other hand, no improvement was observed for queue length related techniques.

Keywords : Optimized Link State Routing, Quality of service, MANET, Queue Length.

1. Introduction

Optimized Link State Routing (OLSR) is a routing protocol used for Mobile Ad-Hoc Networks (Mobile Ad hoc Networks) [1]. It is a best-effort proactive protocol. Proactive protocols are characterized by all nodes maintaining routes to all destinations at all times through periodic exchange of protocol messages [2]. This gives it the advantage of having pre-computed routes available when needed. OLSR performs hop-by-hop routing where each node uses its most recent information for routing.OLSR is highly focused on reducing the protocol overhead. And since OLSR works on periodic exchange of messages, overhead reduction can be achieved by reducing the number of messages and the size of messages as well. As a result of overhead reduction, information about Quality of Service-related state is not propagated throughout the network [4].

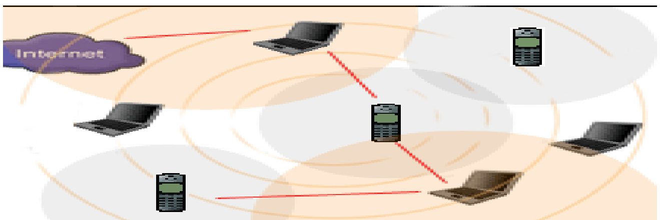

Fig 1: QoS queue length of MANET

Fig 1: The queue length associated with the different nodes from node a's perspective, the actual queue length of the nodes in the network Figure 1 illustrates the importance of having accurate information about Quality

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of Service-related state on the performance of the network. Let us assume that the bar next to the node (a node in this case is a notebook) represents the queue length associated with the node (i.e. how many packets there are in the queue).Figure shows what node *a* believes to be the queue length values for all the nodes in the network; whereas Figure shows the actual queue length value associated with each node in the network. Consider the scenario by which node *a* wants send a message to node *c*. It could send it either via *b* or *e*, however according to node's *a* view of the network, the queue of node *e* is about 100% full while node's *b* queue is only 50% full. As an attempt to achieve better performance, node *a* will send the message through *b*. Now let us look at the actual queue length information at the time node *a* sends the message. Since the time when node *a* obtained the queue length information, node *e* has released some messages from the queue and the queue became about 50% empty, on the other hand the queue of node *b* became really full. Any further messages will either be dropped due to overflow or will incur large delays. Either way the outcome is undesirable and should be avoided by having more accurate information available to all nodes in the network.

The motivation of this research paper is to quantify the accuracy of the Quality of Service-related state information in ad-hoc networks under different conditions and if possible, devise techniques to reduce inaccuracies. Quality of Service-related energy level and queue length and energy level and queue length are used alternatively and mean the same thing. Energy level and queue length represents a Quality of Service-related state. It could be a node attribute such as energy level and queue length, or a link attribute such as bandwidth. In this study, we are interested in node attributes, and mainly energy level and queue length. Due to energy constraints on wireless devices, energy-aware routing protocols have been widely implemented [3]. On the other hand, [6] shows that using a congestion-related metric, such as queue length, could improve the routing performance in Mobile Ad hoc Networks. Energy level and queue length accuracy specifies how accurate is the available Quality of Service-related state information in terms of what their actual values are for different nodes referred to as actual value and what other nodes believe their values are – referred to as perceived value.

The main objectives of this paper are:

1) Quantification of the inaccuracy of energy level and queue length in ad-hoc networks under different traffic loads, using OLSR as the underlying routing protocol. Overall inaccuracy level is calculated as: for each pair of nodes (n1, n2) in the network such that there exists a route from n1 to n2, the average of the sum of the absolute difference between the actual energy level and queue length of n2 and what n1 believes to be the energy level and queue length of n2. The results show that traffic load has a significant impact on overall inaccuracy levels.
2) Studying the impact of tuning the OLSR protocol parameters on the inaccuracy level of the two Quality of Service metrics under consideration (queue length and energy level). With one exception, changing the OLSR protocol parameters had no statistically significant impact on accuracy levels.
3) Suggesting and developing techniques to reduce inaccuracies. We propose two techniques for the queue length metric and three techniques for the energy level metric. We also evaluate the performance of the proposed techniques and compare them to the basic OLSR protocol performance..

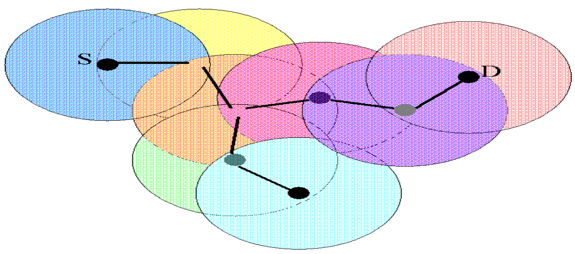

Fig 2: Example network with nodes

To improve the energy level inaccuracies, Guessing, Prediction and Smart Prediction are implemented. Under the *Guessing* mechanism, instead of propagating the energy level information, each node guesses the energy level of the other nodes based on its own energy consumption. Fig 2. Under the Prediction technique, a node's energy level is adjusted based on its past behavior (its own consumption rate). Smart Prediction is a modified version of the Prediction technique such that, if no behavioral pattern was known for a node then its energy levels is adjusted based on the average of all known consumption rates for other nodes[5]. This reduces the chances of the domination of a single consumption rate. Both prediction and smart prediction can greatly reduce the energy level inaccuracy, and smart prediction outperforms prediction, in particular under high traffic loads.

2. Related work

When considering the task of Quality of Service routing, it is important to realize that this ability is very much dependent on the accuracy of the information specifying resource availability at network nodes and links [4]. Quality of Service routing relies on the Quality of Service-related energy level and queue length and uses it to find paths that can satisfy certain Quality of Service requirements. The main consequence of this loss of accuracy in state information, in the context of Quality of Service routing, is that nodes now need to consider not only the amount of resources (bandwidth, buffering capacity, and energy level) that are available, but also the level of certainty with which these resources are indeed available. For example, a link which guarantees 10 Mb/s of available bandwidth may be more desirable than one which advertises 20 Mb/s.

3. Accurate State Information in MANET

3.1 Quantification of Energy Level and Queue Length Accuracy

Energy level and queue length accuracy specifies how accurate the available Quality of Service-related energy level and queue length determined by the difference between the actual values and what other nodes believe their values are referred to as perceived value at different times. In order to quantify the accuracy of state information, the Quality of Service-related state needs to be propagated throughout the network. There are two ways in which Quality of Service-related state can be propagated throughout the network. Either we define a new message type to carry the Quality of Service- related state information, or we include it in the OLSR message types (Hello and TC messages) to be available to other nodes in the network [6]. With the first approach, a new message type has to be defined and exchanged. This will cause more messages to be exchanged. Added to that the fact that the same gain can be obtained by including the Quality of Service-related energy level and queue length in the OLSR protocol messages, the second approach will be taken to propagate the Quality of Service-related energy level and queue length to be available to other nodes in the network.

3.2 Queue Length and Energy Level Metrics Performance

In this Part, we introduce the results of evaluating the accuracy of the two Quality of Service metrics under consideration queue length and energy level as discussed in the previous Part from different perspectives. For each metric, we first assess the accuracy of energy level and queue length using default OLSR parameters under different traffic rates and we then investigate the effect of tuning the protocol parameters on accuracy.

3.3 Queue Length Inaccuracy Improvement

The queue length overall inaccuracy level under five different traffic rates using different OLSR parameters. Tuning the OLSR protocol parameters did not seem to have a positive impact on inaccuracy level. Analysis based on number of hops and knowledge age was conducted to get better insights of what can be done to improve inaccuracies [8].

