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# Performance Enhancement Through Link Stability Scheme in Web-Structured Multicast Routing Protocol

[1]A. Krishnan [2]P. Kamalakkannan and [2]V. Karthikeyani
[1]Department of CSE,
[2]K.S.R. College of Engineering, Tiruchengode-637209, Tamilnadu, India

**Abstract:** A dynamic topology is distinguishing feature and challenge of wireless ad hoc networks. Links between the nodes are created and broken, as the node moves within the network. This node mobility affects not only the source and/or multicast receiver, as in conventional wireless network, but also intermediate nodes, due to network mutihop nature. Furthermore, the packets are more likely to be lost due to external environmental factors wireless interference if the signal strength is not strong enough. The major strength of web-structured multicast routing protocol is simplicity. This study propose an improved stability scheme to estimate link stability based on signal strength. We perform simulations to investigate the benefits and costs of using signal strength as route selection criteria. The proposed method increase total number of bytes received by the receiver and decrease the control overhead compare with the basic WSMRP.

**Key words:** Routing, link stability, signal strength, packets, multicast, ad hoc network

## INTRODUCTION

Multicast routing is becoming an important networking service in the Internet for supporting applications such as remote conferencing, resource discovery. An ad hoc network is a group of wireless nodes with which self-organize into a network in order to communicate. Such a network can operate without the need for existing infrastructure or configuration. Each mobile node in the network act as a router and the nodes forward packets on behalf of other nodes.

Routing protocols for ad hoc networks must discover such paths break due to effects such as node motion, radio propagation or wireless interference. Link failures may occur on the wireless medium or most probably, when pairs of node move out of reciprocal transmission range or shadowed by the obstacles. The situation where a node is disconnected from the rest of the network is equivalent to a recoverable crash fault of the node.

Ad hoc networks adaptable to highly dynamic changes in the network topology change frequency. A routing algorithm targeted toward finding optimal (in terms of distance) routes, the physical distance between two neighboring nodes with in a path to long. Such a distance may even be close to the effective transmission range between any two nodes. A small movement of any of the nodes involved may cause packet loss due to link failure. Also, packet can be lost due to noise or interference in wireless channel if the signal strength of the link is very weak. Therefore, the routing algorithm to find a stable routes that take into account the mobility of nodes, no signal power and interference in the wireless channel.

The major strength of Web Structured Multicast Routing Protocol WSMRP (Kamalakannan *et al*., 2005; Krishnan *et al*., 2006) is its simplicity. We can further improve its performance by a new link stability scheme.

The idea behind Associativity Based Routing ABR (Toh *et al*., 1997) is to prefer stable links over transient links. A link is considered stable if it exists for a time to atleast $A_{thresh} = 2rtrg\ v^{-1}$, where rtrg is the transmission range and v denotes the relative speed of two nodes. It is left open how to determine the relative speed rv among the mobile nodes which in turn determines $A_{thresh}$.

The motivation behind the approach is the assumption that after a connection time of $A_{thresh}$, the corresponding nodes are likely to be moving with a similar speed and direction and thus to stay together for a relatively long period of time. ABR tries to find long-lived routes to receive using estimations of link stability based beacon messages; ABR searches all possible routes to find a route strong links. Therefore, a route is selected for each destination based on link stability. However, the link stability scheme that ABR uses is not accurate for some mobility patterns.

**Corresponding Author:** A. Krishnan, Department of CSE, K.S.R. College of Engineering, Tiruchengode-637209, Tamilnadu, India

Signal Stability based Adaptive routing SSA (Dube *et al*., 1997) estimates link stability based signal strength. Each node measures signal strengths from other nodes. If a node receives a strong signal from a adjacent node, which typically results if 2 nodes are close each other, the link consider as stable. SSA tries to find a route using only stable links. If fail to find a stable route, then tries to find a route using all possible links, resulting in an ordinary route. When a failed link is detected, an intermediate node send an error message to the source node to notify it that route is broken. Then the source reinitiates route discovery process. This causes undue overhead and is thus undesirable.

Link Life Based Routing protocol LBR (Manoj *et al*., 2001) is another link stability-based routing protocol. LBR converts signal strength into distance using free space propagation model assumption. Based on estimated distance and maximum speed of nodes, LBR estimates link life time. When a source node initiates route request, each intermediate node attaches its estimated link life time to the route request message. When a receiver node receives a route request message, it can calculate the path life time for that the route based on the estimated link life times in the route. Therefore, the receiver node can select the route that is expected to have the longest life time. If route failure occurs, proactive maintenance, the source node needs to reinitiate a route request. Which results in, increased delay and control overhead. Several routing protocols were developed based on the link stability (Lim, 2002; Robin *et al*., 2003; Park *et al*., 1997; Agarwal *et al*., 2000; Mcdonald *et al*., 1999; Su *et al*., 2001; Nen-Chung *et al*., 2006; Jenn-Hwan *et al*., 2007).

