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Enhancing Performance of Mobile Nodes by Improving Connectivity in Wireless Mesh Networks

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Abstract: Network partitioning is one of the unique challenges that occur in mobile ad-hoc networking environments. Team members might need to work in groups scattered in the application terrain in the case of crisis management and battlefield communication, but the limitation of MANETs make unsuitable for such applications. Mission-critical information has to be delivered to the right person at the right place and time in order to support decision making processes in the case of emergency Response and Battle Command Systems. In the proposed Enhanced Autonomous Mobile Mesh Network (EAMMNET), forms multiple groups with a single node designated as the lead node responsible for inter group communication. The EAMMNET designate a second node as the successor to the first node responsible for continuing intergroup communication in case of the lead node failure. The simulation is done using ns-2 for the proposed system.

Keywords: Wireless Mesh Network; Connectivity; AODV; Energy model

INTRODUCTION

The explosive growth of the Internet along with the advances in wireless technologies have caused the wireless networks, especially Wireless Mesh Networks (WMNs) to go through an important evolutions [1], [2]. The Wireless Mesh Networks (WMNs) have become a practical wireless solution for providing community broadband Internet access services along with the proliferation of Internet. Wireless Mesh Network has been recognized as one of the promising technologies to provide wireless broadband access [3]. These characteristics of these networks are in the stationary mesh routers wirelessly relay the traffic on behalf of the other mesh routers or client stations and thereby form a wireless backbone [3]. In MANETs and WMNs the range/capacity of the network is extended by active cooperation of the participating nodes. Nodes in the network act as routers and forward messages behalf of the other mesh nodes. The premise of node cooperation induces various challenging security issues [6]. Wireless Mesh Networks (WMNs) can be a special case of mobile ad-hoc networks where the nodes have relative fixed positions and communicate to the Internet through one or more gateways [1], [2], [3]. Finding a single best possible route to any destination out of the various paths that are available is the main aim of routing protocols designed for Mobile Ad-hoc NETworks (MANETs). Mesh Access Points (MAP) provide a standard WLAN interface and act as mesh routers which forward traffic towards the destination via other mesh routers or the gateway, which connects the mesh to the Internet for enabling potentially mobile clients to connect to the mesh [3]. In Infrastructure WMNs, Access Points (APs) provide internet access to Mesh Clients (MCs) by forwarding aggregated traffic to Mesh Routers (MRs), known as relays, in a multi-hop fashion until a Mesh Gateway (MG) is reached. MGs act as the bridges between the Internet and the wireless infrastructure [2].The traffic is primarily routed either towards the Internet Gateways (IGWs) or from the IGWs to the Access Points (APs) [5]. Nodes in the network act as routers and forward messages on behalf of the other nodes. The premise of node cooperation induces various challenging security issues [6],[7]. A mesh network is a network that employs one of two connection arrangements which can be either full mesh topology or partial mesh topology. Self-organizing and simple architecture of mesh network makes them handier for the users. The users are able to deploy, and maintain with limited technology experience [8], [9].

MOTIVATION

In [10], the authors proposed an on-demand channel reservation scheme to reserve some of mesh router radio interfaces (i.e., channels) to support the gateway traffic while the remaining interfaces can be used to support the local traffic.

In [11], there are three methods to classify the architecture of wireless mesh network. They are infrastructural backbone wireless mesh network, client wireless mesh network, and hybrid wireless mesh network. The proposed work focuses on hybrid mesh network, such that the gateway routers are used for accessing the Internet or external network. The mesh routers have been divided into two parts. They are: backbone mesh routers and border mesh routers.

Among several wireless mediums it is identified that the use of signal strength based cross layer approach resolves the congestion issues most of the times. The paper [12] gives a signal strength based measurements to improve such packet losses and no need to retransmit packets so that the node based and link based signal strength can be measured using it. If a link fails due to mobility, then the signal strength measurement provides it with temporary higher transmission power to keep the link alive. When a route is likely to fail due to weak signal strength of a node, it will then find an alternate path and consequently avoids the congestion. Some of the output parameters are used to prove the results of the above approach on AODV and DSR protocols.

In [13], the inter router nodes provide connectivity to an external network. Access Points (APs) provide connectivity to user devices and are collocated with mesh routers [13]. A majority of the traffic within the mesh is either from the user devices to the interrouter nodes or vice-versa. This traffic pattern is typical in wireless mesh deployments. Traffic flows will likely aggregate at routers close to the interrouter nodes. It is important that the placement occur after careful network planning in order to optimize network performance, reduce equipment costs, and address logistical constraints [13].

Wireless Mesh Network

One of the most popular WMN applications is providing the broadband Internet access. In this scenario, WMN routers can be installed on the roofs of the clients and/or light poles in the coverage area of the WMN. The mobile clients may roam while being handed over from one wireless router to another [2]. The main advantage of WMNs in comparison to traditional broadband Internet access technologies is the dramatically reduced initial investment and deployment time. The main advantage in comparison to fixed wireless area networks is the market coverage [3],[4],[7],[8],[6],[12],[14]. An important drawback of WLAN technology in multi-access point (AP) deployments is the requirement to separately provide wired network connectivity to each AP. WMNs in this category solves the problem by placing the APs in range of each other and allowing them to forward each other's packets to and from a common gateway [10]. The main drawback of these deployments is the reduced bandwidth available to the users [4]. Routing is a fundamental characteristic of WMNs. Several features of WMNs over competing technologies are directly enabled by the routing protocol [14].They are:

- Reliability: The routing protocol should be able to reroute fast around failed nodes and broken links; upon the failure of a gateway, it should be able to redistribute the orphaned clients among neighboring gateways. For this property, fast reconfiguration and support of multiple gateways is essential.
- Scalability/efficiency: If the routing protocol has a high overhead, it will be impossible to scale the WMN to a large number of nodes.
- Traffic pattern: In WMNs, most of the traffic is expected to flow between the clients and the Internet (via the gateways).In mobile mesh, the common assumption is that any node is equally likely to be the source or the destination of a traffic flow.
- Mobility: In most WMNs, nodes belong to two distinct categories: either stationary (e.g., on lamp poles, roof tops, etc.) or mobile, capable of roaming in the coverage area provided by the stationary nodes.
- Physical Resource Constraints: Limited battery power is most important and challenging constraint forced on mobile mesh network host. The power supply is determined by mobile mesh host directly. The energy consumption is the main issue in mobile mesh.

In this paper, we focus on the failure of wireless mesh nodes that may fail to provide continuous connectivity of mobile nodes in case of network partition caused due to the loss in physical resource constraints like battery.

ROUTING IN MESH NETWORKS

Routing is the process of information exchange from one host to the other host in a network [4],[20]. Routing is the mechanism is used to forward packet towards its destination through the most efficient path. In Ad-hoc network each host node acts as specialized router itself [9]. The dynamically change in network topologies also adds to this concept [19].

The Ad-hoc On Demand Vector routing algorithm is a routing protocol designed for Ad-hoc mobile networks and is used in this work [15]. It is an on demand routing algorithm and is capable of both unicast and multicast routing. On demand routing means that it establishes routes between nodes only as desired by the source nodes for transmitting data packets. These routes are maintained as long as they are needed by the sources. Destination sequence numbers is used to ensure the freshness of routes. It is a loop-free, self starting and scales to large number of mobile nodes [16].Dynamic link conditions, low processing and memory overhead, low memory utilization are quickly adapted using AODV, and it also determines unicast routes to destinations within the network [17,18].

EAMMNET

AMMNET is a mesh-based infrastructure for mobile client that forwards data towards the destination. A client can connect to any nearby mesh node directly or in directly. They use the property of multi-hop relay data to the destination mesh node through the intermediate mesh nodes. Routers in AMMNET are mobile platforms with autonomous movement capability and can forward data for mobile clients along the routing paths built by any existing ad-hoc routing protocols, e.g., AODV. Clients are not required to know their locations, and only need to periodically probe beacon messages. Once mesh nodes receive the beacon messages, they can detect the clients within its transmission range [1]. Mesh nodes can continuously monitor the mobility pattern of the clients using this capability and move with them to provide them seamless connectivity [1]. Routers are partitioned into two groups. Intra-group routers support intra-group communication; and inter-group routers prevent a network partition. Our main goal is to allocate dynamically a finite number of mesh nodes that cover large number of mobile clients as possible, while maintaining the connectivity between the groups of clients. Mobile mesh nodes can be classified into various types according to the current roles they play in the network to support the dynamically changing mesh topology.

• Intra-group routers: A mesh node act as an intra-group router if it detects at least one client within its radio range and is in charge of monitoring the movement of clients in its range. Intra-group routers that monitor the same group of clients can communicate with each other via multi-hop routing.

• Inter-group routers: A mesh node act as an inter-group router, i.e., if it plays the role of a relay node helping to interconnect different groups. For each group, we designate at least one inter-group router that can communicate with any intra-group routers of that group via multi-hop forwarding as the bridge router.

• Free routers: A mesh node act as free router if it is neither an intra-group router nor an inter-group router.

SYSTEM ENVIRONMENT

A few assumptions are made in our system design for the EAMMNET. We consider a target field to be a two-dimensional terrain with no obstacle. Information, such as locations and the list of detected clients is exchanged with their neighbouring mesh nodes. When obstacles are present in the application domain the radio range of the nodes may not be perfect. This factor may affect the accuracy of the sensing mechanism and, to a minor degree, the coverage [1]. However, this does not affect the general applicability of the proposed techniques for EAMMNETs. The clients belonging to the same group have similar movement characteristics. However, different groups of clients might move in different directions [1].The group mobility model has been verified as a realistic mobility model [1] and applied to many practical scenarios, such as campus networks and ad-hoc networks [1]. This work is done using ns-2.The Network Simulator 2 (ns-2) [9].

ENERGY CONSUMPTION MODEL

The experiment is based on energy model, which represents the level of energy in a mobile host. Each Mobile Node is assigned with an initial amount of energy at the beginning of simulation by setting the initial energy_ Tcl parameter. Each node also receives txPower_ and rxPower_ Tcl parameters that represent the amount of energy spent on transmitting and receiving packets respectively. When the energy level of the node goes down to zero, no more packets can be received or transmitted by the node and the next node which has comparative high charge will become next intergroup router.

SYSTEM STUDY

As simulation scenario having 60 mobile nodes spread over an area of (670x670) m is considered here. The routing protocol used is AODV. The simulation is stopped after 50 seconds. The purpose of the simulation example is to compare the dynamics of the energy level produced by the energy model to the battery level provided by the battery model. The experiment is based on Energy Model implemented in, which is an attribute of node in ns-2. Energy Model represents the level of energy in a mobile host. Experiment-related terms are given in table 1 and block diagram of NS2 mobile node with energy model is shown in fig. 1.the three cases of simulation scenarios are considered.

Case I: Methodology Used in Simulation-I

The energy model presented by Pal Chaudhuri and Johnson in [25], is used for this work. The mobile mesh nodes are divided into groups for simulation. The initial energy of each node is 1000 joules. Two-ray ground is used as propagation model. The communication with the members of same group takes place using multihop communication. All the inter group communication is maintained with the help of inter connecting node. Each group will have its own interconnecting node. The node with the highest battery power will be selected as the intergroup connecting node. All the outside communication has to take place through this node only. If the node maintaining the interconnectivity shut down because of loss in battery power, all the connectivity with other groups will be lost.

