New Protocol To Save Power In Ad-Hoc Networks

Hussein A. Lafta
Computer Science Department - Science Faculty for Girls - Babylon University
Bashar J. Abbas
Computer Science Department - Science Faculty - Babylon University

Abstract

An ad hoc network is a collection of wireless mobile nodes (or routers) dynamically forming a temporary network without the use of any existing network infrastructure or centralized administration. Nodes in an ad hoc wireless network are powered by batteries. Therefore, reducing power consumption is an important issue in ad hoc wireless networks We proposed a new protocol to save power in ad hoc network by finding the least busy routes where all intermediate nodes less busy. This paper also includes generating simulation environment to test the suggesting protocol . It was also compare the results with traditional ad hoc routing protocol.New protocol to save power in ad hoc network will be reactive (on demand) and vector protocol (hop-by-hop).Simulation results shows that proposed protocol can save power consuming more than traditional ad hoc routing protocol with little time delay.

الخلاصة

برتوكول جديد لتوفير استهلاك الطاقة في الشبكات الخاصة

الشبكات الخاصة هي مجموعة من الأجهزة اللاسلكية المتنقلة والتي تشكل شبكات مؤقتة بدون استخدام أي بنى تحتية مسبقة او إدارة مركزية. جميع الأجهزة في الشبكات الخاصة تستخدم البطاريات كمصدر للطاقة لذلك تقليل استخدام الطاقة في هذا النوع من الشبكات يعد من المواضيع الهامة .لقد قمنا بتقديم برتوكول جديد لتوفير استهلاك الطاقة في الشبكات الخاصة من خلال إيجاد مسار يتضمن وجود اقل الأجهزة انشغالا .هذا البحث يتضمن أيضا توليد نظام محاكاة لاختبار البرتوكول المفترض وكذلك مقارنة النتائج المتولدة من نظام المحاكاة مع نتائج اختبار برتوكول تقليدي للشبكات الخاصة. البرتوكول الجديد سوف يكون تفاعلي و اتجاهي النظام . نتائج المحاكاة أظهرت ان البرتوكول المفترض يستهلك طاقة اقل من البرتوكول التقليدي مع زيادة في استخدام الوقت.

1.Introduction

A wireless ad hoc network is a decentralized wireless network. The network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity.

The decentralized nature of wireless ad hoc networks makes them suitable for a variety of applications where central nodes can't be relied on, and may improve the scalability of wireless ad hoc networks compared to wireless managed networks.

Minimal configuration and quick deployment make ad hoc networks suitable for emergency situations like natural disasters or military conflicts. The presence of a dynamic and adaptive routing protocol will enable ad hoc networks to be formed quickly.mobile ad hoc network developed out of the [Charles E. Perkins, 2001] "military need for survivability operation without preplaced infrastructure, and connectivity beyond line-of-sight communication". In despite of packet - switching technology was first introduced by ARPANet in the 1960s, at that time the microcomputer revolution and packet radio network ideas has not became truly applicable and feasible. Mobile ad-hoc networking (also known as Mobile Packet Radio Networking) is the name given to a technology under development for the past twenty years or so, principally by the Defense Advanced Research Projects Agency

