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A COMPARATIVE STUDY OF MAODDP WITH ZRP AND DSR ROUTING PROTOCOLS FOR MOBILE AD-HOC NETWORK

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Abstract

Mobile ad-hoc network offers a unique art of network formation and can be established in the absence of any fixed infrastructure. Due to the absence of centralized supported structure, an ad-hoc network suffers with various challenges. Some of the known challenges to this area include battery power, routing, bandwidth and security. Routing is an integral part of network communication process. It essential stands for route establishment for data transfer among different nodes of the network. Routing schemes for a mobile ad-hoc network can classify into one of many types. With the invention of Mobile Ad-hoc On-Demand Data Delivery Protocol (MAODDP) a new routing family of on-demand data delivery has introduced in the existing portfolio of routing protocols of an ad-hoc network. The contribution of this work is to extend some of the previous work of MAODDP comparison with Zone Routing Protocol (ZRP) and Dynamic source routing protocol(DSR). It was found that MAODDP has several advantages over ZRP and DSR. This work gives an insight into the protocols performance against each other and can be utilized in further extension of the studied schemes.

Key Words: *MAODDP, ZRP, DSR.*

1. Introduction

Mobile ad-hoc network is deployed in applications such as disaster recovery and distributed collaborative computing, where routes are mostly multi-hop and network hosts communicate via packet radios [11, 15]. Routing is one of the challenging issues in mobile ad-hoc network. Much effort is under going to invent an efficient routing algorithm for mobile ad-hoc network. Existing protocols for ad-hoc network can generally be categorized into one of many types. In this context on-demand data delivery can be seen as one of the new addition [10]. In the existing literature several studies highlighted relative benefits and benefits of various routing schemes. This paper presents a comparative study of MAODDP with Destination sequence distance vector routing and Ad-hoc on-demand distance vector routing (AODV) protocols. Each of the studies protocol belongs to different family of an-ad-hoc network. This effort is to further explore the basic foundation theme of different families of an ad-hoc network and their benefits. In this context this paper has been organized as follows in section 1 a brief introduction of each of the studied protocol is focused. Section 2. presents a comparative study of MAODDP against Zone Routing Protocol (ZRP) and Dynamic source routing protocol(DSR) and conclusions and future work is presented in section 3.

2. Protocols Studied

The following section presents a brief introduction of the protocols being studied and compared.

2.1. Zone Routing Protocol (ZRP)

The Zone Routing Protocol (ZRP) is a hybrid routing protocol [1]. It combines both proactive and reactive routing techniques. Each node has a predefined zone centered at itself in terms of number of hops. For nodes within the zone it uses proactive routing protocols to maintain routing information. For those nodes outside of its zone it does not maintain routing information on a

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permanent basis. Instead, on-demand routing strategy is adopted when inter-zone connections are required.

The ZRP protocol consists of three components. In the zone proactive Intra-zone Routing Protocol (IARP) is used to maintain routing information. IARP can be link state routing or distance vector routing depending on the implementation. For nodes outside the zone, reactive Inter-zone Routing Protocol (IERP) is performed. IARP provides a route to nodes within a node's zone. IERP uses the route query (RREQ) route reply (RREP) packets to discover a route very similar to some on-demand routing protocols.

When the intended destination is not known at a node i.e. not in its IARP routing table that node must be outside of its zone. Thus, a RREQ packet is broadcast via the nodes on the border of the zone. Such a RREQ broadcast is called Broadcast Resolution Protocol (BRP). Route queries are only broadcast from one node's border node to other border nodes until one node knows the exact path to the destination node i.e. the destination is within its zone.

2.2. Dynamic source routing protocol (DSR)

Dynamic source routing protocol [2-3] is a reactive protocol. DSR requires no periodic updates of any kind at any level within the network. DSR uses source routing through which the sender knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. A data packet carries the source route in the packet header. DSR makes very aggressive use of source routing and route caching. No special mechanism to detect routing loops is needed. Likewise any forwarding node caches the source route in a packet forwards for possible future use.

The DSR [28] protocol consists of two mechanisms, route discovery and route maintenance. Route discovery mechanism is initiated when a source desires a route to a destination for which it does not have any prior information. Route discovery process functions by flooding the network with route request (RREQ) packets. Each node receiving a RREQ packet rebroadcasts it unless it is the destination or it has a route to the destination. RREQ and RREP packets are also source routed. The route carried back by the RREP packet is cached at the source for future use. For route maintenance whenever a link on a source route is broken the source node is notified using a route error (RER) packet. The source removes any route using this link from its cache. An intermediate node can use an alternative route from its own cache when a data packet meets a failed link on its source route. A source node receiving an RER packet piggybacks the RER packet in the following RREQ.

This is helpful in cleaning up the caches of other nodes in the network that may have the failed link in one of the cached source routes. When a node overhears a packet not addressed to itself it checks if the packet could be routed via itself to gain a shorter route. If so, the node sends a gratuitous RREP to the source of the route with this new and better route. Promiscuous listening helps a node to learn different routes without directly participating in the routing process.

2.3. Mobile Ad-hoc On-Demand Data Delivery Protocol (MAODDP)

MAODDP is a simple multi-hop routing protocol to establish routing while considering some other routing related issues [5]. MAODDP offers self starting; secure; loop free unicast and multicast routing among various hosts of a mobile ad-hoc network. The key feature of MAODDP is route establishment and data delivery simultaneously one after the other. MAODDP enables mobile nodes to identify route breakage or expired route so that such route could be deleted and marked as invalid using the route error message. MAODDP is well known for offering routing with reduced bandwidth and power consumption [4, 5].

3. Comparative study of MAODDP against DSDV and AODV

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In the reported literature MAODDP has previously been compared with DSDV [8] and AODV [6-8]. This section is divided into two parts in section one MAODDP is compared against ZRP and in section 2 it is compared against DSR.

3.1. MAODDP versus ZRP

ZRP limits the proactive overhead to only the size of the zone. It also limits reactive search overhead to only select border nodes. Potential inefficiency may occur when flooding of the RREQ packets goes through the entire network. To some extent this protocol can provide a better solution in terms of reducing communication overhead and delay. But this benefit is subjected to the size of a zone and the dynamics of a zone. MAODDP is an on demand data delivery routing technique that offers route discovery and data delivery simultaneously [10]. Unlike ZRP it does not broadcast route updates to all network nodes on periodic bases [8]. This approach considerably reduces the network overhead and network bandwidth is utilized efficiently. MAODDP allows nodes to sleep, if they are not involved in an active transmission and through this approach it saves battery power considerably [4]. MAODDP support both unicast and multicast routing [8, 12]. MAODDP also provides loop free routing by using combination of sequence numbers and broadcast ID [8].At present mobile ad-hoc network does not adopt any standard security policy [11]. This means that someone could make an active attack on the network to exploit it or to disable the mobile ad hoc network. MAODDP is considered to be the first protocol that deals with security alongside routing and has its own security mechanism [11]. ZRP does not provide an overall optimized shortest path if the destination has to be found through IERP [14]. That might result in unnecessary bandwidth consumption MAODDP does not involve complex calculation for finding suitable routes [4].Moreover with the increase of network size ZRP could create unpredictable large overhead. In ZRP each path to a destination may be suboptimal. This also means that each node will have higher level topological information. This poses a higher memory requirement and an extra burden on the network resources. MAODDP is scalable to large networks and addresses the scalability issue effectively [4].Mobile ad hoc networks suffer with high mobility, frequent topology changes, bandwidth constraints, limited power and hidden terminal problem. Our research concluded that almost all of these issues are interrelated with the overall routing mechanism [9]. Therefore for a routing mechanism to be good enough for such an environment, it should be able to address some or all of these issues at a certain level. ZRP addresses routing without addressing the side effects on the other related issues such as limited bandwidth and battery power of ad-hoc networks.

