



Performance Comparison of Multicast Routing Protocol Parameters in Wireless Network

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Abstract: This paper proposes on demand link weight routing protocol (ODLW). ODLW selects an optimum route on the basis of available bandwidth, low delay and long route lifetime. The technique adapts a cross-layer framework where the ODLW is integrated with application and physical layer. The proposed design allows applications to convey preferences to the ODLW protocol to overcome the default path selection mechanism. The results confirm improvement over AODV in terms of network load, route discovery time and link reliability.

Key-Words: - Routing Protocol, Ad Hoc Network, QoS

I INTRODUCTION

Today, mobile networks are required to support increasing demand for multimedia communications. Maintaining real-time media traffics such as audio and video in presence of dynamic network topology is particularly challenging due to high data rate requirements and stringent delay constraints. In multi hop wireless mobile networks, one of the key issues is how to route packets efficiently. Some of the important factors that need to be considered in designing a routing protocol for mobile networks are: energy efficiency, minimum delivery latency, higher probability of packet delivery, adaptability and scalability. Several routing protocols for mobile networks have been proposed to cope with similar problems and meet various application requirements. For instance, traditional proactive routing protocols eliminated the initial route discovery delay but could not perform efficiently in specific ad hoc conditions [2][3]. The reason is that they waste the limited system resources to discover routes that are not needed. This paper presents a new reliable ad hoc routing protocol, which is essentially a succession of on demand and link-weight routing protocols. ODLW is able to provide a reliable route with assurance of required bandwidth, low delay and longer route lifetime. ODLW makes use of new cross layer interfaces, designed to combine the functionality of the Routing layer with Application, Medium Access Control (MAC) and Physical (PHY) layer parameters to provide the routing algorithm with more accurate information about the current status of the link. It helps to find a more appropriate path that is able to guarantee the QoS requirements during the whole connection. The remainder of the paper describes as follows. Section 2 describes related work. Section 3 provides the operations of the proposed ODLW protocol.

Simulation results are presented in Sections 4. Finally, Section 5 concludes the paper.

II RELATED WORKS

There are several approaches for QoS routing protocols based on on-demand principle of route discovery. The first approach is based on distributed on demand path search, which uses known link bandwidth between nodes [8]. Due to the distributed path calculation, this approach is scalable. Further, by limiting the number of path search requests, flooding is prevented. Although scalability and limited protocol overhead are clearly desirable in all ad hoc QoS routing We believe there are potential drawbacks to this approaches. In particular, the path finding procedure is not designed to take advantages of QoS information available at the MAC layer. The second approach of QoS implementation over ad hoc networks [9][10][11][12][13][14][15] focuses specifically on the MAC layer. It is based on reservation of a node's MAC layer time. In this approaches single or multiple paths to destination are discovered, and the path bandwidth to the destination node is calculated. However, acquiring the complete path information has several potential drawbacks, such as low scalability, poor tolerance to fast topology changes and message flooding. The third approach is different from above solution; it's incorporated QoS path finding procedure is based on bandwidth scheduling mechanism. The routing protocol is made aware of the bandwidth resources availability by coupling routing and MAC TDMA layers [16]. This paper proposes a newer approach by introducing an adaptive mechanism for route selection. Under the proposed mechanism, a route is selected



based on the link bandwidth, delay and route lifetime using a set of default/custom link weight parameters.

III ON DEMAND LINK-WEIGHT ROUTING PROTOCOL (ODLW)

ODLW routing protocol is designed for multi-hop ad hoc wireless networks.

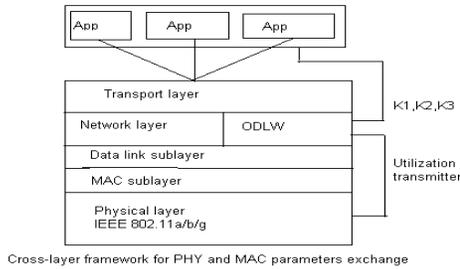


Fig. 1. Cross layer framework of ODLW

The proposed protocol works like the on-demand principle of route discovery and is a part of a cross layer framework as shown in fig.1. The ODLW protocol always selects an Optimum route using a combined link weight of bandwidth, link delay and route lifetime. The route selection process is adaptive and closely matches the application requirements. Different types of applications have dissimilar QoS requirements. Although, an optimum route is always selected by default; however, various applications can convey their individual requirements to the ODLW protocol using three QoS parameters: K_1 , K_2 and K_3 as shown in Table 1.

