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Designing of Efficient Power Aware Routing Protocol for MANET Using PIC Controller

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Abstract*— *Ad hoc network is defined as a network that comes together as needed without the assistance of existing infrastructure. An ad hoc network consists of laptops and/or PDAs that exchange data when brought together. Many of the devices are battery operated and thus energy constrained. For instance, a typical battery used in laptops and PDAs with wireless adapter has a lifetime of two hours. Nodes in an ad hoc network share a symbiotic relationship where each node acts as an end host as well as a router. Thus each node carries out its individual processing as well as acts as a forwarding node, thus expending energy in processing and forwarding of packets. This reduces the lifetime of the nodes in an ad hoc network. Energy conservation is a critical issue as the lifetime of these nodes depends on the life of the system. Research has been carried out to conserve energy at various levels i.e., at the hardware level, operating system, application level. We changed a DSR protocol to incorporate that energy key metrics a new version called a Efficient power routing protocol (EPAR) based on residual battery power in simulation wise and we get minimum mean delay and maximum lifetime. A key question is whether a robust, distributed, energy conserving ad hoc routing protocol can be implemented. On testing our proposed protocol using hardware setup, each node created with PIC16F877A and it is equipped with 12v battery. MC1321x pre scalar is accompanied with controller act as wireless transceiver antenna. Each node senses its attached battery power from its analog channel and knows about the power of other nodes from received packets. This work demonstrates a routing layer protocol implementation that can conserve significant energy.

Keywords*— *Mobile Ad hoc Network, PIC Microcontroller, Hybrid Routing Protocol, Energy Efficiency, Direct sequence spread spectrum modulation.

I. INTRODUCTION

Unlike a commercial cellular communications system, there is no fixed base station in a MANET. All MANET nodes have roughly equal status, so, the energy burden cannot be transferred to energy advantaged nodes such as fixed base stations, although nodes that are in platform do have an energy advantage over those that are battery operated. Specifically, battery-operated store-and-forward nodes present a significant challenge in developing low-energy networking approaches. Often overlooked in the design of a MANET is the impact on energy consumption of the layers above the physical layer. An inefficient data link, MAC, or network layer design can result in additional packets being transmitted and hence in more energy being used. shutting down a node in a MANET if it hasn't participated in the network for a given period of time is one energy saving technique .of course , the designer is then faced with difficult task of determining how and when to wake up a sleeping node when it is needed by the network to forward other users data packets.

A. Challenges of MANET:

i) Dynamic topology
ii) Multi-hop communication
iii) Limited resources (bandwidth, CPU, battery, etc.)
iv) Limited security

B. Objectives of MANET Routing Protocols:

i) To maximize network throughput
ii) To maximize network lifetime
iii) To minimize delay.

An ad hoc network is a decentralized network of mobile nodes that communicate over a wireless medium. Ad hoc networks differ from past networks. It is characterized by dynamic, self-configuring in nature and require de-centralized control and administration, in direct transmission range of each other. Hence these networks require specialized routing protocols that provide self-starting behaviour. Energy constrained nodes; low channel bandwidth, node mobility, high channel error rates, and channel variability are some of the limitations in an ad hoc network. Under these conditions,

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existing wired network routing protocols would fail or perform poorly. Thus, ad hoc networks demand specialized routing protocols.

II. CLASSIFICATION OF ROUTING PROTOCOL

Ad hoc wireless network routing protocols can be classified into three major categories based on the routing information update mechanism. They are:

A. Proactive or table-driven routing protocols:

In table driven routing protocols, every node maintains the network topology information in the form of routing tables by periodically exchanging routing information. Routing information is generally flooded in the whole network. Whenever a node requires a path to a destination, it runs an appropriate path-finding algorithm on the topology information it maintains.

B. Reactive or on-demand routing protocols:

Protocols that fall under this category do not maintain the network topology information. They obtain the necessary path when it is required, by using a connection establishment process. Hence these protocols do not exchange routing information periodically.

C. Hybrid routing protocols:

Protocols belonging to this category combine the best feature of the above two categories. Nodes within a certain distance from the node concerned, or within a particular geographical region, are said to be within the routing zone of the given node. For routing within this zone a table-driven approach is used. For nodes that are located beyond this zone, an on-demand approach is used.

III. PRIOR WORK INVOLVING ENERGY CONSUMPTION

Ravi Shankar et al proposed a technique called "Energy conservation Technique in Ad hoc Network". In that, the authors has introduced Capacity aware Routing for energy conservation .The merits of this approach is that All nodes in the network are equally important ,no other node should be used for routing more often than the other node. The shortcomings are Consume more energy to route traffic reduce the lifetime of the network.