## IMPROVED LINK STABILITY SCHEME

Signal stability based adaptive routing estimates link stability using signal strengths. Each node monitors signal from its neighboring nodes. If signal strength of a received packet is higher than a certain threshold, the link to that neighbor is considered stable.

Advanced signal strength based link stability estimation model, is takes improved link stability based on previous and current values of link strength. If two nodes are getting closer together and the link is getting stronger. Therefore, the link with increasing signal strength is as stable. If the signal strength is getting weaker, this means that two nodes are getting away and the link may become disconnected.

We propose a new link stability scheme, Improved Link Stability Scheme that uses two thresholds. In ILSS, a link is considered as stable when two nodes are located very close to each other. ILSS uses two thresholds

```
LSScum_j =ρ LSS cum_j + (1- ρ) LSS_j
VLSS_j = LSScum_j – previous LSScum_j
If(LSScum_j > Threshold1)
 {
   e_i,j is stable
 } else
If (LSScum_j > Threshold2)
 {
 If (VLSS_j > μ)
 {
  E i,j stable
 } else {
 E i,j is unstable
 } else {
 E i,j is unstable
 }
Previous LSScum_j = LSScum_j
```

Fig. 1: Proposed link stability scheme algorithm

threshold1 and threshold2 with the property threshold1 > threshold2. If the signal strength is greater than threshold1, then the link is always considered as stable because the distance between two nodes is very small. If the signal strength is less than threshold1but it is grater than threshold2, then variation in signal strength VLSS (i.e. The difference or change in the signal strength from the value measured during the previous measurement period) is used to estimate link stability. In addition due to external environmental factors like interference and white noise, signal strength may decreased by external environment factors. Therefore, we add an additional parameter $\mu$, where $\mu < 0$ to address this problem. A link is considerable as unstable in ILSS only when VLSS $< \mu$. Figure 1 shows the algorithm for improved link stability scheme.

## EVALUATION

Simulation are conducted to evaluate the proposed link stability scheme using GloMoSim (UCLA Department of Computer Science).Which is the simulator commonly used in wireless networking research. We compare the performance of without link stability and with link stability scheme in WSMRP.

**Simulation environment:** We conducted our simulations using the GloMoSim. Our simulation is based on the environment of closed 1000 * 1000 unit area in which there are number of randomly distributed mobile hosts. Radio propagation range for each node was 300 meters and channel capacity is 2Mbps. A Source generates 512 bytes data packets. Each simulation executed for 600 seconds of simulation time.

The nodes in our simulations move according to the random waypoint model. Each node independently starts at a random location in the simulation area and remains stationary for a period of time called the pause time. The node then chooses a random new location to move and speed to move at, both uniformly randomly generated and once it reaches that new location, again remains stationary for the pause time. Each node independently repeats this movement pattern over the duration of each simulation run.

For our simulation experiments, we study runs with a different node movement speeds were 0, 05, 10, 15 and 20m $sec^{-1}$. We used 5 different numbers of mobile hosts10, 20, 30, 40 and 50. We randomly generated 10 different scenarios. Multiple runs were conducted for each scenario and collected data was averaged over those runs.

## MATERIALS AND METHODS

To investigate the impact of our enhancements, we simulated the following 2 schemes:

**Scheme A:** The basic web-structured multicast routing.

**Scheme B:** The enhanced web-structured multicast routing that uses improved link stability scheme as a route selection metric.

The protocols were evaluated as function of mobility speed and number of hosts in the network. In the first set of experiments, the number of nodes in the network was 40 and mobility speed was varied from 0-20 m $sec^{-1}$. In the 2nd set of simulations, node mobility speed was constant 10 m $sec^{-1}$ and the number of node was varied from 10-50.

The following metrics were used for the simulation:

**Average of total number of bytes received:** The number of data bytes received by all the multicast receivers are added and divided by the number of multicast receivers.

**Control overhead:** The total number of control packets transmitted.

## RESULTS AND DISCUSSION

**Average of total number of bytes received:** We compare the result from scheme A and scheme B. The average of total number of bytes received as a function of the mobility speed and the number of nodes is shown in Fig. 2 and 3, respectively.

