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Energy supported AODV (EN-AODV) for QoS routing in MANET

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Abstract

A Mobile Ad-hoc Network (MANET) is a wireless network competent of autonomous actions. No infrastructure is required for nodes to communicate with each other in the network. MANET operates without centralized administration. The nodes are self configuring, independent, quickly deployable. Nodes are movable since topology is very vibrant and they have restricted energy and computing resources. Routing protocols should incorporate QoS metrics in route finding and maintenance, to support end-to-end QoS. General AODV routing faces problems like long route, time delay, mobility and many other while routing. The nodes low in energy level will not be in a position to complete the routing. The QoS parameters like throughput, PDR and delay are affected directly. The proposed Energy based AODV protocol (EN-AODV) announces energy and based on nodes sending and receiving rates and the sizes of the data to be transmitted it justifies whether its energy level is maintained or decreased. It calculates the energy levels of the nodes before they are selected for routing path. A threshold value is defined and nodes are considered for routing only if its energy level is above this threshold value. The work is implemented and simulated on NS-2. The simulation results have shown an increase in PDR, decrease in delay and throughput is maintained. The proposed EN-AODV provides more consistent and reliable data transfer compared to general AODV.

"Keywords: Adhoc;MANET;AODV;PDR;EN-AODV"

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1. Introduction

A mobile ad hoc network consists of wireless mobile nodes that can communicate with other nodes through wireless links without any fixed infrastructure. Mobile Ad-Hoc network [1] is a system of wireless mobile nodes that self-organizes itself in dynamic and temporary network topologies. Ad hoc networks are easier to organize than wired networks and are used in many applications, such as in human or nature induced disasters, battlefields, meeting rooms where either a wired network is unavailable or deploying a wired network is inconvenient. MANETs are characterized by self-configured, dynamic changes of network topology, limited bandwidth, instability of link capacity and other resource constraints. This dynamic nature of MANET makes it enormously complicated to obtain accurate knowledge of the network state and that's why the consistency of data transmission in this network cannot be guaranteed

There have been many MANET routing protocols, which fall into several categories: proactive routing protocols such as dynamic Destination-Sequenced Distance-Vector routing (DSDV), Optimized Link State Routing (OLSR), Topology Broadcast based on Reverse Path Forwarding (TBRPF), on-demand routing protocols such as Dynamic Source Routing (DSR), Adhoc on demand distance vector (AODV), Signal Stability-based Adaptive routing (SSA). Proactive routing protocols have little delay for route discovery and are robust enough to link breaks and obtain a global optimal route for each destination. However, their routing overhead is also high. On-demand routing protocols are easy to realize and their overhead is low. But routes in on-demand routing protocols are easy to break in the case of topology variations. In AODV [2] node doesn't have any information about other nodes until a communication is needed. By broadcasting HELLO packets in a regular interval, local connectivity information is maintained by each node. Local connectivity maintains information about all the neighbours.

In ensuring QoS provisioning, a network is expected to guarantee a set of measurable pre-specified service attributes to the users in terms of end-to-end performance, such as challenging task to ensure QoS provisioning including routing in ad-hoc networks due to the mobile and dynamic nature of the nodes. Recent Qos solutions are planned to operate on trusted environments and totally assume the participating nodes to be cooperative and well behaved [3,4]. The major drawback of conventional AODV protocol is the absence of the Quality of Service (QoS) provision that make routing protocols which requiring applications of QoS lower efficiency.

MANETS usually consist of mobile battery operated devices that communicate over the wireless medium. These devices are battery operated and therefore need to be energy conserving so that the battery life of each individual node can be extended. To make the most of the lifetime of an ad hoc network, it is essential to lengthen each individual node life through minimizing the total transmission energy consumption for each communication request. Therefore, an efficient routing protocol must satisfy that the energy consumption rate at each node is evenly distributed and at the same time the total transmission energy for each request is minimized.

Therefore, energy for nodes needs to be considered while routing since nodes may drain out of energy levels. Though a node is providing its complete support for routing it can perform well only if it has sufficient energy. Traditional AODV does consider the energy levels of nodes before routing. Energy is announced by the proposed AODV protocol that checks for energy levels of nodes before taking part in routing in order to make the MANET routing efficient and effective and also ensure Qos.

2. Literature survey

An energy efficient routing protocol for maximizing lifetime in MANET [5] is introduced. If the network is divided into more than two, and one of the nodes consumes all the energy, that node can no longer participate in the network. In recent years, more works has been under taken to not only improve the energy storage but also to lengthen the networks lifetime. A enhanced AODV routing protocol is presented which is modified to improve the networks lifetime in MANET .One improvement for the AODV protocol is to maximize the networks lifetime by applying an Energy Mean Value algorithm which considerate node energy-aware.

