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A SURVEY OF ROUTING PROTOCOLS AND GEOGRAPHIC ROUTING PROTOCOL USING GPS IN MANET

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Abstract: The wireless associations in this network are highly error level and can go down usually due to mobility of nodes, interference and less infrastructure. Therefore, routing in MANET is a critical task due to highly dynamic environment. In recent years, several routing protocols have been proposed for mobile ad hoc networks and prominent among them are DSR, AODV and TORA. This review paper provides an overview of these protocols by presenting their characteristics, functionality, benefits and limitations and then makes their comparative analysis so to analyze their performance. The objective is to make observations about how the performance of these protocols can be improved. The limited battery energy is an important consideration in the effective operation of an Ad- hoc network. We propose a protocol named as Energy Saving Geographic Routing protocol (ESGRP) using with GPS that provides a lower energy cost effective routing solution. With peer to peer communication with using GPS in MANET. The perform evaluation of our protocol is agreed out using a statistically composed data over Dynamic Source Routing (DSR) and Ad-Hoc On-Demand Distance Vector (AODV) protocol. Analysis exhibits a clear edge over the existing protocol.

KEYWORDS: Routing Protocols, GPS-free positioning, mobility, MANET.

INTRODUCTION

In MANET, each node acts both as a router and as a host & even the topology of network may also change rapidly. Mobile Ad Hoc Network (MANET) is compilation of multi-hop wireless mobile nodes that correspond with each other without federal direct or establish communications. Some of the challenges in MANET include:

1) Uncast routing
2) Multicast routing
3) Dynamic network topology
4) Speed
5) Frequency of updates or Network overhead
6) Scalability
7) Mobile agent based routing
8) Quality of Service
9) Energy efficient/Power aware routing
10) Secure routing

RELATED WORK

Position based routing means forwarding packets to the destination's position or nearer to the position. Position-based routing algorithms eliminate some of the limitations of topology-based routing by using additional information. They

require that information about the physical position of the participating nodes be available. Each node determines its own position through the use of GPS or some other type of positioning service. A location service is used by the sender of a packet to determine the position of the destination. GPS uses the satellites as reference points to effectively calculate the positions of ground nodes. Some of the real world applications of GPS include location estimation, tracking, navigation mapping and providing timing services. To use GPS, a node must be equipped with a GPS receiver which is responsible for estimating the absolute position of the node in the global coordinate system. Though GPS makes it possible to provide a wide range of positioning services, it is not a completely viable solution for ad hoc networks due to its additional hardware support, cost, and power consumption. A wide variety routing protocols aimed to localize the ad hoc network without the support of GPS [1, 3, 5, 6, 7] have been proposed over the years. Some techniques use GPS but for very few nodes. These nodes are often referred as anchor nodes or reference nodes. Both of these type of localization i.e. 'Completely GPS Free Localization [1], [3], [5], [6], [7] etc or 'Using Very Few Anchor Node' [2], [8], [14], provide techniques to localize the network in a GPS Less or GPS-Scarce area. The GPS-less localization approaches establish a virtual coordinate system and try to localize the network in that coordinate System. These coordinate system are established on the basis distance measurement [1, 6] (using ToA or AoA) or on the basis of hop count [5, 7]. But the problem with this coordinate system is that the exact physical position of the nodes cannot be determined in the absence of GPS. In paper [1], nodes can measure relative distances from neighbours using the method called Time of Arrival (ToA) mobile nodes estimate their positions. AOA (Angle of Arrival) and other approaches are also used for calculating position of the node [2]. Only a fraction of the nodes have positioning capabilities through GPS. However, each node will be able to calculate the position and orientation. Nodes are required to have compass to compute the AoA. A localization procedure is proposed in [3] which is mainly designed for completely GPS-free and mobile environment. The network nodes do not need to calculate their position with respect to any anchor node. A local network coordinate system is formed in absence of GPS. This localization is based on directional neighbours localization. This algorithm runs on a fairly large or small and mobile environment.

ROUTING PROTOCOLS

A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks. These protocols find a route for packet delivery and deliver the packet to the correct destination. The studies on various aspects of routing protocols have been an active area of research for many years. Many protocols have been suggested keeping applications and type of network in view. Basically, routing protocols can be broadly classified into two types as (a) Table Driven Protocols or Proactive Protocols and (b) On-Demand Protocols or Reactive Protocols

Table Driven or Proactive Protocols: In Table Driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes keep on updating these tables to maintain latest view of the network. Some of the existing table driven or proactive protocols are: DSDV [6], [19], DBF [7], GSR [24], WRP [23] and ZRP [28], [13].[33].