Table 1: Configuration Parameters

Applications	K_1	K_2	K_3
Video Conferencing	0.5	0.4	0.1
FTP	0.5	0.3	0.2
Messaging Service	0.1	0.4	0.5
Default (Optimum)	0.33	0.33	0.33

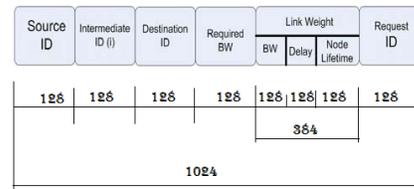
For an example, a video conferencing application requires larger bandwidth and is also delay sensitive. In this case, ODLW parameters for a video conferencing application will be configured as follows: $K_1=0.5$, $K_2=0.4$ and $K_3=0.1$. Here, K_1 corresponds to Bandwidth (data rate); K_2 corresponds to Delay (latency) and K_3 corresponds to Node lifetime (which is determined by the minimum battery lifetime of nodes in the route). The ODLW protocol uses the information given by applications in the form of K_1 , K_2 and K_3 to calculate the link-weight for selecting a route using the following equations: $Link\ Weight = (K_1 \times Bandwidth) + (K_2 \times Delay) + K_3 \times Node_lifetime$ and $K_1 + K_2 + K_3 = 1$ (1). It implies that a different route may be selected between the same source and destination nodes if different types of applications are hosted at these nodes. The node lifetime weighting is shown in table 2.

Table 2: Node Lifetime Weighting

Remaining Battery	up to 100%	up to 80%	up to 60%	up to 40%	up to 20%
Node lifetime weighting	1	2	3	4	5

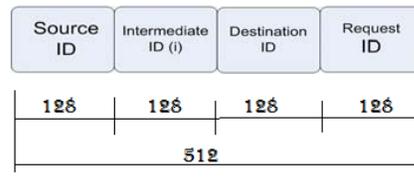
A. Packets Format

The ODLW routing protocol finds the best route with QoS assurance by using two control packets: Route Request Message (RREQM) and Route Reply Message (RREP) in Fig.2 and 3, respectively.



ROUTE REQUEST MESSAGE (RREQM)

Fig.2



ROUTE REPLY MESSAGE (RREP)

Fig 3

The RREQM packet consists of the following fields: source ID, Intermediate ID, Destination ID, Required Bandwidth, Link Weight which mainly based on three QoS factors (Bandwidth, Delay, Node lifetime) and Request ID. The source node fills the field value in the RREQM message and broadcast it to the neighbouring nodes. When an intermediate node received the RREQM message, it compares among all other RREQMs received from the neighbouring nodes, and records the link weight information of the route that meets the required bandwidth, and has low accumulated delay and long route lifetime. In a similar fashion, the RREQM messages are updated at every intermediate node and rebroadcasted to its neighbouring nodes till it reaches the destination. Every intermediate node has a table that keeps the optimum route with best link weight values that meets the QoS requirements. This route will eventually be traced back using the RREP in unicast nature. The route discovery mechanism used in ODLW avoids unnecessary flooding and overloading of the ad hoc network. It does not use 'HELLO' messages for route maintenance; instead an alternative route is always available at every node.

B. Route Parameters (Link Weight)

In order to select an optimum path this protocol uses the three QoS parameters: available bandwidth (BA) in terms



of data rate, delay and node lifetime. A simulation model for the ODLW protocol is developed in ns2. The available channel bandwidth is calculated using the transmitter-utilization parameter directly from the PHY layer to the routing layer using a cross-layer interface shown in Fig.1. In order to calculate the available bandwidth from the utilization-parameter we use the following equation [10]: $100 BA (10 Utilization) * channel_bandwidth = (2)$ where channel bandwidth is a constant value and depends on different extensions of IEEE 802.11 standard. The link delay is calculated after reception of every RREQM by using the RREQM packet creation time information and reception time. The Node lifetime is an important parameter for route selection and our implementation provides an estimated value of remaining battery lifetime in each RREQM

C. Route Discovery Process

The route discovery process begins when a source node needs a route to some destination. It places its own ID, destination ID, required bandwidth and request ID in RREQM. Also RREQM will contain the node’s available bandwidth, link delay and node lifetime. The receiving node will compare this RREQM and update its local tables. The table contains Node-ID, the link weight parameters and the Request-ID. When processing the received RREQM from neighbouring nodes, the current node selects the route that meets the required bandwidth, low accumulated delay and long node lifetime.