Table 1: Energy Consumption Parameters

ei	Energy Consumption during Idle mode
es	Energy Consumption during Sleep mode
et	Energy Consumption during data Transmission

Case II: Methodology Used in Simulation-II

In this simulation scenario the communication with the members of same group takes place using multihop communication, whereas all the inter group communication is maintained with the help of inter connecting node. Each group will have its own interconnecting node. All the outside communication has to take place through this node only. The node with the highest battery power will be selected as the intergroup connecting node. In the first simulation if the node maintaining the interconnectivity shut down because of loss in battery power, all the connectivity with other group members will be lost, where as in this scenario the next node with the highest battery power will take over the function of the inter group communication after the first intergroup communicating node fail. So the intergroup communication will prolong. Even if this node fails due to the loss of all its battery power, the next node will take over and maintain full connectivity.

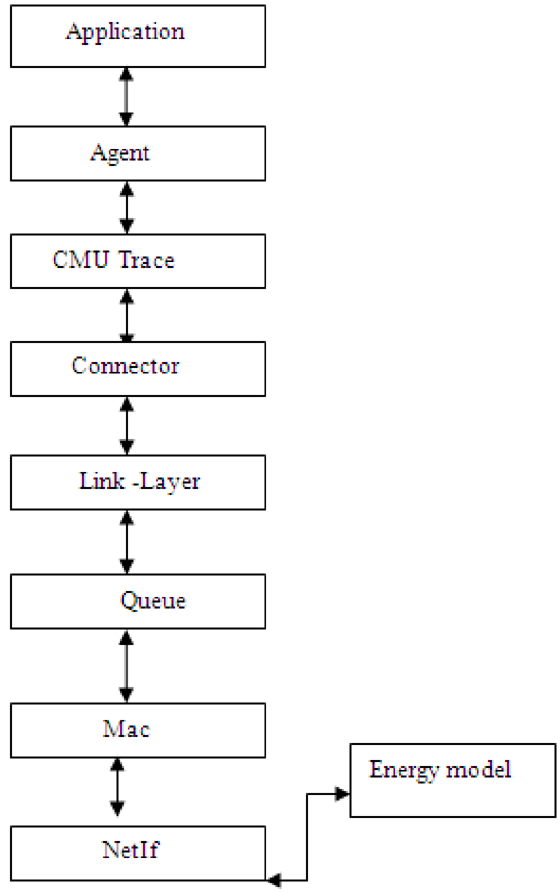

Fig1: Block diagram of NS2 mobile node with energy model

Case III: Methodology Used in Simulation-III

Each group will have its own interconnecting node. All the outside communication has to take place through this node only. The node with the highest battery power will be selected as the intergroup connecting node. When this node start indicating that it is losing its battery power and is about to shut down completely, the next node with highest battery is found. It constantly monitors to ensure that selected node has highest battery power even when the initial intergroup connecting node discharges completely, if any other node has high battery power at this time then the third node will be made the role of maintain the intergroup connectivity not the second one. This is because during the time of initial node takes to discharge completely the second node may have lost some of its energy. When the node responsible for maintain the inter group connectivity start indicating that it is about to shut down at time t1 and node 2 is found to have the highest energy at

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Table 2: Parameters for simulation

Parameters	Values
MAC Type	IEEE 802.11
Antenna	Omni directional
Simulation Time	300 sec
Transmission range	600 x 600 m
Node speed	1 m/s to 10 m/s
Traffic Type	TCP
Mobility Model	Random Waypoint
Interface Queue Type	Drop Tail/Priori Queue
Interface Queue Length	50
Energy Model	EnergyModel
No. of Nodes	38
idle Power	0.005
rxPower	1.0
txPower	5.0
sleep power	0.0001
Transition Power	0.0002
Transition Time	0.0005

time. But when node1 shutdown completely at time t2, it again checks which nodes have the highest energy and node3 may have more energy than node 2 at time t2. Node 2 may have lost some of its energy at that time.

Performance evaluation of the three simulation scenarios are evaluated based on the parameters named: throughput, average end to end delay and packet transmitted. Results of various simulations are shown in the table 3.

Table 3: Shows the results of the simulation

Simulation	Throughput	Average end to end delay	Packet transmitted
I	30.45 KB	478.56ms	20775
II	105.55 KB	110.33ms	34677
III	200.44 KB	261.41ms	43568

Throughput of the simulation III will be higher than the other two simulations because the node that is selected as the intergroup connecting node can serve for more time while comparing with other two simulations. Each time when a new node is assigned as the inter group connecting node the energy of all other nodes are constantly being monitored. It constantly monitors to ensure that selected node has highest battery power even when the initial intergroup connecting node discharges completely.

In the case of simulation I the throughput will be very low because when the node responsible for maintaining intergroup connectivity fails due to energy discharge there is no secondary node assigned to take over its responsibility and hence no packets will reach the destination. In the case of simulation II the throughput is less than simulation III because the failure of node that is assigned the role of maintaining intergroup connectivity is more common due to energy loss. Similarly in the case of packet transmitted also more for simulation III and lowest rate for simulation I. Comparison in terms of energy of the node assigned as intergroup communicator of the three simulations is shown in figure 2. The remaining energy is plotted against initial energy in the graph. Initial there is an overlap between the graphs, this indicate period where node is initially starts its role. The energy consumption in case of simulation I is a steep slope because if the node responsible for intergroup connectivity fails, there is no secondary node to take over and thus all other node. In the case of simulation III the secondary take over when initial node fail ,so there is a steep slope initially then when that node fail secondary node take over. In case of simulation II the slope is not steep.

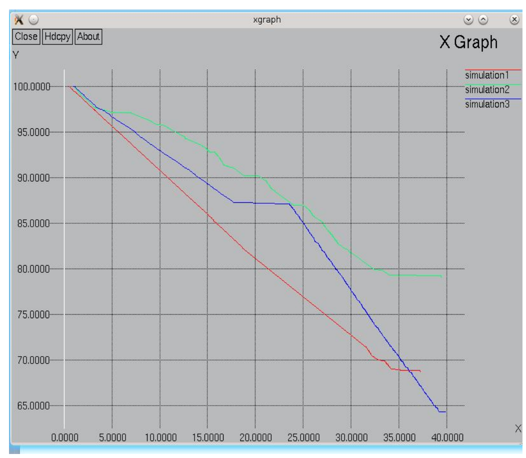

Fig. 2: Comparison in terms of energy of various simulations of a single node

CONCLUSION

Crisis management and battlefield communications are critical application where the mobile users need to work in dynamically formed groups that occupy different parts of a large and uncertain application terrain at different times. Challenges are due to the potentially hostile environment and the uncertainty in how the application terrains unfold with time. Unlike conventional mobile Ad-hoc networks that suffer network partitions when the user groups move apart, the mobile mesh routers of an EAMMNET track the users and dynamically adapt the network topology to seamlessly support both their intragroup and inter-group communications. EAMMNET provides continuous connectivity to all the mobile users. The proposed Enhanced Autonomous Mobile Mesh Network (EAMMNET), forms multiple groups, each with a single node designated as the lead node responsible for inter group communication.