An energy consumption analysis based on mobility models [6] is discussed to know which protocol is better than another in different mobile network scenarios, four mobility models are proposed for simulating different scenarios of mobile ad hoc networks. Also a byte-based energy consumption evaluation methodology is introduced for the protocol assessment. The experiment built upon mobility models show that it is fit for the mobile ad hoc network with low node mobility, while AODV, DSR, and especially DSDV perform well on energy consumption for the mobile ad hoc network with high node mobility.

A novel cross layered energy based AODV protocol [7] is proposed. A dynamic energy conscious routing algorithm ECL-AODV where cross layer interaction is provided to utilize the energy related information from physical and MAC layers. This algorithm avoids the nodes which are having low residual energy. By maximizing the lifetime of mobile nodes routing algorithm selects a best path from the viewpoint of high residual energy path as part of route stability. The RTS/CTS transmission is a crucial step towards saving the energy of mobile nodes. In this scheme, the RTS/CTS transmission occurs after route discovery and route reply process. The path is reserved for further transmissions. The receiving power of sender, intermediate nodes and receiver are also another part of route stability. The protocol is implemented for achieving quality of service (QoS) in terms of average energy consumption, packet delivery ratio, end-to-end delay and throughput

An energy level based routing protocols-ELBRP [8] that not only makes the system energy consumption down but also prolongs the system lifetime and improves the delay characteristic. The proof of correctness and complexity analysis of ELBRP are presented and also compares the performance of existing protocols. The studies show that ELBRP has a better delay performance, and lower energy consumption and longer network lifetime.

The analysis are based on the comparison of two energy-based mechanisms called E-AODV, an energy consumption rate-based routing protocol, and F-AODV, a cross-layer-based routing protocol [9]. The trends and the challenges on designing cross-layer communication protocols for MANETs are investigated. The results show that the performance of the layer cooperation paradigm depends on the network characteristics and the application constraints.

An energy efficient integrated routing protocol (E2IRP) [10] for mobile ad hoc networks used in remote surveillance systems is presented. The integration of MAC and routing layers can effectively reduce the amount of control information being exchanged for discovery and maintenance of the route in the network. This in turn reduces the energy and time consumed for the processing of these packets. Though the number of packets and processing is less, the protocol provides a better reliability and throughput. The nodes are organized in concentric tiers around the gateway. The event reports are routed towards the gateway from one tier to another and the response is routed back to the source, in the same manner. The proposed E2IRP outperforms traditional AODV routing protocol in terms of battery power consumption and also the throughput.

A new routing protocol called energy-aware grid multipath routing (EAGMR) [11] protocol is proposed. The proposed protocol can conserve energy and provide the best path to route according to probability. Simulation results indicate that this new energy-aware protocol can save energy of mobile hosts and improve data packet delivery ratio

A novel energy saving energy routing protocol: ES-AODV [12] is presented. Nodes made use of the HELLO message mechanism in AODV and reduced energy consumed by inserting intermediate node iteratively. From performance analysis and simulation results, it could be found that ES-AODV had many advantages. Compared to the AODV protocol, ES-AODV prolonged nodes' lifetime and substantially improved the saving energy performance.

3. Proposed work

All Many energy management schemes have been proposed to evaluate energy values and most of the energy based protocols for calculated values based on the energy consumed by nodes during the transmission. Routing in mobile ad hoc networks is pretentious due to the dynamic nature of nodes, which are not stable and keep moving. But still nodes communicate with each other and exchange data within the available nodes on the network. The architecture of the proposed work is presented in fig 1.

