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Power Saving Mechanism with Less Number of Nodes in the Routing Path in Adhoc Wireless Networks Using MARI Algorithm

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Abstract - Adhoc wireless networks have emerged as one of the key growth areas for wireless3 networking and computing technology. Adhoc networks are a new wireless networking paradigm for mobile hosts. Unlike traditional mobile wireless networks, adhoc networks do not rely on any fixed infrastructure. Instead, hosts rely on each other to keep the network connected. The nodes in ad-hoc networks are battery operated and have limited energy resources, which is indeed a key limitations. Each node consumes a large amount of energy while transmission or reception of packets, among the nodes. While the nodes depend on each other for efficient transferring of packets, it is a key issue in adhoc networks to have efficient methods for forwarding of packets between any given pair of nodes, with minimum power consumption and less number of intermediate nodes . In this study we propose an optimal routing protocol called MARI (Mobile Agent with Routing Intelligence). The MARI Topology proposed for power management is novel and is used for the consumption of minimum power in an adhoc wireless network, at each node. The Protocol groups the network into distinct networks with the selection of MARI nodes and Gateways for efficient packet transmission between any member node pair. The operational cycle at each node is classified into four distinct operations, i.e., transmitting, receiving, idle and sleep cycle, in order to achieve efficient power management in an Adhoc wireless network.

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Abstract - Adhoc wireless networks have emerged as one of the key growth areas for wireless3 networking and computing technology. Adhoc networks are a new wireless networking paradigm for mobile hosts. Unlike traditional mobile wireless networks, adhoc networks do not rely on any fixed infrastructure. Instead, hosts rely on each other to keep the network connected. The nodes in ad-hoc networks are battery operated and have limited energy resources, which is indeed a key limitations. Each node consumes a large amount of energy while transmission or reception of packets, among the nodes. While the nodes depend on each other for efficient transferring of packets, it is a key issue in adhoc networks to have efficient methods for forwarding of packets between any given pair of nodes, with minimum power consumption and less number of intermediate nodes . In this study we propose an optimal routing protocol called MARI (Mobile Agent with Routing Intelligence). The MARI Topology proposed for power management is novel and is used for the consumption of minimum power in an adhoc wireless network, at each node. The Protocol groups the network into distinct networks with the selection of MARI nodes and Gateways for efficient packet transmission between any member node pair. The operational cycle at each node is classified into four distinct operations, i.e., transmitting, receiving, idle and sleep cycle, in order to achieve efficient power management in an Adhoc wireless network.

I. Introduction

Wireless networking grows rapidly because of the human desires for mobility and for freedom from limitation, i.e., from physical connections to communication networks [10]. Recent advances in wireless technology have equipped portable computers, such as notebook computers and Personal Digital Assistants (PDA's) with wireless interfaces that allow networked communication even while a user is mobile [4]. A particular kind of wireless network called mobile adhoc network is presently under development, which is the subject of this. A mobile adhoc network is a self-organizing and rapidly deployable network in which neither a wired backbone nor a centralized control exists. The network nodes communicate with one another over scarce wireless channels in a multi-hop fashion.

In this, we propose an algorithm for topology management for the Adhoc wireless networks is: A power management algorithm to reduce the consumption of the power of each node in the adhoc wireless networks, by the introduction of MARI (**Mobile Agents with Routing Intelligence**) topology (a topology having MARI nodes) and management.

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The absence of a central infrastructure implies that an adhoc wireless network does not have an associated fixed topology. Hence, a most important task of an adhoc wireless network consisting of geographically dispersed nodes is to determine (in real time) an appropriate topology over which high-level routing protocols can be implemented [12].

Some of the properties of adhoc networks that make them difficult to manage are:

1. Complexity of nodes.
2. Message overhead
3. Energy consumption.
4. Mobility
5. Degraded channel quality
6. Security

II. Mari Topology Formation and Management

Minimizing energy consumption is an important as well as a difficult challenge in mobile networking. The requirement of cooperation between power saving [7] and routing protocols is particularly important in the case of multi-hop adhoc wireless networks, where nodes must forward packets from one to another [3,8,9].