On Demand or Reactive Protocols: In these protocols, routes are created as and when required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. Some of the existing on demand routing protocols are: DSR [8], [9], AODV [4], [5] and TORA [26], [27]. The emphasis in this research paper is concentrated on the survey and comparison of various On Demand/Reactive Protocols such as DSR, AODV and TORA as these are best suited for Ad Hoc Networks. The next sub-section describes the basic features of these protocols.

Dynamic Source Routing [8, 9]

Dynamic Source Routing (DSR) is an Ad Hoc routing protocol which is based on the theory of source-based routing rather than table-based. This protocol is source-initiated rather than hop-by-hop. This is particularly designed for use in multi hop wireless ad hoc networks of mobile nodes. Basically, DSR protocol does not need any existing network infrastructure or administration and this allows the Network to be completely self-organizing and self-configuring. This Protocol is composed of two essential parts of route discovery and route maintenance. Every node maintains a cache to store recently discovered paths. When a node desires to send a packet to some node, it first checks its entry in the cache. If it is there, then it uses that path to transmit the packet and also attach its source address on the packet. If it is not there in the cache or the entry in cache is expired (because of long time idle), the sender broadcasts a route request packet to all of its neighbors asking for a path to the destination. The sender will be waiting till the route is discovered. During waiting time, the sender can perform other tasks such as sending/forwarding other packets. As the route request packet arrives to any of the nodes, they check from their neighbor or from their caches whether the destination asked is known or unknown. If route information is known, they send back a route reply packet to the destination otherwise they broadcast the same route request packet. When the route is discovered, the required packets will be transmitted by the sender on the discovered route.

Also an entry in the cache will be inserted for the future use. The node will also maintain the age information of the entry so as to know whether the cache is fresh or not. When a data packet is received by any intermediate node, it first checks whether the packet is meant for itself or not. If it is meant for itself (i.e. the intermediate node is the destination), the packet is received otherwise the same will be forwarded using the path attached on the data packet. Since in Ad hoc network, any link might fail anytime. Therefore, route maintenance process will constantly monitors and will also notify the nodes if there is any failure in the path. Consequently, the nodes will change the entries of their route cache.

BENEFITS AND LIMITATIONS OF DSR

One of the main benefit of DSR protocol is that there is no need to keep routing table so as to route a given data packet as the entire route is contained in the packet header. The limitations of DSR protocol is that this is not scalable to large networks and even requires significantly more processing resources than most other protocols. Basically, In order to obtain the routing information, each node must spend lot of time to process any control data it receives, even if it is not the intended recipient. The flowchart [17] for DSR Protocol is given below:

Adov (Ad Hoc on Demand Distance Vector) [4], [5] AODV is a variation of Destination-Sequenced Distance-Vector (DSDV) routing protocol which is collectively based on DSDV and DSR. It aims to minimize the requirement of system-wide broadcasts to its extreme. It does not maintain routes from every node to every other node in the network rather they are discovered as and when needed & are maintained only as long as they are required. The key steps of algorithm used by AODV for establishment of unicast routes are explained below.

ROUTE DISCOVERY

When a node wants to send a data packet to a destination node, the entries in route table are checked to ensure whether there is a current route to that destination node or not. If it is there, the data packet is forwarded to the appropriate next hop toward the destination. If it is not there, the route discovery process is initiated. AODV initiates a route discovery process using Route Request (RREQ) and Route Reply (RREP). The source node will create a RREQ packet containing its IP address, its current sequence number, the destination's IP address, the destination's last sequence number and broadcast ID. The broadcast ID is incremented each time the source node initiates RREQ. Basically, the sequence numbers are used to determine the timeliness of each data packet and the broadcast ID & the IP address together form a unique identifier for RREQ so as to uniquely identify each request. The requests are sent using RREQ message and the information in connection with creation of a route is sent back in RREP message. The source node broadcasts the RREQ packet to its neighbors and then sets a timer to wait for a reply. To process the RREQ, the node sets up a reverse route entry for the source node in its route table. This helps to know how to forward a RREP to the source. Basically a lifetime is associated with the reverse route entry and if this entry is not used within this lifetime, the route information is deleted. If the RREQ is lost during transmission, the source node is allowed to broadcast again using route discovery mechanism [34], [35].

Tora (Temporary Ordered Routing Protocol) [26], [27] TORA is a distributed highly adaptive routing protocol designed to operate in a dynamic multihop network. TORA uses an arbitrary height parameter to determine the direction of link between any two nodes for a given destination.

Consequently, multiple routes often exist for a given destination but none of them are necessarily the shortest route.

To initiate a route, the node broadcasts a QUERY packet to its neighbors. This QUERY is rebroadcasted through the network until it reaches the destination or an intermediate node that has a route to the destination. The recipient of the QUERY packet then broadcasts the UPDATE packet which lists its height with respect to the destination. When this packet propagates in the network, each node that receives the UPDATE packet sets its height to a value greater than the height of the neighbour from which the UPDATE was received. This has the effect of creating a series of directed links from the original sender of the QUERY packet to the node that initially generated the UPDATE packet. When it was discovered by a node that the route to a destination is no longer valid, it will adjust its height so that it will be a local maximum with respect to its neighbours and then transmits an UPDATE packet. If the node has no neighbors of finite height with respect to the destination, then the node will attempt to discover a new route as described above. When a node detects a network partition, it will generate a CLEAR packet that results in reset of routing over the ad hoc network. The flowchart [17] for TORA Protocol is given below:

PERFORMANCE METRICS

There are number of qualitative and quantitative metrics that can be used to compare reactive routing protocols. Most of the existing routing protocols ensure the qualitative metrics. Therefore, the following different quantitative metrics have been considered to make the comparative study of these routing protocols through simulation.

1) **Routing overhead:** This metric describes how many routing packets for route discovery and route maintenance need to be sent so as to propagate the data packets.

2) **Average Delay:** This metric represents average end-to-end delay and indicates how long it took for a packet to travel from the source to the application layer of the destination. It is measured in seconds.

3) **Throughput:** This metric represents the total number of bits forwarded to higher layers per second. It is measured in bps. It can also be defined as the total amount of data a receiver actually receives from sender divided by the time taken by the receiver to obtain the last packet.

4) **Media Access Delay:** The time a node takes to access media for starting the packet transmission is called as media access delay. The delay is recorded for each packet when it is sent to the physical layer for the first time.

5) **Packet Delivery Ratio:** The ratio between the amount of incoming data packets and actually received data packets.

6) **Path optimality:** This metric can be defined as the difference between the path actually taken and the best possible path for a packet to reach its destination.

POWER AWARE METRICS

The problem of routing in mobile ad hoc networks becomes difficult because of node mobility. Due to mobile nature of the nodes, frequent topology updates are required which result in higher message overhead, and hence causes more power consumption. The main performance metrics widely used in networks are end-to-end throughput and delay. They belong to a small set of metrics used in different routing protocols for determining optimal paths. Beside these, link quality and location stability are other performance metrics, such metrics influence the design of protocols and there is a need to optimize them by balancing the trade-offs between them. Some of these metrics can have a negative impact on some nodes of the network by selecting several paths through them. When energy metrics are used for the design of the routing protocols the ultimate goal is to maintain the network connected and extend the time until it gets partitioned. Some energy-aware metrics, which do result in energy-efficient routes, are [29]:

- *Minimize Energy consumed/packet*

To conserve energy, the amount of energy consumed by all packets traversing from the source node to the destination node needs to be minimized. That is, the total amount of energy the packets consumed when it travels from each and every node on the route to the next node should be known. The energy consumed for one packet is given as:
(1) Node needs to be minimized. That is, the total amount of energy the packets consumed when it travels from each and every node on the route to the next node should be known. The energy consumed for one packet is given as:
where, mi to mk are nodes in the route while T denotes the energy consumed in transmitting and receiving a packet over one hop. Then, minimum E for all packets is taken. However, this metric suffers a drawback as the nodes tend to have widely differing energy consumption profiles resulting in early death for some nodes.

- Maximize Time to Network Partition

For a given network topology, removal of a minimal set of nodes will cause the network to partition. Therefore a routing procedure must divide the work among nodes to maximize the lifetime of the network. However, optimizing this metric is extremely difficult as finding the nodes that will partition the network is non-trivial and the "load balancing" problem is known to be an NP-complete problem.

