



## Energy-Aware Service and Route Discovery Scheme for AODV using Piggybacking in MANETs

### (AODV-EASARD)

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#### ABSTRACT

*Mobile ad-hoc network* (MANET) is an infrastructure-less multihop network where each node communicates with other nodes directly or indirectly through intermediate nodes. Thus, all nodes in a MANET basically function as hosts as well as routers participating in some routing protocol required for deciding and maintaining the routes. Since MANETs are infrastructure-less, self-organizing, rapidly deployable wireless network, they are highly suitable for applications involving special outdoor events, communications in regions with no wireless infrastructure, emergencies and natural disasters, and military operations.

**Key Words:** MANETs, Routing, Energy-Aware.

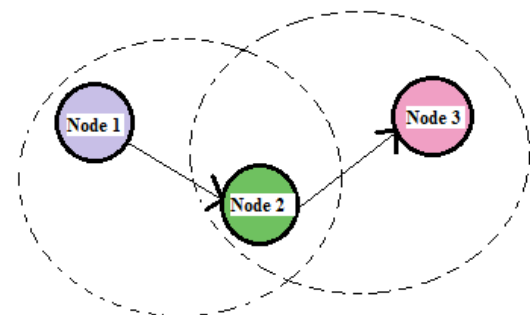
#### INTRODUCTION

With recent performance advancements in computer and wireless communications technologies, advanced mobile wireless computing is expected to see increasingly widespread use and application, much of which will involve the use of the Internet Protocol (IP) suite. The vision of mobile ad hoc networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes.

A mobile ad hoc network (MANET) is a self-configuring and infrastructure-less network of mobile devices connected by wireless medium. Ad-hoc is Latin and means "for this purpose". Each device in a MANETs is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANETs is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. MANETs are a kind of Wireless ad-hoc network that usually has a routable networking environment on top of a Link Layer ad-hoc network. The applications

include military services, rescue operations, students on campus and many more.

In a MANET, the router connectivity may change frequently, leading to the multi-hop communication paradigm that can allow communication without the use of BS/AP, and provide alternative connections inside hotspot cells. A dual-mode MS can operate in both the infrastructure (communicating directly to a BS or AP) and MANET modes using the WLAN interface. A MANET is a type of ad hoc network that can change locations and configure itself on the fly. All nodes in this network are mobile and they use wireless connections to communicate with various networks.



**Fig: An Example Mobile ad-hoc network**

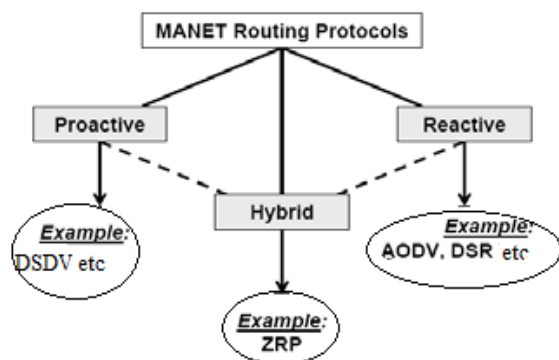
Routing is one of the core problems of networking for delivering data from one node to the other. Wireless ad-hoc networks are also called Mobile ad-hoc multihop networks without predetermined topology or central control. This is because MANETs can be characterized as having a dynamic, multihop, potentially rapid changing topology. The aim of such networks is to provide communication capabilities to areas with limited or no existing communication infrastructures. A MANET is usually formed by mobile nodes using wireless communications. It uses a peer-to-peer multihop routing instead of a static network infrastructure to provide network connectivity.

Several routing protocols have been suggested and used for MANET. Dynamic Source Routing (DSR), Ad Hoc On-Demand Distance Vector Routing (AODV) and Destination Sequenced Distance-Vector (DSDV) have been implemented. Routing protocols for MANETs can be broadly classified into three main categories:-

1.) Proactive (Table-driven) routing protocols:- Every node in the network has one or more routes to any possible destination in its routing table at any given time.

2.) Reactive (On demand) routing protocols:-Every node in the network obtains a route to a destination on a demand fashion. Reactive protocols do not maintain up-to-date routes to any destination in the network and do not generally exchange any periodic control messages.

3.) Hybrid routing protocols:-Every node acts reactively in the region close to its proximity and proactively outside of that region, or zone.



