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Effect Of Delay And Jitter On Wireless Ad-Hoc Networks (IEEE 802.11) With Various Routing Protocols

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Abstract

Wireless Ad-hoc networks have a dynamic nature that leads to constant changes in their topology. Therefore, there is need for robust dynamic routing protocol which can face the challenges of frequently changes topology. And to select a particular routing protocols for given Ad-hoc network situation, its performance characteristics be known in advance. This article presents effect of throughput in wireless Ad-hoc network on different routing protocols. Network simulator QualNet 5.0.2 has been used to evaluate the performance of wireless networks with various routing protocols.

Key words: Delay, Jitter, AODV, DSR, DYMO, ZRP.

I. INTRODUCTION

A wireless Ad hoc network is a collection of wireless nodes which are able to communicate with each other without relying on predefined infrastructures. There is no static infrastructure such as base stations. Each node in the network also acts as a router, forwarding data packets to other nodes [1].

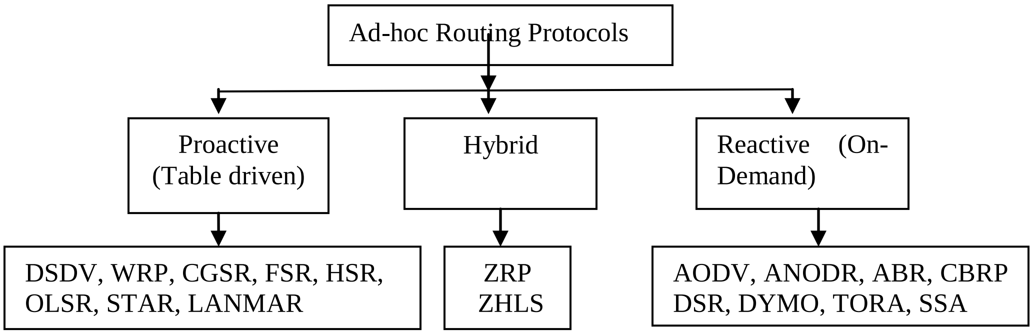
The popularity of WLANs is growing due to improvement in transmission speed, flexibility and low cost infrastructure. The convenience of wireless networking has led IEEE 802.11 to emerge from the individual home to large-scale deployments in environments covering medium to large enterprises, apartment complexes and housing Developments, and public area hot-spots [2]. Routing protocols for wireless networks have to face the challenge of frequently changing topology, low transmission power and asymmetric links. There are more routing protocols used in wireless Ad-hoc for improving Quality of Service (QoS). This paper presented some routing protocols to improving the performance of Wireless Ad-hoc network i.e. as Anonymous On-Demand Routing protocols (ANODR), Ad hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR), Dynamic MANET On-Demand (DYMO), Landmark Routing protocols (LANMAR), Inter-zone Routing Protocol (IERP) and Zone Routing Protocol (ZRP).

In section II, overview of IEEE 802.11 has discussed. Overview of routing protocols used in wireless Ad-hoc has given in section III. Simulation setup of Ad-hoc networks with various routing protocols is provided in section IV. Results are discussed in section V. Last conclusion of wireless Ad-hoc networks is discussed in section VI.

II. OVERVIEW OF IEEE 802.11

IEEE 802.11 standard was first introduced in 1997. It was envisioned for home and office environments for wireless local area connectivity and supports three types of transmission technologies namely i) Infrared Radiation(IR), ii) Frequency Hopping Spread Spectrum (FHSS), iii) Direct Sequence Spread Spectrum (DSSS). In 1999 two other transmission technologies were included as i) Orthogonal Frequency Division Multiplexing (OFDM) and ii) High Rate-Direct Sequence Spread Spectrum (HR-DSSS). IEEE 802.11 has two different access methods, the mandatory Distributed Coordinator Function (DCF) and the optional Point Coordinator Function (PCF).

Wireless LAN has introduced two operating modes as a) Infrastructure and b) Ad-hoc mode on basis of PCF and DCF sub layers of MAC layer as given Fig.1. The infrastructure operating mode is a network with an Access Point (AP), in which all Stations (STAs) must be associated with an AP to access the network. STAs communicate with each other through the AP.

