PDR And HOP Count based Routing for Efficient Energy Usage

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ABSTRACT
Wireless Communication has taken the vow of many applications in various areas. All the applications are used for special purpose, and thus the maintenance of energy efficient routing is one of the biggest problem and the most challenging task in recent days. In below mentioned methodology, path selection will be based on packet delivery ratio and Hop count. So the particular path, selected for the communication, will yield in maximum energy efficiency without changing any hardware parameters.

Index terms
PDR, Degree of Path Selection (DPS), nodes

1. INTRODUCTION
The fullest demand of the future networks is speedily deployment of mobile nodes which are independent and which can interact with one another without the requirement of centralized and organized network infrastructure. This network order is put in a specific bunch beneath the classes of Ad-Hoc Networks. Since the nodes in a Ad-Hoc network are moving, the arrangement of various elements of a computer network may become different very drastically and unknowingly. When we say something about any network type, whether it is transfer of information between points that are connected or not connected by an electrical conductor, the most essential point that need to be solved is the energy efficiency of that network[1].

In data gathering data loss often happens due to external faults such as random link failures, hazard node faults, low packet delivery ratio and conjunction. Failing nodes alter the topology of the network resulting in segmented routing paths and lost messages, ultimately increasing energy consumption. The question of energy consumption itself has various looks, which vary from energy equired for single packet, energy lost in faults to the energy required for whole network. The energy consumption is hampered by many of the set of rules by bringing together mechanisms on many layers, right from the MAC layer up to the application layer[6].

The paper is organized as follows. In section II, Energy Conservation Issues. In section III , Energy calculations of network, Reliable Routing Protocol with numerical results.

2. ENERGY CONSERVATION ISSUES AND CHALLENGES
The wireless communication nodes operate in the three states of sensing, computing and communications, and all of these consume energy. Out of the three modes, maximum energy is required for the communications. The sensing unit is responsible to detect the physical characteristics of the environment and has an energy consumption which depends on the hardware nature and applications. However, sensing requires very less energy of the entire energy consumption. In comparison, computations energy is much more. Communication unit uses short-range RF circuit to perform the transmission and reception[6].

Communication energy requires to data forwarding and it depends on the transmission range that increases with the signal propagation in an exponential way. The energy model includes the five stages: Transmission, Reception, Acquisition, Listen and Sleep[6].

3. ENERGY CALCULATION OF NETWORK
To minimize the energy usage of the network, it is very important to study the factors, which affects the energy usage of the network. If we assume that there is only one data flow in the network, then energy required for whole communication is directly proportional to the number of transmissions.

Number of transmissions can be calculated if we know the hop count and number of packets transmitted from source.

$$\begin{aligned}&\text{Total Energy Required}\\&= \text{ Total Number of Transmissions}\\&\times \text{ Unit energy required for a packet to be}\\&\cdot \text{ transmitted from one node to another.}\\&\cdot \qquad\qquad\qquad\qquad \cdots \text{(Equation1)}\end{aligned}$$

Here, Unit energy required for a transmitting a packet from one node to another adjacent node is assumed to be same in all the scenarios

Now total number of transmissions is a direct multiplication of number of packets sent and hop count, as we have assumed that there is only one transmission is going on.

$$\begin{aligned}&\therefore \text{Total Energy required}\\&= \text{ Hop Count X Total number of packets}\\&\cdot \text{ sent from source } \times \text{ Unit energy required for one packet.}\\&\cdot \qquad\qquad\qquad \cdots \text{(Equation 2)}\end{aligned}$$

As we know Packet Delivery ratio (PDR) = $\frac{\text{Number of Packets Received}}{\text{Number of Packets tranmitted}}$

$$\begin{aligned}&\therefore \text{Total energy required}\\&= \text{ Hop Count X}\frac{\text{Number of Packets Received}}{\text{PDR}}\\&\times \text{Unitenergy for 1 Packet} \quad \cdots \text{(Equation 3)}\end{aligned}$$

$$\text{Total energy required} = \text{Unit energy for 1 Packet} \times \text{Number of Packets Received} \times \text{Hop Count/PDR} \quad \ldots \text{(Equation 4)}$$

Unit Energy for One packet to transmit from one node to another node is assumed to constant and the number of packets received will be constant for a particular communication irrespective of the path chosen. So Total Energy Required is directly proportional hop count / Packet Delivery Ratio.

Therefore if the path which will give minimum value of hop count / Packet Delivery ratio is chosen, then it will yield in minimum energy consumption.

4. RELIABLE ROUTING PROTOCOL

Reliable Routing Protocol is designed for efficient use of the energy of network. The Hop count metric for path selection is changed in the Reliable Routing Protocol with a combination of Hop count and Packet delivery Ratio.

4.1 Overview

Reliable Routing Protocol shares several characteristics with Ad hoc on-demand multipath distance vector routing (AOMDV). It uses hop by hop routing approach and end-to-end routing approach. Moreover, Reliable Routing Protocol finds routes on demand by using route discovery procedure. In AOMDV, RREQ propagates from the source to the destination establishes more than one reverse paths both at destination as well as the intermediate nodes. Multiple RREPs travels by these reverse paths back to form multiple forward paths to the destination at the source and intermediate nodes. After getting all possible disjoint routs AOMDV chooses for path of minimum hop count first and starts transmission from that path. The main difference in Reliable routing Protocol and AOMDV lies here. Reliable Routing Protocol uses a combination of Hop count and packet Delivery ratio for the selection of the path.

4.2 Route Discovery

The Path Discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table Every node maintains two separate counters a node sequence number and a broadcast id. The source node initiates path discovery by broadcasting a route request RREQ packet to its neighbors. The pair <source_addr,broadcast_id> uniquely identifies a RREQ broadcast id is increments whenever the source issues a new RREQ Each neighbor either satisfies the RREQ by sending a route reply RREP back to the source or re broadcasts the RREQ to its own neighbors after increasing the hop count. Notice that a node may receive multiple copies of the same route broadcast packet from various neighbors. When an intermediate node receives a RREQ if it has already received a RREQ with the same broadcast id and source address it drops the redundant RREQ and does not rebroadcast it.

When Destination node receives a RREQ, it sends RREP packets from all the possible paths towards source, same as that of AOMDV. Source keeps the information of all possible disjoint paths. After getting the information of all the paths, source send few packets from every path and calculates the packet delivery ratio for every path.

4.3 Degree of Path Selection (DPS)

As we have seen in the mathematical proof in section 4, Total energy required for the communication is depends on the ratio of hop count and packet delivery ratio. So the minimum value of this ratio will result in the minimum energy usage. So the new term, Degree of path selection (DPS), is introduced here. Degree of path selection is the ratio of Hop count and packet delivery ratio.

$$\text{Degree of Path Selection (DPS)} = \frac{\text{Hop Count}}{\text{Packet Delievery ratio}} \ldots\ldots\ldots \text{(Equation 5)}$$

So the DPS is calculated for all the paths and the path having lowest DPS is chosen for the communication.

4.4 Switching of Route

After selecting a particular path for data transmission, if PDR decreases for that particular path beyond threshold then data will be transmitted using another path.(Automatic switching of route is proposed, where as below results are observed by manual switching)

Conditions for Threshold:

1) Threshold ≤ 2^{nd} Highest PDR
2) Threshold ≤ (Highest PDR – 0.1 Highest PDR)

(.1 taken above is variable for network)

5. NUMERICAL RESULTS

After considering various networks with different number of nodes, applying AOMDV and Reliable Routing Protocol together, it is found that the path chosen by Reliable routing protocol always gives the packet delivery ratio, which is equal or greater than the packet delivery ratio of the path chosen by AOMDV. Along with that the Energy consumed by AOMDV and Reliable Routing Protocol is compared and found that the energy used by Reliable Routing Protocol is equal to or less than that of AOMDV.

Table 1. DPS calculations of AOMDV

Sr. No	Traffic Interval	Hop Count	PDR	Degree of Path Selection = Hop Count/PDR	% Energy Consumed
1	0	10	0.7616	13.14	10.5
2	0.1	10	0.6191	16.16	12.07
3	0.05	10	0.5345	18.71	12.5
4	0.01	10	0.3965	25.23	13.32

Table 2. DPS calculations of Reliable Routing Protocol

Sr. No	Traffic Interval	Hop Count	PDR	Degree of Path Selection = Hop Count/PDR	% Energy Consumed
1	0	10	0.7616	13.14	10.5
2	0.1	12	0.7325	12.07	11.39
3	0.05	12	0.7374	12.5	12.09
4	0.01	12	0.7225	13.32	13.14

Table 1 and Table 2 shows the PDR, Hop count, DPS and energy calculations of AOMDV and Reliable Routing Protocol respectively.

Table 3. Comparative study of AOMDV and Reliable Routing Protocol

Sr. No	Traffic Interval	% Energy Consumed for AOMDV	% Energy Consumed for Reliable Routing Protocol	% Decrement in Energy Usage
1	0	10.5	10.5	0
2	0.1	12.07	11.39	5.61
3	0.05	12.5	12.09	3.3
4	0.01	13.32	13.14	1.32

From Table 1, 2 and 3, we can observe that if we arrage all DPS values in ascending order then percentage energy consumed is also in ascending order, This proves that the energy consumed by the network is directly proportional to the Degree of Path Selection. It also proves that Reliable routing protocol always gives the energy efficient path.

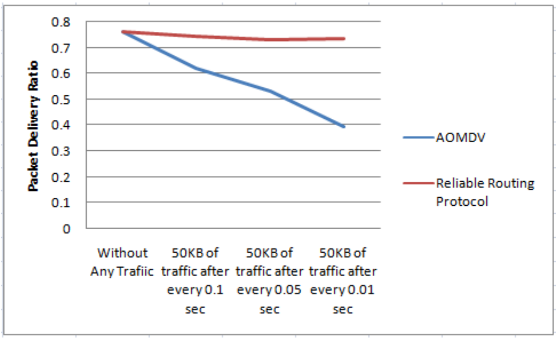

Figure 1: Comparison of PDR of AOMDV and Reliable Routing Protocol

Figure 1 shows the comparison of packet delivery ratio of AOMDV and Reliable Routing Protocol.

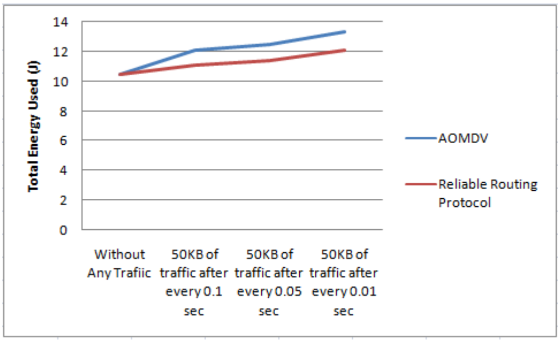

Figure 2: Comparison of Energy Used for AOMDV and Reliable Routing Protocol

Figure 2 shows the comparison of Energy used for AOMDV and Reliable Routing Protocol.

6. CONCLUSION

It is mathematically proven that the energy requirement of the communication depends on both, Hop count and Packet delivery ratio. Energy requirement is directly proportional to the hop count and inversely proportional to packet delivery. So the Reliable Routing Protocol uses Degree of Path Selection, which is based on hop count and packet delivery ratio, for the path selection. Results show that there is around 5% energy saving by using Reliable Routing Protocol. Also it is observed that Reliable routing protocol selects the path of Maximum packet delivery ratio, so even if the traffic in network increases, Reliable routing protocol goes for the path with highest packet delivery ratio

7. REFERENCES

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