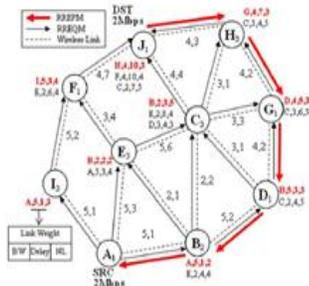


Fig.4. Route establishment of ODLW

Referring to Fig.4, node-A wants to communicate with node-J, node-A will broadcast RREQM to look for the destination. The relay node- B when receives RREQM from node “A” and “E”, the local table that it shall generate will look like: {[A,5,1,2], [E,2,4,4]} respectively. Node-B will compare the requirements mentioned in RREQM from A with the available entries in its local table. In this case, it will compare it with its second entry which is [E,2,4,4]. Then, it will make a new RREQM with the same Request-ID and the following information :{ BW=5, Delay=1, and Node lifetime=2}. While at every intermediate node, a new link weight will be calculated from the available information at each node. At the destination multiple RREQMs will arrive and the node-J has a list of the qualified routes

through nodes H, F and C. In this case, node-J will choose the best path through node-H which meets the requirements. When Node-H receives the RREPM sent by node-J, it shall check the Request- ID to search for corresponding table-ID and then update the intermediate-node-field in the RREPM and unicast again. This process is repeated and RREPM fields are updated from node to node until the original source is reached. In some cases the selected route is longer than others but it offers better data rate, longer route lifetime and at the same time offers minimal delay. The other path through node-C is one of the other available paths to reach the source node-A but the node lifetime is 5 which shows that the node has only up to 20% remaining battery life (see Table 2). The node lifetime is very important because if the node runs out of battery, the source node would have to find an alternative path to the destination again. However, an alternate route is ODLW exits in the ODLW routing protocol and it can be used in case of failure of a node on the initially selected route. As mentioned previously, ODLW is a succession of AODV protocol and inherently it follows similar mechanism. Table 3 provides a comparison of various features between AODV and ODLW.

Table 3: Comparison of ODLW and AODV

	ODLW	AODV
On demand route selection	Yes	Yes
Alternative route	Yes	Yes
Network size	All size	Large
Routing path	adaptive	Shortest
Link reliability	Yes	No
Network load	Low	High
Routing overload	Low	High
Application adaptive	Yes	No

However, in case of ODLW there is support of QoS parameters and an optimum route is selected according to a request. The route selection mechanism in ODLW is dependent on the selection of Link weight parameters and is not fixed as AODV where it always selects a route with minimum hops to the destination. In scenario, where a node using ODLW protocol and particularly requests any one of the three link-weight parameters; the route discovery process will be initiated with a higher priority to that parameter. So, the route discovery process is adaptive and depends on the requested QoS features. Likewise, in case of failure of the primary route, the AODV initiates a rediscovery process while in case of ODLW. An alternative route is always available in all nodes from source to destination.

D. Route Maintenance

Route maintenance procedure triggers whenever selected route between source and destination is broken or changed



due to the nodes mobility. Selection is made; destination node starts a timer to keep track of the availability of the selected route. If data packets from source do not arrive to the destination node and timer expires, it is assumed that the selected route between source and destination is lost or broken. In this case destination node selects alternative best route and unicasts a new RREPM after starting the timer again. The alternative route is available for all the nodes, which received the RREQM.

IV SIMULATION RESULTS

The environment that we consider consists of 10 mobile nodes, each one operating at different a data rate (1Mbps, 2Mbps, 5.5 Mbps and 11Mbps), in an area of 4100x4100 meters. We developed a complete simulation model of ODLW protocol in NS2. In similar scenarios (same number of nodes, mobility patterns etc.), we compared the performance of ODLW with AODV protocol using network load and route discovery time. The individual route link weights from source to destination are also presented to highlight the difference between ODLW and AODV path selection procedure in Fig.5 of Simulation Scenario.

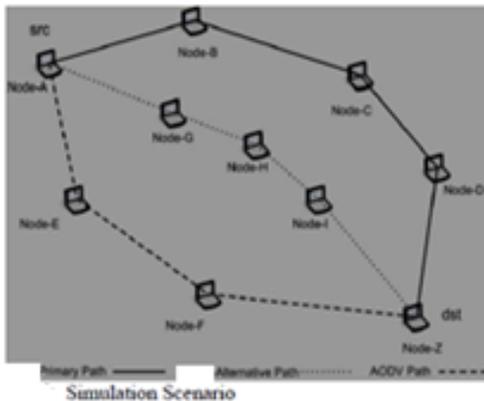


Fig. 5

A. Network Load

Fig.6 shows the network load using AODV and ODLW routing protocols. It is obvious from the curves in Fig.6 that the network load in case of ODLW is much lower than that offered by AODV. The reason for a higher network load lies in the inherent design of the AODV protocol, where mobile nodes periodically send „HELLO“ messages for monitoring connectivity to their neighbours. In an ad hoc network, with a large number of mobile nodes, these periodic „HELLO“ messages account for a higher network load.