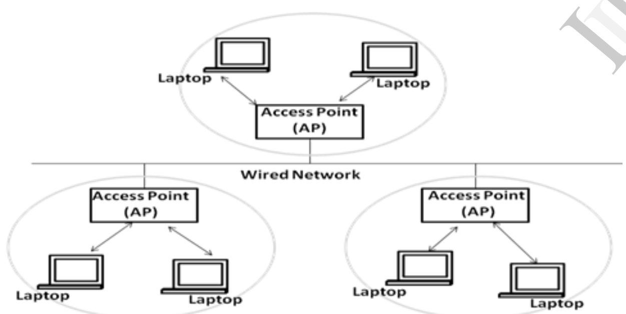


DSDV: Destination-Sequenced Distance-Vector Routing
WRP: Wireless Routing Protocol
CGSR: Clusterhead Gateway Switch Routing
HSR: Hybrid source routing protocol
FSR: Fisheye State Routing
OLSR: Optimized Link State Routing Protocol
STAR: Source-Tree Adaptive Routing
LANMAR: Landmark Ad-hoc Routing Protocol
TORA: Temporally-Ordered Routing Algorithm

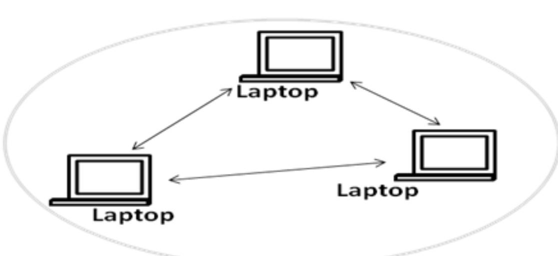
ZRP: Zone Routing Protocol
ZHLS: Zone-based Hierarchical Link State
AODV: Ad hoc On-Demand Distance Vector
ANODR: anonymous on-demand routing
ABR: Associativity-Based Routing
CBRP: Cluster Based Routing Protocol
DSR: Dynamic source routing protocol
DYMO: Dynamic MANET On-demand
SSA: Signal Stability based Adaptive

Fig.2 Classification of Ad-hoc Routing Protocols

The second operating mode, the independent mode or the ad hoc mode, is used if there are no APs in the network. In this mode, STAs form an ad-hoc network directly with each other [14].



(a) Infrastructure mode



(b) Adhoc mode

Fig.1: IEEE 802.11 modes

III. OVER VIEW OF ROUTING PROTOCOLS

Ad-hoc routing protocols can be divided into three categories, Proactive (Table driven) routing protocol, Reactive (On demand) routing protocol and Hybrid routing protocol as given in Fig. 2 [6]. Routing protocols are work as transported across an internetwork. In general, routed protocols in this context also are referred to as network protocols.

a) Proactive (table driven) routing protocols

Proactive routing protocols maintain information continuously. Typically, a node has a table containing information on how to reach every other node and the algorithm tries to keep this table up-to-date. Proactive protocols use excess bandwidth by attempt to maintain the routes information to all other nodes and by propagating any changes in the network topology throughout the entire network.

b) Reactive (on demand) routing protocols

Reactive routing involves long route request delays. Reactive routing also inefficiently floods the entire network for route determination. In this routing protocol, information is acquired on-demand. This is the route discovery operation. Route maintenance is the process of responding to change in topology that happen after a route has initially been created.

c) Hybrid routing

Hybrid routing protocol combines the best features of the above two protocols. Nodes within certain distance, from the node concerned, or within a particular geographical region, are said to be within the routing zone of the given nodes. For routing within this zone, a table-driven approach is used. For nodes that are located beyond this zone, an on-demand approach is used. There are many routing protocols used for Ad-hoc network.

a) Anonymous On-Demand Routing protocols (ANODR)

Liu Yang et al (2006) proposed an approach- discount ANODR for anonymous on demand routing in mobile ad hoc networks [7]. ANODR is identity free, i.e. it does not use the nodes' identities but it exploits a route pseudonymity approach to address the route untraceability problem. The source node initiates a Route Request (RREQ) packet containing an anonymous global trapdoor and an onion. When a node receives the RREQ message it tries to open the trapdoor using its private key to check if it is the intended destination. Otherwise it generates a public/private key pair and replaces it's one time public key in the appropriate field in RREQ message and broadcasts the packet to its neighbors. The next node performs the same modification and records the one time public key of the previous node to use it in Route Error (RERR) phase. Each intermediate node will add its self-aware layer to the onion. ANODR is a reactive protocol [8]. ANODR prevents strong adversary from packet flow back to its source or destination.

b) Ad-hoc On Demand Distance Vector (AODV)

