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ENERGY AWARE ZONE ROUTING PROTOCOL FOR MANET

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ABSTRACT

Mobile ad hoc network (MANET) is a dynamic network consisting of a collection of wireless mobile nodes that communicate with each other without the need of centralized authority. Each node can send and receive data, and it should also forward routing information unrelated to its own use. Routing protocols in MANET establish path between source and destination based on number of hops. Establishment of shortest path alone is not sufficient to prolong the network lifetime. Energy consumption reduction methods are necessary as the nodes in MANET are restricted by battery supply. Energy is drained when the MANET nodes transmit and receive the data. For itself, energy management techniques are necessary to improve the performance of the routing protocol. Both proactive and reactive protocols have trade-off in them. Zone routing protocol (ZRP) is a hybrid protocol which overcomes the shortcomings of proactive and reactive routing protocols. ZRP divides the entire network into zones of variable size where routing inside the zone is performed using proactive routing approach and exterior to zone is performed using reactive routing approach. The performance characteristics of the ZRP protocol are established through simulations by comparing it to well-known routing protocol, namely, AODV.

Keywords: MANET, Adaptive routing, Energy aware protocols

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INTRODUCTION

Mobile ad-hoc network (MANET)

A MANET consists of group of independent mobile nodes that can communicate with each other through radio waves [1,2]. The mobile nodes that are in wireless range of each other can directly communicate, whereas others need the help of intermediate nodes to route their packets [3-7]. Each of the node has a wireless interface to communicate with each other. Special features of MANET are dynamic topology, unstable links, limited energy capacity, and absence of fixed infrastructure. Some of the applications of MANET are military applications, emergency operations, wireless mesh networks, and wireless sensor network [8-12]. The unique characteristics of MANETs have led to the design of MANET routing protocols. A routing protocol is a process by which user traffic is directed and transferred through the network from a source node to a destination node [13-18].

MANET routing protocols

In MANET, Routing protocols are classified into three types, namely: (1) Proactive or table driven [19-21] (2) reactive or on-demand [22-24] and (3) hybrid protocol [25-27].

Proactive routing protocol

This protocol is also known as table-driven routing. It preserves the route data when it is needed. This protocol makes use of an already existing route. It maintains routes to all possible destinations even while some of the routes may not be required. Each node in the network maintains tables of routes and when there is a change in network topology; updates are transferred across the network. Some of the examples of proactive protocols are destination sequenced distance vector, optimized link state routing.

Reactive routing protocol

It is an on-demand routing protocol. In this protocol, the route is created only when it was required. If a node desires to transmit a packet to another node first check route through on demand and after that it establishes the connection between the mobile nodes. The source node starts the route discovery segment. There are two stages in reactive routing after the node needs to send data to the destination. The source node broadcasts RREQ messages and is extend across the whole network. Routes are added to the list one time the RREP packets came from the destination reach the source using different forwarders. Examples of Reactive protocols are DSR, AODV.

Hybrid routing protocol

Hybrid routing protocol is the combination of both proactive and reactive routing protocols. zone routing protocol (ZRP) and TORA are commonly used hybrid protocols.

RELATED WORK

Li *et al*. proposed an energy level-based routing protocol-ELBRP. It use a simple mechanism of delay in ELBRP. This delay mechanism is motivated by the fact that each node accepts only an previously arrived request packet and discards later duplicate requests. Using delay mechanism, request packets from nodes with lower energy levels are being transmitted after a longer delay to the neighborhoods, thus they are more likely to be discarded than the packets from nodes with higher energy. This route discovery process continues until a destination node receives the first request packet whose recorded routes may include nodes with higher energy levels.

Safa *et al*. have described a power aware routing protocol for a MANET formed of heterogeneous nodes. The proposed PHAODV assumes that the nodes are enabled with an interoperability model that is a middleware which is mounted between the application layer and the lower layers of the protocol stack. PHAODV considers the node residual energy and the power cost when establishing heterogeneous routes between nodes. Two thresholds have been used by nodes to control their energy consumption: The first one aims at keeping a node aware of the changes in its residual energy. The second one aims at preventing nodes from being exhausted over routes when it is possible to use alternative routes.

Yitayal *et al*. proposed an energy efficient algorithm called balanced battery usage (BBU)-AODV which maximizes the lifetime of a MANET by avoiding routing of packets through nodes with low residual energy and balance the total energy consumption among all nodes in the network while selecting a route to the desired destination. The BBU-AODV algorithm combines threshold, summation of residual energy, minimum residual energy, and hop count as a cost metric and integrates these metrics into AODV in an efficient way.

Banerjee *et al*. proposed an experience-based energy-efficient reactive routing protocol (EXERP) which considerably reduces energy consumption during route discovery by electing a stable as well as lively path as the optimal one for communication between a given pair of source and destination nodes. EXERP assigns weights to these paths depending on the weight of the links. Among the various paths through which the route request arrives at the destination, any one with the highest path weight is elected as optimal and chosen for communication between the pair of source and destination nodes.

Zhang *et al*. proposed an energy-efficient broadcast scheme motivated by the analysis of the information dissemination process using the susceptible-infectious-recovered (SIR) scheme. In SIR scheme, a relay node does not forward the received packets indefinitely, which reflects the real-world scenarios where mobile devices usually have limited energy supply and buffer size.

Kashwan *et al*. proposed a new algorithm called energy-aware span routing protocol that uses energy-saving approaches such as span and the adaptive fidelity energy conservation algorithm (AFECA). The power consumption is further optimized using a hardware circuit called the remote activated switch to wake up sleeping nodes. In this approach, Span is combined with the existing combination of ZRP and AFECA to increase the energy efficiency.

PROBLEM DEFINITION AND BACKGROUND

Existing approach

Routing protocols for a MANET can be categorized into three groups: Proactive, Reactive and Hybrid. Energy management in MANETs is based on which routing protocols are improved to attain energy efficiency. The choice of the routing protocol aspects each of the dimensions along which energy is consumed, such as transmission, battery, device, and processor energy. In proactive routing, every node in the network constantly checks and evaluates paths to every other node in the network to establish a complete or partial view of the network. Consequently, routing latency is low because paths to destinations can be calculated locally quickly. In proactive approach, the channel usage overheads are high for route update control messages and the time to convergence of the network path data. If the control packets are not sent regularly enough, they cause the routing table entries at intermediate nodes along the path to expire, which will require route discovery procedures to be activated that use high amounts of pure broadcasting. This can lead to a broadcast storm problem, which also wastes large network throughput and causes high-power consumption in network nodes. Reactive protocols have lower overhead since routes are determined on demand and moreover constantly updating routing tables with the latest route topology is not required in on demand concept. The drawbacks of reactive protocols are the high cost of broadcast to establish routes and the latency inherent in the process of finding a route to the destination [26-28].

Problem statement

Energy is a limited resource in ad hoc wireless networks. Every node can play a role of either as a source, destination node, or as a router for forwarding packets to intended destination. Battery power of the node is primarily utilized for transmitting (and receiving) packets. The breakdown of some nodes or links causes failure in the network which will lead to partitioning of network. Since the lifetime of mobile nodes is restricted by their battery capacity, an energy efficient routing protocol is essential for sustenance of the network.

PROPOSED APPROACH

A hybrid technique has been conceived, using zone and cluster-based routing that aims to minimize the weaknesses of reactive and proactive approaches. The ZRP is a hybrid routing protocol that divides the network into contiguous zones. The proposed protocol uses a one hop clustering algorithm that splits the network into zones managed by reliable leaders that are mostly static and have abundant battery resources, in addition with some of the supporting computational protocols as mentioned in [26-32].

Objective

To develop an energy efficient zone-based routing protocol that uses parallel and distributed broadcasting technique to reduce redundant rebroadcasting and thereby maintaining low energy consumption at nodes.

ZRP protocol

The ZRP is constructed based on the concept of zones. A routing zone is defined for each and every node separately. It is also defined for the zones of neighboring nodes which overlap. In ZRP, there are further two sub-protocols, namely, intra-ZRP (IARP) and inter-ZRP (IERP). IARP is used inside routing zones where a particular node employs proactive routing whereas IERP is used between routing zones which employs reactive routing. The proposed protocol uses a one-hop clustering algorithm that splits the network into contiguous zones. Nodes in the ZRP have one of three roles: Zone leader (ZL), member or idle. By default, idle nodes can only hold a single role at a time. Various phases involved in zone construction are identifying ZL, role assignment for nodes, calculating the fitness factor, route discovery, reduction of redundant rebroadcasts, and route maintenance. ZRP architecture is shown in the Fig. 1 where data flow diagram is shown in Fig. 2 below.

Identifying ZL

During the initial phase, while formatting the network backbone, all nodes will exist with an idle role, and they will exchange Hello messages among themselves. Subsequently, two or more nodes will recognize their existence within their limited wireless range, and their roles are equal to idle. At this stage, they automatically decide to execute the zone construction protocol to decide fairly on the most reliable node to become the ZL of this zone. ZL is selected based on fitness criteria such as high battery power, high degree of connectivity and low mobility. Once selected, the remaining members of the zone construction process that are placed within a one-hop count of the newly selected ZL, may change their status to member nodes and start publishing their ZL IP through the Hello messages header in the ZL-IP field. The ZL eventually establishes connectivity among themselves directly or through reliable intermediate nodes.

Role assignment for nodes

ZRP protocol sorts the received FFs, and the first occurrence of the best FF identifies the ZL. Consequently, each ZRP should independently identify the same ZL. ZRPs with a one-hop count become member

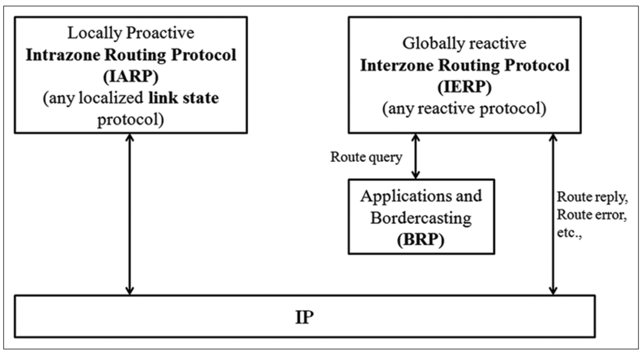

Fig. 1: Zone routing protocol architecture diagram

nodes and put the ZLs IP in their Hello headers, thus forming the zone. Any remaining ZRPs located within a hop count greater than one from the newly selected ZL become idle nodes and subsequently, they may become members of close by ZLs, or else they initiate a new zone construction process. This process will be repeated until every node belongs to a zone and has its own ZL or is one.

Fitness factor calculation

The zone construction process is used to recognize a ZL, thereby nodes with the most desirable attributes, such as minimum mobility, a high degree of connectivity, and plentiful battery power are preferred for the ZL role. The flow diagram and its subsequent compraission is shown in (Figs. 1 and 3-5). Each node in the network needs to calculate the distance to its one-hop neighbors using Euclidean formula.

Route discovery

A node in the network that has a packet to send initially checks whether the destination is within its local zone using information provided by IARP. In that case, the packet can be routed using proactive approach.

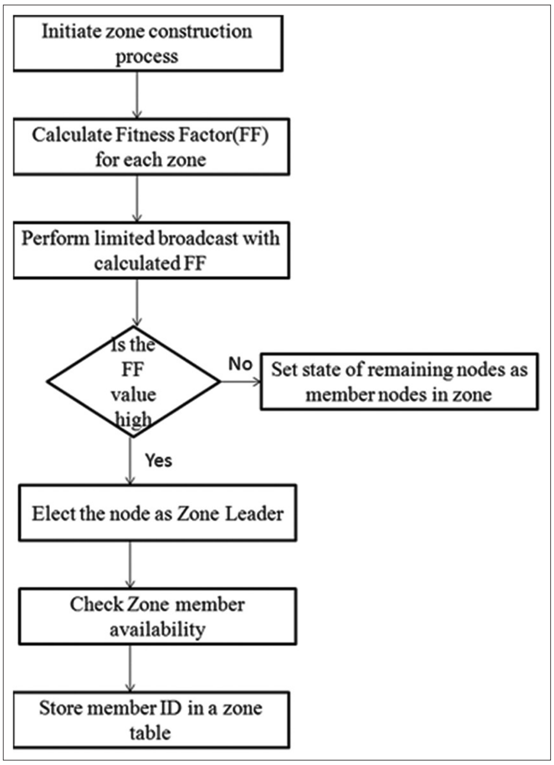

Fig. 2: Flow diagram

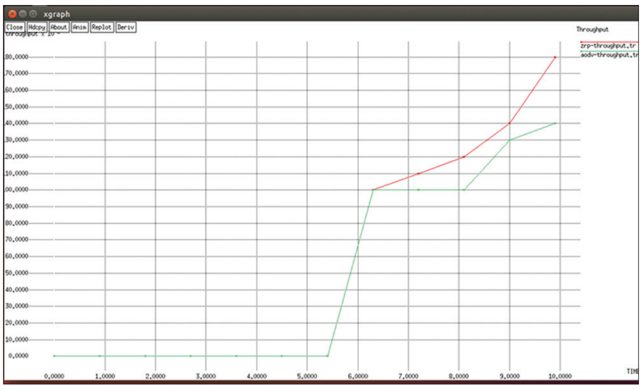

Fig. 3: Throughput comparison of zone routing protocol with AODV protocol

Reactive routing is employed when the destination is located outside the zone.

Reduction of redundant rebroadcasts

Routing between distant nodes of two different zones is done by a similar strategy to the time to live in the AODV protocol, but instead of hop numbers zone to live (ZTL) is used here. It refers to the number of zones a RREQ needs to cross before it gets discarded, that is when the ZTL value becomes zero. Member nodes in the network protect their zones from rebroadcasting needlessly. Where performance evaluation of the presented system is shown in the (Figs. 3-5) above. This ZTL value is conserved during the proactive data exchange among ZL nodes as they can readily identify the number of zones between themselves in the network.

Route maintenance

Route maintenance is essential in ad hoc networks, where links are damaged or broken and established as nodes travel relatively among each other with limited radio coverage. In ZRP, the knowledge of the local topology can be used for route maintenance. The proposed approach supports link failure maintenance similar to that used in the AODV routing protocol. That is, its nodes use periodic Hello messages or any packet such as RREQ and RREP to identify the link status of their neighbors that are part of active routes, thus when a link failure is noticed by one or more nodes, a route error packet message will be sent to pronounce a list of all unreachable destinations caused by this link failure to its neighbors, known as the precursor list, which are likely to use this node as the next hop to reach these destinations.

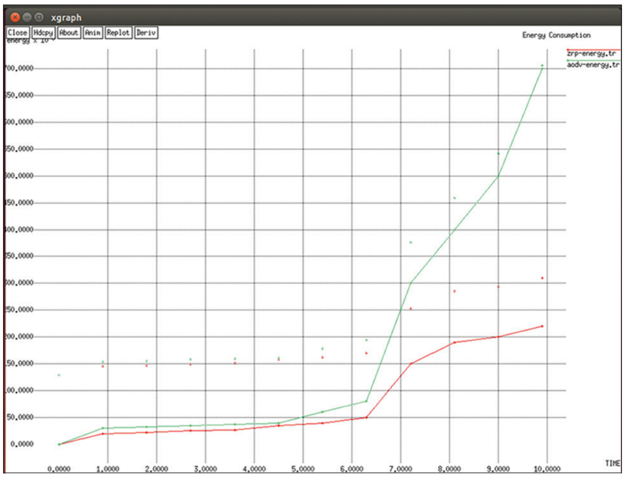

Fig. 4: Comparison of Energy consumption in zone routing protocol with AODV protocol

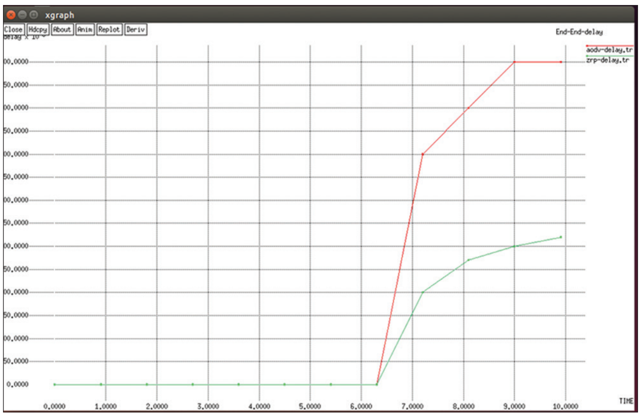

Fig. 5: End-to-end delay comparison of zone routing protocol with AODV protocol

Energy consumption model

At each network node, the energy cost of each packet was computed as the total of incremental cost relative to the packet size and fixed energy cost associated with channel acquisition.

CONCLUSION

MANET is the network of devices that communicate with the help of instant infrastructure. Each node in MANET is provided with a battery backup. Efficient use of this battery power is essential to establish a long-term communication between any two nodes in the network. An important goal of a routing protocol is to keep the network functioning as long as possible. It is achieved by reducing mobile nodes energy during active communication. A ZRP has been proposed and tested along with AODV protocol, to assess the foremost effectiveness. It was found that the ZRP can speed up the routing process in a MANET through its on-demand parallel broadcasting because it reduces redundant rebroadcasts. Using ZRP not only enhances the lifetime of the network but it also makes the communication more effective in terms of throughput and end-to-end delay. In sum, the simulation result shows that the ZRP meets its design objectives, and there is significant increase in energy efficiency.

REFERENCES

1. Basurra SS, De Vos M, Padget J, Ji Y, Lewis T, Armour S. Energy efficient zone based routing protocol for MANETs. Ad Hoc Netw 2015;25:16-37.
2. Safa H, Karam M, Moussa B. PHAODV: Power aware heterogeneous routing protocol for MANETs. J Netw Comput Appl 2014;46:60-71.
3. Ray NK, Turuk AK. A technique to improve network lifetime in mobile Ad hoc networks. Int J Commun Syst 2014;29(5):840-58.
4. Banerjee A, Dutta P, Ghosh S. Experience based energy efficient reactive routing protocol (EXERP) for mobile ad-hoc networks. Arabian J Sci Eng 2014;39(2):891-901.
5. Shankar S, Varaprasad G, Suresh HN. Importance of on-demand modi_ ed power aware dynamic source routing protocol in mobile ad-hoc networks. IET Microw Antennas Propog 2014;8(7):459-64.
6. Yitayal E, Pierson JM, Ejigu D. A balanced battery usage routing protocol to maximize network lifetime of MANET based on AODV. Switzerland: International Publishing; 2014.
7. Li L, Li C, Yuan P. An energy level based routing protocol in ad hoc networks. Wirel Pers Commun 2014;81(3):981-96.
8. Gopinath S, Nagarajan N. Energy based reliable multicast routing protocol for packet forwarding in MANET. J Appl Res Technol 2015;13(3):374-81.
9. Wang Y. Study on energy conservation in MANET. J Netw 2010;5:708-15.
10. Wu SH, Sheu JP, King CT. Unilateral wakeup for mobile ad hocnetworks with group mobility. IEEE Trans Mob Comput 2013;12(12):2507-17.
11. Song L, Hatzinakos D. Broadcasting energy efficiency limits in wireless networks. IEEE Trans Wirel Commun 2008;7(7):5517-27.
12. Kristensen MD, Bouvin NO. Energy efficient MANET routing using a combination of span and BECA/AFECA. J Netw 2008;3(3):49-56.
13. Kamboj P, Sharma AK. Energy efficient multicast routing protocol for MANET with minimum control overhead. Int J Comput Appl 2010;8(7):1-11.
14. Zhu J, Qiao C, Wang X. On accurate energy consumption models for wireless ad hoc networks. IEEE Trans Wirel Commun 2006;5(11):226-37.
15. Alghamdi SA. Load balancing ad hoc on-demand multipath distance vector (LBAOMDV) routing protocol. EURASIP J Wirel Commun Netw 2015;2015:242.
16. Ravi G, Kashwan KR. A new routing protocol for energy efficient mobile applications for ad hoc networks. J Comput Electr Eng 2015;48:77-85.
17. Chary VD, Padmanabham P, Rao BP. Energy efficient routing protocol for mobile ad hoc networks using trust based security. Int J Adv Res Comput Commun Eng 2012;1(9):605-11.
18. Sureshkumar N, Vijayalakshmi G, Natraj NA, Senthil T, Prabu P. Energy efficient routing protocol for MANET. Int J Comput Sci 2012;9(2):344-9.
19. Patil AP, *et al*. An Improved Energy Efficient AODV Routing Protocol for MANETs. Wireless and Optical Communications Networks (WOCN), 2014 Eleventh International Conference on IEEE; 2014.
20. Weng CC, Chen CW, Ku CJ, Hwang SF. A bandwidth-based power-aware routing protocol with low route discovery overhead in mobile ad hoc networks. Comput J 2010;53(7):969-90.
21. Junhai L, Liu X, Danxia Y. Research on multicast routing protocols for mobile ad-hoc networks. Comput Netw 2008;52(5):988-97.
22. Prakash S, Saini JP. A review of energy efficient routing protocols for mobile ad hoc wireless networks. Int J Comput Inf Syst 2010;1(4):36-73.
23. Banerjee A, Dutta P. Fuzzy-controlled power-aware routing protocol (FPRP) for mobile ad hoc networks. Int J Comput Appl 2010;11(7):39-43.
24. Zhu J, Wang X. Model and protocol for energy efficient routing over mobile ad hoc networks. IEEE Trans Mob Comput 2011;10(11):546-1557.
25. Zhang Z, Mao G, Anderson B. Energy Efficent broadcast in mobile networks subject to channel randomness. IEEE Trans Wirel Commun 2015;14(6):2929-41.
26. Rai A. An introduction of smart self-learning shell programming interface. J Adv Shell Program 2015;1(2):3-6.
27. Rai A. Automation of community from cloud computing. J Adv Shell Program 2014;1(2)
28. Rai A. Shell implementation of neural net over the UNIX environment for file management: A step towards automated operating system. J Oper Syst Dev Trends 2014;1(2):10-4.
29. Rai A. Parallelizing mutations for genetic algorithm. Recent Trends Parallel Comput 2015;1(3):7-9.
30. Rai A. Dynamic data flow based spatial sorting method for GPUs: Software based autonomous parallelization. Recent Trends Parallel Comput 2014;1(1):15-8.
31. Rai A. Dynamic pagination for efficient memory management over distributed computational architecture for swarm robotics. J Adv Shell Program 2014;1(2):1-4.
32. Rai A, Ramanathan S, Kannan RJ. Quasi Opportunistic Supercomputing for Geospatial Socially Networked Mobile Devices. Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE), 2016 IEEE 25th International Conference on IEEE; 2016.