- Minimize Variance in node power levels

This metric ensures that all the nodes in the network remain up and running together for as long as possible. It achieves the objective by using a routing procedure where each node sends packets through a neighbor with the least amount of packets waiting to be transmitted. In this way, the traffic load of the network is shared among the nodes with each node relaying about equal number of packets. Therefore, each node spends about the same amount of power in transmission.

- . Minimize Cost/Packet

For this metric, the path is selected such that it do not contain nodes with depleted energy reserves. In other words, this metric is a measurement of the amount of power or the level of battery capacity remaining in a node and that those nodes with a low value of this metric are not chosen (unnecessarily) for a route. This metric is defined as the total cost of sending one packet over the nodes, which in turn can be used to calculate the remaining power. The cost is given as: (2) where, xi represents the total energy expended by node *i* so far and *f* is the function that denotes the cost. Then the minimum C for all packets is calculated.

- Minimize Maximum Node Cost

This metric finds the minimum value from a list of costs of routing a packet through a node. The costs themselves are maximized value of the costs of routing a packet at a specific time. The equation for this metric is:
Minimize $\hat{C}(t)$, for all $t > 0$, where, $\hat{C}(t)$ denote the maximum of the Ci(t) and Ci(t) is the cost of routing a packet through node *i* at time *t*.

5. Energy Efficient Ad Hoc Routing Protocols

Different routing protocols have been developed to establish a correct and efficient route between a pair of nodes. But due to the limited available power of each node, the selected route cannot remain for a long time. To achieve this goal, nodes energy is minimized not only during active communication but also when they are in inactive state.
Two approaches to minimize the active communication energy are:

a. Transmission power control approach and

b. Load distribution approach. and to minimize energy during inactivity [40] the approach used is
C.sleep/power-down mode

- Transmission Power Control Approach

When a node's radio transmission power is controllable, their direct communication ranges as well as the number of its immediate neighbors are also adjustable. While stronger transmission power increases the transmission range and reduces the hop count to the destination, weaker transmission power makes the topology sparse which may result in network partitioning and high end-to-end delay due to a larger hop count. There has been active research on topology control of a MANET via transmission power adjustment [41, and the primary objective is to maintain a connected topology using the minimal power. Energy efficient routing protocols based on transmission power control find the best route that minimizes the total transmission power between a source-destination pair [34].
Flow Augmentation Routing (FAR) [35] protocol assumes a static network and finds the optimal routing path for a given source–destination pair that minimizes the sum of link costs along the path and chooses the path with least cost. **Online Max-Min Routing (OMM)** power-aware routing protocol proposed by Li et a[36]] for wireless ad-hoc networks dispersed over large geographical areas to support applications where the message sequence is not known. This protocol optimizes the lifetime of the network as well as the lifetime of individual nodes by maximizing the minimal residual power,

which helps to prevent the occurrence of overloaded nodes. **Power-aware Localized Routing (PLR)** protocol [21] is a localized, fully distributed energy-aware routing algorithm. It works with the assumption that a source node has the location information of its neighbors and the destination. PLR is equivalent to knowing the link costs from the source node to its neighbors, all the way to the destination. Based on this information, the source cannot find the optimal path but selects the next hop through which the overall transmission power to the destination is minimized. The main goal of **Minimum Energy Routing (MER) protocol** [16], [17] is not to provide energy efficient paths but to make the given path energy efficient by adjusting the transmission power just enough to reach to the next hop node. **Smallest Common Power (COMPOW)** protocol [18] presents a simple solution to maintain bi-directionality between any pair of communicating nodes in a MANET. **Power-aware routing (PAR)** [33] maximizes the network lifetime and minimizes the power consumption by selecting more stable and less congested route during the source to destination route establishment process, to transfer real-time and non real-time traffic, hence providing energy efficient routes.