1. Ad Hoc On-Demand Distance Vector Routing (AODV) – uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. Without source routing, AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers.
2. Destination-Sequenced Distance Vector (DSDV)- The first MANET algorithm that we implemented as part of this work is called the Destination-Sequenced Distance Vector (DSDV) routing algorithm. It is a proactive routing algorithm. The DSDV algorithm is a Distance Vector (DV) based routing algorithm designed for use in

MANETs, which are defined as the cooperative engagement of a collection of Mobile Hosts without the required intervention of any centralized Access Point (AP).

### PIGGYBACK MECHANISM

In AODV protocol, some periodic Hello messages are redundant when control packets or data packets which include many messages of nodes to its neighbors are transmitted correctly. Obviously, such redundancy will increase route cost and energy consumption, even bring the deterioration of the entire network. The idea of piggyback is displayed by the way that Hello messages will not need to be broadcasted if a node has transmitted the packets such as control or data packets in a Hello interval. Although we can benefit from the lower route cost by use of the thought of piggyback, the network topology may be damaged in the case of the accidental losing of control packets or data packets. The fault will make the performance of delivery ratio weak, but overall, the advantage is more prominent.

### RELATED WORK

The following section provides the details regarding various routing protocols used in various types of networks. Each protocol excelling in different parameters, for getting the good outcome from a particular protocol, it is required to integrate two or more protocols or to just compromise.

“Fatma Outay\_y, V`eronique V`eque\_, Ridha Bouall`eguey[1]”, discussed that MANETs are highly dynamic and suffer from frequent and unpredictable changes in the network topology due to the fact that devices are mobile and operate with low battery power. Due to limited computing power, high mobility and the lack of a central coordinating entity, service discovery in MANETs has been an attractive area of research. However, proposed solutions are broadcast-based and result in overloading the constrained network.

“ Varun Verma, Sumi Helal, Nitin Desai and Choonhwa Lee. Konark[2]”,proposed an energy aware routing technique that selects the MAX energy holding nodes and calculate the average of nodes energy and if the path has maximum energy then in that case, the maximum average energy path is selected for sending data in network. This proposed method always utilizes the maximum energy nodes and for reliable connection it is essential in network.

A simulation-based performance comparison between a normal energy based routing ad hoc protocol and its modified proposed energy based protocol are done by ns-2 simulator and the simulation results are showing the better results of network performance and energy utilization.

“Aodv Based Improved Method for detecting good neighbor nodes[3]”, discussed that wireless technology provides noteworthy impact on Internet and Communication area. It is supported by popular technique known as Ad-hoc Network. In Ad-hoc Networks nodes are interconnected with each other using wireless link and also receiving

attention in the scientific community. In this, routes may be disconnected due to dynamic movement of nodes. So route selection and topology combination is very difficult and challenging issue. This type of networks is more susceptible to both internal and external attacks due to presence of malicious neighbor nodes. Paper explores new method using AODV protocol to find out good neighbor node according to their signal strength, flow capacity relative position of node in network. By simulating new methods it is seen that our protocol has better signal strength and flow

“Optimized Ad-hoc On Demand Distance Vector Routing Protocol[4]” explained that, A Mobile Ad-hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using any centralized access point, infrastructure, or centralized administration. Data transmission between two nodes in MANETs may be requires multiple hops as the nodes transmission range is limited. Mobility of the different nodes makes the situation even more complicated. Multiple routing protocols especially for these conditions have been developed during the last few years, to find optimized routes from a source to some destination capacity.

“Pottie, G.J. and Clare, L.P. Wireless integrated network sensors: Towards low cost and robust self-organizing security networks[5]” analyzed that, A very important benefit of continuing advances in CMOS IC technology is the ability to construct a wide variety of micro electrical-mechanical systems (MEMS) including sensors and RF components. These building blocks enable the fabrication of complete systems in a low cost module, which include sensing, signal processing, and wireless communications. Together with innovative and focused network design techniques that will make possible simple deployment and sustained low power operation, the small size and cost can be enabling for a very large number of law enforcement and security applications, including remote reconnaissance and security zones ranging from persons to borders. Work outlined how the application can be exploited in the network design to enable sustained low-power operation. In particular, extensive information processing at nodes, hierarchical decision making, and energy conserving routing and network topology management methods will be employed in the networks under development.

