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A NOVEL BAL-AODV ALGORITHM IN ISM BAND FOR EFFICIENT ROUTING BASED ON THE ENERGY OF THE NODES

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Abstract

AODV algorithm is implemented both in ADHOC and WSN. Energy consumption during routing and in ideal condition, energy status of the other contributing nodes is unknown for decision making in routing. We proposed a novel routing algorithm based on each node energy status and routing. The real time implementation of the algorithms based on ISM band and the characteristic features are studied in this paper. The novel routing is Bal-AODV. From the real time implementation in both hardware and simulation concluded the Bal-AODV is efficient routing algorithm.

Keywords: Adhoc network, energy consumption, network life time , WSN

Introduction

In today's technology WSN replaces wired and wireless communication. There is a definite performance for WSN as it needs no infrastructure. Each of participating nodes would be a router and no base station is preferred in WSN. In base station based wireless network, each node would involve only its own data transmission. But in the case of WSN, a node does not seek for data transmission for its own purpose. It might be need to act as router to the nodes. Each node should provide service to all other nodes in order that the entire network could be active. In view of the service providing feature of the nodes, energy constraints have become the biggest issue in WSN.

WSN refers to group of nodes communicating with other another, through intermediate nodes within the group of network without a base station. Each node in the WSN consists of three units. The WSN node is equipped with sensors to monitor its environmental parameters. The data packets received by the nodes are processed by processor organized in the node which collects the data from the sensors. The data collected would be transmitted via wireless transceivers. Wireless network finds application in various areas including military operations, rescue operations and agriculture monitoring. This is due to this advanced technology miniature size, reduced (saving in) cable cost, and ease in forming a network. WSN can be deployed during any natural disaster or erection of a base station. But, there is also the major disadvantage of shorter lifetime. The receipt of a large number of packets by an intermediate node from several directions causes energy drain, and additional consumption. These result in shorter network lifetime

With decrease in residual energy of nodes, transmitting power of nodes is also reduced. The node may not have sufficient energy power to radiate the signal. The other problem faced by WSN networks due to energy loss occurring at the node is decrease of the transmitting and receiving radius of the nodes. Future, a packet loss occurs due to the reduced strength of the nodes. So, there is a chance of a large number of packets being dropped en route. (on the route). In such a situation, the remote node may feel that the data rate difference between nodes causes this congestion loss. The node sending data attempts reduction of its data rate to control congestion, But the real problem is at its residual energy.

Related Works

Designing energy efficient protocols, improvement of the lifetime of the node as a multi cast free routed at the source and spanning the destination constructed have been subjects of study for many researchers. Node at the short distance sender spends low energy while it spends more energy when it moves for long distance. But when nodes move randomly, it is not deterministic to ensure the fixed distance and hence fixed transmitting power. Another resource points out to greater waste of energy due to congestion [4].

Overcoming this problem needs a slow start, increasing the data buffer size and increasing the speed of the retransmission in case of packet loss. So the energy consumption cost can reduce a little. The other research [3] intimate that the network, where all contributing nodes share their position in which all nodes equipped with GPS. Apart from required data traffic the information regards positioning the nodes counts overhead to the traffic and hence it consume more energy.

The sensor network is commonly used for collecting information while scarping a data to sensor unit does not have continues power supply [5].The life time of sensor unit is depending on the duty cycle.

Reducing power supply of sensor units need accessing a node directly via MAC protocol and also to reduce retransmission. To achieve more life time of sensor units to reduce battery usage. Routing protocol is entirely based on the cluster protocols [7]. The cluster protocol uses bandwidth reusability and has reduced power consumption but this method suffers from the problem of inefficient transmission.

The collusive sensor nodes have more advantage on wireless sensor network [8]. The LFTM evaluation is used to reduced the power consumption and increase the data accuracy. The platform based sensor networks helps in reducing energy consumption [11]. The life time of node is based on the unit re transmission, computational and also its battery. Slicing and resembling methods [9] are recommended, where security over transmitted data depends on the reliability of all one hop nodes from an aggregator node.

In this paper [12] unbalanced energy consumption is main disadvantage of the WSN node. A hybrid transmission mechanism is used for reduction of needed energy. This needs a fully covered service area in the presence of a large number of sensors. This paper suggests methods for eliminating the disadvantages. One such is a Bal-AODV network protocol which balances Adhoc on demand vector distance. A specific node is used for collecting data from a sensing range based on the utility function. The point of interest and important factor varies with respect to the utility function which is calculated using the step and the exponential functions. The method based on PBD paradigm has been applied on various TeleosB modes. Case studies on the subject have been documented.

