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# Performance Analysis of Routing Protocols in Mobile Ad-Hoc Networks

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**Abstract:-** In recent years mobile ad hoc networks have become very popular and lots of research is being done on different aspects of MANET. Mobile Ad Hoc Networks (MANET)-a system of mobile nodes (laptops, sensors, etc.) interfacing without the assistance of centralized infrastructure (access points, bridges, etc.). There are different aspects which are taken for research like routing, synchronization, power consumption, bandwidth considerations etc. This paper concentrates on routing techniques which is the most challenging issue due to the dynamic topology of ad hoc networks. There are different strategies proposed for efficient routing which claimed to provide improved performance. There are different routing protocols proposed for MANETs which makes it quite difficult to determine which protocol is suitable for different network conditions .This paper provides an overview of different routing protocols proposed in literature and also provides a comparison between them.

**Keywords:-** MANETs, Routing Protocol, Performance, Dynamic Topology, Synchronization

## I. INTRODUCTION

Wireless networks provide connection flexibility between users in different places. Moreover, the network can be extended to any place or building without the need for a wired connection. Wireless networks are classified into two categories; Infrastructure networks and Ad Hoc networks [2] as shown in Figure 1.

**Infrastructure networks**

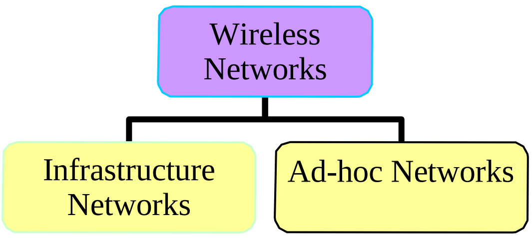



**Figure1: Wireless Networks Categories**

An Access Point (AP) represents a central coordinator for all nodes. Any node can be joining the network through AP. In addition, AP organizes the connection between the Basic Set Services (BSSs) so that the route is ready when it is needed. However, one drawback of using an infrastructure network is the large overhead of maintaining the routing tables. Infrastructure network as shown in Figure 2

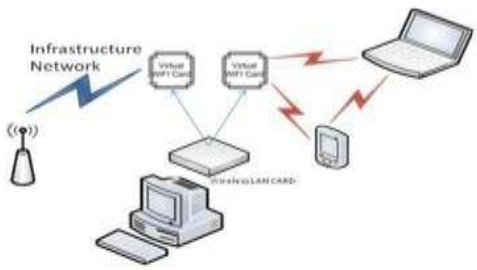



**Figure 2: Infrastructure Network.**

**Ad Hoc networks**

A wireless ad hoc network is a decentralized type of wireless network. The network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks [1]. Ad Hoc networks do not have a certain topology or a central coordination point. Therefore, sending and receiving packets are more complicated than infrastructure networks. Figure 3 illustrates an Ad Hoc network.


**Figure 3: Ad Hoc network**.

Nowadays, with the immense growth in wireless network applications like handheld computers, PDAs and cell phones, researchers are encouraged to improve the network services and performance. One of the challenging design issues in wireless Ad Hoc networks is supporting mobility in Mobile Ad Hoc Networks (MANETs). The mobility of nodes in MANETs increases the complexity of the routing protocols and the degree of connection‟s flexibility. However, the flexibility of allowing nodes to join, leave, and transfer data to the network pose security challenges [3].

A MANET is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. MANET has dynamic topology and each mobile node has limited resources such as battery, processing power and on-board memory[3] This kind of infrastructure-less network is very useful in situation in which ordinary wired networks is not feasible like battlefields, natural disasters etc. The nodes which are in the transmission range of each other communicate directly otherwise communication is done through intermediate nodes which are willing to forward packet hence these networks are also called as multi-hop networks. MANET[2] as shown in Figure 4

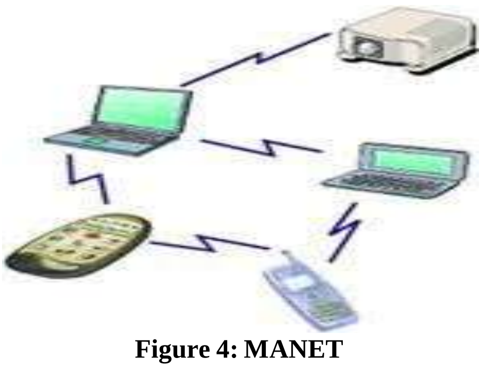


**Figure 4: MANET**

## II. CHARACTERISTICS OF MANET

Mobile ad hoc network nodes are furnished with wireless transmitters and receivers using antennas, which may be highly directional (point-to-point), omnidirectional (broad-cast), probably steerable, or some combination. At a given point in time, depending on positions of nodes, their transmitter and receiver coverage patterns, communication power levels and co- channel interference levels, a wireless connectivity in the form of a random, multihop graph or "ad hoc" network exists among the nodes. This ad hoc topology may modify with time as the nodes move or adjust their transmission and reception parameters[6]. The characteristics of these networks are summarized as follows:

- Communication via wireless means.
- Nodes can perform the roles of both hosts and routers.
- Bandwidth-constrained, variable capacity links.
- Energy-constrained Operation.
- Limited Physical Security.
- Dynamic network topology.
- Frequent routing updates.

## III. CLASSIFICATION OF ROUTING PROTOCOLS

Routing protocols define a set of rules which governs the journey of message packets from source to destination in a network. In MANET, there are different types of routing protocols each of them is applied according to the network circumstances. Figure 1 shows the basic classification of the routing protocols in MANETs[1].

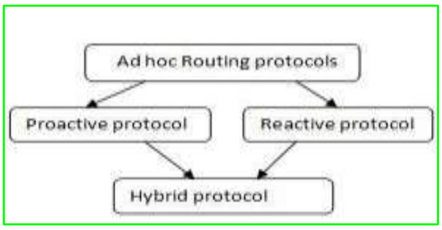
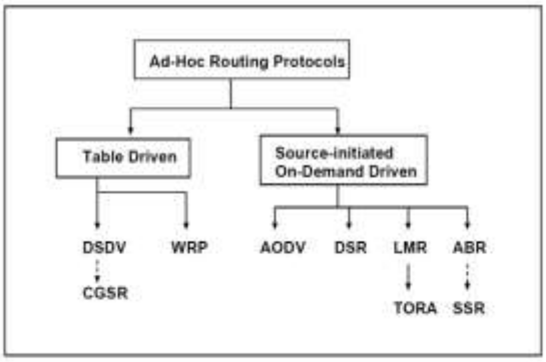



**Fig. 1 Classification of Routing protocols the Family Tree**




### 3.1).Proactive Routing Protocols

Proactive routing protocols are also called as table driven routing protocols. In this every node maintain routing table which contains information about the network topology even without requiring it[2]. This feature although useful for datagram traffic, incurs substantial signalling traffic and power consumption [12]. The routing tables are updated periodically whenever the network topology changes. Proactive protocols are not suitable for large networks as they need to maintain node entries for each and every node in the routing table of every node [13]. These protocols maintain different number of routing tables varying from protocol to protocol. There are various well known proactive routing protocols. Example: DSDV, OLSR, WRP etc.

***i) Dynamic Destination-Sequenced Distance-Vector Routing Protocol (DSDV)***

DSDV[14] is developed on the basis of Bellman–Ford routing[15]algorithm with some modifications. In this routing protocol, each mobile node in the network keeps a routing table. Each of the routing table contains the list of all available destinations and the number of hops to each. Each table entry is tagged with a sequence number, which is originated by the destination node. Periodic transmissions of updates of the routing tables help maintaining the topology information of the network. If there is any new significant change for the routing information, the updates are transmitted immediately. So, the routing information updates might either be periodic or event driven. DSDV protocol requires each mobile node in the network to advertise its own routing table to its current neighbors. The advertisement is done either by broadcasting or by multicasting. By the advertisements, the neighboring nodes can know about any change that has occurred in the network due to the movements of nodes. The routing updates could be sent in two ways: one is called a „„„full dump‟‟‟ and another is „„„incremental.‟‟‟ In case of full dump, the entire routing table is sent to the neighbors, where as in case of incremental update, only the entries that require changes are sent[6].

***ii) Wireless Routing Protocol (WRP)***

WRP [15] belongs to the general class of path-finding algorithms [14,16,17], defined as the set of distributed shortest path algorithms that calculate the paths using information regarding the length and second-to-last hop of the shortest path to each destination. WRP reduces the number of cases in which a temporary routing loop can occur. For the purpose of routing, each node maintains four things: 1. A distance table 2. A routing table 3.A link-cost table 4. A message retransmission list (MRL). WRP uses periodic update message transmissions to the neighbors of a node. The nodes in the response list of update message (which is formed using MRL) should send acknowledgments. If there is no change from the last update, the nodes in the response list should send an idle Hello message to ensure connectivity. A node can decide whether to update its routing table after receiving an update message from a neighbor and always it looks for a better path using the new information. If a node gets a better path, it relays back that information to the original nodes so that they can update their tables. After receiving the acknowledgment, the original node updates its MRL. Thus, each time the consistency of the routing information is checked by each node in this protocol, which helps to eliminate routing loops and always tries to find out the best solution for routing in the network[6].

***iii)Cluster Gateway Switch Routing Protocol (CGSR)***

CGSR [18] considers a clustered mobile wireless network instead of a „„flat"" network. For structuring the network into separate but interrelated groups, cluster heads are elected using a cluster head selection algorithm. By forming several clusters, this protocol achieves a distributed processing mechanism in the network. However, one drawback of this protocol is that, frequent change or selection of cluster heads might be resource hungry and it might affect the routing performance. CGSR uses DSDV protocol as the underlying routing scheme and, hence, it has the same overhead as DSDV. However, it modifies DSDV by using a hierarchical cluster-head-to-gateway routing approach to route traffic from source to destination. Gateway nodes are nodes that are within the communication ranges of two or more cluster heads. A packet sent by a node is first sent to its cluster head, and then the packet is sent from the cluster head to a gateway to another cluster head, and so on until the cluster head of the destination node is reached. The packet is then transmitted to the destination from its own cluster head[6].

| Parameters | DSDV | CGSR | WRP |
|---|---|---|---|
| Time Complexity (link addition / failure) | O(d) | O(d) | O(h) |
| Communication Complexity (link addition / failure) | O(x=N) | O(x=N) | O(x=N) |
| Routing Philosophy | Flat | Hierarchical | Flat[1] |
| Loop Free | Yes | Yes | Yes, but not instantaneous |
| Multicast Capability | No | No[2] | No |
| Number of Required Tables | Two | Two | Four |
| Frequency of Update Transmissions | Periodically & as needed | Periodically | Periodically & as needed |
| Updates Transmitted to | Neighbors | Neighbors & cluster head | Neighbors |
| Utilizes Sequence Numbers | Yes | Yes | Yes |
| Utilizes "Hello" Messages | Yes | No | Yes |
| Critical Nodes | No | Yes (cluster head) | No |
| Routing Metric | Shortest Path | Shortest Path | Shortest Path |

Table 1: Comparisons of the Characteristics of Table-Driven Routing Protocols.

**Abbreviations:**

$N = Number\ of\ nodes\ in\ the\ network$
$d = Network\ diameter$
$h = Height\ of\ routing\ tree$
$x = Number\ of\ nodes\ affected\ by\ a\ topological\ change$

***3.2). Reactive Routing Protocols***

Reactive routing protocol is also known as on demand routing protocol. In this protocol route is discovered whenever it is needed Nodes initiate route discovery on demand basis. Source node sees its route cache for the available route from source to destination if the route is not available then it initiates route discovery process. The on- demand routing protocols have two major components [7]:

***Route discovery***: In this phase source node initiates route discovery on demand basis. Source nodes consults its route cache for the available route from source to destination otherwise if the route is not present it initiates route discovery. The source node, in the packet, includes the destination address of the node as well address of the intermediate nodes to the destination.

***Route maintenance***: Due to dynamic topology of the network cases of the route failure between the nodes arises due to link breakage etc, so route maintenance is done. Reactive protocols have acknowledgement mechanism due to which route maintenance is possible

Reactive protocols add latency to the network due to the route discovery mechanism. Each intermediate node involved in the route discovery process adds latency. These protocols decrease the routing overhead but at the cost of increased latency in the network. Hence these protocols are suitable in the situations where low routing overhead is required. There are various well known reactive routing protocols present in MANET for example DSR, AODV, TORA and LMR [1].

***i) Dynamic Source Routing (DSR)***

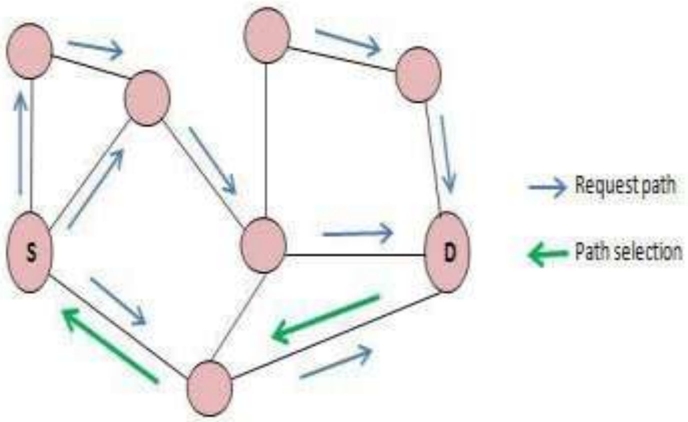



**Fig:2**

Dynamic Source Routing (DSR) is a reactive protocol based on the source route approach [9]. In *Dynamic Source Routing (DSR)*, shown in Figure.2, the protocol is based on the link state algorithm in which source initiates route discovery on demand basis. The sender determines the route from source to destination and it includes the address of intermediate nodes to the route record in the packet. DSR was designed for multi hop networks for small Diameters. It is a beaconless protocol in which no HELLO messages are exchanged between nodes to notify them of their neighbours in the network[2].

**ii)** ***Ad Hoc On-Demand Distance Vector Routing (AODV)***

AODV [10] is basically an improvement of DSDV. But, AODV is a reactive routing protocol instead of proactive. It minimizes the number of broadcasts by creating routes based on demand, which is not the case for DSDV. When any source node wants to send a packet to a destination, it broadcasts a route request (RREQ) packet. The neighboring nodes in turn broadcast the packet to their neighbors and the process continues until the packet reaches the destination. During the process of forwarding the route request, intermediate nodes record the address of the neighbor from which the first copy of the broadcast packet is received. This record is stored in their route tables, which helps for establishing a reverse path. If additional copies of the same RREQ are later received, these packets are discarded. The reply is sent using the reverse path. For route maintenance, when a source node moves, it can reinitiate a route discovery process. If any intermediate node moves within a particular route, the neighbor of the drifted node can detect the link failure and sends a link failure notification to its upstream neighbor. This process continues until the failure notification reaches the source node. Based on the received information, the source might decide to re-initiate the route discovery phase[6].

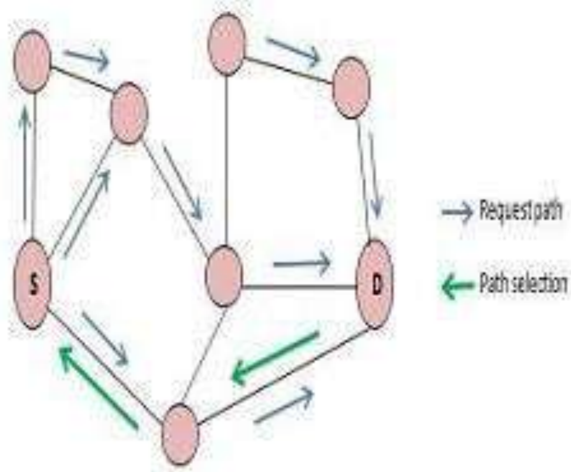



**Fig:3**

***iii) Associativity-Based Routing (ABR)***

ABR [11] protocol defines a new type of routing metric "degree of association stability" for mobile ad hoc networks. In this routing protocol, a route is selected based on the degree of association stability of mobile nodes. Each node periodically generates beacon to announce its existence. Upon receiving the beacon message, a neighbor node updates its own associativity table. For each beacon received, the associativity tick of the receiving node with the beaconing node is increased. A high value of associativity tick for any particular beaconing node means that the node is relatively static. Associativity tick is reset when any neighboring node moves out of the neighborhood of any other node[6].

