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Performance Comparison of OLSR, AODV and ZRP Protocols

Nishtha Maggu[1] and Anshul Anand[2]

[1]M. Tech. Scholar, Department of Computer Science & Engineering, Shri Baba Mastnath Engineering College, Rohtak (Haryana)
nishthamaggu33@gmail.com

[2]Assistant Professor, Department of Computer Science & Engineering, Shri Baba Mastnath Engineering College, Rohtak (Haryana)
anshulnnd9@gmail.com

Abstract

Mobile ad hoc networking is one of the most important and essential technologies that support future computing scheme. The characteristics of MANET bring this technology as a great opportunity together with many challenges. There have been several routing protocols like proactive, reactive and hybrid protocols which have been proposed for MANETs. A broad classification of the routing protocols is given and the working principle of a few of them is described along with their pros and cons. In this paper, the behavior of Three routing protocols AODV (Ad hoc On demand distance vector), OLSR (Optimized link state routing) and ZRP (Zone routing protocol) based on IEEE 802.11CSMA/CA MAC protocol are analyzed and compared using NS-2 simulator on the basis of performance metrics such as Packet Delivery Ratio, End-to-End Delay, Throughput, dropped packets due to non availability of routes and Energy consumption in transmit and receive Mode.

Keywords: *MANET, OLSR, ZRP, AODV.*

I. Introduction

Over the past decade, there has been a growing interest in wireless networks, as the cost of mobile devices such as PDAs, laptops, cellular phones, etc have reduced drastically and enhance information processing and accessing capabilities with mobility [1]. The latest trend in wireless networks is towards pervasive and ubiquitous computing- catering to both nomadic and fixed users, anytime and anywhere. During the last decade, advances in both hardware and software techniques have resulted in mobile hosts and wireless networking common and miscellaneous. Wireless networks consist of a number of nodes which communicate with each other over a wireless channel. Wireless was emerging fast as latest technology to allow users to access information and services via electronic media, without talking geographic position in account. Wireless networks provide rapid, unthread access to information and computing, eliminating the barriers of distance ,time and location for many applications ranging from collaborative, distributed mobile computing to disaster recovery (such as fire, flood, earthquake),law enforcement(crowd control, search and rescue) and military communications [2].

II. Mobile Ad Hoc Networks (MANETs)

Mobile Ad Hoc Networks (MANETs) has become one of the most prevalent areas of research in the recent years because of the challenges it pose to the related protocols. MANET is the new emerging technology which enables users to communicate without any physical infrastructure regardless of their geographical location, that’s why it is sometimes referred to as a ―infrastructure less network. The proliferation of cheaper, small and more powerful devices make MANET a fastest growing network. A mobile ad-hoc network (MANET) consists of wireless devices, commonly called "nodes," that communicate with each other without a central access point. Essentially, each MANET node is a router. They are typically used to quickly set up a network where a wired infrastructure does not exist. All nodes are capable of movement and can be connected dynamically in arbitrary manner. These networks are self-configurable [3] and autonomous systems consisting of routers and hosts. These nodes are constrained in power consumption, bandwidth, and computational power [2].

The nodes in a MANET can be PDAs, laptops or any other device that is capable of transmitting and receiving information. Device in mobile ad hoc network should be able to detect the presence of other devices and perform necessary set up to facilitate communication and sharing of data and service.

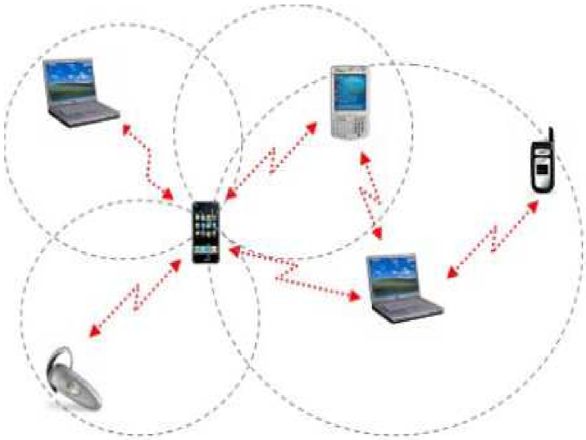

Figure 1: Mobile Ad-hoc Network

III. Routing in MANETS

Unlike wired networks, routing in MANETs poses unique challenges. Designers of routing protocols for MANETs need to address several issues. Routing protocols define a set of rules which governs the journey of message packets from source to destination in a network. Routing in ad-hoc networks faces additional problems and challenges when compared to routing in traditional wired networks [3]. A common routing protocol (the set of rules defining how routing nodes determine the path that packets follow to reach their destination) is used to route communications through intermediate nodes [4]. In MANET, there are different types of routing protocols each of them is applied according to the network circumstances. Figure 2 shows the basic classification of the routing protocols in MANETs

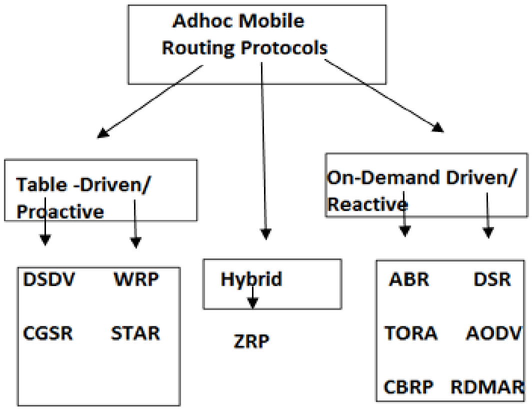

Figure 2: Classification of Routing Protocols

A. Optimized Link State Routing (OLSR)

OLSR is a proactive link state routing protocol specially designed for ad-hoc networks. OLSR maintains multipoint Relays (MPRs) which minimizes the control flooding by only declaring the links of neighbors within its MPRs instead of all links. The multicast nature of OLSR route discovery procedure can be integrated with the mobile IP management by embedding the mobile IP agent advertisement into the OLSR MPR- flooding [5]. This is important for the 4G global ubiquitous networks, which requires the wireless access network to be fully ad-hoc. Several extensions of OLSR are available that correspond to different network scenario. For fast changing MANET, provides a fast-OLSR version which reacts faster to topology changes than standard OLSR by enabling the fast moving nodes to quickly discover its neighbors and select a subset of their MPRs to establish connection to other nodes. Another routing protocol commented by IETF, Topology Dissemination Based on Reverse-Path Forwarding (TBRPF) is very similar to OLSR [6]. TBRPF achieves path optimization and uses an estimation algorithm to selectively broadcast the neighbor information, which leads to lower bandwidth overhead.

B. Zone Routing Protocol (ZRP)

The behavior of purely proactive and reactive schemes suggests that what is needed is a protocol that initiates the route determination procedure on-demand, but at limited search cost [5]. The Zone Routing Protocol [7] or ZRP combines the advantages of both proactive and reactive approaches into a hybrid scheme, taking advantage of pro-active discovery within a node's local neighborhood, and using a reactive protocol for communication between these neighborhoods. ZRP is not so much a distinct protocol as it provides a framework for other protocols. The separation of a nodes local neighborhood from the global topology of the entire network allows for applying different approaches - and thus taking advantage of each technique's features for a given situation. These local neighborhoods are called zones (hence the name); each node may be within multiple overlapping zones, and each zone may be of a different size.