“Kai Chen and Samarth H. Shah and Klara Nahrstedt. Cross-Layer Design for Data Accessibility in Mobile Ad hoc Networks., Wirel. Pers. Commun. Kluwer [6]” explained that, Mobile ad hoc networks (MANET) are becoming an integral part of the ubiquitous computing and communication environment, providing new infrastructure for multimedia applications such as video phone, multimedia-on-demand, and others. In order to access multimedia information in MANET, Quality of Service (QoS) needs to be considered, such as high success rate to access multimedia data, bounded end-to-end delay, and others. This work presents a data accessibility service for a group of mobile users to access desired data with high success rate.

This accessibility service is only possible if it utilize advanced data advertising, lookup and replication

services, as well as a novel predictive location-based QoS routing protocol in an integrated fashion. Using cross-layer design, it illustrate how the QoS routing protocol assists data advertising, lookup and replication services to achieve high data access success rate. Simulation results have shown that the design is successful in a dynamic MANET.

“Obaid, A. and Khir, A. and Mili, H. and Laforest, L. A Routing BasedService Discovery Protocol for Ad hoc Networks. ICNS07:[7]” discussed that, Ad hoc networks are networks that consist of wireless mobile nodes. They are networks that do not require any pre-established infrastructure. Their ability to quickly and dynamically provide a means of communication makes them an adequate choice for many types of applications both in civil, industrial and military fields. The mobility and the autonomy of ad hoc nodes require a mechanism for service discovery, which allow to provide mobile nodes with information about the services offered in the network. This work focus on a strategy for services discovery and publication coupled with ad-hoc routing. The work proposed a new protocol for services discovery called SEDIRAN (Service Discovery and Interaction with Routing protocols in Ad hoc Network), on top of a reactive routing protocol, namely, AODV (Ad hoc On demand Distance Vector). However, it analyzed that our protocol can be easily generalized to other reactive routing protocols.

“S. Murthy and J. J. Garcia-Luna-Aceves. An Efficient Routing Protocolfor Wireless Networks. MobileNetworks and Applications,[8]”, proposed A new routing protocol which increases the effectiveness of the routing protocol within a mobile ad-hoc network . The proposed on-demand link weight (ODLW) routing protocol is targeted for real-time multimedia applications where QoS parameters such as bandwidth, delay and node lifetime are considered. The ODLW is essentially a succession of on-demand and link-state routing protocols. It was shown that the unique route discovery mechanism of the ODLW outperformed Dynamic Source Routing protocol (DSR) and Optimized Link State Routing Protocol (OLSR) in reducing the end-to-end delay by 80% and 40% respectively as well as the packet drop by 30% and 20% respectively.

“Shah H, Nahrstedt K. Predictive location-based QoS routing in mobile ad-hoc networks.[9]”, explained that mobile ad hoc networks, nodes are dynamically changing their locations. The QoS information used for routing by traditional QoS routing protocols becomes obsolete due to node mobility. To overcome this problem,a predictive QoS routing scheme was needed.This work presented a location-delay prediction scheme, based on a location-resource update protocol, which assists a QoS routing protocol. Our location updates also contain resource information pertaining to the node sending the update. This resource information for all nodes in the network and the location prediction mechanism are together used in the QoS routing decisions. The simulation results shows that, with our approach, it can predict the location at a given instant in the future with a high degree of accuracy.

“Charles E. Perkins, Pravin Bhagwat. Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV)

for Mobile Computers[10]”, discuss that An ad-hoc network is the cooperative engagement of a collection of Mobile Hosts without the required intervention of any centralized Access Point. The work presents an innovative design for the operation of such ad-hoc networks. The basic idea of the design is to operate each Mobile Host as a specialized router which periodically advertises its view of the interconnection topology with other Mobile Hosts within the network. This amounts to a new sort of routing protocol. This work also investigated modifications to the basic Bellman-Ford routing mechanisms as specified by RIP to make it suitable for a dynamic and self starting network mechanism as is required by users wishing to utilize ad-hoc networks. Finally, it describes the ways in which the basic network layer routing can be modified to provide MAC layer support for ad-hoc networks.

“Ding, Gang and Bhargava, Bharat. Peer-to-peer File-sharing over Mobile Ad hoc Networks. PERCOMW[11]”, describes that current peer-to-peer file-sharing systems mostly worked on wired networks. Mobile ad hoc network is characterized as multi-hop wireless communications between mobile devices. It explains five routing approaches with different complexity, also enabled peer-to-peer file-sharing over mobile ad hoc networks. The complexity of the proposed approaches is evaluated and compared. It is concluded that the cross-layer protocols perform better than simply overlaying peer-to-peer searching protocol on mobile ad hoc networks.