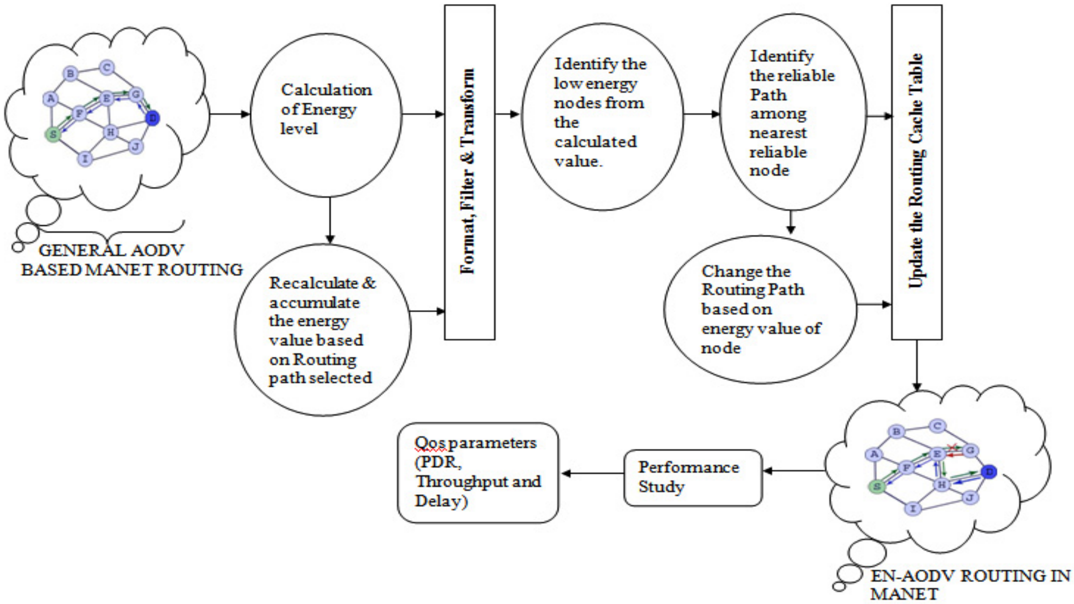

Fig.1. Architecture of proposed EN-AODV routing in MANET

The node energy level also plays a very crucial role in MANET routing. Focus is on identifying the nodes energy level consumed so far and energy level left over and higher than the threshold value assumed to be half the initial value of the nodes energy assumed, which should be sufficient for performing the upcoming transmission. If energy level not sufficient the proposed protocol selects an alternate path to carry on routing successfully using reliable nodes. The proposed work concentrates on identifying these unreliable nodes (running low in energy level) using the energy level values calculated for each node. The energy level value calculation is based on the parameters shown in the table 1.

Table 1. Energy value calculation parameters

Parameters	Description
Initialenergy	The initial energy of each node in the MANET set to default value 100 Joules
Maxenergy	The maximum energy is set to 0
Nodes	The number of nodes that are part of MANET
Nodeid	Unique Id of each node in MANET
Event	Energy consumption based on the various events like R – received, D – Dropped, S – Sent, F – Failed
Time	Time consumed for the event

Intermedenergy	The energy consumed for various events are accumulated for a each node separately and stored as intermediate energy
Consumedenergy	The energy consumed by a node to complete the transmission successfully
Totalenergy	The total energy consumed by all nodes in the network
Averagenergy	Average Energy consumed by a node

Energy calculation is based on nodes sending and receiving rate. If a node is selected for transmission then it should concentrate more on the corresponding transmission in order to save energy and not to drain out by involving in unnecessary transmissions. To identify energy level the nodes are evaluated where sender to increase radio frequencies to identify best nodes with more energy levels. Current Energy level of node can be calculated by the initial energy level and the consumed energy level of a node. Drawback in energy based work is that the source itself may drain out. In such cases introduce external energy to source node by introducing Virtual energy concepts. Other nodes have to store energy for future transmissions.

Energy value calculation procedure:
Step 1: Set initial parameters values as initialenergy = 100, maxenergy=0, nodes=50 and Nodeid (unique id for each node)
Step 2: Calculate Intermedenergy based on event , time where events can be (event = "r" || event= "d" || event ="s"|| event="f")
Step 3: Compute consumed energy for each node;
for (i in Intermednergy) {
consumenergy[i]=initialenergy-Intermedenergy[i]
totalenergy +=consumenergy[i]
if(maxenergy<consumenergy[i]){
maxenergy=consumenergy[i]
nodeid=i }}
Step 4: Compute average energy
averagenergy=totalenergy/nodes.

4. Results

The proposed EN-AODV protocol's performance is analyzed using NS-2 simulator. The network is planned and implemented using network simulator with maximum of 50 nodes and other parameters based on which the network is shaped are given in Table2. The simulator is applied with traditional AODV and with proposed energy based EN-AODV and results are obtained for assessment. The proposed EN-AODV protocol has shown good progress over the Qos parameters like PDR & Delay and throughput is maintained. PDR is increased and delay is reduced compared to the traditional AODV. The performance of the proposed protocol is also represented graphically where it clearly shows the betterment of the Qos parameters. The consumed energy levels of each node are also shown graphically.

Table 2. Simulation Parameter Values

Parameter	Value
Network size	1600 x 1600
Number of nodes	50
Movement speed	100 kbps
Transmission range	250 meters.
Packet size	5000

Traffic type	CBR
Simulation time	30 minutes.
Maximum speed	100 kbps
MAC layer protocol	IEEE 802.11
Protocol	AODV
NS2 version	2.34

The values obtained using traditional AODV and proposed EN-AODV at different node sizes are listed in table 3. The traditional AODV doesn't provide reliable routing since the nodes present in the network are not checked against its energy levels which may result in packet loss since node may drain out of energy.

Table 3**.** Result comparison with different node sizes

Node Size	Traditional AODV		Proposed EN-AODV	
	PDR	*Delay*	*PDR*	*Delay*
25	64.32	0.33567	84.15	0.19538
50	72.56	0.22496	94.93	0.09409
100	74.73	0.18624	89.25	0.12595

The Qos parameter values are showing better improvement when the routing takes place with the proposed EN-AODV protocol which works using energy levels of each node that identifies nodes with low energy levels in the route and immediately take an alternate path to provide reliable routing. The results shown in the following table clearly shows the PDR and delay of the proposed EN-AODV protocol are superior compared to traditional AODV protocol at different node sizes. Fig 2 specifies the increase in PDR by implementing the proposed energy based EN-AODV protocol compared to the traditional AODV protocol. Fig 3 specifies the decrease in delay while using the proposed energy based EN-AODV compared to traditional AODV. Fig 4 specifies the energy consumed by each node in the MANET during the transmission.

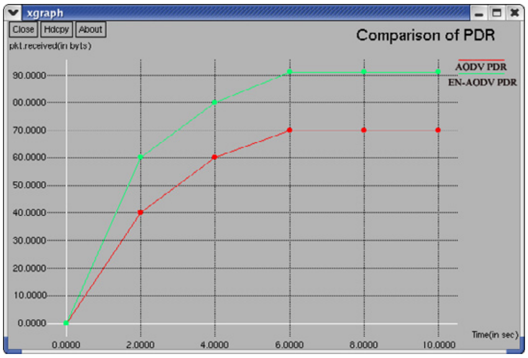

Fig.2. Comparison of general AODV PDR and EN-AODV PDR

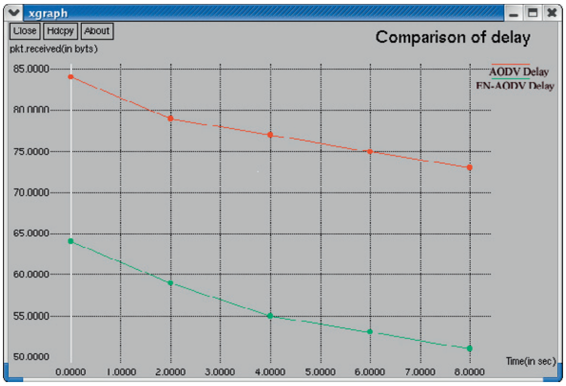

Fig.3. Comparison of general AODV Delay and EN-AODV Delay

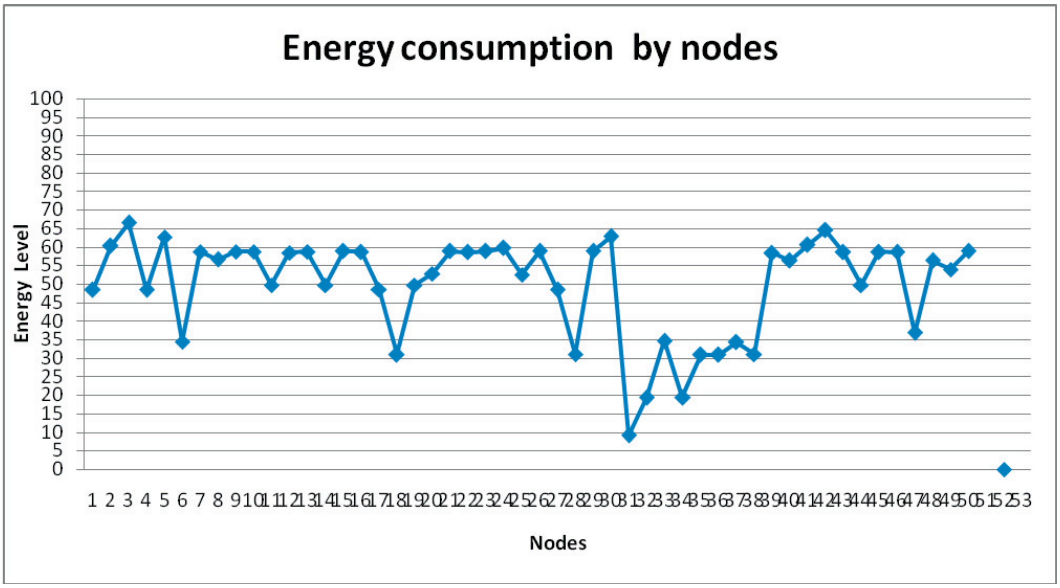

Fig.4. Comparison of energy consumed by nodes in MANET

5. Conclusion and future enhancements

In this paper, energy based EN-AODV protocol is proposed that identifies the nodes that drain out of energy level during data transmission. Energy value for each node is calculated to spot the unreliable nodes in the path during routing. A node is which has sufficient energy level for the transmission is selected for routing. This proposed scheme has shown a good development over Qos parameters like PDR and delay and has also provided reliable routing. The same scheme can also be implemented on other MANET routing protocols and check the performance with respect to Qos parameters. The future work may provide an encryption scheme for secured packet transmission and also to provide virtual energy for source nodes participating in the routing to still more enhance reliability in MANET routing.

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