We can see from Fig. 2 that as host mobility speed increases, the number of bytes received in scheme A degrades rapidly compared with scheme B. The number of

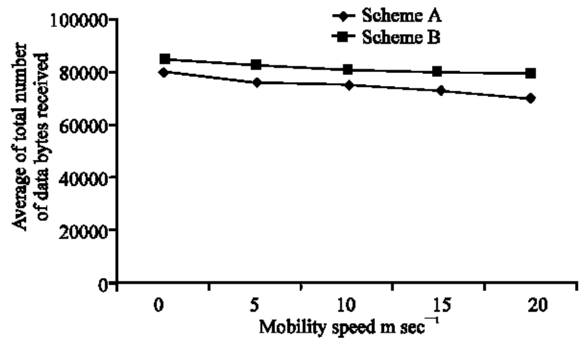


Fig. 2: Average of total number of byte received as a function of mobility speed

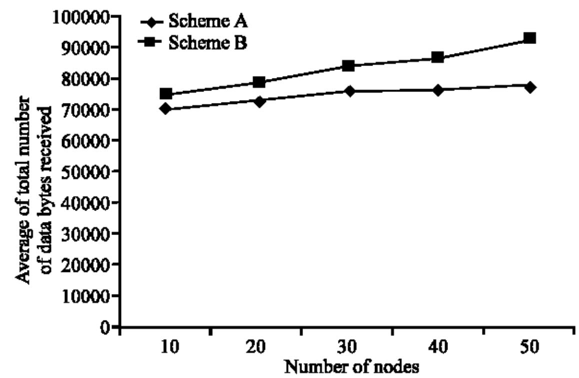


Fig. 3: Average of total number of byte received as a function of number of nodes

route reconstruction is consistently lower for improved link stability scheme B compare with the scheme A because of its stable route. Scheme B received 6.67% of bytes higher than scheme A. In Fig. 3 scheme B outperform scheme A again. The result shows that the enhanced method is robust to the number of hosts in addition to mobility speed. Scheme B's performance improves as the host size becomes larger. As the number of host's increases, the number of adjacent forwarding nodes also increases accordingly. Hence, the connectivity of multicast members become richer and the redundancy of the routes help delivering data to multicast receivers.

**Control overhead:** Figure 4 shows the control overhead as a function of mobility speed for each protocol.

The transmission of control packets decreased in scheme B compare with scheme A because of stable route. The route reconstruction is lower when strong route was chosen by the improved Scheme B. Control overhead of scheme B is much lower than the scheme A, even though mobility speed increases. In Fig. 5, control overhead of both schemes increases when the number of nodes increases. But the scheme B has much less

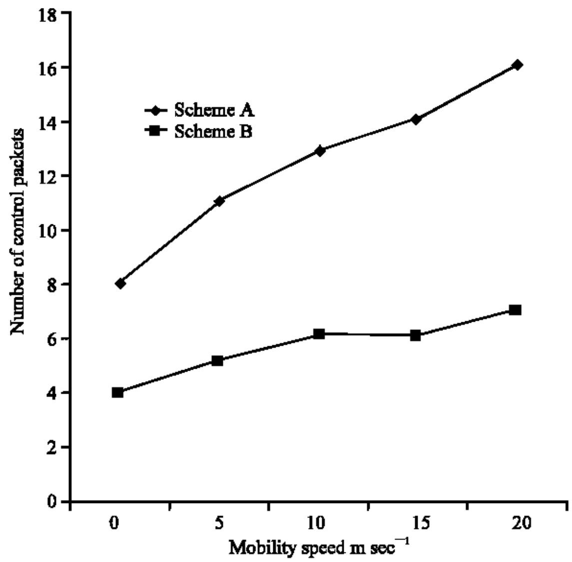


Fig. 4: Control overhead as a function of mobility speed

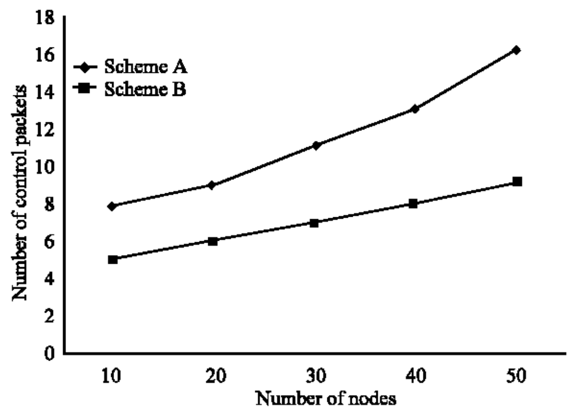


Fig. 5: Control overhead as a function of number of nodes

overhead than that of scheme A. The numbers of control packet transmissions were more then 40% less in link stability scheme is used for route selection in scheme B.

## CONCLUSION

We propose a new technique to enhance the performance of web-structured multicast routing protocol. We have applied new route selection scheme to choose routes that will stay for the longest time. The use of the link stability scheme included in basic WSMRP, average of total number of byte received by multicast receivers are increased over 6.67% and control overhead is also reduced more than 40%. Simulation results showed that our new method Improved over the basic scheme significantly. In the enhanced link stability scheme more data bytes were delivered and less control packets were produced even in high mobility speed.

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