3.2. MAODDP versus DSR

DSR is not designed to track topology changes occurring at a high rate [34]. Two sources of bandwidth overhead in DSR are route discovery and route maintenance. On the other hand, to maintain fresh topology information MAODDP relies on one of four different messages types. It is expected that MAODDP might consume less bandwidth than DSR. Both MAODDP and DSR are On-demand approaches and share certain characteristics. Being on demand routing protocols, both avoid periodic updating like proactive routing protocols. They are based on request reply cycle and support the storage of routing information at the intermediate nodes. However there are some silent features that significantly create performance differences. DSR is based on source routing due to which it has considerably greater routing information as compared to that of MAODDP.

In DSR, the query packet contains the sequence of all the intermediate nodes it has to traverse to reach the destination. This information is stored in the header of the data packets, indicated by the source node. Once the destination node receive the query packet, it then retrieve the entire path from the query packet and use it via source routing to respond back to the source. Source route are stored in the headers of the data packet. That’s how source node aware of routes to each intermediate node on the route to destination.. This approach is useful when a broken link is found in a way to destination. It can easily search out its cache to find an alternative route to destination instead of initiating the route recovery process. However, Due to source routing DSR has major scalability problem. Nodes use routing caches to reply to route queries. This results in 'uncontrolled' replies and repetitive updates in hosts' caches. Moreover, early queries cannot stop the propagation of all query messages which are flooded all over the network. Therefore when the network becomes larger, the control packets and message packets also become larger. This could degrade the protocol performance after a certain amount of time. On the other hand MAODDP also support a route recovery process and broadcast the route error message when a broken link is detected. It does not follow an alternative route providing process but cope with the problem using route recovery mechanism.

DSR is cited in some simulation studies. In an analytical study of the probabilities of successful deliveries and the total amount of traffic generated for a successful delivery is presented. It is argued that an end-to-end recovery mechanism does not scale if the routing path lengths increase. Instead a local recovery mechanism is suggested that gives much better results. It is reported that DSR performs better at high mobility rates due to the overhead of AODV's route discovery messages [8]. These occur when new routes need to be discovered or when the network topology changes. In DSR this overhead can be reduced by employing intelligent caching techniques in each node at the expense of memory and CPU resources. The remaining source of bandwidth overhead is the required source route header included in every packet. This overhead cannot be reduced by techniques outlined in the protocol specification [34].

Loop free routing is another aspect in ad-hoc routing. DSR achieved loop free routing through source routing mechanism.[17] MAODDP support loop free routing using sequence numbers[10]. DSR is not designed to track topology changes occurring at a high rate [28].While MAODDP through the use of hop-counter and information gathered during various network operation is capable of tracking all topology changes in different environments. In DSR any node with possible route to the destination can send route replies back to the source node [3]. In MAODDP only destination node issued acknowledge message on receiving data from source node [7]. This Acknowledgement packet is the confirmation of successful transmission. MAODDP supports a special type of message called a 'Joining' message that is broadcasted only once at the time of joining an ad-hoc network [8].

Both DSR and MAODDP flood the route request network wide. This approach creates some network overhead. But the advantage of MAODDP over DSR is that MAODDP deliver the data along with route request and does not need to establish a route before data transmission. In DSR, hosts are required to operate in promiscuous mode, which could result in a higher routing and processing overhead as it needs to process every packet heard [17]. However MAODD Pall functions of MAODDP are completely on-demand, thus no periodic updates are required[44].DSR saves nodes battery power to considerable extent [28]. MAODDP also claims to be power efficient protocol.[53]DSR is an unsecured routing protocol and visible to various security attacks However the Security mechanism used by MAODDP make it a secure routing protocol[17].MAODDP is a secure routing protocol and uses an efficient security technique to ensure security against various routing attacks [11].