CONCLUSION

In this research paper, an effort has been made to concentrate on the comparative study and performance analysis of various on demand/reactive routing protocols (DSR, AODV and TORA) on the basis of above mentioned performance metrics. It has been observed that the performance of all protocols studied was almost stable in sparse medium with low traffic. ESGRP performs much better in packet delivery owing to selection of better routes using acyclic graph. The evaluation predicts that in spite of slightly more overhead in some cases DSR and AODV outperforms TORA in all cases. It has been further concluded that due to the dynamically changing topology and infrastructure less, decentralized characteristics, security and power awareness is hard to achieve in mobile ad hoc networks. Hence, security and power awareness mechanisms should be built-in features for all sorts of applications based on ad hoc network. Also peer to peer communication with using GPS in MANET. The focus of the study is on these issues in our future research work and effort will be made to propose a solution for routing in Ad Hoc networks by tackling these core issues of secure and power aware/energy efficient routing.

REFERENCES

[1] Ashwani Kush, Phalguni Gupta, Ram Kumar, "PerformanceComparison of Wireless Routing Protocols", Journal of the CSI, Vol.35 No.2, April-June 2005

[2] Anne Aaron, Jie Weng, "Performance Comparison of Ad-hoc RoutingProtocols for Networks with Node Energy Constraints", available at http://ivms.stanford.edu

[3] Charles Perkins, Elizabeth Royer, Samir Das, Mahesh Marina,"Performance of two on-demand Routing Protocols for Ad-hoc Networks", IEEE Personal Communications, February 2001, pp.16-28.

[4] C. Perkins, E. B. Royer, S. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing - Internet Draft", RFC 3561, IETF Network Working Group, July 2003.

[5] C. E. Perkins and E. M. Royer, "Ad-Hoc On Demand Distance Vector Routing", Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA), New Orleans, LA, 1999, pp. 90-100.

[6] C. E. Perkins and P. Bhagwat, "Highly dynamic destination-sequenced distance vector routing (DSDV) for mobile computers", Proceedings of ACM SIGCOMM 94, 1994, pp. 34–244.

[7] D. Bertsekas and R. Gallager, "Data Networks" Prentice Hall Publ., New Jersey, 2002.

[8] D. B. Johnson, D. A. Maltz, Y.C. Hu, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", IETF Draft, April 2003,work in progress. http://www.ietf.org/internet-drafts/draft-ietf-manet-dsr-09.txt

[9] D. B. Johnson and D. A. Maltz, "Dynamic Source Routing in Ad Hoc
Networks", Mobile Computing, T. Imielinski and H. Korth, Eds.,
Kulwer Publ., 1996, pp. 152-81.

[10] David A. Maltz, "On-Demand Routing in Multi-hop Wireless Mobile Ad Hoc Networks', May 2001, available at www.monarch.cs.rice.edu

[11] E.M.Rover, C.K.Toh, "A review of current routing protocols for ad hoc networks", IEEE Communications, vol 6, 1999, pp 46-55.

[12] F. Bertocchi, P. Bergamo, G. Mazzin, "Performance Comparison of Routing Protocols for Ad hoc Networks", IEEE GLOBECOM 2003.

[13] Farhat Anwar, Md. Saiful Azad, Md. Arafatur Rahman, Mohammad Moshee Uddin, "Performance Analysis of Ad hoc Routing Protocols in Mobile WiMAX Environment", IAENG International Journal of Computer Science, 35:3, IJCS_35_3_13

[14] H. Ehsan and Z. A. Uzmi (2004), "Performance Comparison of Ad HocWireless Network Routing Protocols", IEE,E 8th International Multitopic Conference, Proceedingsof INMIC, December 2004,
pp.457 – 465.

[15] Iskra Djonova Popova, "A PowerPoint presentation on Routing in Ad-hoc Networks", 9th CEENet Workshop on Network Technology,
Budapest 2004.

[16] J. Broch, D.A. Maltz, D. B. Johnson, Y-C. Hu, J. Jetcheva, "A
performance comparison of Multi-hop wireless ad-hoc networking routing protocols", in the proceedings of the 4th International Conference on Mobile Computing and Networking (ACM
MOBICOM '98), October 1998, pages 85-97.

