ANALYSING THE IMPACT OF TTL SEQUENCE-BASED EXPANDING RING SEARCH ON ENERGY AWARE ROUTING PROTOCOLS FOR MANETS.

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Abstract:
In this paper we analyze the impact of TTL Sequence-based expanding ring search on Energy Aware Routing protocols for MANETs. We compared the energy consumed in Transmit mode, Receive mode and Idle Mode for Low mobility and High mobility with different TTL values. From simulation results we observe that there is no impact of pause time on energy consumed in Receive Mode for different TTL values with High Mobility. At TTL3 energy consumed is maximum in Transmit mode and Minimum in Receive mode and also the percentage of time spent is maximum in Transmit mode and minimum in Receive mode.

Key Words: Power Aware Routing Protocols – Energy-Time Efficiency of ERS and BERS in MANETS, TTL.

1. INTRODUCTION
In ad-hoc networks, each mobile node acts as both a router and an end node that takes part in route discover and maintains. The failure of a node greatly affects the performance of the network. The essence of using wireless device is that they can be used anywhere at any time. One of the greatest disadvantages is limited power capacity. Since battery provides limited power, a general constraint of the wireless communication is the short life of mobile terminals. Therefore, power management is one of the most challenging problems in wireless communication. The goal of this paper is to minimize the total energy consumed when a packet is transmitted with less energy consumption. This approach is called transmission power control.

RREQ packets are flooded throughout the network; this algorithm does not scale well to large networks. If the destination node is located relatively near the source, issuing a RREQ packet that potentially pass through every node in the network is wasteful. The optimization AODV uses is the expanding ring search algorithm, which works as follows [1]. The source node searches successively larger areas until the destination node is found. This is done by, for every RREQ retransmission until a route is found, incrementing the time to live (TTL) value carried in every RREQ packet, thus expanding the "search ring" in which the source is centered [2].

2. ROUTING PROTOCOLS
2.1 Ad Hoc On-Demand Distance Vector (AODV):
The Ad Hoc On-Demand Distance Vector (AODV) routing protocol is intended for use by mobile nodes in an ad hoc network. It offers quick adaptation to dynamic link conditions, low processing and memory overhead, low network utilization, and determines unicast between sources and destinations. It uses destination sequence numbers to ensure loop freedom at all times (even in the face of anomalous delivery of routing control messages), solving problems (such as .counting to infinity.) associated with classical distance vector protocols.
3. METHODOLOGY

ERS - Expanding Ring Search: Reactive routing protocols in MANETs support Expanding Ring Search. During the route discovery stage, the RREQ (Route REQest packet) is broadcasted by flooding and propagated from one intermediate node to another to find the route information from the source to the destination node.

Figure 1, 2 and 3 show how the broadcasts and propagation form searching ‘rings’ in such a route discovery process.

In Figure 1, a RREQ is broadcasted by the source and two neighbour intermediate nodes receive the message. Each arrow line represents a send-receive relationship between the broadcasting source and one neighbour node. Each broadcast is issued with a hop number which is a serial number indicating the sequence of the nodes alone a route from the source.

In Figure 2, for example, a RREQ is broadcasted with a hop number ‘1’ by the source and five intermediate nodes receive the message and are given the same hop number. If none of them has the route information to the destination node, the five nodes rebroadcast the RREQ with an incremental hop number, 2 in Figure 3, for example. In this way, the nodes with the same hop number from the source node form a circle, i.e. the search rings. As the route discovery in progress, the diameter of the searching ring increases. Utilizing the route cache during routing is widely adopted in MANETs to achieve time and energy saving routing. A node in MANETs broadcasts RREQs and the intermediate nodes within the broadcast range cooperate the route discovery process.
by checking their own route caches for requested route information and maintaining an updated list of known routes. An intermediate node who has the requested route information towards the destination is defined as a route node. Efficient route discovery relies largely upon how quickly a route node can be found. When a RREQ is received, an intermediate node searches for the requested route information in its route cache. If there is route information to the destination node in its route cache, the route node would stop rebroadcasting the RREQ and sends a RREP to the source node with the complete route information consisting of the cached route in itself and the accumulated route record in the RREQ. In this way, the route may be established much quicker.

3.1 TTL Sequence-Based Expanding Ring Search.

The goal of the expanding ring search is to find nodes that have the required route information to the destination node in their route cache by propagating RREQs. The propagation of RREQs is, on one hand, an efficient way for route discovery. It, on the other, may lead to ineffective flooding. Nodes in MANETs, for example, can be trapped in a loop of actions and end up asking each other for routing information for a long time without any solutions[1].

To control the flooding in MANETs, TTL (Time To Live) [1] sequence-based Expanding Ring Search is used. The TTL sequence-based ERS restrains its searching range by giving RREQs a pre-defined TTL number. Each time it fails to find any node that has route information to the destination node or the destination node itself, the source node rebroadcasts the RREQ in the next round with an increased TTL number to allow the RREQ to reach the remote nodes in further distance.

The TTL number increases linearly with a specified value [4]. The incremental value of TTL is fixed to 2 in [2] and [5], 1 in [6]. Figure 4 shows how TTL controls the RREQ relay range by predefined TTL values of 1, 2 and 3.

![Figure 4: TTL based RREQ sequence diagram](image)

3.2 Blocking-ERS.

The Blocking-ERS integrates, instead of TTL sequences, a newly adopted control packet, stop instruction and a hop number (H) to reduce the energy consumption during route discovery stage.