(DARPA), the U.S. Army and the Office of Naval Research (ONR) [Joseph P. Macker and M. Scott Corson, 1999].
Soldiers must be able to move about freely without any of the restrictions imposed by wired communications devices. An additional motivation for ad hoc network is that the military cannot rely on access to a fixed, preplaced communications infrastructure in battlefield environments. A rapidly deployable self-organizing mobile network is the primary factor that differentiates ad hoc network design issues from those associated with commercial cellular systems.
Wireless networking has witnessed an explosion of interest from consumers in recent years for its applications in mobile communications [Adel Ben Mnaouer, Abdelfattah Belghith and Wafa Akkari, 2008].
Energy efficiency has recently become one of the most critical issues in routing of ad hoc networks [Gruia Calinescu, Sanjiv Kapoor, Alexander Olshevsky and Alexander Zelikovsky, 2003].
An ad-hoc network is a multi-hop wireless network where all nodes cooperatively maintain network connectivity without a centralized infrastructure. If these nodes change their positions dynamically, it is called a mobile ad-hoc network (MANET).
Thus, a MANET may simply be defined as a collection of mobile nodes that maintain inter-connection without the intervention of a centralized access point.
Each mobile node of an ad-hoc network operates not only as a host but also as a router, forwarding packets for other mobile nodes in the network that may not be within the transmission range of the source. Each node participates in an ad-hoc routing protocol that allows it to discover multi-hop paths through the network to any other node[Ritabrata Roy, 2002].
The objective of new protocol to save power in ad hoc network was to save power consuming in ad hoc network by find the least busy routes where all intermediate nodes less busy.
New protocol to save power in ad hoc network will be reactive (on demand) and vector protocol (hop-by-hop).
Because of ad hoc network is dynamic network the new protocol to save power in ad hoc network will use reactive routing strategy and it will be hop-by-hop protocol because it only include information about the destination in the header and that gives it the advantage of the limitation of the packet size.

2. Relate Work

In 2002 Anders Lindgren and Olov Schelen,[Anders Lindgren and Olov Schelen, 2002] proposed Infrastructured Aodv for Ad Hoc network . As many ad hoc routing protocols an AODV-node informs its neighbors about its own existence by constantly sending ``hello messages'' at a defined interval. This enables all nodes to know the status about their neighbors. To resolve a route to another node in the network AODV floods its neighbors with a route request(RREQ). The receiving node checks if it has a route to the specified node. If a route exists and the sequence-number for this is higher than the supplied a new route is found. The node replies to the requesting by sending a route reply (RREP).
The node replies to the requesting by sending a route reply (RREP). If on the other hand a route does not exist the receiving node sends a RREQ itself to try to find a route for the requesting node.
If the original node does not receive an answer within a time-limit the node can deduce that the sought node are unreachable. Since the request was sent to all neighbours the node may end up with several routes but they are easily separated by

the sequence numbers. nodes along the route keep their routing tables updated as long as traffic flows along the route.

In 2003 T. X Brown , S. Bhandare and S. Doshi, [T. X Brown , S. Bhandare and S. Doshi, 2003] proposed energy aware dynamic source routing (EADSR) protocol is an extension to the dynamic source routing (DSR) protocol for mobile ad hoc networks. It retains the features and benefits of DSR while it incorporates new features for energy limited nodes. The EADSR features include :

(1) A DSR header option so that link power costs can be passed with source routes.

(2) An extended route discovery protocol to find lower energy routes than minimum hop routes.

(3)An additional route maintenance mechanism that allows the source node to respond to link changes without route disruption.

In DSR, when a node receives a route-request message, it appends its identity in the message's header and forwards it toward the destination. Thus, an intermediate node always relay messages if the corresponding route is selected. However, in EADSR, a node determines whether to forward the routerequest message or not depending on its residual battery power (Er). When Er is higher than it's threshold value (Thr), the node forwards the route-request message; otherwise, it drops the message and refuses to participate in relaying packets.

In 2007 Fumiaki Sato and Sumito Liiima, [Fumiaki Sato and Sumito Liiima, 2007] proposed battery and power aware routing in mobile ad hoc networks by considering both of power consumption and the amount of the battery remainder.

To improve the availability of ad hoc networks, routing which considers both at the same time is needed though power consumption and the amount of the battery remainder have been separately examined in the research so far. They propose BPA-DSR (Battery and Power Aware enhancement to Dynamic Source Routing) which searches for the route by the flooding of two times.

The path with large amount of the battery remainder is detected by the first flooding, and the location of the neighboring nodes of the route is computed from the received radio power at the same time. Each link of the route is divided into the power saving link and tuned up by the flooding of the second. Simulation results show that the amount of the battery remainder of the proposed method is better than other method (LP-DSR) which is aware of the power.

In 2008 Adel Ben Mnaouer, Abdelfattah Belghith and Wafa Akkari ,[Adel Ben Mnaouer, Abdelfattah Belghith and Wafa Akkari, 2008] proposed mechanisms to enhance power saving for ad hoc networks using neighborhood information by reducing the number of exchanged announcement frames in order to increase the throughput and decrease power consumption and delay.

The proposed new mechanisms: BTA-PSM (Broadcast Topology Aware PSM) and UTA-PSM (Unicast Topology Aware PSM) strive to minimize the number of announcement frames sent during the announcement period by using the knowledge gained from the ATIM frames announcement exchanged so far to save further, useless announcements.

They showed that the new proposed mechanisms outperform PSM with respect to the energy power consumption, delay, throughput and power consumed per delivered data frame. That is both BTA-PSM and UTA-PSM thrive to deliver much more throughput

than PSM for a reduced value of ATIM window by reducing the number of exchanged announcement frames, yet provide better energy consumption.

In 2009 Yi-Chao Wu and Chiu-Ching Tuan,[Yi-Chao Wu and Chiu-Ching Tuan, 2009] proposed power saving routing protocol with power sieving in wireless ad hoc networks (PSRPS) they partitions the network area into several square grids by the location information such as global position system (GPS). Routing is performed in a grid-by-grid manner. One node is elected as the grid leader in its grid with power sieving mechanism without broadcasting election packets.
In PSRPS, the partial nodes join in the grid leader election to be elected as the leader and other nodes are tuned into sleep mode to save power. Therefore, PSRPS could save more power in the grid leader election and maintenance. Moreover, PSRPS reduces more power consumption when the density of nodes is increased by the simulation results.

Also in 2009 S. Chettibi and M. Benmohamed,[S. Chettibi and M. Benmohamed, 2009] proposed multipath energy-aware on demand source routing protocol for mobile ad hoc networks (MEA-DSR) he exploits route diversity and information about batteries-energy levels for balancing energy consumption between mobile nodes.
MEA-DSR protocol is based on DSR. In fact, DSR is a multipath routing protocol. However, in DSR multiple routes are stored in a trivial manner with no constraint on number or quality. MEA-DSR, limits the number of routes that a destination node provides to a source node to two. It was shown in that the performance advantage from using more than one or two alternate routes is minimal.
The choice of the primary route in MEA-DSR is conditioned by two factors: 1) the residual energy of nodes belonging to the route; 2) the total transmission power required to transmit data on this route.

3. New Protocol to Save Power in Ad-Hoc Networks Algorithm

The objective of proposed protocol was to save power consuming in ad hoc network by find the least busy routes where all intermediate nodes less busy.
New protocol to save power in ad hoc network will be reactive (on demand) and vector protocol (hop-by-hop).
As known an ad hoc network is dynamic network the proposed protocol will use reactive routing strategy and it will be hop-by-hop protocol because it include information about the destination in the header only and that gives it the advantage of the limitation of the packet size.
Algorithm of the proposed protocol consist the following main stages :

3. 1. Route Discovery

In this stage source node discovers a route through the network to destination node. When the node needs to send information to some destination, source node will initiate a route discovery process by sending a route request packet across the network to all nodes at the radio range of the source nodes.
Every route request packet has a unique identification number. The source node found the rout by examining packets queue for all nodes that overlaps with source node and chose the less packet queue node and repeating this until the request packet reaches the destination node.
To do this we generate network topology and distribute the network nodes using random function after that the nodes have their number starting from the [0,0] position continuing raw by raw. After that source node makes cross layer searching request to

find a rout path to the destination node. The (overlap) function list all the nodes at the transition radio range from the source node, then (rout) function examine the packet queue of these nodes to find the smallest queue. When the less busy node rout was found, the address of this node will be added to the packet and the packet goes to the packet queue of the source node, because may be there are some packets in this node waiting to be transmit.