A. Rathinam et al (2008) [9] improved version of the AODV algorithm with route repair scheme, where if any link failure takes place the nodes in the active communication path between the source and the destination acts as virtual source and continues the search process to re-establish the communication. The AODV routing protocol is a dynamic, self starting protocol used in Mobile Ad-hoc Networks (MANET) which is basically a collection of mobile nodes that can communicate with each other. This routing protocol functions without any need for fixed infrastructure or base station. AODV routes are only established when it needed to reduce traffic overhead with small delay. That means, AODV supports Uncast, Broadcast and Multicast (UBM) without any further protocols. AODV is belongs to the class of Distance Vector Routing Protocols (DV). It is also expanded by routing flags, the interface, and a list of precursors and for outdated routes the last hop count is stored.

c) Dynamic Source Routing protocol (DSR)

The dynamic source routing protocol is an on demand routing protocol. And it is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The DSR protocol is composed of two main mechanisms that work together to allow the discovery and maintenance of source route in the ad hoc network.

d) Dynamic MANET On demand (DYMO)

The Dynamic MANET On demand (DYMO) is a reactive or on demand, multihop, unicast routing protocol that not update route information periodically [10]. The basic operation of DYMO protocols to generates RREQ messages and floods them for Destination routers for whom it doesn't have route information. Intermediate nodes store a route to the originating router by adding it into its routing table during this dissemination Process. A RERR message is generated when a node receives a data packet for the destination for which route is not known or the route is broken. The source node reinitiate route discovery quickly as it receives this RERR. Hello messages are used by all nodes to maintain routes to its neighbor nodes. The sequence numbers are used by nodes to determine the order of route discovery messages and so avoid propagating stale route information.

e) Landmark ad-hoc routing (LANMAR)

LANMAR is an efficient routing protocol in a "flat" Ad-hoc network which combines the feature of Fisheye State Routing (FSR) and Landmark routing protocols. This protocol combines properties of link state and distance vector algorithm and builds subnets of groups of nodes which are likely to move together [11]. LANMAR helps to resolve both scalability and mobility problems in Ad-hoc networks while reducing bandwidth and storage overhead. Each node in wireless networks are maintains routing information only about nodes which lies within its scope and the landmark nodes. It is significantly reduces routing large ad-hoc networks. The landmark table maintains direct landmarks from all the subnets,

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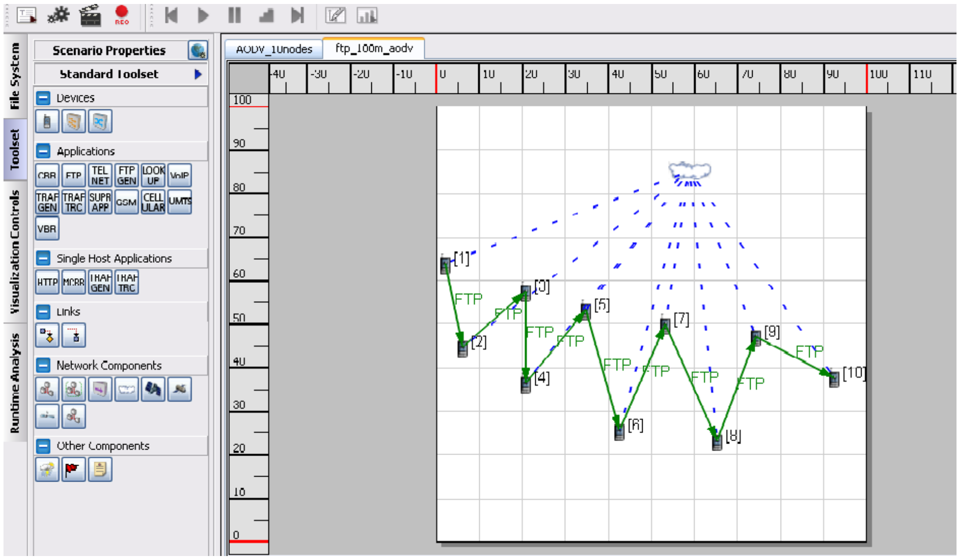

Fig. 4 Placement of number of nodes in Wireless Ad-hoc routing protocols.

respectively. table size and routing update overhead and thus scalable to routes to near-by destinations and routes to all the If destination is not present in node's scope, the logical subnet field of the destination is searched and packet is forwarded towards the landmark of destination's logical subnet.

f) Inter-zone Routing Protocol (IERP)

The Inter-zone Routing Protocol (IERP) is responsible for reactively discovering routes to the destination beyond a node's routing zone [12]. An IERP protocol is used where the destination is not found within the routing zone. The route request packets are transmitted to all border nodes, which in turn forward the request if the destination node is not found within their routing zone. IERP distinguish The 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 each node may be within multiple overlapping zones, and each zone may be of a different size. The "size" of a zone is not determined by geographical measurement, but is given by a radius of length, where is the number of hops to the perimeter of the zone. Each component works independently of the other and they may use different technologies in order to maximize efficiency in their particular area.

itself from standard flood search by implementing the concept, called border-casting. The border casting packet delivery service is provided by the Border-cast Resolution Protocol (BRP) [13]. The IERP takes the advantage of the local routing information provided by the IARP. When there is request for a route beyond the local zone, global route discovery is required**.**

g) Zone Routing Protocol (ZRP)

Zone Routing Protocol (ZRP) combines the advantages of both reactive and pro-active protocols 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 [14].

