AN EFFICIENT POWER CONTROLLED ROUTING IN MANETs

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ABSTRACT

A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed with the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes. An ad hoc network [1] is a collection of wireless mobile nodes dynamically forming a temporary network without the use of any existing network infrastructure or centralized administration. This work is incorporated with three different protocols namely PC-AODV (Power Controlled Ad hoc on-demand Distance Vector protocol. Applying power control into routing protocols in wireless ad hoc networks has become a hot research issue, because rational use of power control in routing protocols can not only reduce network energy consumption but also improve network throughput, packet delivery ratio and other performances of ad hoc networks. So this work proposes an on-demand routing algorithm based on cross-layer power control termed as PC-AODV. This algorithm builds different routing entries according to the node power levels on demand, and selects the minimum power level routing for data delivery. In addition, PC-AODV uses different power control policies to transmit data packets, as well as control packets of network layer and MAC layer.

Keyword : - *PC-AODV, Power controlled Routing, MAC layer*

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1. INTRODUCTION

Wireless Ad hoc Networks are a collection of two or more devices equipped with wireless communications and networking capability. These devices can communicate with other nodes that immediately within their radio range or one that is outside their radio range. For the later, the nodes should deploy an intermediate node to be the router to route the packet from the source toward the destination. The Wireless Ad-hoc Networks [1] do not have gateway, every node can act as the gateway. In the next generation of wireless communication systems, there will be a need for the rapid deployment of independent mobile users. Significant examples include establishing survivable, efficient, dynamic communication for emergency/rescue operations, disaster relief efforts, and military networks. Such network scenarios cannot rely on centralized and organized connectivity, and can be conceived as applications of Wireless ad hoc networks.

A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes. The set of applications for MANETs[1] is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, MANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing. However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to MANETs[3]. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes, become relevant issues. The network should be able to adaptively alter the routing paths to alleviate any of these effects. Hence, nodes prefer to radiate as little Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work. power as necessary and transmit as infrequently as possible, thus decreasing the probability of detection or interception. A lapse in any of these requirements may degrade the performance and dependability of the network.

Recently a large volume of research has been conducted on the issue of energy efficiency for wireless networks. Since energy conservation is not an issue of one particular layer of the network protocol stack. Many researchers have focused on cross layer designs to conserve energy more effectively. One such effort is to employ power control at the MAC layer and to design a power aware routing at the network layer.

Wireless ad hoc networks are self-organizing networks without the use of any existing network infrastructure or centralized administration, which can be useful in a variety of applications including one-off meeting networks, disaster, military applications, and the entertainment industry and so on. Each node in ad hoc networks performs the dual task of being a possible source or destination of some packets while at the same time acting as a router for other packets relay. Traditional routing protocols cannot be applied to ad hoc networks directly because ad hoc networks inherently have some special characteristics and unavoidable limitations such as dynamic topologies, bandwidth-constrained, variable capacity links, and energy-constrained operations compared with traditional networks. Consequently, research on routing protocols in ad hoc networks becomes a fundamental and challenging task. This ad-hoc routing protocols can be divided into two categories:

1.1 Table-driven routing protocols

In table driven routing protocols, consistent and up-to-date routing information to all nodes is maintained at each node.

1.2 On-Demand routing protocols

In On-Demand routing protocols [2], the routes are created as and when required. When a source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination. In recent years, a variety of new routing protocols targeted specifically at this environment have been developed.ch work.

2. POWER CONTROLLED – AD HOC ON DEMAND DISTANCE VECTOR

The protocol which is proposed is named as Power controlled – ad hoc on demand distance vector (PC-AODV). It is an extension of AODV [1], difference with existing protocol is that it selects the route from source to destination according to the power level in route table. Route table contains the two routes from source to destination with its power level. Algorithm chooses the route with lowest power level. It is so called because it reduces the power consumption of Network layer as well as MAC layer [6].