“Z. J. Haas, M. R. Pearlman and P. Samar. AODV PROTOCOL works, InterneCOLt draft 4, Cornell University[12]” analysed that Wireless Ad Hoc Network is collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized network. An Ad-hoc network does not have any centralized arbitrator or server. Routing is process of selecting path in a network along which to send data packets. In this paper effect of different Mobility models and Data traffic are comparatively on the basis of different routing protocols AODV, OLSR and ZRP. The performance of these routing protocols is analyzed by three metrics i.e. End to end delay, Jitter and Through-put.

“Johnson DB, Maltx DA. Dynamic source routing in ad hoc wireless networks. In mobile computing, Imielinski T, Korh H(eds).[13]”, explained that Mobile Ad-Hoc networks (MANETs) are collection of mobile nodes that dynamically forming a temporary network without pre-existing network infrastructure and communicate with its neighbors to perform peer to peer communication and transmission. Propagation models focused on predicting the average received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in close spatial proximity to a particular location. The accuracy of any particular propagation model in any given condition will depend on the suitability among the constraints required by the model and depend on terrain. A number of propagation models like Free Space and Two Ray ground have been exist. This work presents comparative study on the behavior of various routing protocols with path loss propagation models, various performance metrics used

for this comparison such as packet delivery fraction, average jitter, throughput and average end to end delay.

“Morshed, M.M. Ko, F.I.S. Dongwook Lim Rahman. Performance evaluation of DSDV and AODV routing protocols in Mobile Ad-hoc Networks[14]”, analysed that, Mobile Ad-hoc Network is an infrastructure less and decentralized network which need a robust dynamic routing protocol. It compared the performance of traditional proactive DSDV routing protocol along with on-demand reactive routing protocols for MANET: AODV.

From analysis, AODV has given better performance than table driven DSDV routing protocol. To compare the performance of DSDV and AODV routing protocol, the simulation results were analyzed by graphical manner and trace file based on QoS metrics such as Delay, Jitter. The performance differentials have been analyzed based on network load, mobility, and network size. The simulation result analysis verifies the DSDV and AODV routing protocol performances.

“David B. Johnson. Routing in Ad Hoc Networks of Mobile Hosts[15]”, explained that An ad hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration or standard support services. In such an environment, it may be necessary for one mobile host to enlist the aid of others in forwarding a packet to its destination, due to the limited propagation range of each mobile host’s wireless transmissions. Some previous attempts have been made to use conventional routing protocols for routing in ad hoc networks, treating each mobile host as a router This position work points out a number of problems with this design and suggests a new approach based on separate route discovery and route maintenance protocols.

“Survey of Service Discovery Protocols and Benefits of Combining Service and Route Discovery, IJCSNS Journal, pages 87–91, 2007[17]”, discuss that service discovery is an emerging field in the area of ubiquitous computing. There are various techniques and protocols particularly tailored to specific sets of objectives. This work also analyses the current state of the art and presents taxonomy of service discovery protocols. It demonstrates the benefits of combining the service discovery with route discovery in MANETs.

Broch J, Maltz DA, Johnson DB, Hu YC, Jetcheva J. A performance comparison of multi hop wireless ad hoc network routing protocols.[18] “DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks”. DSR is simple and efficient routing protocol used in multihop wireless ad hoc networks of mobile nodes. It follows two mechanisms of route discovery and route maintenance and allow nodes to discover and maintain source routes to arbitrary destinations in the network. DSR operates entirely on demand with no periodic activity of any kind of any level in the network. It automatically scales to only needed to track the routes usually in use.



**COMPARATIVE STUDY OF PIGGYBACKING TECHNIQUES**

The following table gives the list of algorithms used for routing in various types of networks. Each algorithm or protocol given provides good performance in different fields or parameters.