***iv) Signal Stability–Based Adaptive Routing Protocol (SSA)***

SSA [19] protocol focuses on obtaining the most stable routes through an ad hoc network. The protocol performs on demand route discovery based on signal strength and location stability. Based on the signal strength, SSA detects weak and strong channels in the network. SSA can be divided into two cooperative protocols: the Dynamic Routing Protocol (DRP) and the Static Routing Protocol (SRP). DRP uses two tables: Signal Stability Table (SST) and Routing Table (RT). SST stores the signal strengths of the neighboring nodes obtained by periodic beacons from the link layer of each neighboring node. These signal strengths are recorded as weak or strong. DRP receives all the transmissions and, after processing, it passes those to the SRP. SRP passes the packet to the node"s upper layer stack if it is the destination. Otherwise, it looks for the destination in routing table and forwards the packet. If there is no entry in the routing table for that destination, it initiates the route- finding process. Route-request packets are forwarded to the neighbors using the strong channels. The destination, after getting the request, chooses the first arriving request packet and sends back the reply. The DRP reverses the selected route and sends a route-reply message back to the initiator of route request. The DRPs of the nodes along the path update their routing tables accordingly. In case of a link failure, the intermediate nodes send an error message to the source indicating which channel has failed. The source in turn sends an erase message to inform all nodes about the broken link and initiates a new route-search process to find a new path to the destination[6].

***v) Temporarily Ordered Routing Algorithm (TORA)***

TORA [20] is a reactive routing protocol with some proactive enhancements where a link between nodes is established creating a Directed Acyclic Graph (DAG) of the route from the source node to the destination. This protocol uses a „„link reversal"" model in route discovery. A route discovery query is broadcasted and propagated throughout the network until it reaches the destination or a node that has information about how to reach the destination. TORA defines a parameter, termed height. Height is a measure of the distance of the responding node"s distance upto the required destination node. In the route discovery phase, this parameter is returned to the querying node.

| Performance Parameters | AODV | DSR | TORA | ABR | SSR |
|---|---|---|---|---|---|
| Time Complexity (initialization) | O(2d) | O(2d) | O(2d) | O(d+z) | O(d+z) |
| Time Complexity (postfailure) | O(2d) | O(2d) or 0 (cache hit) | O(2d) | O(l+z) | O(l+z) |
| Communication Complexity (initialization) | O(2N) | O(2N) | O(2N) | O(N+y) | O(N+y) |
| Communication Complexity (postfailure) | O(2N) | O(2N) | O(2x) | O(x+y) | O(x+y) |
| Routing Philosophy | Flat | Flat | Flat | Flat | Flat |
| Loop Free | Yes | Yes | Yes | Yes | Yes |
| Multicast Capability | Yes | No | No[3] | No | No |
| Beaconing Requirements | No | No | No | Yes | Yes |
| Multiple Route Possibilities | No | Yes | Yes | No | No |
| Routes Maintained in | route table | route cache | route table | route table | route table |
| Utilizes Route Cache/Table Expiration Timers | Yes | No | No | No | No |
| Route Reconfiguration Methodology | Erase Route; Notify Source | Erase Route; Notify Source | Link Reversal; Route Repair | Localized Broadcast Query | Erase Route; Notify Source |
| Routing Metric | Freshest & Shortest Path | Shortest Path | Shortest Path | Associativity & Shortest Path & others[4] | Associativity & Stability |

Table 2: Comparisons of the Characteristics of Source-Initiated On-Demand Ad-Hoc Routing Protocols.

**Abbreviations:**

$l$ = *Diameter of the affected network segment*
$y$ = *Total number of nodes forming the directed path where the REPLY packet transits*
$z$ = *Diameter of the directed path where the REPLY packet transits*

As the query response propagates back, each intermediate node updates its TORA table with the route and height to the destination node. The source node then uses the height to select the best route toward the destination. This protocol has an interesting property that it frequently chooses the most convenient route, rather than the shortest route. For all these attempts, TORA tries to minimize the routing management traffic overhead[6].

### *3.3) Hybrid Routing Protocol*

There is a trade-off between proactive and reactive protocols. Proactive protocols have large overhead and less latency while reactive protocols have less overhead and more latency. So a Hybrid protocol is presented to overcome the shortcomings of both proactive and reactive routing protocols. Hybrid routing protocol is combination of both proactive and reactive routing protocol. It uses the route discovery mechanism of reactive protocol and the table maintenance mechanism of proactive protocol so as to avoid latency and overhead problems in the network. Hybrid protocol is suitable for large networks where large numbers of nodes are present. In this large network is divided into set of zones where routing inside the zone is performed by using reactive approach and outside the zone routing is done using reactive approach. There are various popular hybrid routing protocols for MANET like ZRP, SHARP [2]