IV. SIMULATION SETUP

In Qualnet setup an Ad-hoc network scenario has been created with following details.

- Area of network- 100m×100m
- No. of nodes – 5, 10, 15, 20
- Network- 802.11b
- Application- FTP with CBR

Other remaining parameters are used for setting up scenario of Ad-hoc network to be simulated as given in Table1.

Table 1 Simulation Parameters

Method	Value
Channel type	Wireless
Radio Propagation model	Two ray
Network interface type	Wireless phy
Antenna	Omni direction
Number of mobile node	5, 10, 15, 20
Data rate	2 Mbps
Simulation time	1800 s
Routing protocol	ANODR, AODV, DSR, DYMO, IERP, LANMAR, ZRP
Noise factor	10 dB
Network protocol	IPv4
Item size	512 bytes

V. RESULT

The above simulation scenario was worked with different number of nodes (5, 10, 15, and 20) and result has been obtained for jitter and delay variation on different routing protocols (Table 2 and 3).

Average Jitter: It has been observed that jitter variation in Wireless Ad-hoc networks is decreased from 5-10, 10-15, and 15-20 nodes respectively 61.7449.6%, 32.49% and 25.35% in case of IERP protocols as Table 2. Average jitter have increased from 5 to 10 nodes is 77.5% in case of ZRP routing protocols and DSR show the low jitter as 92.4%. Jitter has increased 36.9% (low) for 5 to 10 nodes in case of ANODR routing protocols.

Table 2 Average jitter variation in wireless Ad-hoc network with different routing protocols

	5 nodes	10 nodes	15 nodes	20 nodes
IERP	0.19025	0.284641	0.376921	0.472488
ZRP	0.05876	0.104256	0.189036	0.254323
LANMAR	0.05849	0.098463	0.174809	0.259986
AODV	0.03606	0.050602	0.077941	0.119515
DYMO	0.02917	0.048151	0.089624	0.137209
ANODR	0.02897	0.038517	0.059445	0.087375
DSR	0.02479	0.047558	0.080532	0.120797

And in case of DSR routing protocols, jitter is increased 92.7% (high). Jitter has increased by 32.9% (low) for 10 to15 nodes in case of IERP protocols. In case of DYMO routing protocols, jitter is increased 86.13% (high) for 10 to 15 nodes in given scenario. In case of IERP routing protocols, average jitter is increased 25.35% for 15 to 20 nodes. In case of DYMO routing protocols, jitter has increased by 53% (high) for above scenarios.

In case of IERP routing protocols, average jitter has been observed high for 5 to 20 nodes in wireless Ad-hoc networks as given in Table 2. Using data from table 2, average jitter have plotted against different no. of nodes in Fig. 5.

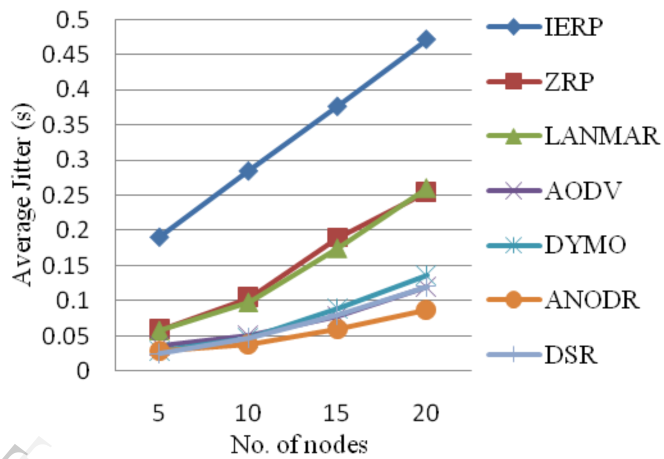

Fig. 5 Variation in average jitter (s) for Ad-hoc network with FTP application

It has been observed in Figure 5 that jitter varies from 0.024719 to 0.120797 in case DSR routing protocols. In case of ANODR routing protocols, jitter is increased from 0.028917 to 0.087375 for 5 to 20 nodes. In case of DYMO routing protocols, jitter is increased from 0.029197 to 0.137209. In case of AODV routing protocols, jitter is increased from 0.036026 to 0.119515 for 5 to 20 nodes. In case of LANMAR routing protocols, jitter is increased from 0.05849 to 0.259986 for 5 to 20 nodes. In case of ZRP routing protocols, jitter is increased from 0.058736 to 0.254323 for 5 to 20 nodes. In case of IERP routing protocols, jitter is increased from 0.190235 to 0.472488 for 5 to 20 nodes.