Methodology

A. Route Discovery and Packet Transmission

In wireless sensor network, all nodes work following a common routing protocol. The various routing protocol provide different merits and demerits to the network. Most of the methods in earlier papers have proposed to find the shortest path selection such that the minimum hop count exists between source and destination. Recent papers have presented new ideologies in WSN focused various protocols for minimum energy consumption such as LEACH, Multipoint Relay based protocols, centric data collection and Clustering protocols.

All these protocols prefer to select the head for a set of nodes and there is always contention occurring between nodes. The center or head selection process itself and adds more traffic to the network and this traffic consuming energy apart from the data to be transmitted. This paper ultimately aims to predict and forward the packets only through the nodes with the maximum battery power in the shortest path routing algorithm. Unlike the existing methods, this protocol is not designed to content for header selection conflicts. Apart, this paper proposes to select the immediate hop with more power. In the existing methods the shortest path routing protocol tries to utilize only the minimum hop, it does not consider the residual energy of the neighboring nodes. In other words, the route through which a requester receives an earlier reply decides the path for further transmission. Our proposed method prefers selection of the balanced min-hop and the best energy path by implementing the minimum energy path prediction in Ad-hoc On Demand Distance Vector Routing. This method allows packets to travel through more number of hops with achieving minimum energy consumption path. Whenever the master control node demands the sensor values in the paddy field, it floods route requests to all neighbor nodes in the network. All the neighboring nodes seek for destination and further routes packets to neighbors. At the end the, master receives the route reply from all available paths. But in our proposed method, only the node with high energy replies for a route request. Based on the route reply, the master node would identify the nodes with higher energy and sends packets only to the nodes from which it received the route reply.

In the existing methods, when the master M seeks the value measured at sensor F, node M receives the route reply from multiple paths such as MDCF, MHGF, MABEF, MABECF etc.

In the AODV protocol, the node detects the reply packets through minimum hop count and chooses that particular path for further communication. Our approach prefers the path with maximum residual energy. As Fig 1.1 shows M finds the minimum hop count 2 from two paths such as MDCF, MHGF and M selects the path based on the earlier arrival of route reply. Rather based on an earlier reply, this paper suggests choice of the path based on energy metrics. Path MDCF has the highest residual energy in it, and so is l selected as our paper suggests.

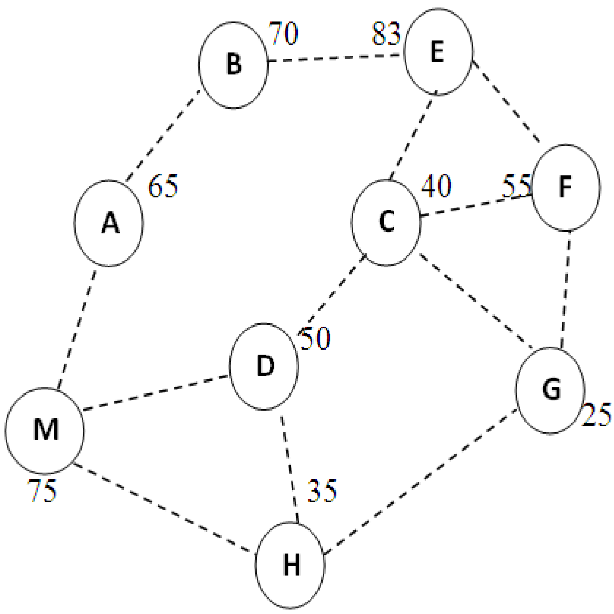

Figure 1.1: Paddy field nodes deployment.

Furthermore, our method proposes balanced min-hop energy metric. That is, A node with a minimum hop count not offering a long lifetime network should not be chosen. Instead, this method allows selecting the path MABEF with 3 hop count, though min hop count 2 available, if min hop count path does not have sufficient power. Node H has lesser energy and M selects D as immediate neighbor. If D also drains out its energy M selects A, even it permits additional hop count.

B. Design and Implementation
The proposed method offers a balanced minimum hop count and maximum battery power path selection for data transmission. It offers a minimum hop count and avoids the earlier die of low power nodes. Adoption of the best path helps enhancement of the lifetime of the individual node and of the entire network.