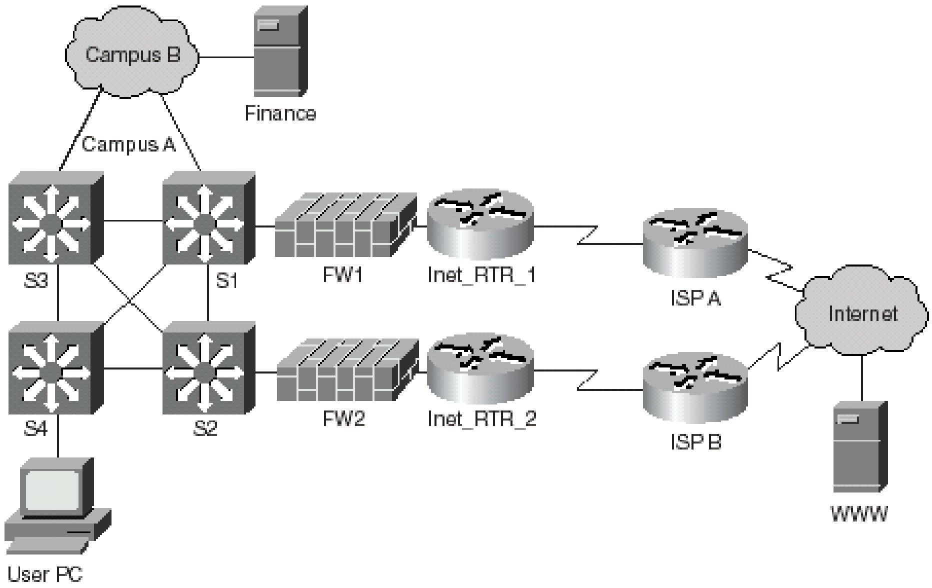

Fig :3 State information in MANET

Number of hops and knowledge age analysis concluded that the inaccuracies are mostly caused by nodes that are far away or equivalently nodes that we have only "old" knowledge for. In this Part, we will look at methods to improve queue length inaccuracy level. We propose two techniques: Probing and Exponential Averaging. Then we compare the proposed techniques to the Default OLSR solution (OLSR with the Quality of Service related state propagated and using the default parameters).

3.4 Energy Level in Accuracy Improvement

In this Part, we will look at methods to improve energy overall inaccuracy levels[6]. Based on the knowledge age inaccuracy level analysis, we propose techniques to deal with old data. We propose three techniques: Guessing, Prediction and Smart Prediction [7] .

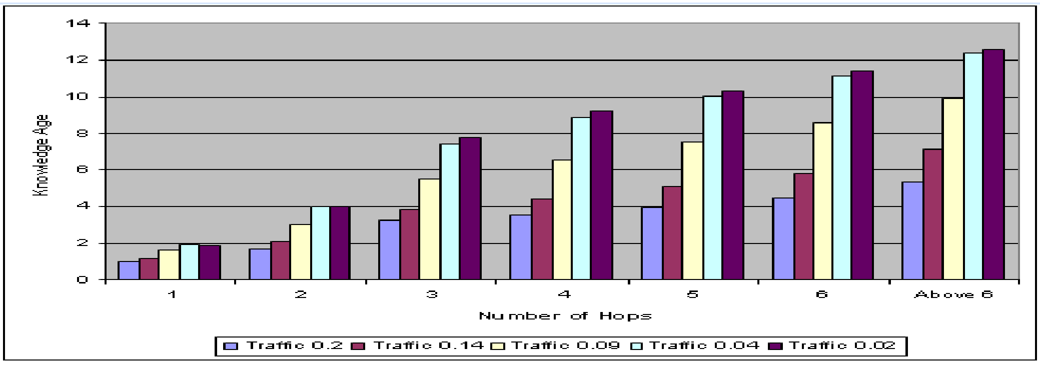

Fig :4 Knowledge Age versus Number of Hops under Different Traffic Rates

All proposed methods are compared to Default OLSR. We refer to OLSR with Quality of Service related state propagated, and using the default parameters (Hello interval 2, TC interval 5, MPR coverage 1 and TC redundancy 0) as "Default OLSR".

4. Conclusion

The queue length, two techniques were proposed to reduce inaccuracies: A Probing technique in which whenever a node has old knowledge about another node, it sends that node a probe message requesting a state information update; and an Exponential Averaging technique in which a parameter is used to smooth short term fluctuations and to highlight long-term trends. Under the Probing technique, although probe messages did provide a high percentage of more recent state information, it was not sufficient to improve inaccuracy level since the information provided was still relatively old under different threshold values of knowledge age. The increased levels of overhead resulting from the extra messages sent caused longer delays and higher loss rate, contributing to this unexpected behavior of our probing technique. Similarly, the Exponential Averaging technique did not positively impact the overall inaccuracy level. On the contrary, the trend was towards less accurate queue length information as older data was weighted more. For the energy level, a Guessing technique in which a node guesses the energy level of other nodes based on its consumption rate showed that propagating the energy level information, using Default OLSR, provided the nodes in the network with more accurate energy level information. The results show that both Prediction and Smart Prediction outperform the Default OLSR (OLSR with QoS related state propagated and using default parameters). Moreover, Smart Prediction outperforms Prediction since energy levels adjustments take place all the time. In addition to that, the overheads associated with Prediction and Smart Prediction is exactly the same as the Default OLSR since no extra messages or fields are required.

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