Average end to end delay: Average End to End Delay [16] can be defined as a measure of average time taken to transmit each packet of data from Source node to Destination node.

It has been observed that the average end-to-end delay is increased from 5-10, 10-15, and 15-20 nodes in case of various routing protocols. In case of ZRP, average end-to-end delay is more than others for 5 to 10 nodes as 59.66% and in case of DSR; it is less than others as 22.43%. In case of IERP, average end-to-end delay is more (84.43%) others for 10 to 15 nodes.

Table 3 Average End to End Delay (s) variation in different routing protocols

	5 Nodes	10 Nodes	15 Nodes	20 Nodes
IERP	0.4868	0.7056	1.3014	2.20783
LANMAR	0.2409	0.3624	0.5533	0.85775
ZRP	0.2354	0.3761	0.6273	0.91205
AODV	0.1599	0.2191	0.3528	0.52165
ANODR	0.1484	0.2263	0.29967	0.4273
DYMO	0.1448	0.1765	0.25316	0.3666
DSR	0.1408	0.1794	0.2668	0.4283

And in case of DYMO, it is less (43.4%) than others routing protocols. In case of IERP routing protocols, average end-to-end delay is more (69.65%) than remaining routing protocols. And in case of DYMO, it is less (44.81%) than remaining routing protocols.

In case of IERP routing protocols, average end-to-end delay has been observed high for 5 to 20 nodes in wireless Ad-hoc networks as given in Table 3. Using data from table 3, average end-to-end delay have plotted against different no. of nodes in Fig. 6.

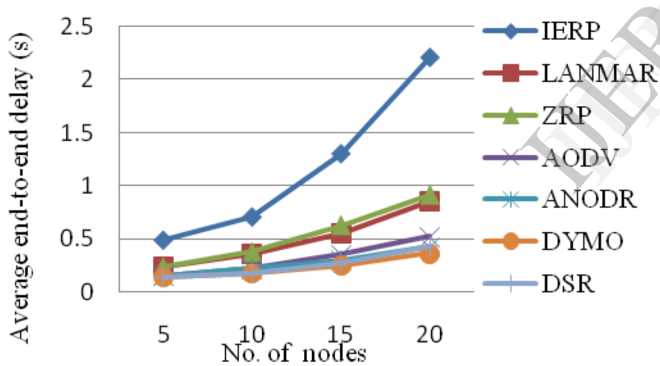

Fig.6 Variation in average end-to-end delay for Wireless Ad-hoc with FTP application

It has been also observed in figure 6 that QoS parameter end-to-end delay (s) varies from 0.140841 to 0.4283 in case DSR routing protocols. In case of DYMO routing protocols, end-to-end delay (s) is increased from 0.144198 to 0.3666 for 5 to 20 nodes. In case of ANODR routing protocols, end-to-end delay (s) is increased from 0.148451 to 0.427373. In case of AODV routing protocols, end-to-end delay (s) is increased from 0.152949 to 0.521625 for 5 to 20 nodes. In case of ZRP routing protocols, end-to-end delay (s) is increased from 0.235574 to 0.912053 for 5 to 20 nodes. In case of LANMAR routing protocols, end-to-end delay (s) is increased from 0.240059 to 0.857752 for 5 to 20 nodes. In case of IERP routing protocols, end-to-end delay (s) is increased from 0.486758 to 2.207832 for 5 to 20 nodes.

VI. CONCLUSION

In this paper authors, study and compare throughput of wireless Ad-hoc network with different routing protocols i.e. ANODR, AODV, DSR, DYMO, IERP, LANMAR AND ZRP. Average Jitter and end-to-end delay of Wireless Ad-hoc is more in case of IERP routing protocols with compare to other protocols. But DSR protocols provided the less jitter and delay for Ad-hoc networks with variation of no. of nodes from 5 to 20.

Jitter and end-to-end delay of above scenario is better given by using DSR routing protocols with respect to others studied routing protocols. It means DSR gives the better QoS for given wireless Ad-hoc network for FTP application. Authors' future plan is to providing better security for Wireless network in different layers by using different routing protocols.

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