[17] Md. Golam Kaosar, Hafiz M. Asif, Tarek R. Sheltami, Ashraf S. Hasan Mahmoud, "Simulation-Based Comparative

Study of On Demand Routing Protocols for MANET", available at http://www.lancs.ac.uk
[18] Per Johansson, Tony Larsson, Nicklas Hedman, Bartosz Mielczarek, "Routing protocols for mobile ad-hoc networks – a comparative
performance analysis", in the proceedings of the 5th International
Conference on Mobile Computing and Networking (ACM
MOBICOM '99), August 1999, pages 195-206.
[19] P. Chenna Reddy, Dr. P. Chandrasekhar Reddy, "Performance Analysis of Adhoc Network Routing Protocols", Academic Open
Internet Journal, SSN 1311-4360, Volume 17, 2006
[20] R. Misra, C. R. Manda, "Performance Comparison of AODV/DSR On-Demand Routing Protocols for Ad Hoc Networks in Constrained Situation", IEEE ICPWC 2005.
[21] S. Gowrishankar, T.G. Basavaraju, M. Singh, Subir Kumar Sarkar, "Scenario based Performance Analysis of AODV and OLSR in Mobile Ad hoc Networks", available at http://www.ijcim.th.org
[22] Samir R. Das, Charles E. Perkins, Elizabeth M. Royer, "Performance Comparison of Two On-demand Routing Protocols for Ad Hoc Networks", in the proceedings of NFOCOM 2000, Nineteenth Annual
Joint Conference of the IEEE Computer and Communications Societies,IEEE, volume 1, pages 3 – 12 and also available at www.cs.ucsb.edu
[23] S. Murthy and J. J. Garcia-Luna-Aceves, "An Efficient Routing
Protocol for Wireless Networks", ACM Mobile Networks and App.Journal, Special Issue on Routing in Mobile Communication Networks,
pp.183-97, 1996.
[24] Tsu-Wei Chen and M. Gerla, "Global State Routing: A New Routing Scheme for Ad-hoc Wireless Networks" Proceedings of International
Computing Conference IEEE ICC 1998.
[25] V. Nazari, K. Ziarati, "Performance Comparison of Routing Protocols for Mobile Ad hoc Networks", IEEE 2006.
[26] V. Park and S. Corson, Temporally Ordered Routing Algorithm (TORA) Version 1, Functional specification IETF Internet draft,
http://www.ietf.org/internet-drafts/draft-ietf-manet-tora-spec-01.txt,
1998.
[27] V. D. Park and M. S. Corson, "A Highly Adaptive Distributed Routing Algorithm for Mobile Wireless Networks", Proceedings of the IEEE International Conference on Computer Communications (INFOCOM), Kobe, Japan, 1997, pp. 1405-1413.
[28] Z. J. Hass and M. R. Pearlman, "Zone Routing Protocol (ZRP)", Internet draft available at www.ietf.org.
[1].M. Maleki, K. Dantu, and M. Pedram (2002). Power-aware source routing protocol for mobile ad hoc networks, Proceedings of the international symposium on Low power electronics and design, USA, Pp. 72-75.
[29].Charles E. Perkins and Elizabeth M. Royer (1999). Ad hoc On-Demand Distance Vector Routing. Proceedings of the 2nd IEEE
Workshop on Mobile Computing Systems and Applications, New Orleans, LA, Pp. 90-100.
[30].David B. Johnson, David A. Maltz, and Josh Broch,(2001).DSR: The Dynamic Source Routing Protocol for Multihop Wireless
[31]Ad Hoc Networks, Ad Hoc Networking, edited by Charles E.Perkins, Chapter 5, Pp 139–172. Addison-Wesley
[32].E. Royer and C. K. Toh,(1999) A review of Current RoutingProtocols for Ad Hoc Mobile Wireless Networks, IEEE Personal Communication, Pp 46-55
[33].A. Anand, P. K. Pattnaik and R. Mall,(2004) An Energy Saving Routing Protocol for Adhoc Networks with Nodes havingDeterministic Movements, ADCOM,India, Pp 325-329
[34] Sunil Taneja and Ashwani Kush "A Survey of Routing Protocols in Mobile Ad Hoc Networks" , International Journal of Innovation, Management and Technology, Vol. 1, No. 3, August 2010 ISSN: 2010-0248.
[35] B.Soujanya, T.Sitamahalakshmi, Ch.Divakar ," STUDY OF ROUTING PROTOCOLS IN MOBILE AD-HOC NETWORKS", B.Soujanya et al. / International Journal of Engineering Science and Technology (IJEST), ISSN : 0975-5462 Vol. 3 No. 4 April 2011.
[36] Sunil Taneja, Ashwani Kush," PERFORMANCE EVALUATION OF DSR AND AODV OVER UDP AND TCP CONNECTIONS", International Journal of Computing and Business Research (IJCBR)
Volume 1, N. 1 December – 2010.