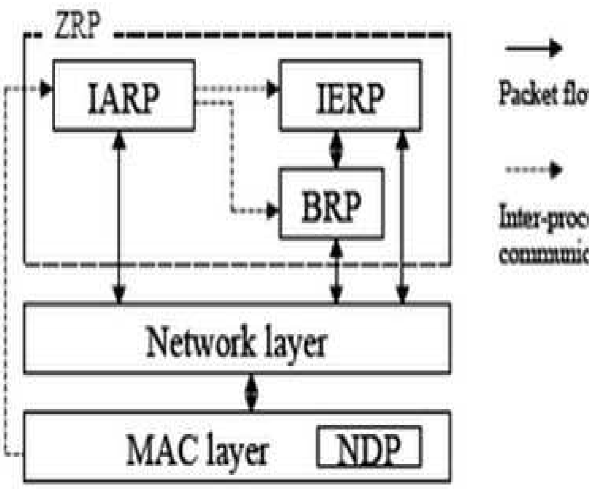

Figure 3: ZRP Architecture

C. Ad Hoc on-Demand Distance Vector (AODV) Routing Protocol

The Ad hoc On-demand Distance Vector routing protocol [8] inherits the good features of both DSDV and DSR. The AODV routing protocol uses a reactive approach to finding routes and a proactive approach for identifying the most recent path. More specifically, it finds routes using the route discovery process similar to DSR and uses destination sequence numbers to compute fresh routes. The two phases are discussed in more detail-

- **Route Discovery**

During the route discovery process [9], the source node broadcasts RREQ packets similar to DSR. The RREQ packet contains the source identifier (SId), the destination identifier (DId), the source sequence number (SSeq), the destination sequence number (DSeq), the broadcast identifier (BId) and TTL fields.

- **Route Maintenance**

The route maintenance mechanism works as follows – Whenever a node detects a link break by link layer acknowledgements or HELLO beacons [5], the source and end nodes are notified by propagating an RERR packet similar to DSR.

IV. Results

The implementation is done using the NS2 tool. The comparison of ZRP protocol is done with the existing AODV and OLSR protocol. The comparison is done by varying the number of nodes and keeping the transmission of data same and data transmission is low. It means the comparison is done on various scenarios with low data transmission. Various parameters used for analysis are described below:

- **Packet Delivery Ratio (PDR)**

The ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

$\sum$ Number of packet receive / $\sum$ Number of packet send

- **End-to-end Delay**

The average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.

$\sum$ (arrive time – send time) / $\sum$ Number of connections.

- **Throughput**

The throughput of a receiver (per-receiver throughput) is defined as the ratio of the number of bits received over the time difference between the first and the last received packets.

The Table 1 to table 3 shows the result of various parameters on various protocols i.e. AODV, OLSR & ZRP.

Table 1: Performance Analysis of AODV

Number of nodes	PDR	END TO END DELAY	THROUGHPUT
10	98.47	3.558	41.89
20	97.24	3.010	181.45
30	95.46	2.983	549.97
40	93.31	2.743	1237.46
50	85.92	2.490	2222.75

Table 2: Performance Analysis of OLSR

Number of nodes	PDR	END TO END DELAY	THROUGHPUT
10	98.1013	5.80706	42.64
20	90.42	16.000	73.01
30	89.88	11.836	73.58
40	84.04	11.837	74.81
50	80.80	11.854	82.20

Table 3: Performance Analysis of ZRP

Number of nodes	PDR	END TO END DELAY	THROUGHPUT
10	56.21	5.824	51.95
20	24.72	19.916	308.36
30	15.04	52.815	1186.55
40	11.36	147.37	2723.46
50	8.547	704.013	3172.65

The above results can be analyzed graphically as shown:

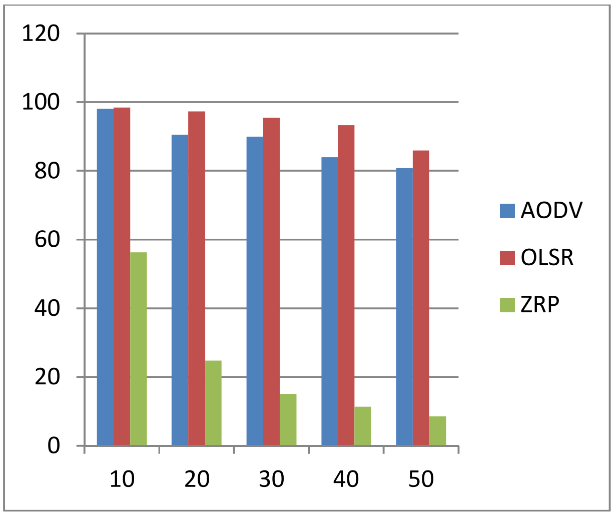

Figure 4: PDR Comparison

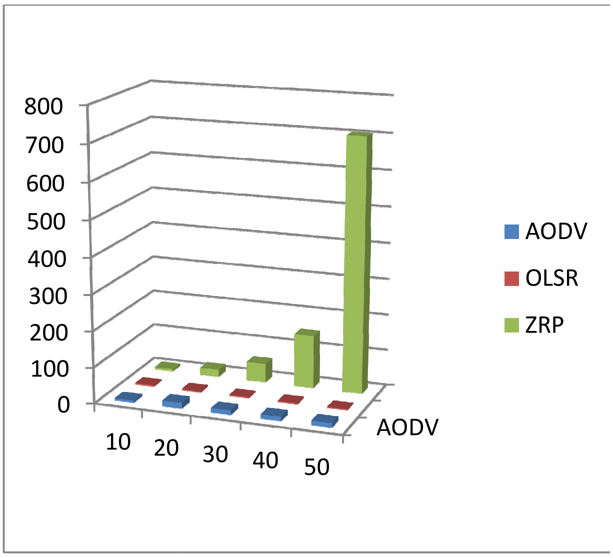

Figure 5: Comparison of End to end delay

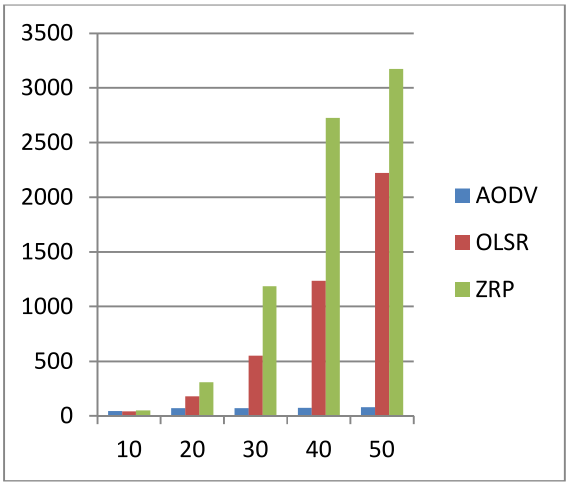

Figure 6: Comparison of Throughput

The tables as well as the graphical analysis shows that the PDR of the OLSR protocol is better than the all other protocols. The PDR for ZRP protocol decrease with the increase in number of nodes; this shows that in the ZRP protocol doesn't perform well with larger nodes with lower transmission.
The OLSR protocol shows minor improvement of PDR as compared to AODV protocol. The end-to-end delay decreases in each protocol as number of nodes increases except ZRP protocol. The OLSR protocol shows better (lesser) end-to-end delay as compared to other protocol. The throughput is increased in each protocol with increase in number of nodes. The difference between the throughputs gets increased between the ZRP and other with increase in number of nodes is large.

V. Conclusion

The simulation results show that the PDR of the OLSR protocol is better than the all other protocols. The PDR for ZRP protocol decrease with the increase in number of nodes; this shows that in the ZRP protocol doesn't perform well with larger nodes with lower transmission. The OLSR protocol shows minor improvement of PDR as compared to AODV protocol. The end-to-end delay decreases in each protocol as number of nodes increases except ZRP protocol. The OLSR protocol shows better (lesser) end-to-end delay as compared to other protocol. The throughput is increased in each protocol with increase in number of nodes. The difference between the throughputs gets increased between the ZRP and other with increase in number of nodes is large**.**

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