This thesis proposes a novel topology management scheme for adhoc wireless networks for power management called, MARI Topology. The nodes in this scheme are classified into three categories based on their power level. They are:

a) MARI Nodes

MARI nodes are selected in such a way that they have the maximum power level among their one-hop neighbors and all non-MARI nodes in the one-hope neighborhood are within the transmission range of MARI nodes. These MARI nodes [16] have the routing intelligence i.e. they make decisions related to routing, such as path finding. Every MARI node has a group of member nodes connected to it, usually in its one-hop neighborhood. The responsibility of every MARI node is

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to make necessary communication with any member node connected to itself or with other MARI nodes (through Gateways) within the network, for both transmission and reception of the packets. MARI nodes are selected or formed by a procedure that is explained later in this chapter.

b) Gateway Nodes

The Gateway nodes [16] having sufficient power level are selected by the MARI nodes such that they can be used to forward packets between MARI nodes. Any two adjacent MARI nodes (within two-hop distance usually) in the network are connected through the concerned Gateway node only. Gateway nodes do not have routing intelligence. The MARI nodes select these Gateway nodes, according to the procedure outlined later. *The MARI and the Gateway nodes stay continuously awake to route the packets of other member nodes.*

c) Member Nodes

A member node is a non-MARI and non-Gateway node. These are the nodes, which want to communicate with each other [16,17]. Every member node is connected to one of the MARI nodes (some kind of belonging or bonding) through which it transmits or receives the packets. The member nodes wake up only at certain specified time epochs, and for very short periods, during any given beacon period T. When a member node wakes up and if it does not have to transmit or receive data, then it goes to sleep mode again, after a brief period. This is the main principle behind the power-efficient operation of the network. The wake-up time epochs of each member node are determined apriority (pre-determined). In our simulation of the operation of an adhoc wireless network, this is accomplished with the help of pseudo-random number generator. Also, these wake-up time epochs of a member node are known to its corresponding MARI node and its one-hop neighbor nodes, through the WAKEUP messages that are exchanged at the beginning of a beacon period. Thus, the member node can remain in power saving sleep mode for most of the time [6,11], especially when it is not actively sending or receiving packets. The packets are routed over the virtual backbone consisting of MARI nodes and Gateway nodes, which are awake continuously. This is the main power-saving advantage of the topology that is suggested and nurtured in this thesis.

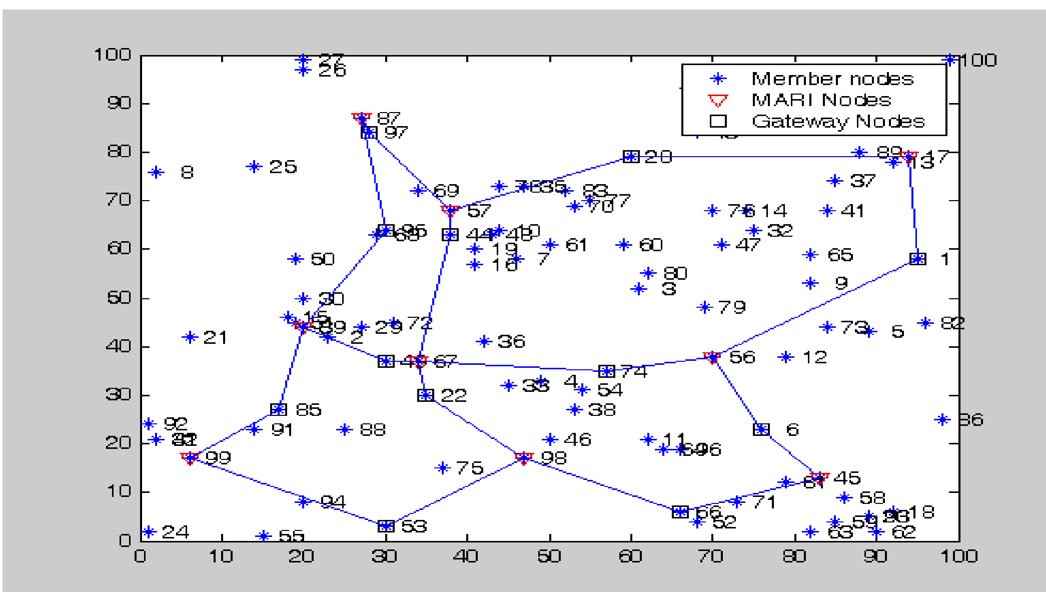

Fig.1: Random distribution of 100 nodes in the adhoc wireless network

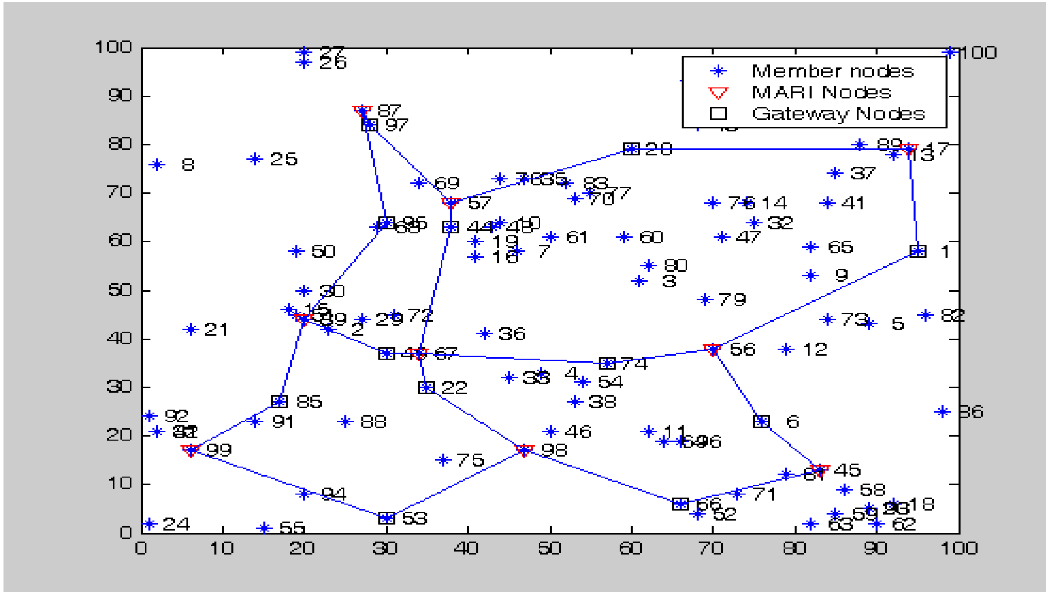

Fig. 2 : Adhoc network with MARI nodes, Gateway nodes and member nodes

The Fig.2 is the resultant after executing the following algorithms:

(1) MARI Placement algorithm and
(2) Gateway node selection algorithm

From the fig.2 it is clear that the number of nodes in the virtual backbone is 20% to 25% only. For an example, the list of MARI nodes, Gateway nodes and member nodes for the given MARI Topology network is shown in the table.1. From the table it is clear that the number of MARI nodes are: 09, number of Gateway nodes are: 12, and the number of member nodes are: 79.

File Edit View Web Window Help

Mari Nodes															
2	26	33	41	48	56	72	80	85							
Gateway Nodes															
3	12	16	18	19	22	27	54	64	93	94	100				
Member Nodes															
1	4	5	6	7	8	9	10	11	13	14	15	17	20	21	23
24	25	28	29	30	31	32	34	35	36	37	38	39	40	42	43
44	45	46	47	49	50	51	52	53	55	57	58	59	60	61	62
63	65	66	67	68	69	70	71	73	74	75	76	77	78	79	81
82	83	84	86	87	88	89	90	91	92	95	96	97	98	99	

Table.1: List of MARI nodes, Gateway nodes and member nodes

In our simulation, we have considered that the nodes are operating in one of the four modes and their power consumptions are listed in table-2.

Mode	Transmit	Receive	Idle	Sleep
Power Consumption	1400mW	1000mW	830mW	130mW

Table. 2: Shows the amount of power consumption value by each node based on their mode of operation

III. Results

We have used MATLAB 7.0 for the simulation of results. In this section we have shown the analysis of adhoc wire less network with MARI topology. The results are compared with the existing flat topology. The parameters we considered for analysis and evolution, and their respective results are given below:

a. Power consumption of the network as number of nodes in the network increases. (fig-3)
b. Number of nodes in the backbone as the number of nodes in the network increases is shown in fig.4.
c. Overhead in each packet is shown in fig.5.