In the current specification of DSR, there is no explicit mechanism to expire stale routes or support of preferring fresh route when faced with multiple choices. Stale routes, if used, may start polluting other caches. Some stale entries are indeed deleted by route error packets. But because of promiscuous listening and node mobility, it is possible that more caches are polluted by stale entries than are removed by error packets. However MAODDP follow a more conservative approach than that of DSR. It always prefers afresh route in case of multiple choices. It assigned sequence number to each route and a route with most updated sequence number is always selected. Multicasting capability is one of the essential routing requirements. DSR does not support Multicasting[17].While MAODDP can support both unicast and multicast routing [47].

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4. Conclusion and Future Work

The contribution of this paper is to critically evaluate protocols belong to three different routing families of mobile ad-hoc network. MAODDP is compared against ZRP and DSR where MAODDP found to be followed a better operational structure then the other two protocols.. In future, we intend to conduct a comprehensive study highlighting MAODDP comparison against protocols belong to routing families not focused in this work. We intend to contribute our findings with the ongoing research in this area.

References

[1] Z.J Hass and M.R. Pearlman, The Performance of Query Control Schemes for the Zone Routing Protocol. ACM/IEEE Transactions on Networking, August,2001. **9**(4): p. 427-438.

[2] D. B. Johnson and D.A. Maltz, Dynamic Source Routing in Ad hoc wireless Networks. Mobile Computing, 1996. 353.

[3] C.K. Toh, S.J.Lee, and M.Gerla, A simulation study of table driven and on-demand routing protocols for mobile ad hoc networks. IEEE Network, 1999. **13**: p. 48-54

[4] H. Bakht, M. Merabti, and R. Askwith. Mobile Ad-hoc On Demand Data Delivery Protocol, in 3rd Annual Post-Graduate Symposium on theConvergence of Telecommunications, Networking and Broadcasting . 2002:Liverpool, United Kingdom.

[5] Humayun Bakht, On-Demand Routing in Mobile Ad-Hoc Network, Georgian Electronic Scientific Journal: Computer Science and Telecommunications 2009|No.5(22)

[6] Subburaj.V, Dr. K.Chitra, IDS for Detection and Prevention of Dynamic mobile node positioning based on Logical Distance Measures, International Journal of Engineering Research and Development, Volume 3, Issue 7 (September 2012), PP. 27-32.

[7] H.bakht. Simulaton Based Comparison of on--Demand Routing Protocols for Mobile Ad--hoc Network, Annals. Computer Science Series. 9th Tome 1st Fasc. – 2011

[8] M.Asim and A.J. Pullin, Comparison analysis of MAODDP with some other prominent wireless ad hoc routing protocols, in IBITE Computing. 2005, Liverpool Hope University: Liverpool.

[9] H. Bakht, M. Merabti, and R. Askwith. Centralized frame for routing in mobile ad-hoc networks. in International Conference on Computer Communication, . September, 2004.Beijing, China.

[10] H.bakht “Theory of Centralization for Routing in Mobile Ad-hoc Network” in Annals. Computer Science Series, May 2011. Tome 9, Fasc. 2, December 2011

[11] H.bakht. Mobile Ad-hoc Networking, Create Space, 2010

[12] H.bakht, A study of routing protocols for mobile ad hoc networks, 1st International Computer Engineering Conference, 2005.

[13] H.bakht “Survey of Routing Protocols for Mobile Ad-hoc Network” in International Journal of Information and Communication Technology Research, Volume 1 No. 6, October 2011.

[14] Xiaoyan Hong, Kaixin Xu, and Mario Gerla, Scalable Routing Protocols for Mobile Ad Hoc Networks. IEEE Network,, July/August 2002. **16**(4): p. 11-21.

[15] H.bakht, Some Applications of mobile Ad-hoc Networks, Computing Unplugged.

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