The basic route discovery structure of Blocking-ERS is similar to that of conventional TTL sequence-based ERS. One of the differences from TTL sequence-based ERS is that the Blocking-ERS does not resume its route search procedure from the source node every time when a rebroadcast is required [9].

![Figure 5: HOP based broadcasting](image)
4. SIMULATION ENVIRONMENT

The simulation is done with the help of Qualnet simulator version 5.0.4. The network contains 100 nodes randomly distributed in a 1500m X 1500m area, pause time of 0, 900s.

4.1 Energy Evaluation Model

We have used the following simulation parameters for evaluation as given in the following table1.

<table>
<thead>
<tr>
<th>Routing Protocol</th>
<th>AODV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>1500m x 1500m</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>900 sec</td>
</tr>
<tr>
<td>Mobile Nodes</td>
<td>25</td>
</tr>
<tr>
<td>Node’s Placement Model</td>
<td>Random</td>
</tr>
<tr>
<td>Propagation Model</td>
<td>Two ray</td>
</tr>
<tr>
<td>Mobility Model</td>
<td>Random Way Point</td>
</tr>
<tr>
<td>Pause Time</td>
<td>0sec and 900sec</td>
</tr>
<tr>
<td>Minimum Speed</td>
<td>0 m/s</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>5,(m/s)</td>
</tr>
<tr>
<td>Traffic</td>
<td>CBR,</td>
</tr>
<tr>
<td>Packet size</td>
<td>512 bytes</td>
</tr>
<tr>
<td>MAC layer</td>
<td>802.11</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>Omni directional</td>
</tr>
</tbody>
</table>

Energy is converted in joules by multiplying power with time. The following equations are used to convert energy in joules:

4.2 Transmitted Energy:

\[ T_e \text{ Energy} = \left( T_e \text{ Power} \times \text{Packet Size} \right) / 2 \times 10^6 \]  \hspace{1cm} (1)

4.3 Receiving Energy:

\[ R_e \text{ Energy} = \left( R_e \text{ Power} \times \text{Packet Size} \right) / 2 \times 10^6 \]  \hspace{1cm} (2)

Total energy consumed by each node is calculated as sum of transmitted and received energy for all control packets.

\[ \text{Total Energy E} = \sum_{i=1}^{n} c_i \]  \hspace{1cm} (3)

4.4 CBR Traffic Model:

CBR generates traffic at a deterministic rate. It is not as ON/OFF traffic.

5. RESULTS

We have made following evaluation with pause time 0s, 900s and simulation time 900s

1. Energy consumption in Transmit Mode.
2. Energy consumption in Receive Mode.
3. Energy consumption in Idle Mode

5.1 Performance Metrics for Simulation:

There are four important performance metrics are evaluated for performance analysis of Ad-hoc routing protocols:
5.2 Packet delivery ratio: The calculation of the packet delivery ratio uses the ratio of the total number of CBR (Constant Bit Rate) packets received in the network to the total number of CBR packets sent during the simulation.

\[
\text{Packet Delivery ratio} = \frac{\sum_{i=1}^{n} CBR_{\text{recv}}}{\sum_{i=1}^{n} CBR_{\text{sent}}} \quad (4)
\]

5.3 Routing Overhead: routing overhead indicates the ratio of the number of routing packets (total number of control packets) required to route a CBR generated data packet.

\[
\text{Routing Overhead} = \frac{\sum_{i=0}^{t} P_{c}}{\sum_{i=0}^{t} P_{d}} \quad (5)
\]

Where \( P_c \) is the number of control packets generated to route the data packets, \( P_d \) is the number of data packets received at the destination and \( t \) is the simulation time.

5.4 Average Hop Count: It refers total number of hops are needed by a packet to reach the destination.

\[
\text{Average Hop count} = \frac{\sum_{i=0}^{n} h_i}{n} \quad (5)
\]

Where \( h_i \) the number of hops the \( i_{th} \) packet takes to reach the destination and \( n \) is the total number of packets.

5.5 Energy consumption in Transmit Mode:
The above graph shows the total transmission energy. The energy consumed is mainly due to the transmission process. When TTL value is low, the transmitting energy is less in pause time zero and it is high in pause time is high. When the number of nodes are more in the ring, transmission will take more time than compare to other rings in that networks.

5.6 Energy consumption in Receive Mode:
The above graph shows the total Received Energy. The energy consumed is mainly due to receiving process. When the no of nodes in that ring is small, it consumes less energy and it is depends on the node density. At pause time zero, receiving energy is more and when the node speed is reduced the consumption of received energy also decreases.

5.7 Energy Consumed in Idle Mode
The above graph shows the total Idle mode energy. The energy is consumed mainly due to Idle process. TTL value is not influenced, when a node is idle, in this case the node neither transmits the data nor receives the data. It simply monitors the network.
6. Conclusions and Future Scope:

From Simulation results we observe that there is no impact of pause time on energy consumed in Receive Mode for different TTL values with High Mobility.

At TTL3 energy consumed is maximum in Transmit mode and Minimum in Receive mode. The percentage of time spent is maximum in Transmit mode and minimum in Receive mode.

In future this work can be expanded to different traffic models like Deterministic, Exponential and Pareto.

7. References: