A SURVEY ON FACTORS EFFECTING ENERGY CONSUMPTION IN MANET

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ABSTRACT
In the last years, Mobile Ad hoc Networks (MANET) have gained increasing attention from both the research community and actual users. As network nodes are generally battery-powered devices, the crucial aspects to face concern how to reduce the energy consumption of nodes, so that the network lifetime can be extended to reasonable times. In this paper we have discussed mobility models (which are used for efficient movement of nodes) and then routing protocols of MANET. Energy plays the vital role in any ad hoc network, hence total lifetime of the network depends upon the individual energy consumption of node. Energy is consumed in ad hoc networks mainly in two tasks i.e. processing (routing, forwarding, congestion control) and transmission (data receiving and sending). This paper has discussed the factors effecting power consumption in MANET. The factors like distance between two nodes, environment conditions, mobile nature of nodes, modes of node, transmission range of nodes and memory capacity of node are discussed here.

Keywords - MANET, mobility models, overall power consumption, routing protocols.

1. INTRODUCTION

MANET consist of three words i.e. *Mobile*, means moving in nature, *ad hoc*, means for temporary/this purpose and *Network*, means collection of nodes over the internet [7]. MANET is having dynamical topological structure i.e. due to mobility of nodes, the topology keeps on changing. It does not have fixed infrastructure and does not require any establishment cost. It can be deployed anytime anywhere depending upon the current transmission. Fig.1 shows the general structure of MANET [6]:

Figure 1: structure of MANET

These networks are useful where temporary connections are required i.e. law enforcement, disaster, battlefield, remote areas etc. Energy plays the vital role in any ad hoc network, hence total lifetime of the network depends upon the individual energy consumption of node. A sending node after data transmission consumes power and may reach to a threshold level. A threshold level is minimum value at which the node is unable to transmit and process. Ad hoc network undergoes various challenges like limited bandwidth, battery backup, route discovery, data forwarding and memory space.

A Homogeneous [5] Mobile Network is that in which same type of batteries are installed whereas Heterogeneous Mobile Network is that in which different type of batteries are used. Depending upon the requirement/ application we can choose any of the network (Homogeneous or Heterogeneous). There are various power- aware protocols which are used to improve lifetime of network. Some of them are explained below.

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The paper is organized as: In section 2, Mobility Models are discussed. In section 3, Routing protocols are discussed little bit. In section 4, factors effecting the energy consumption in MANET are discussed. We conclude our paper in section 5.

2. MOBILITY MODELS

In MANET, nodes are mobile in nature and topology keeps on changing, so there are some movement models which define the algorithms and rules that produce the node movement paths. There are mainly four types [1] of mobility models and they are:

1. Random Movement
2. Models with temporal dependency
3. Models with spatial dependency
4. Models with geographic Restriction

Most frequently used model is Random model. In random model, nodes are free to move randomly without any restrictions [1]. It is further divided into three sub models:

2.1. Random Waypoint Model

It was the 'benchmark' mobility model to estimate the MANET routing protocols, because of its wide availability and simplicity [1].

2.2. Random Walk model

The Random Walk model was originally planned to emulate the random movement of particles in physics. It is also known as Brownian Motion. Mobile nodes can move in an unexpected way, so to mimic their movement behaviour Random Walk mobility model was proposed [3]. Random Walk model was just similar to specific Random Waypoint model with zero pause time.

2.3. Random Direction model

In Random Direction model, the node uniformly and randomly chooses a direction by which to move along until it reaches the boundary [8]. When the node reaches the boundary of the simulation field and it stops with a pause time say T , it then again uniformly and randomly chooses another direction to move. In this way, the nodes are uniformly dispersed within the simulation field.

3. ROUTING PROTOCOLS

Mainly there are two category of routing protocols in MANET:
Source-initiated (Reactive or on-demand) and Table-driven (Pro-active).

3.1. Source-initiated Routing Protocols

These protocols create routes on demand i.e. when source demands a route to destination. examples of source-initiated Routing protocols are DSR, AODV, TORA etc.

3.2. Table-driven Routing Protocols

In these protocols, up-to-date routing tables are maintained on every node. As network topology changes rapidly in highly dynamic networks [2], these protocols are not suited well in these networks because of extra overhead generated for maintaining the most recent routes. Examples of these protocols are DSDV, OLSR, CGSR etc.

4. FACTORS EFFECT THE ENERGY

4.1. Distance between nodes

As the nodes move, network topology changes. In transmission range of node A, node X is there, in transmission range of node B, node X and node Y are there. In transmission range of node C, node Y and node Z are there. Node X transmits the data to node Z in two ways; first it will sends the data directly to node z and secondly it sends via node Y, as shown in Fig.2.

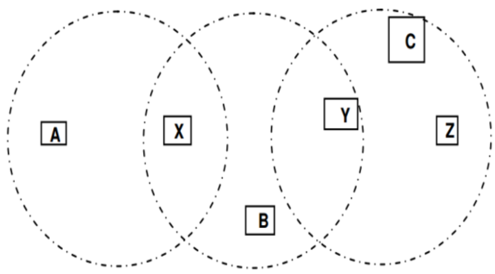

Figure 2: transmission range of nodes

But energy consumes more in the first way. Equation 1 shows the energy consumption [4]:

$$P(X,Y) + P(Y,Z) < P(X,Z) \qquad (1)$$

4.2. Environment conditions

4.2.1. Temperature

Inside the batteries, chemical reactions occur. As the temperature of the surroundings increases, rate of reactions increases. Faster chemical reactions leads to loss of battery life. According to the Arrhenius equation, rate of chemical reaction increases exponentially [10] as the temperature rises. Equation 2 shows this:

$$K=A\ \exp(-E_A/RT) \quad (2)$$

where: K= rate of chemical reaction proceed
A= frequency factor
exp= mathematical constant, 2.71
E= activation constant
R= universal gas constant
T= temperature in degrees kelvin

4.2.2. Pressure

Increased temperature can cause internal pressure of a cell to rise. As the ambient temperature increases, cell temperature automatically increases and it will cause expansion of chemicals inside the cell which in turn internal pressure of a cell to rise [10].

4.2.3. Load on node

Load means the data packets waiting in queue at any node to be transmitted over outgoing path. As the load increases, node starts discarding the data packets which results in retransmission and again incurs lots of power in transmission , forwarding and receiving.

4.3. Mobility of nodes

As nodes change their position rapidly, topology of the network changes (neighbouring nodes, paths). Then each node has to update its routing information in order to follow the routing protocol and to maintain QoS. As we know lot of energy is consumed in this updation. Hence we use mobility models. Mobility defines the movement of nodes in advance. So that we can preserve the energy consumed in identifying optimal paths and maintaining the routing tables.

4.4. Mode of nodes

Power consumption in MANET mainly depends on the mode of nodes. Each node can be in transmission mode, forwarding mode (over hearing mode), reception mode, idle mode and sleep mode. A node is said to be in transmission mode when it transmits a packet and the energy it consumes in this mode is called transmission energy. Transmission energy is directly proportional to packet size [9]. Equation 3 shows the relationship between transmission energy and length of data packet:

$$T_e \propto l_p \quad (3)$$

where T_e is the transmission energy and l_p is the packet length.

Forwarding or overhearing mode is that in which it receives and forward the data packets without any processing. This receiving and forwarding incurs little bit of energy. Intermediate nodes only overhear (bypass to next node in path) the data packets. Reception mode involves receiving of data by destination node. This node should have appropriate energy to receive and process the data. Idle mode is that in which node doing nothing except listening the wireless medium regularly so that it can detect the incoming packet. unnecessarily listening and identifying incurs some amount of energy. Sleep mode is that in which node is in dead state (no listening, no identification, no sending and receiving). The modes of node is shown in fig.3:

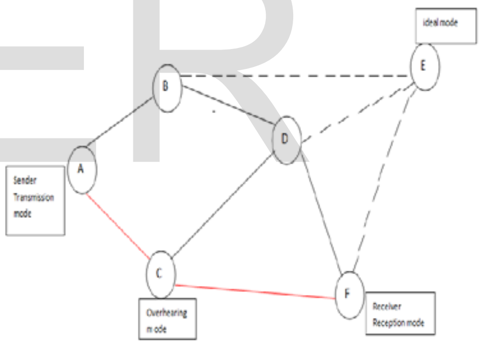

Figure 3: modes of node

4.5. Transmission power of a node

When a node transmits with low frequency, there is a need of acknowledgement as shown in fig.5. If acknowledgement is not received by the sender it means data is not reached to its destination and sender has to retransmit the data as shown in fig.6. Power is consumed in retransmission and acknowledgement. But, when a node transmits with high frequency**,** as shown in following fig. 4, data packets will guaranteed to reach its destination and there is no need of acknowledged the data. In this case no power is saved because receiver is not sending the acknowledgement. Let

P_T is total power consumed by node A to transmit the data to node C, where P_{HA} and P_{LA} stand for High and low power consumed by node A respectively. Similarly for node B and node C. Fig.5 shows transmission between two hopes A and B includes the negative acknowledgement of node C i.e. $P_{NACKB.}$ In Fig.5 and Fig. 6 P_{int} is intermediate power consumed between two hopes. In Fig. 6 P_{reLA} is power consumed in retransmission of data by node A.

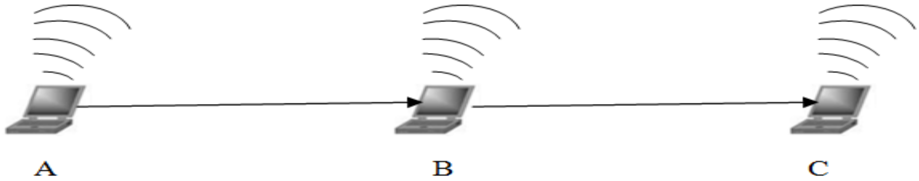

Figure 4: Transmission with high Frequency

The total power consumed in this task is given in equation 4 below and it shows successful transmission:

$$P_T = P_{HA} + P_{HB} + P_{HC} \qquad (4)$$

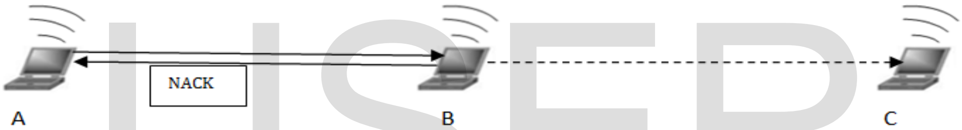

Figure 5: Transmission with low frequency

The power consumed between two nodes (A and B) is given in equation 5 below and it shows unsuccessful transmission:

$$P_{int} = P_{LA} + P_{LB} + P_{NACKB} \qquad (5)$$

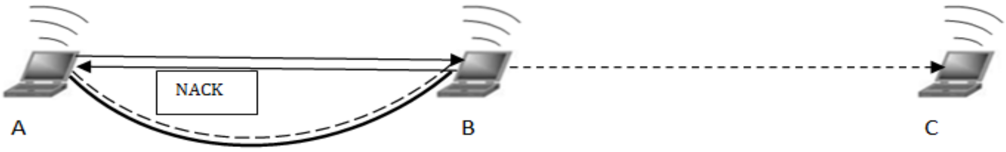

Figure 6: Showing retransmission

The power consumed between these two nodes is given in equation 6 below :

$$P_{int} = P_{LA} + P_{LB} + P_{NACKB} + P_{reLA} \qquad (6)$$

4.6. Capacity of node

As we know, in MANET mobile nodes are hardware devices. Memory instructions consumes more power [9] in processing. CPU scheduling is necessary for efficient utilization of CPU. Here power consumed by the processor is directly proportional to the supply voltage, clock frequency and switching capacitance of devices.

5. CONCLUSION

Mobile Ad Hoc Networks are having so many applications. The mobile nodes in MANET have limited resources like buffer space, battery power, bandwidth, etc. that hinders the smooth communication of the network, therefore resource optimization plays an important role in these types of networks. As the demand of Ad hoc networks increases among users, it's not feasible for the network to conserve its power for long time. This paper has discussed the factors effecting power consumption in MANET. To maintain the proper working of network all devices should function in efficient manner. The lifetime of a nodes collectively identify the network lifetime. As we know the energy consumes in three tasks i.e. sensing, processing and communication. So for efficient communication in the network, energy should be consumed efficiently in each tasks, so that the network keeps on functioning. This energy is effected by various factors like environment conditions, distance between two nodes, transmission range of node, memory capacity, etc. Hence it is the very big challenge for the researchers to optimize the network resources efficiently.

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