Algorithm:
1. If destination address RREQ packet = node x address?
Send RREP to neighbor node x-1.
2. Else if check battery power of node > Min power
Forward RREQ to x+s
3. Else No Reply to RREQ
4. If Data received at node x, check destination address of Data packet if x+1 = d or x-1 = d?
Forward data to d
5. Or else forward data to node x-s
Step 1 to 5 continues for each newly arrived request. If the data servicing for past requests step 2 to 5 continues.

Results and Discussions

A. Hardware Implementation
The proposed method has implemented and verified in hardware. In real time, each node is created with a 512 kb memory and each node is associated with a Zigbee transmitting antenna [17]. Whenever the master node seeks for data at sensor id S. M sends packet format.

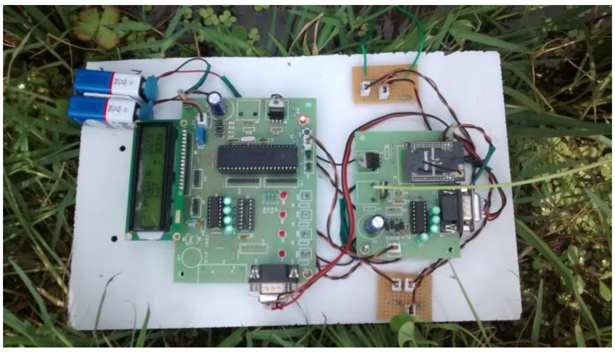

Figure 1.2: paddy field nodes setup

Each node consists of a control unit, transceiver unit, sensor unit, and power supply unit.

Control unit: The control unit in the node is controlled by a pic16f controller developed by micro chip. The PIC refers to “Peripheral Interface Controller”. It uses a modified Harvard memory architecture and it is an RISC type controller since it uses only small set of instruction to program it.

Figure 1.3: Master node setup

The pic16f in an 8bit controller and it has an inbuilt Flash Program Memory Up to 8K x 14 words, Data Memory (RAM) Up to 368 x 8 bytes, EEPROM Data Memory Up to 256 x 8 bytes. It works in maximum of 5voltage. Hence it consumes less power.

Transceiver unit: The transceiver unit uses the MCI322x type free scale processor for transmitting and receiving the packets between the nodes. It is designed for low to medium transmitting power. The module operates in 2.4 to 2.4835 GHz frequency band with IEEE 802.15.4 baseband. The free scale module has its own unique address, PAN id. Those configurations for the module are configured using the TMFT software using the AT commands required by it to configure.

Sensor unit: Sensor unit in the nodes consist of different sensors needed for application. Sensors are like temperature sensor, humidity sensor, chemical sensor etc. To figure out the environmental conditions and the requirements needed in the paddy field.

Power supply unit: The node uses the 12V battery power source. Since the nodes are mobile nodes each node is fixed with the battery source.

All ad-hoc nodes are operating in battery voltage, since they are mobile nodes. The battery voltage and respective energy spent on idle time transmit time and receipt time would be measured by a voltage divider circuit and these readings have been measured as analog and it would be converted through ADC channel in the controller. These readings are measured from battery consumption as inputs to the controller to take for necessity action. Sensors such as moisture sensor, chemical content sensor, temperature sensor, air pressure sensor, current sensor, motor status and water sensor are mounted on paddy fields in real time implementation. The request from Master device and replies from respective sensors indicating the real time environment values have been achieved through serial communication. The entire packet formats sent from a node serially and received serially. The serially received packets could be converted to parallel data and the controller checks for the headers indicating source address, destination address, last intermediate node, sensors identity numbers. Apart from residual energy measurements, the data extracted from the received packets also an important measure to proceed as per our method form. At initial position, each node has 0.8537 Watts of power. When the node involved in communication it consumes some energy and it drains.

PIC 16F controller is programmed to perform a balanced AODV protocol. Each node is built with MC1341 free scalar module, which performs the transmission and reception of RREQ, RREP and DATA packets. The inlet packets at every free scalar modules are processed by its attached controllers. Each inlet request or data would be processed and the respective replies will be sent through free scalar module based on this protocol.

In hardware implementation each node is designed to transmit packets whose size is 256 bits (32 bytes). By varying the number of packets transmitted, power derived from each node is measured in hardware. The Voltage divider circuit is used to predict the power consumed by node to transmit particular packets. The Number of similar size packets transmitted and corresponding power drain has measured. In transmitting single packets it 0.005214A i.e. 0.52mA and 12V battery has been used as power source. When the number of packets increases, time duration to transmit also increases and hence the power consumption varies. Based on the transmission time Power used by node to transmit packets is in terms of micro Watts. i.e. battery has drained from its initial voltage at the rate of change in traffic size or number of packets. By having various traffic sizes, the resultant values recorded as in table 1.1

Table 1.1: Power consumption in hardware implementation

No of Packets (Size in bits)	Battery power Consumed (In Micro Watts)
256	2.145
512	3.224
1024	6.424
2048	11.332

B. Simulation Measures

The similar like pattern created in Network Simulator Ns-2.35 and each node configured to spend various level of energy for transmission, reception and idle time as those values mentioned in table 1.2.

Network lifetime differs from nodes being idle to the nodes carries traffic. There is a long life during idle time, When it is involved in transmission it must spent some energy and this causes dryness in battery levels. Based on readings measured, the fig 1.5 is plotted.

Table 1.2: Simulation parameters

Number of nodes	12
Area Size	700 x 700
Mobility model	Random Way Point
Traffic's type	CBR
Channel capacity	2 Mbps
Transmit Power	0.3 J
Receive power	0.1 J
Idle power	0.01 J
Initial energy	11 J
Communication system	MAC IEEE 802.11g
Routing protocol	Bal-AODV

$R_{min} = \mathit{Min}\ R_e$

$N_v = R_{min} / E_i$

$N = R_{min} / (E_{tr} + E_{tx} + E_i)$

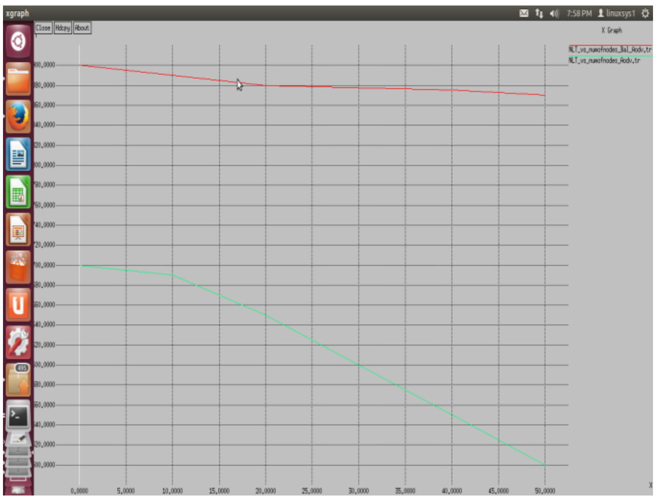

Figure 1.4: Network life time as the function of no of nodes

Measurement of the duration of the energy node remaining in the network is calculated on the basis of the network lifetime. In formulae R_e, R_{min} are referred to residual energy and minimum residual energy to carry forward packets. N_v , N represents Network lifetime non-functional and functional. E_{tr} ,E_{rx} and E_i indicates transmit, receive and idle energy respectively. The residual energy of the node is calculated first, Out of this the minimum power node is calculated in terms of Rmin (non functional) from which N, (functional) is calculated.

The network life time has considerably enhanced in our proposed Bal-AODV, while comparing with AODV slightly decreasing slope idle or non-functional network life time. Figure 1.5 shows the functional network life measured against the traffic size.

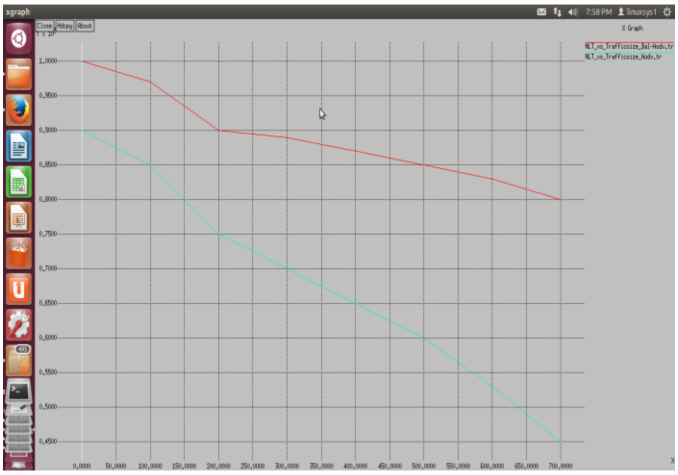

Figure 1.5: Network life time as the function of traffic

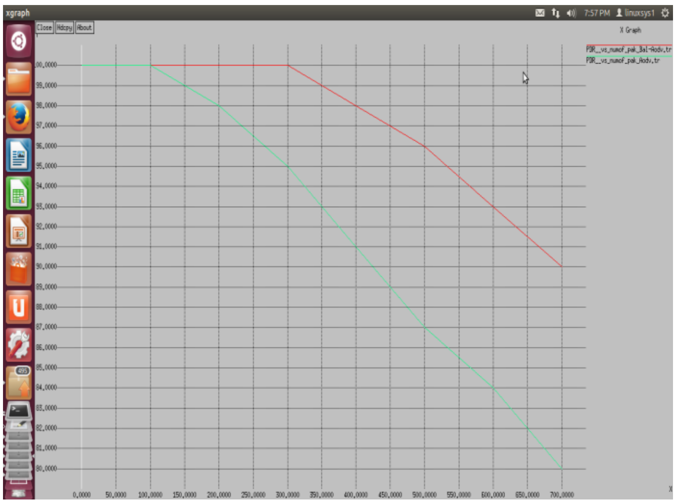

Figure 1.6: Packet Delivery Ratio Vs no of packets

The fraction of dropped packets increases with the traffic size and number of packets increases. Therefore, performance at a node is measured in terms of probability of dropped packets. To ensure the data receipt at master controller, it sends acknowledgment packets for confirmation. The sensor nodes wait for ACK packet. If not received, it retransmit & the DATA packets. In AODV protocols, sensor nodes always follow the shortest path. It causes earlier dryness of nodes in that particular path and losses occur. In our proposed method only the high power nodes be contributing in communication are considered. It assures good packet delivery ratio than existing methods. The comparison of packet delivery ratio has plotted in fig 1.6.

The residual energy is the remaining energy in each node, it maintained above some level in this method. When same set of nodes has been used for packet transmission, it drains out its energy and die earlier. Due to this issue, those nodes are unable to transmit their own data to master when it needed. This paper proposes to utilize only high power nodes. No power node would die earlier and residual energy of nodes is maintained above some uniform level. But this method allows low power nodes to respond, if the particular request intended to acquire its own sensor readings.

Apart from other On-demand routing protocol Bal-AODV intimates last intermediate hop only, and not the entire path. Since the packet carries only the source, intermediate hop, destination address and data the amount of overhead is considerably reduced from other reactive protocols. This overhead reduction further reduces the energy consumption and enhances the network life time and hence the residual energy has maintained above some sufficient level.

Fig 1.7 plotted by monitoring the residual energy of sensor nodes when particular sensor nodes follows AODV and Bal-AODV. It clearly shows that the earlier dying situation completely avoided. Fig 1.4.and Fig 1.5 plotted by calculating the nodes how long it could live, if the node spends idle power and node spends transmit and receive power.

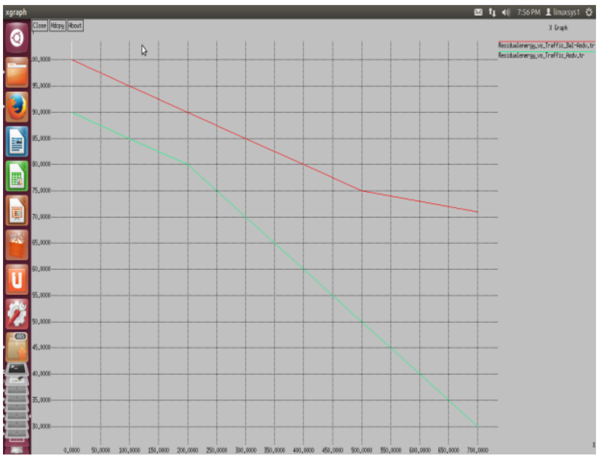

Figure 1.7: Residual energy Vs Traffic size

Conclusion

Even many more protocols were proposed for best energy based routing most of the methods still in paper level and the results were analyzed only in simulation. Our proposed method has been implemented in ground and the real time experiments render good results. The simulation and hardware implementation has shown that proposed balanced ad-hoc on-demand distance vector enhances the network life time and ensures good packet delivery ratio.

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