Md Nafees Rahman developed an" Efficient Algorithm for Prolonging Network Lifetime of Wireless Sensor Networks". This approach proposed a Particle Swarm Optimization (PSO). It has the merits to locate the optimal sink position with respect to those relay nodes to make the network more energy efficient. The demerits is that it only satisfies low density Network Subbarao et al. dynamic power-conscious routing for MANETS suggests a minimum power routing scheme that has been designed using the table-driven approach at the routing layer. Ramanathan et al "Topology control of multihop wireless networks using transmit power adjustment" brings about power savings by setting the transmit power of all nodes of a multi-hop wireless network to control the topology.

IV. HARDWARE CONSTRUCTION

PIC microcontroller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality and ease of availability. It is ideal for machine control applications, measurement devices, and study purpose and so on.

A. General Features:

- High performance RISC CPU
- Only 35 simple word instructions
- All single cycle instructions except for program branches which are two cycles
- Operating speed: clock input-200MHz; instruction cycle-200ns
- Pin out compatible to PIC 16C74B, PIC 16C76, PIC 16C77
- Interrupt capability (up to 14 sources)
- Different types of addressing modes (direct, indirect, relative addressing modes)
- Power On Reset. (POR)
- Power-Up Timer (PWRT) and oscillator start-up timer
- Low power-high speed CMOS flash/EEPROM
- High sink/source current (25mA)
- Commercial, industrial and extended temperature ranges
- Low power consumption

B. Hardware Implementation:

On testing our proposed protocol using hardware setup shown in Fig. 1, each node created with PIC16F877A and it is equipped with 12v battery. MC1321x pre scalar is accompanied with controller act as wireless transceiver antenna. Each node senses its attached battery power from its analog channel and knows about the power of other nodes from received packets. This work demonstrates a routing layer protocol implementation that can conserve significant energy. The hardware model is given below.

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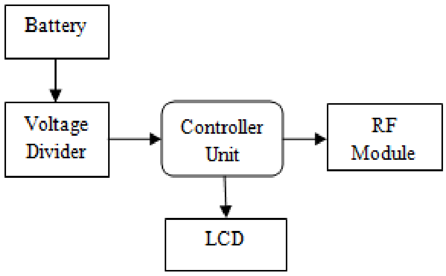

Fig.1 Model of hardware design

In Hardware implementation of our proposed energy power aware routing we use PIC16F877a microcontroller. The proposed algorithm would be programmed in embedded C. In our concept, finding the residual energy of all contributing nodes is being an important measure. Before sharing their power details, every node must sense their own residual energy. In real time implementation we use 18V (voltage) power source, while controller and transceiver modules works at 5v and 3.3v respectively.

In Fig. 2, Tarang P 20 module used as wireless module, which internally consists Arm cortex7 controller. Directly feeding 18v is vulnerable to controller, since we use voltage divider circuit internally to measure the voltage. Hardware circuit is designed in such a manner that 18 – 0v mapped to 5 - 0v and it measured at analog input pins of controller. The various logic levels would be matched by intermediate Max232 level converter. 0-1/3(5v) of controller for symbol '0' would be matched to 0-1/3(3.3v) of tarang p20. Similarly 2/3(5v)-5v of controller for logic '1' would be mapped to 2/3(3.3v) – 3.3v of tarang by Max232 level converter. Tarang p20 is a low transmit power module operates at 2.4-2.4835GHZ of bandwidth. It offers a successful delivery of packets between nodes in wireless network.

