Modeling of Mobility-Induced Losses in MANETs (MILMAN) *

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Introduction : We study the effects of mobility on packet loss in mobile ad-hoc networks (MANETs). Mobility is generally accepted as a cause of packet loss. Other broad causes of loss in MANETs are losses in the wireless channel and losses due to congestion. While there exist many models for wireless channel and congestion losses, mobility-related losses have not been studied in depth. Past studies have investigated the effect of mobility on actual transport-layer throughput, an approach that does not capture the character of losses that occur and are then corrected by the transport layer. Our approach is to measure the likelihood of a packet being affected by mobility-related loss, rather than to measure the throughput achieved by any particular MANET transport layer.

Loss Metric : A mobility-related packet loss may occur in one of many different ways. In order to distinguish mobility-related packet loss from other kinds of packet loss, we need to decide which mechanisms at which layers of the protocol stack are responsible for this kind of loss. This involves assuming particular link layer and routing protocols. In our simulations, we use 802.11 and DSR respectively. A challenge we face is that some kinds of mobility-related losses occur through similar mechanisms as losses due to congestion (namely, buffer overflow and timeout). We have identified four mechanisms that cause the complete set of losses that we attribute to mobility. [1] Drops at intermediate hops because the source route was invalid and salvaging did not succeed. [2] Drops due to send failure at the source. [3] Drops from the source's send buffer because of timeout. [4] Drops at the source's send buffer due to insufficient space to queue all packets which are pending route discovery. We include losses due to these four causes in the loss metric we define, the *MILMAN* metric. In addition, we count the number of packets that had their original source routes modified en-route in the salvaging process, and reached the destination successfully. Though these packets are not lost, they are clearly affected by mobility, and we include them in the metric. Through experimentation, we found that this component contributes a very small percentage to the metric.

Connectivity Metric: We studied the correlation of the MILMAN metric with a metric that measures the number of changes in the shortest path between the source and destination on the connectivity graph. We find that there is weak positive correlation for dense graphs, but strong negative correlation for sparsely connected graphs. (Figure 1). However, we note that for sparse networks, the above metric has negative correlation with velocity, and hence may not be representative of *mobility*. We considered another metric, the disconnection time between the source and destination and as expected we found that the MILMAN metric varies directly with this metric(Figure2).

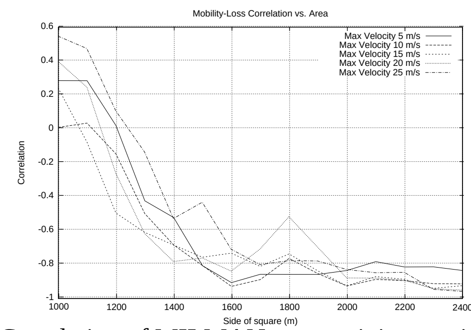

Fig 1. Correlation of MILMAN-connectivity metric vs.area

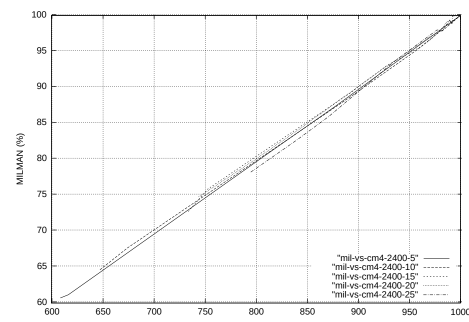

Fig 2. MILMAN vs.Disconnection time

Setup : Simulations were conducted in ns-2 with the random waypoint mobility model for CBR traffic. A single source-destination pair was used for each of the simulations. The area was varied from 1000sq.m. to 2400 sq.m. at intervals of 100 sq.m. and maximum velocity of nodes from 5 m/s to 25 m/s in steps of 5. Ten different scenarios were chosen for each area-velocity combination. Hence, a total of 750 simulations were conducted.

Results and Future Work : Our preliminary results indicate that though an increase in mobility(velocity) leads to greater packet loss in densely connected networks, we can observe some interesting (though isolated) cases where it leads to a *decrease* in packet loss in case of sparsely connected networks.

We plan to study the characteristics of these interesting cases, losses in other mobility models and routing protocols as well as formulating models for mobility-related losses for particular mobility models, with the goal of being able to use the model in the performance analysis of specific transport layers.

*MILMAN website. *http://nile.usc.edu/ee499/milman*

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