3. 2. Packet Forwarding

When a node has receives a packet the node check if it data packet, rout replay or rout request.

If it is data packet then there is another check if this node the destination of the packet the node receives the data packet and sends an acknowledgement to the source node. Else that means the node must forward the packet to its destination using the rout path in this packet, so the packet will added to the packet queue of this node (when the nodes want to send any packet from the packet queue it check whether the sending channel busy or not, if it is busy the node white until it become free).

If it is rout replay the node will use this rout to transmit the data packets .

If it is not a rout replay then it is rout request, by using (overlap) function the protocol will list all the nodes at the transition radio range from the this node, then (rout) function examine the packet queue of these nodes to find the smallest queue. When the less busy node rout was found, the address of this node will be added to the packet and the packet goes to the packet queue of the source node.

3. 3. Route Maintains

Since the ad hoc network is a mobile network the protocol double check the distance between the transmission node and the receiver node using (dist) function, before the transmission and when the node transmit the data to ensure that the receiver node still at radio range of the transmitter node, if it is not the protocol begins to find new rout.

After sending the packet the source node must receive an acknowledgement showing that the packet reaches the destination. When no acknowledgement has been received after a set timeout (in this protocol the time out set to (0.2) depending on the parameter of [6]), the packet is resent after a timeout a set number of times (we set the number of resending the massage after time out to (3) to avoid wasting power and time) . If no acknowledgement is received after the three retransmissions, then a route error packet will be sent back to the source node to indicate that the link is broken and beginning to fine new rout.

Figure 1 illustrates the flowchart for the proposed protocol to save power in ad hoc network.

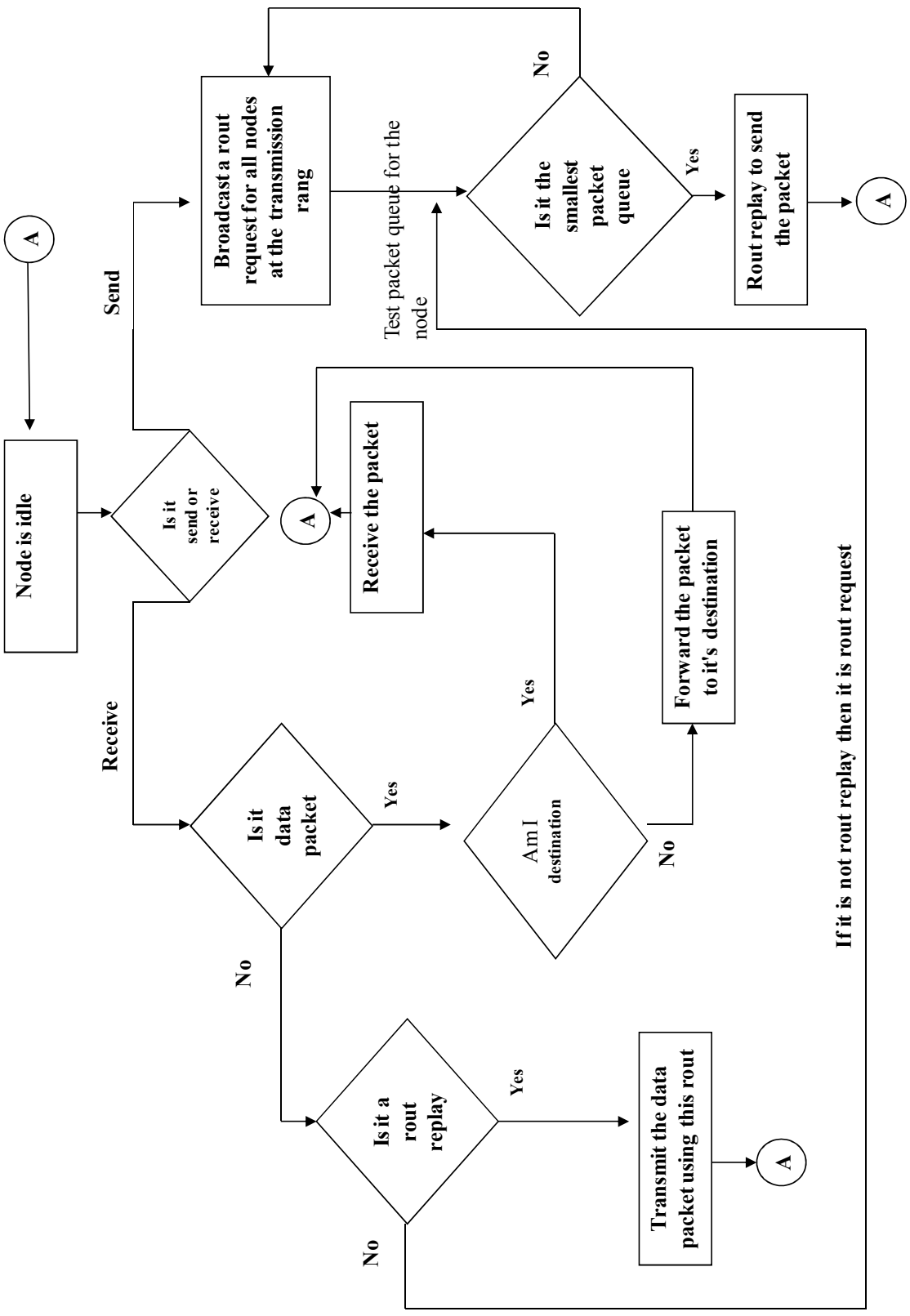

Fig 1

New Protocol to Save Power in Ad-Hoc Networks flowchart

4. New Protocol to Save Power in Ad-Hoc Networks Power Measurement

To find the power consumed by the proposed protocol we must have very accurate standard power measure. We measure power basically depending on crossover distance using (dist) function to find these distance, and depending on that distance the power measured.

If the distance less than crossover distance we use (free space propagation model [Zhibin Dou, Zenghua Zhao, Quan Jin, Lianfang Zhang, Yantai Shu and Oliver Yang, 2011]).If the distance more than crossover distance we use (Two-ray ground reflection model [F. Lassabe, P. Canalda, D. Charlet, P. Chatonnay and F. Spies, 2006]). We set crossover distance to (10 *m*) depending on [Ritabrata Roy, April 2002] and [Fumiaki Sato and Sumito Liiima , 2007].

Because of ad hoc network is mobile network we update the position before calculating distance using (position update) function [Roberto Corvaja, 2006].

5. Simulation Environment

There are many network simulators but we chose the following network simulators as the best possible candidates to run our simulation study:

- OPNET
- OMNeT++
- Network Simulator
- MATLAB

OPNET, OMNeT++ and Network Simulator NS are widely used in academic study of mobile ad hoc networks, mainly on network layer. but they are a huge packages that takes time to learn, modify and collect data.

While MATLAB is a computing platform that enables various simulation projects. It has been particularly used for wireless communications. But in general, MATLAB is an easy-to-use language that can do more.

For the above we decided to used MATLAB for simulation. MATLAB is quite difficult to use for first time user but once user get to know the MATLAB it becomes fairly easy.

51. Simulation model

The objective of the simulation is to generate simulation environment to test the suggesting protocol and compare the results with traditional ad hoc routing protocol.

Because of we did not have a model for traditional ad hoc routing protocol to tested with our protocol we must build two models the first one is traditional ad hoc routing protocol and the second one is our protocol.

We use Dynamic Source Routing (DSR) protocol as a traditional ad hoc routing protocol because it is simple and robust routing protocol designed for use in multi-hop wireless ad-hoc networks of mobile nodes [Rajendra V. Boppana and Anket Mathur, 2005].

We establish these models in two basic topologies the first on contain 10 nodes while the second one contain 20 nodes with two sub topologies to the second one at the end we get 3 different topologies .

The nodes at all topologies will distributed randomly.

5.2. Simulation results

The first simulation results illustrate in figure 2 :

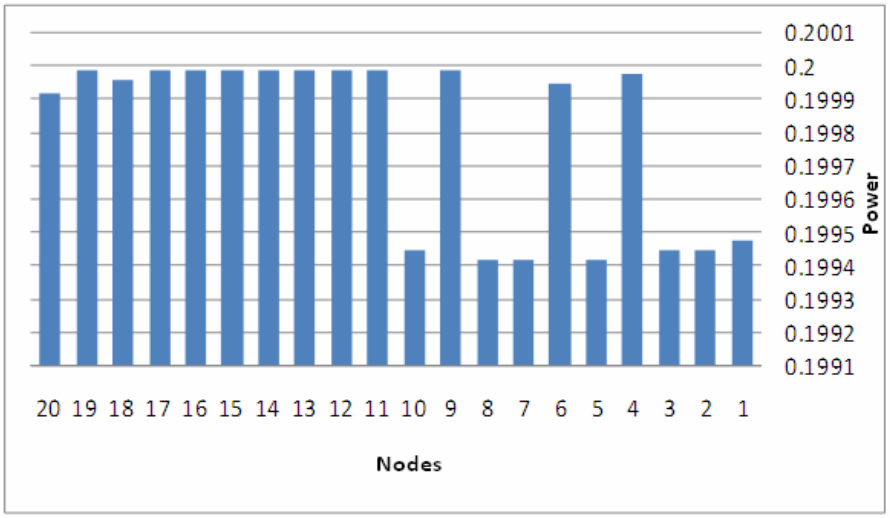

Fig 2

Remaining power at the nodes of dynamic source routing protocol model

The second simulation results illustrate in figure 3 :

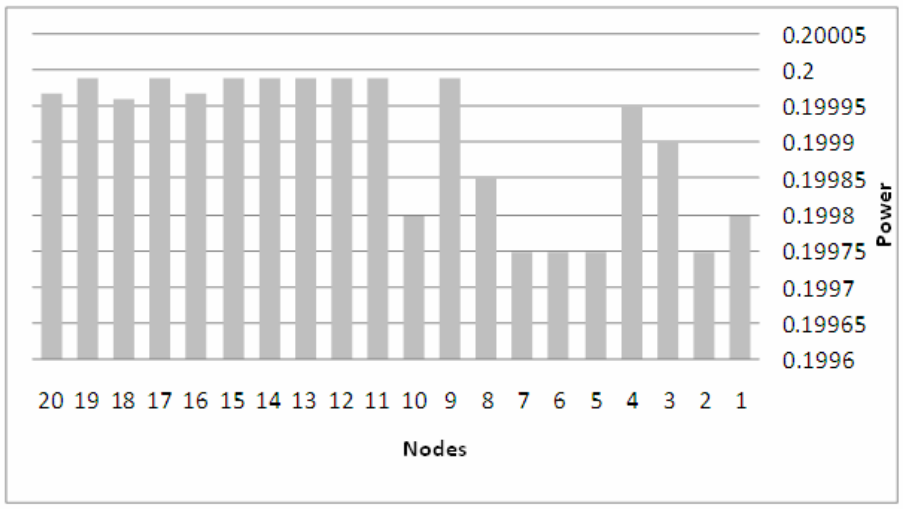

Fig 3

Remaining power at the nodes of the new protocol to save power in ad hoc network model

6. Conclusions

From the results of simulation for the two models new protocol to save power in ad hoc network model and dynamic source routing protocol model we find :

1. New protocol to save power in ad hoc network model consumes power less than dynamic source routing protocol model as we saw in figure 2 and figure 2.Acording to that we success to find a new protocol to save power in ad hoc network by find the least busy routes where all intermediate nodes less busy.
Figure 4 illustrate power consuming comparison between new protocol to save power in ad hoc network model and dynamic source routing protocol model .

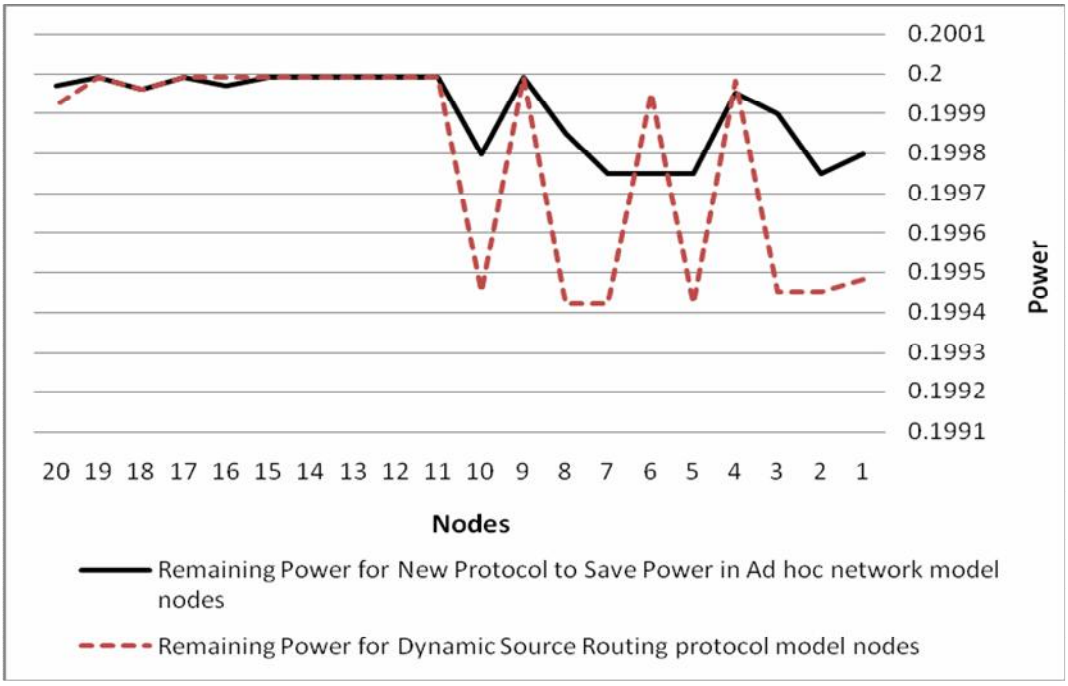

Fig 4
Power consuming comparison

2.We discover that new protocol to save power in ad hoc network model takes more time than dynamic source routing protocol model when they transfer packets between nodes in ad hoc network with three different topologies as we see in figure 5.