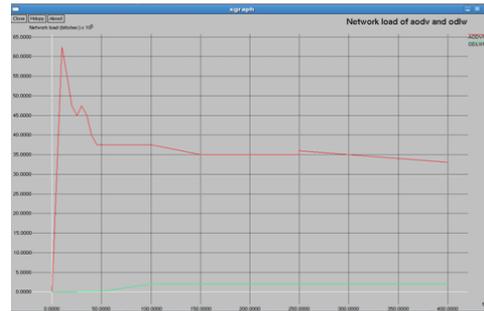


Fig. 6 Network load

B. Network Load

In another scenario, the data rate values of all the mobile nodes along the shortest path to destination we are kept at the lowest value (1Mbps). Other nodes along other paths operated at a higher data rate. As mentioned early, the ODLW selects a route which meets the required bandwidth and most of the time the selected path offers comparatively higher data rate. The route discovery time is lower in case of ODLW than AODV because the RRE PM follows a route where all the Nodes operate a comparatively higher data rate. Fig.7 shows the route discovery time curves for both ODLW and AODV protocols.

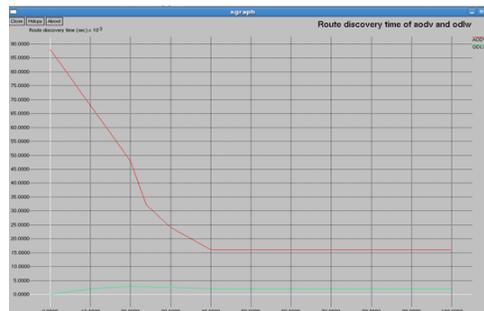
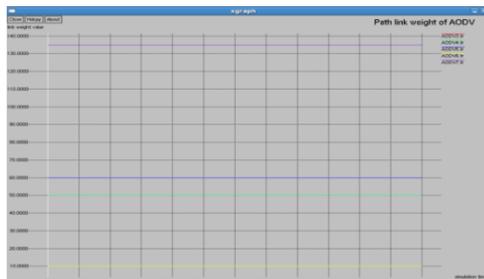


Fig 7 Route discovery time

Individual Route Link Weights

Fig.8 shows the individual node link-weight along with the path link weight or the routes selected by AODV and ODLW respectively.



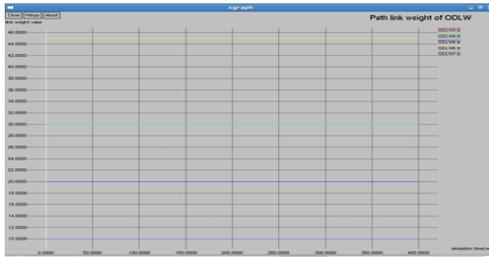


Fig.8 Path link weight of AODV and ODLW

Although, AODV ODLW always selects a route with minimum hops, but it does not guarantee minimum delay, higher data-rate and route reliability. Here, in the case, the path (A B-C-D-Z) is selected by ODLW because it has the lowest path link Weight value of 110 (combination of A=15 B=30, C=20, D=30, Z=15) as Shown in Fig. 5. This is the selected Primary path which supports higher data-rate (bandwidth), with minimum delay and higher route reliability. ODLW has also found an alternative path (A-G-H I-Z) in which the path link weight value is slightly higher than the primary. On the other hand AODV selects a path with minimum number of nodes along the path A-E-FZ but this path has a path link weight of 35 (combination of A=15, B=50, C= 0, D=10), Which is higher than the ODLW. This Result manifested that a shortest path may not always be the best in terms of delay, bandwidth and route reliability.

V CONCLUSIONS

This paper presented a novel approach for routing in mobile networks. Keeping in view the dynamic nature of wireless medium, the proposed routing protocol is adaptive and minimizes the routing overhead. ODLW considers link weight parameters during route discovery and select an optimum path which meets the required QoS level. ODLW provides flexibility and the default route selection parameters can be overridden with custom parameters specified according to the application requirements. The protocol deviates from previous approaches by using new cross layer interfaces to communicate PHY layer information to the network layer. Comparison of ODLW and AODV clearly highlights the improvement in performance in terms of lower route discovery time, reliability of selected routes, meeting the requested bandwidth parameter and minimizing the network load.

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