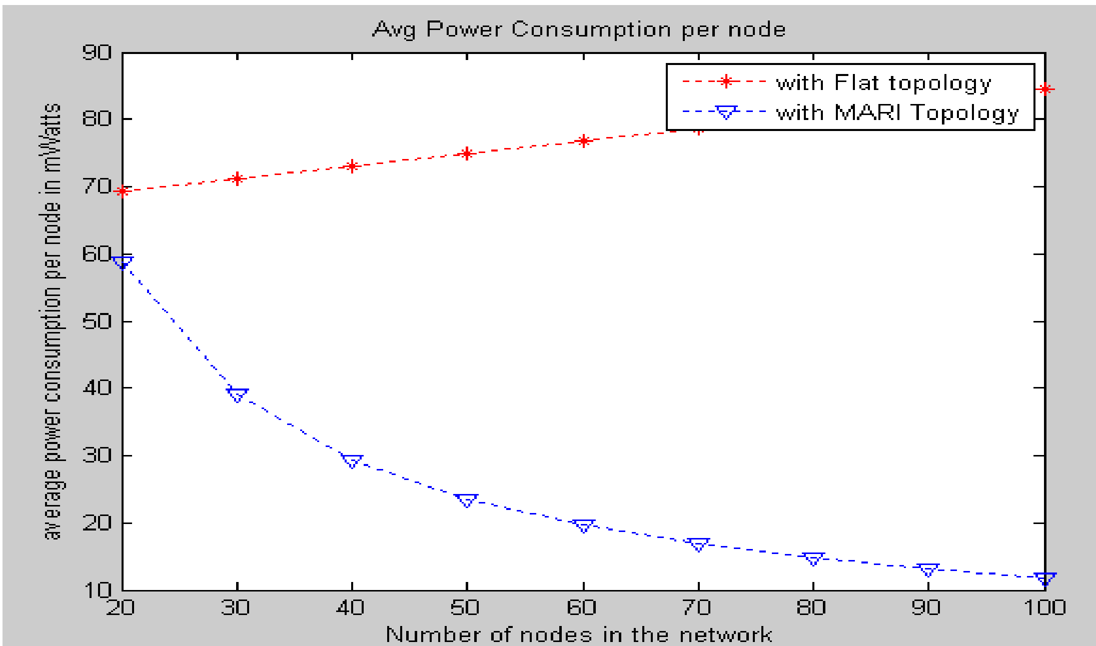

Fig. 3: Power consumption of the network as number of nodes in the network increases