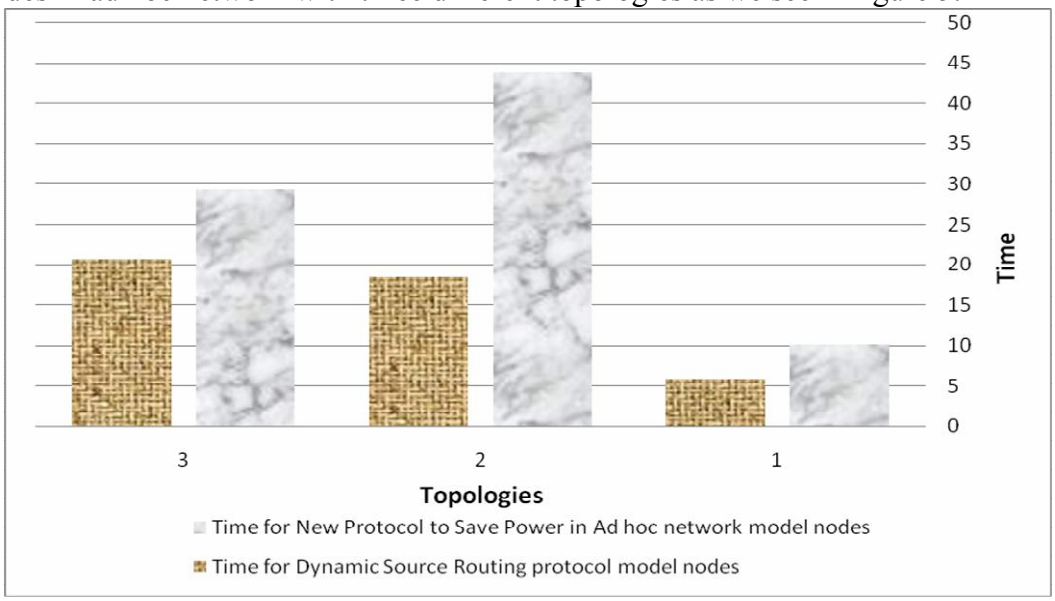

Fig 5
Packets transfer time comparison

REFERECES

Adel Ben Mnaouer, Abdelfattah Belghith and Wafa Akkari , 2008, Enhancing power saving mechanisms for ad hoc networks using neighborhood information, IEEE.

Charles E. Perkins, 2001, Ad-Hoc Networking, Upper Saddle River (NJ): Addison-Wesley.

Lassabe, F. P. Canalda, D. Charlet, P. Chatonnay and F. Spies, 2006, Refining WiFi Indoor Positioning Renders Pertinent Deploying Location-Based Multimedia Guide, IEEE Computer Society.

Fumiaki Sato and Sumito Liiima , 2007, *LNCS* - Battery and power aware routing in mobile ad hoc networks , Springer Volume 4658/2007, 30-39, DOI: 10.1007/978-3-540-74573-0_4.

Fumiaki Sato and Sumito Liiima , 2007, *LNCS* - Battery and power aware routing in mobile ad hoc networks , Springer Volume 4658/2007, 30-39, DOI: 10.1007/978-3-540-74573-0_4.

Gruia Calinescu, Sanjiv Kapoor, Alexander Olshevsky and Alexander Zelikovsky, 2003, Network lifetime and power assignment in ad hoc wireless networks, ESA'03.

Joseph P. Macker and M. Scott Corson, April 1999, Mobile Ad Hoc Networking and the IETF, ACM Mobile Computing and Communications Review.

Rajendra V. Boppana and Anket Mathur, December 2005, Analysis of the Dynamic Source Routing Protocol for Ad Hoc Networks, Workshop on Next Generation Wireless Networks.

Ritabrata Roy, April 2002, Introduction to Ad-Hoc Network Routing Algorithms , final term paper – Gorge Washington university.

Ritabrata Roy, April 2002, Introduction to Ad-Hoc Network Routing Algorithms , final term paper – Gorge Washington university.

Roberto Corvaja, 2006, Performance of Overlay Bluetooth–WiFi Networks with QoS-oriented Vertical Handover, IEEE Transactions on Mobile Computing.

Chettibi S. and M. Benmohamed, 2009, A Multipath Energy-Aware On demand Source Routing Protocol for Mobile Ad-Hoc Networks, 1st Workshop on Next Generation Networks: Mobility, WNGN, Maroc.

Brown , T. X S. Bhandare and S. Doshi , December 2003, Energy Aware Dynamic Source Routing Protocol , Internet Draft.

Yi-Chao Wu and Chiu-Ching Tuan, 2009, Power Saving Routing Protocol with Power Sieving in Wireless Ad hoc Networks, International Conference on Networks Security, Wireless Communications and Trusted Computing IEEE.

Zhibin Dou, Zenghua Zhao, Quan Jin, Lianfang Zhang, Yantai Shu and Oliver Yang, 2011, Energy-Efficient Rate Adaptation for Outdoor Long Distance WiFi Links, IEEE.