Table 1: Comparison Study of Various Techniques

TITLE	AUTHORS	PUBLICATION	DESCRIPTION
Predictive location-based QoS routing in mobile ad-hoc networks.	Shah H, Nahrstedt K	Proceedings of the IEEE Int'l Conference on Communications, 2010	discussed that MANETs are highly dynamic and suffer from frequent and unpredictable changes in the network topology due to the fact that devices are mobile and operate with low battery power. Due to limited computing power, high mobility and the lack of a central coordinating entity, service discovery in MANETs has been an attractive area of research. However, proposed solutions are broadcast-based and result in overloading the constrained network
Improving TCP performance in ad-hoc networks using signal strength based link management [J]	Klemm F, Ye Z, Krishnamurthy S, Tripathi S	AdHoc Networks Journal, 2012, 12(4):175-191	propose an energy aware routing technique that selects the MAX energy holding nodes and calculate the average of nodes energy and if the path has maximum energy then in that case, the maximum average energy path is selected for sending data in network. This proposed method always utilizes the maximum energy nodes and for reliable connection it is essential in network.
An Efficient Routing Protocol for Wireless Networks.	S. Murthy and J. J. Garcia-Luna-Aceves,;	Mobile Networks and Applications, 1(2):183- 197, October 2010	Discussed that wireless technology provides noteworthy impact on Internet and Communication area. It is supported by popular technique known as Adhoc Network. In Adhoc Networks nodes are interconnected with each other using wireless link and also receiving attention in the scientific community. In this, routes may be disconnected due to dynamic movement of nodes. So route selection and topology combination is very difficult and challenging issue.
“Position Based Routing algorithm For Mobile Ad Hoc Networks”	G.S. Tomar	International Journal of Simulation-Systems, Science and Technology, January 2010.	Techniques for finding relative coordinate based on signal strengths provided justification for applying position based routing methods in ad hoc networks. . Due to the booming of the adhoc networks and the battery power is not expected to increase significantly in future, power aware routing schemes need the better investigation.
AODV PROTOCOL works	Z. J. Haas, M. R. Pearlman and P. Samar	Internetworking draft 4, Cornell University New York, USA., pages 1–11, 2010.	An intelligent AODV protocol that follows an efficient method of route discovery based on network density and probability, and adjusts itself dynamically based on the network density of MANET is proposed
Optimized Link State Routing Protocol (OLSR).	Clausen, T. and Jacquet, P. RFC3626:	RFC Editor United States, 2011.	It follows the signal strength and residual battery capacity of nodes for route selection through cross layer approach. The parameters used to calculate the link stability are the signal strength of the link and selective speed between the nodes.

Peer-to-peer File-sharing over Mobile Ad hoc Networks. PERCOMW .	Ding, Gang and Bhargava, Bharat.	International Conference on Statistical Physics Approaches to Multi-disciplinary Problems, 2012	This paper describes that current peer-to-peer file-sharing systems mostly worked on wired networks. Mobile ad hoc network is characterized as multi-hop wireless communications between mobile devices. It explains five routing approaches with different complexity, also enabled peer-to-peer file-sharing over mobile ad hoc networks. The complexity of the proposed approaches is evaluated and compared. It is concluded that the cross-layer protocols perform better than simply overlaying peer-to-peer searching protocol on mobile ad hoc networks
Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers.	Charles E. Perkins, Pravin Bhagwat.	ICCPCT 2013	Analysed that Wireless Ad Hoc Network is collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized network. An Ad-hoc network does not have any centralized arbitrator or server. Routing is process of selecting path in a network along which to send data packets. In this paper effect of different Mobility models and Data traffic are comparatively on the basis of different routing protocols AODV, OLSR and ZRP. The performance of these routing protocols is analyzed by three metrics i.e. End to end delay, Jitter and Throughput.
“Wireless and ad hoc network: the art of networking without a network”	M. Frodigh, P. Johansson, and P. Larsson.	IJAREEIE, July 2013	Studies that Mobile Ad-Hoc networks (MANETs) are collection of mobile nodes that dynamically forming a temporary network without pre-existing network infrastructure and communicate with its neighbors to perform peer to peer communication and transmission. Propagation models focused on predicting the average received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in close spatial proximity to a particular location. The accuracy of any particular propagation model in any given condition will depend on the suitability among the constraints required by the model and depend on terrain. A number of propagation models like Free Space and Two Ray ground have been exist. This work presents comparative study on the behavior of various routing protocols with path loss propagation models, various performance metrics used for this comparison such as packet delivery fraction, average jitter, throughput and average end to end delay.

## CONCLUSION

Most previous research efforts on service discovery does not address the problem of energy consumption. In addition, traditional service discovery at the application layer suffers from the redundancy of packet transmissions during the service and route discovery processes (the control messages for information discovery are necessary at both network and application layers). We presented piggyback mechanism that integrates the service discovery functionality with existing routing protocol. We examined the impact of network density and node mobility on the energy efficiency of the integrated service discovery protocol called EASARD.

## FUTURE ENHANCEMENT

This paper is intended for reducing delay and route cost but still the work will need to improve in packet delivery fraction by using effective algorithm, so that it can prove that it is more effective than the normal AODV.

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