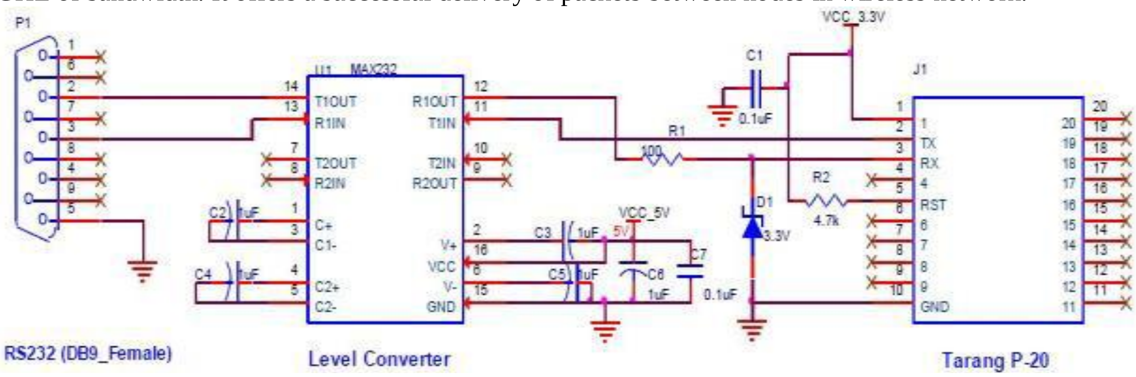

Fig.2 Connection between level connector and Tarang

The signal modulated by tarang module uses direct sequence spread spectrum (DSSS). Each node upon receiving request from other nodes seeks the destination address whether it is intended for it or else to someone. If it so, it sends its own battery power data to the node who sent request. Upon receiving all nodes power details sender calculates the path where it could drive long life time and select that path to further communication.

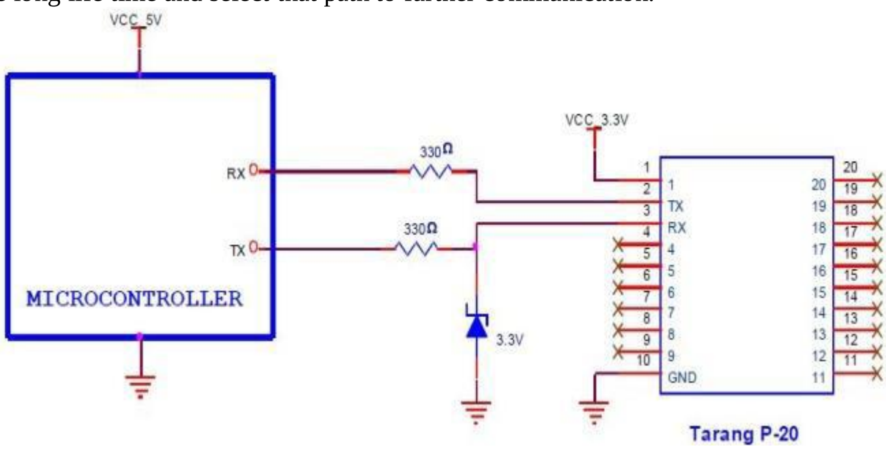

Fig.3 Connection between controller and Tarang

In Fig. 3 shows a 3.3v zener connected at receive (rx) pin of Tarang. There max232 used as level converter. There is possibility of high voltage of 5v in rx pin when received signal strength increases. For safety purpose to save Tarang p20 we use 3.3 zener at reverse bias.

V. SOFTWARE DESCRIPTION

We use PIC C COMPILER and Embedded c programs. Because of this Reason PIC C is the suitable compiler since we choose PIC16f877a controller. For programming we use embedded C, which is the preferable language suits

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embedded controller. Reason for embedded controller/embedded c are embedded provides the platform of hardware and software interfacing, by using embedded C suitable program can be written and verified in hardware, Compiler is used to convert embedded c to hex file, Interrupts programming and header is easy to use in PIC C compiler and Ease understanding and efficient handling of memory space is one main factor to go to Embedded C programming.

VI. RESULTS

In hardware implementation, each node senses its power level and arranges it in 10 step level L9-L1 respectively from VDD to 0v. After identifying its own level every node sends its voltage level information to sender node. Actually it will be appended in route reply messages. For our case from 5v to 0v coded as L1 – L9. A node has very less battery power <5.4v will not reply to the request packet, if the request was not intended for it. I.e. the destination address of packet is not indicating its address. If it has sufficient power level, it appends its level information to reply packet.

Table I Power Level for Nodes

Level	Voltage
L1	18
L2	16.2
L3	14.4
L4	12.6
L5	10.8
L6	9
L7	7.2
L8	5.4
L9	No reply

When source node receives power level information from other intermediate nodes it compares and calculates the best route. A node lies at L1 said to have good residual energy and have good life time. If it falls at L5 said to have average level. At L8 it has very low power and hence very less residual energy and its network life time will be very poor. So on communication these nodes must not be preferred. The request packet has source ID, destination ID. Here type represents whether it is request or reply, Data or Ack packet. Those things pointed as RR, RP, DT, AK respectively. Source ID indicates the identity of source and similarly to packet id and destination id. In reply packets, it will carry the power level information indicates from L1-L9. For example: RR.2.1.7: Node 2 sends request packet to node 7. In reply: RP.7.1.2.L1. Node 7 sends reply to node 2 and appends its power level information L1.

Type	Source ID	Packet ID	Destination ID

Fig. 4 Request Packet

Type	Source ID	Packet ID	Destination ID	Power Level Info

Fig. 5 Reply Packet Power

In Fig. 6 shows that the consumed power of networks using EPAR and MTPR decreases significantly when the number of nodes exceeds 60. On the contrary, the consumed power of a network using the DSR protocol increases rapidly whilst that of EPAR based network shows stability with increasing number of nodes.

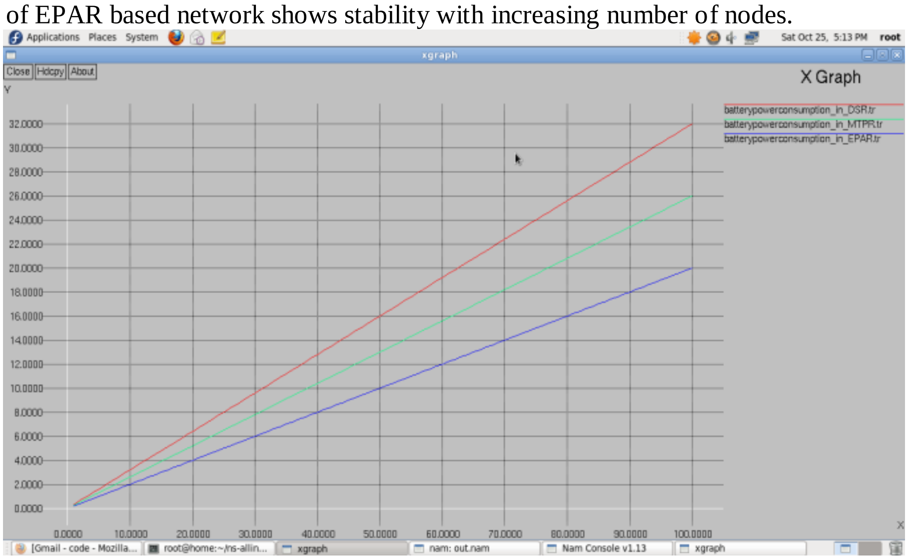

Fig. 6 Average Consumed Power versus Number of Nodes

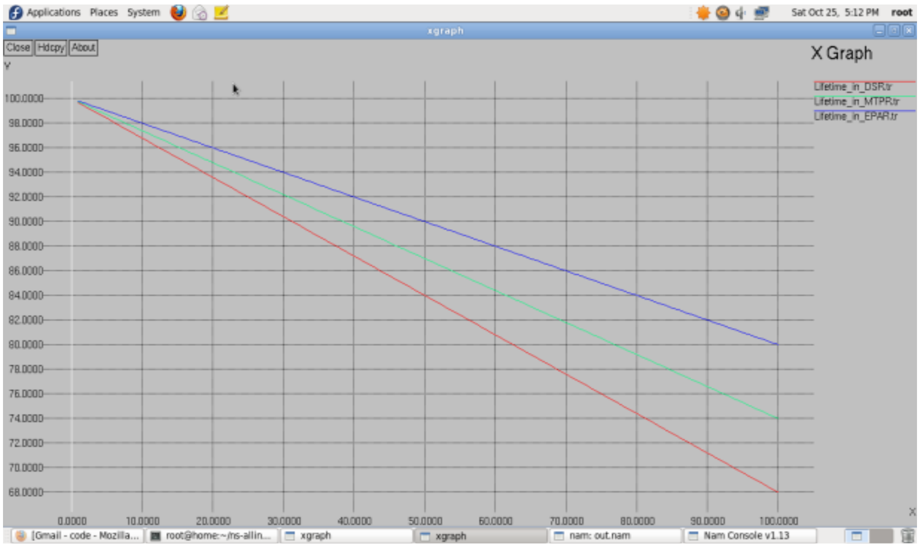

Fig. 7 Network Lifetime Varying With Respect Network Size

In Fig. 7 shows that the DSR protocol becomes inefficient when the network consists of more than 700 traffic size for low density network while for high density network becomes inefficient when the network consist more than 1000 sources. EPAR shows the best performance with maximum network lifetime than MTPR and DSR.

In Fig. 8 shows that the node is simply idle and not participating in any traffic transmission at this situation residual energy will be a function of only of idle power. Since no transmission reception is carried out. Therefore, by spending idle power, how long the low power node could remain in network. The network life time = The time over which the residual energy could spend on keeping the node remains in network.

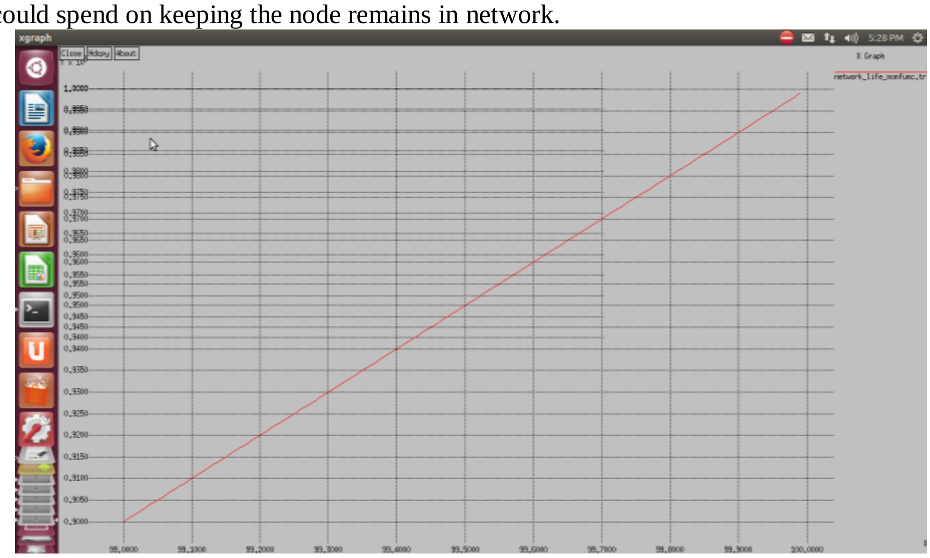

Fig. 8 Network Life time Varying With Respect to Network Size (Non-functional)

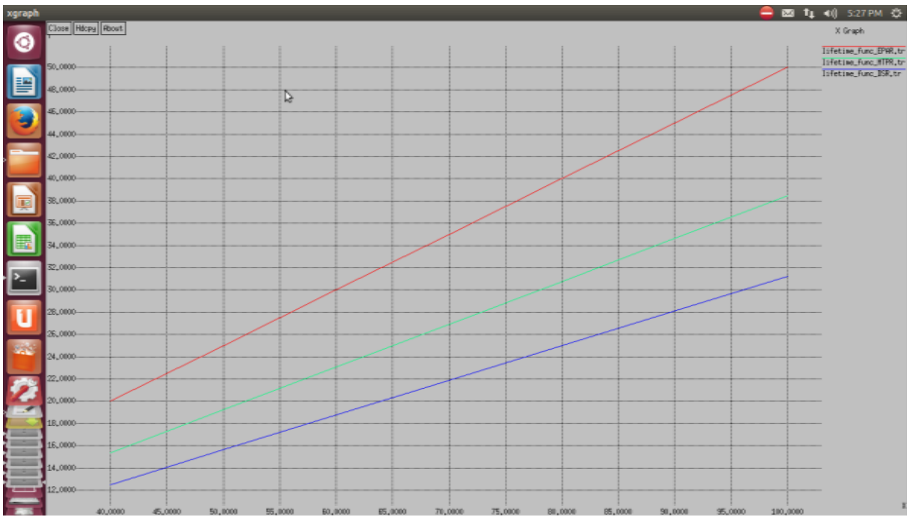

Fig. 9 Network Lifetime Varying With Respect Network Size(Functional)

In Fig. 9 shows the network lifetime as a function of the number of nodes. The life-time decreases as the number of nodes grow; however for a number of nodes greater than 100, the life-time remains almost constant as the number of nodes increases. Lifetime decreases because MANET has to cover more nodes as the number of nodes in the network size increases. We observe that the improvement achieved through EPAR is equal to 85 %. Energy is uniformly drained from all the nodes and hence the network life-time is significantly increased. Network lifetime as a functional can be calculated as: RESIDUAL ENERGY= (transmission power + receiving power) * network lifetime

VII. CONCLUSION

In Ad hoc network reducing the probability of using low power nodes is always a good thing to keep node to live long. Taking the decision only on analysis of next hop may put more risk for successful delivery of packets and good network life time. While comparing all other existing method our proposed method has found as worthy method to improve lifetime and successful delivery of packets. In future this concept can be enhanced to cluster hierarchy based protocols and mobile sink selection for improving its performance.

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