REFERENCES

1. i-Liang Shen, Kate Ching-Ju Lin, Kien A. Hua "Autonomous Mobile Mesh Networks," Mobile Computing,IEEE Transactionson, vol:13, Issue:2 Page(s): 364 – 376,Feb 2014.
2. Djohara Benyamina, Abdelhakim Hafid, Michel Gendreau "Wireless Mesh Networks Design — A Survey",IEEE Communications Surveys & Tutorials, vol. 14, NO. 2, Page(s): 299 – 310, May 2012 .
3. Dely, P. , Karlstad Univ., Karlstad, Sweden , Kassler, A. , Bayer, N ,"OpenFlow for Wireless Mesh Networks",In proceedings of the of 20th International Conference Computer Communications and Networks (ICCCN). Page(s):1 – 6,Aug 2011.
4. S. Huang ,R. Dutta, "Design of wireless mesh networks under the additive interference model", IEEE International Conference on Computer Communications and Networks (ICCCN), October 9-11, USA, 2006.
5. Loscri, V. "A Routing Protocol for Wireless Mesh Networks ",Vehicular Technology Conference, 2007. VTC-2007 Fall. 2007 IEEE 66th Publication, Page(s): 1523- 1527.Oct 2007.
6. Graffi, K. , Mogre, P.S. , Hollick, M. , Steinmetz R. ,"Detection of Colluding Misbehaving Nodes in MobileAd-hoc and Wireless Mesh Networks" Global TelecommunicationsConference,2007. GLOBECOM '07. IEEE, Page(s): 5097 - 5101 , Nov. 2007.
7. Wei Zhou ; Xi Chen ; Qiao,D."Practical Routing and Channel Assignment Scheme for Mesh Networks with Directional Antennas" IEEE International Conference Communications ICC '08 , Page(s): 3181 - 3187, May 2008.
8. Jangeun Jun, Mihail L. Sichitiu ,"MRP: Wireless mesh networks routing protocol", Wireless mesh networks routing protocol, Comput. Commun. ,2008.
9. G. Jose, Moses,D., Sunil Kumar ,Prof.P.Suresh ,Varma, N.Supriya " A Simulation Based Study of AODV, DSR, DSDV Routing Protocols in MANET Using NS-2", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 3, March 2012.
10. H. A. Mogaibel, M. Othman, S. Subramaniam, N. A. W. Abdul Hamid, "On-demand channel reservation scheme for common traffic in wireless mesh networks" ,Journal of Network and Computer Applications, vol. 35, no. 4, pp. 1329–1351, 2012.
11. Mohammad Meftah Alrayes, Sanjay Kumar Biswash, Neeraj Tyagi, Rajeev Tripathi, Arun Kumar Misra, and Sanjeev Jain, "An Enhancement of AODV with Multi-Radio in Hybrid Wireless Mesh Network" ISRN Electronics Volume 2013 (2013), Article ID 925176, 13 pages,2013.
12. Prof. Shitalkumar Jain, Miss. Sunita I. Usturge, "Signal Strength Based Congestion Control in MANET", Advances in Physics Theories and Applications, Vol 1, pp. 26-36, 2011.
13. K. N. Ramachandran, E. M. Belding, K. C. Almeroth, M. M. Buddhikot, "Interference-aware channel assignment in multi-radio wireless mesh networks," in Proceedings of the 25th IEEE International Conference on Computer Communications (INFOCOM '06), vol. 1,pp. 1-12, April 2006.
14. Mihail L.Sichitiu, Wireless Mesh Networks: Opportunities and Challenges, IEEE Communications Mazagine, pp. 73-80, Nov. 2011.
15. Rua Yang ; Zhi-yuan Li ,"A stablity routing protocols base on Reverse AODV",Computer Science and Network Technology (ICCSNT), 2011 International Conference, vol. 12, Page(s): 2419 – 2423,2011.
16. Liu Yujun ; Han Lincheng , "The research on an AODV-BRL to increase reliability and reduce routing overhead in MANET" Computer Application and System Modeling (ICCASM), 2010 International Conference, Page(s): 526 -530, 2010.
17. Jian Liu ; Fang-min Li , "An Improvement of AODV Protocol Based on Reliable Delivery in Mobile Ad-hoc Networks " Information Assurance and Security, 2009. IAS '09. Fifth International Conference , vol 1,Page(s): 507 - 510 ,Aug 2010.
18. Ayash, M. , Mikki, M. , Kangbin Yim "Improved AODV Routing Protocol to Cope with High Overhead in High Mobility MANETs " Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), 2012 Sixth International Conference , Page(s): 244 – 251,July 2012.
19. Gouda, B.S. , Panigrahi, P.P. , Shial, R.K. ,"Efficient Optimal Route Stability Routing Protocol inMANET Using Gauss-Markov Mobility Model " Advances in Computing and Communications (ICACC), 2013 Third International Conference, Page(s): 445 – 448 ,2013.
20. Julith Jacob,shinu Koyakutty , "A Hello Messaging Scheme for Neighbor Discovery in Manet" National Conference on Information and Communication Technologies"(NCICT-2014) BPC college pivaram,March4,2014