### *i) Zone Routing Protocol (ZRP)*

ZRP [21] is suitable for wide variety of MANETs, especially for the networks with large span and diverse mobility patterns. In this protocol, each node proactively maintains routes within a local region, which is termed as routing zone. Route creation is done using a query-reply mechanism. For creating different zones in the network, a node first has to know who its neighbors are. A neighbor is defined as a node with whom direct communication can be established, and that is, within one hop transmission range of a node.Neighbor discovery information is used as a basis for Intra-zone Routing Protocol (IARP), which is described in detail in [22]. Rather than blind broadcasting, ZRP uses a query control mechanism to reduce route query traffic by directing query messages outward from the query source and away from covered routing zones. A covered node is a node which belongs to the routing zone of a node that has received a route query. During the forwarding of the query packet, a node identifies whether it is coming from its neighbor or not. If yes, then it marks all of its known neighboring nodes in its same zone as covered[2]. The query is thus relayed till it reaches the destination. The destination in turn sends back a reply message via the reverse path and creates the route.

Parametric Comparison

| Parameters | Reactive protocol | Proactive protocol | Hybrid protocol |
|---|---|---|---|
| Routing philosophy | Flat | Flat/Hierarchical | Hierarchical |
| Routing scheme | On demand | Table driven | Combination of both |
| Routing overhead | Low | High | Medium |
| Latency | High due to flooding | Low due to routing tables | Inside zone low outside similar to Reactive protocols |
| Scalability level | Not suitable for large networks | Low | Designed for large networks |
| Availability of routing information | Available when required | Always available stored in tables | Combination of both |
| Periodic updates | Not needed as route available on demand | Yes. Whenever the topology of the network changes | Yes needed inside the zone |
| Storage capacity | Low generally Depends upon the number of routes | High ,due to the routing tables | Depends on the size of Zone, insid0e the zone sometimes high as proactive protocol |
| Mobility support | Route maintenance | Periodical updates | Combination of both |

***ii) Sharp Hybrid Adaptive Routing Protocol (SHARP)***

SHARP [23] adapts between reactive and proactive routing by dynamically varying the amount of routing information shared proactively. This protocol defines the proactive zones around some nodes. The number of nodes in a particular proactive zone is determined by the node-specific zone radius. All nodes within the zone radius of a particular node become the member of that particular proactive zone for that node. If for a given destination a node is not present within a particular proactive zone, reactive routing mechanism(query-reply)is used to establish the route to that node. Proactive routing mechanism is used within the proactive zone. Nodes within the proactive zone maintain routes proactively only with respect to the central node. In this protocol, proactive zones are created automatically if some destinations are frequently addressed or sought within the network. The proactive zones act as collectors of packets, which forward the packets efficiently to the destination, once the packets reach any node at the zone vicinity[2].

## IV. CONCLUSION

We have seen a great development in the field of wireless networks (infrastructure based) and in the field of Mobile ad hoc network (infrastructure less network).In this paper a number of routing protocols for MANET, which are broadly categorized as proactive and reactive and Hybrid protocols. The effort has been made on the comparative study of Reactive, Proactive and Hybrid routing protocols has been presented in the form of table. There are various shortcomings in different routing protocols and it is difficult to choose routing protocol for different situations as there is tradeoff between various protocols. There are various challenges that need to be met, so these networks are going to have widespread use in the future.

## REFERENCES


[1]. C K Toh, Ad Hoc Mobile Wireless Networks, Prentice Hall Publishers , 2002.

[2]. Robinpreet Kaur & Mritunjay Kumar Rai, A Novel Review on Routing Protocols in MANETs, Undergraduate Academic Research Journal (UARJ), ISSN : 2278 – 1129, Volume-1, Issue-1, 2012

[3]. Ammar Odeh, Eman AbdelFattah and Muneer Alshowkan, Performance Evaluation Of AODV And DSR Routing Protocols In Manet Networks, International Journal of Distributed and Parallel Systems (IJDPS) Vol.3, No.4, July 2012.

[4]. Mina Vajed Khiavi, Shahram Jamali, Sajjad Jahanbakhsh Gudakahriz, Performance Comparison of AODV, DSDV, DSR and TORA Routing Protocols in MANETs, International Research Journal of Applied and Basic Sciences. Vol., 3 (7), 1429-1436, 2012 ISSN 2251-838X ©2012 Victor Quest Publications.