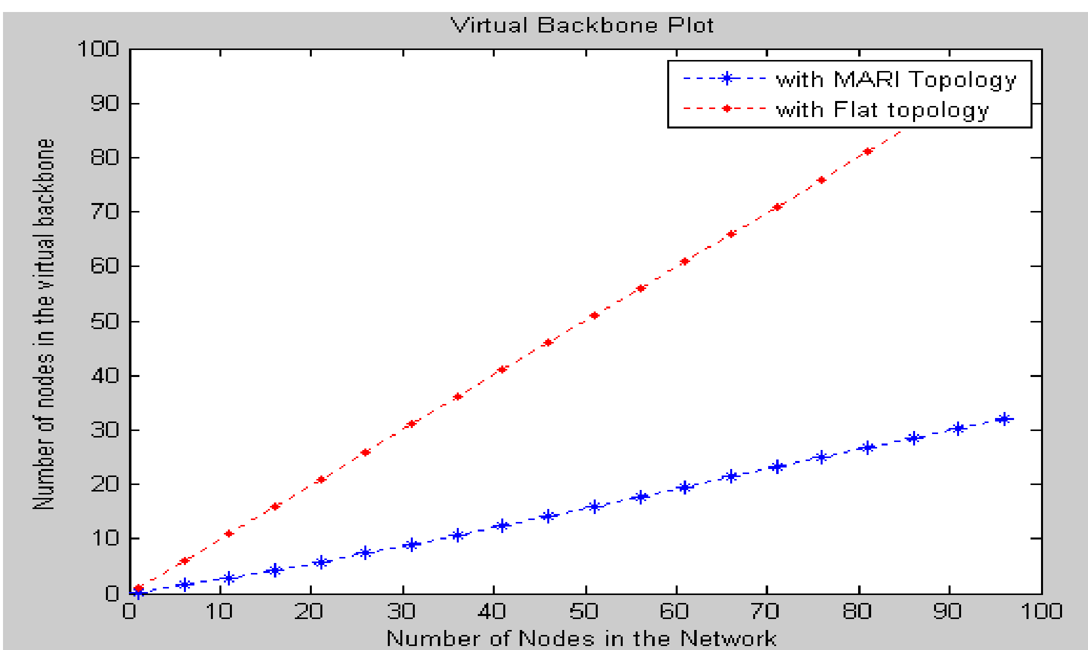

Fig.4: Number of nodes in the backbone as the number of nodes in the network increases

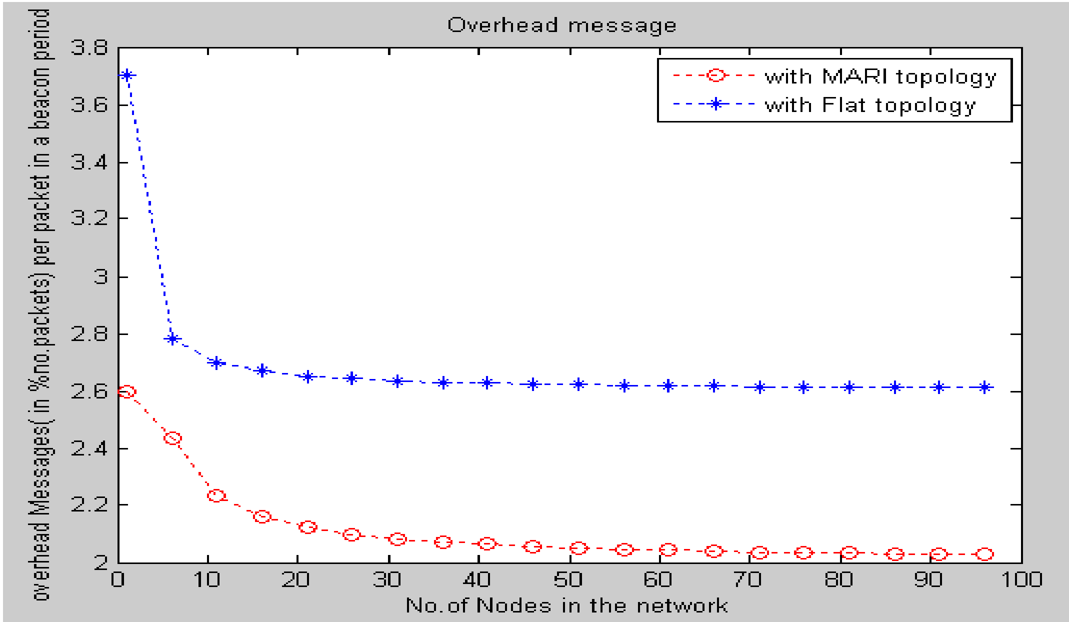

Fig.5: overhead in each packet per node

IV. Conclussions

The performance evaluation of the implemented wireless network is carried out in order (i) to demonstrate the successful operation of the MARI topology concept, (ii) to compare its performance to that of an equivalent (in size) flat-topology network, (iii) to prove the point that the MARI topology performs a way better than an equivalent flat-topology. In our illustration and demonstration, the performance measures that we have considered for simulation study are, (i) the number of backbone nodes as a proportion of the total number of nodes in the network, (ii) overhead messages, and (iii) average power consumption in the network. Analysis is also done in the following cases:

1. Keeping the data packet size and beacon period constant.
2. Variable data packet size with constant beacon period.
3. Fixed data packet size with variable beacon period.

V. Further Scope

(1) Management protocols for multicasting (one source to Many number of destinations simultaneously) can be designed upon MARI topology or with some further and appropriate modifications to the MARI topology. Load distribution and load balancing among the paths in the network can be considered.

(2) Performance study for multi-access level ($l > 1$) is another important topic. When the multi-access level increases, the power dissipation and the throughput increase. Therefore, there may exist an 'optimal' multi-access level in a given context and under certain conditions. Finding that optimal multi-access level can be a very good topic for R&D.

(3) Security levels on each packet, path and node can be implemented, with analysis of security by simulation or bench marking.

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