[5]. Sachin Dnyandeo Ubarhande, Performance Evolution of AODV and DSR Routing Protocols in MANET Using NS2,

[6]. International Journal of Scientific & Engineering Research Volume 3, Issue 5, May-2012, ISSN 2229-5518

[7]. G.Vijaya Kumar , Y.Vasudeva Reddyr , Dr.M.Nagendra , Current Research Work on Routing Protocols for MANET: A Literature Survey, International Journal on Computer Science and Engineering Vol. 02, No. 03, 2010, 706-713

[8]. Tarek Sheltami and Hussein Mouftah “Comparative study of on demand and Cluster Based Routing protocols in

[9]. MANETs”, IEEE conference, pp. 291-295, 2003

[10]. Dr. Kamaljit I. Lakhtaria, Analyzing Reactive Routing Protocols in Mobile Ad Hoc Networks, Int. J. Advanced Networking and Applications Volume:03 Issue:06 Pages:1416-1421 (2012) ISSN : 0975-0290

[11]. Johnson. D and Maltz. D. A, “Dynamic source routing in ad hoc wireless Networks” in Mobile Computing

[12]. (Imielinski and H. Korth, eds.), Kluwere Academic Publishers, 199

[13]. Perkins CE, Royer EM, Chakeres ID (2003) Ad hoc On-Demand Distance Vector (AODV) Routing. IETF Draft,

[14]. October, 2003, available at http://tools.ietf.org/html/draft-perkins- manet-aodvbis-00. Accessed 21

[15]. Toh C-K (1996) A Novel Distributed Routing Protocol to Support Ad- Hoc Mobile Computing.Proceedings of the 1996 IEEE 15th Annual International Phoenix Conference on Computers and Communications:480–486

[16]. Elizabeth M. Royer“A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks” University of California, Santa Barbara Chai-Keong Toh, Georgia Institute of Technology, IEEE Personal Communications, pp. 46-55, April 1999.

[17]. Krishna Gorantala , “Routing Protocols in Mobile Ad-hoc Networks”, A Master’ thesis in computer science, pp-1- 36, 2006.

[18]. Perkins CE, Bhagwat P (1994) Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers. Proceedings of ACM SIGCOMM 1994:234–244

[19]. Cheng C, Riley R, Kumar SPR, Garcia-Luna-Aceves JJ (1989) A Loop Free Extended Bellman-Ford Routing Protocol Without Bouncing Effect. ACM SIGCOMM Computer Communications Review, Volume 19, Issue 4:224– 236

[20]. Humblet PA (1991) Another Adaptive Distributed Shortest-Path Algorithm. IEEE Transactions on Communications, Volume 39, Issue 6:995–1003

[21]. Rajagopalan B, Faiman M (1991) A Responsive Distributed Shortest- Path Routing Algorithm Within Autonomous Systems. Journal of Internetworking Research and Experiment, Volume 2, Issue 1:51–69 Chiang C-C, Wu H-K, Liu W, Gerla M (1997) Routing in Clustered Multihop, Mobile Wireless Networks with Fading Channel. Proceedings of IEEE SICON:197–211

[22]. Dube R, Rais CD, Wang K-Y, Tripathi SK (1997) Signal Stability- Based Adaptive Routing (SSA) for Ad Hoc Mobile Networks. IEEE Personal Communications, Volume 4, Issue 1:36 45

[23]. Park VD, Corson MS (1997) A highly adaptive distributed routing algorithm for mobile wireless networks.

[24]. Proceedings of IEEE INFOCOM 1997, Volume 3:1405–1413 Haas ZJ,Pearlman MR, Samar P (2002) The Zone Routing Protocol (ZRP) for Ad Hoc Networks. IETF draft, July 2002, available at http://tools.ietf.org/id/draft-ietf-manetzone-zrp-04.txt. Accessed [22] February 2008 94 A.-S.K. Pathan and C.S. Hong Haas ZJ, Pearlman MR, Samar P (2002) Intrazone Routing Protocol (IARP). IETF Internet Draft, July 2002.

[25]. Ramasubramanian V, Haas ZJ, Sirer, EG (2003) SHARP: A Hybrid Adaptive Routing Protocol for Mobile Ad Hoc Networks. Proceedings of ACM MobiHoc 2003:303–314