Power control [7],[8],[10] is a very complex issue, simplified it into assignment of transmission ranges, short to as RA problem (Range Assignment), and analyzed its computational complexity in details. Let N = {U_l,⋯ ,U_n} be a set of n points in the d-dimensional Euclidean space(d=I,2,3), denoting the positions of the network nodes and r(ui) be the transmission radius of node Ui, the network transmission power f[r(ui)] can be expressed as:

$$f\left[r(u_i)\right] = \sum_{u_i \in N}\left[r(u_i)\right]^{\alpha} \qquad (1)$$

Where: 2 <= α <=5.

RA problem is to minimize j[r(ui)] while maintaining the network connectivity, that is:

$$f\left[r(u_i)\right]_{\min} = \min\sum_{u_i\in N}\left[r(u_i)\right]^{\alpha} \tag{2}$$

In the one-dimensional case, (2) can be solvable in $O(n^4)$ time, while it is shown to be NP-hard in the case of the two-dimensional and three-dimensional networks. The actual power control problem is more complex than RA problem. For the RA problem, in this paper we try to reduce packets transmission power based on cross-layer to reduce network energy consumption. Assume that the link is symmetric and the maximum transmission power P_{trnax} is known and the same to all nodes which are capable of changing their transmission power below it, and the relation between the power P_t used to transmit packets and the received power P_r can be characterized as:

$$cP_t\, d^{-\alpha} = P_r \tag{3}$$

Where, c is a constant, and α is a loss constant between 2 and 5 that depends on the wireless medium. For Free Space propagation model and Two-Ray Ground propagation model, α is 2 and 4 respectively. Suppose that in order to receive a packet, the received power must be at least γ, i.e.,

$$cP_t\, d^{-\alpha} \geq \gamma \tag{4}$$

From (4) it comes out that:

$$P_t \geq \frac{\gamma}{c} T\ d^{\alpha} \tag{5}$$

In order to effectively support node mobility and reduce network energy consumption while simplify the network model, we only adjust the node's transmission power in a number of different discrete power levels.

Definition

In order to facilitate expression, we make the following definitions:

Definition 1*:* (Power Level) Power levels (termed as PL) are defined as the discrete grades of node transmission power. The power level between node A and node B is expressed as $PL_{(A,B)}$, the minimum power level between node A and node B is expressed as $PL_{min(A,B)}$, and the power level for a node to send data packets and MAC[11],[12] layer control packets are expressed as PL_{Data} and PL_{MAC} respectively.

Definition 2*:* (routing selection rules 1) If node S have k routes $RT_{(PL,h)}^{(S,D)}$ at different power levels to destination node D, then node S select a route at smallest power level to transmit data packets.

Definition 3*:* (routing selection rules 2) If node S have more than one routes $RT^{(S'D)}_{(PL,h)}$ at the same power levels to destination node D, the node select the route with the minimum hop to transmit data packets.

PC-AODV (Power controlled AODV) is an on-demand routing protocol, the essential idea is that it:

- Building different routing entries at different power levels on demand, and a node selects the route according to routing selection rules 1,2;
- Using different power control policies to transmit data packets as well as control packets of network layer and MAC layer.

PC-AODV consists of two main phases: route discovery and route maintenance. We assume that each node uses the MAC protocol specified by IEEE 802.11 Distributed Coordination Function (DCF) which mainly uses three kinds of MAC layer control packets including RTS (Request To Send), CTS (Clear To Send) and ACK (Acknowledge). Our algorithm uses different power control strategies to transmit data packets, and control packets of network layer and MAC layer, that is, use different PLs to send network layer control packets, and the transmission power to send actual data packets is set according to the routing table entry. Furthermore, the transmission power to send MAC layer control packets is set and varied according to transmission power to send network layer[13] control packets and actual data packets. Simulation is performed on the basis of simulation parameters. This is performed for comparing AODV and CP-AODV algorithms to evaluate the performance.

3. PERFORMANCE EVALUATION AND RESULTS

Average End-to-End Delay

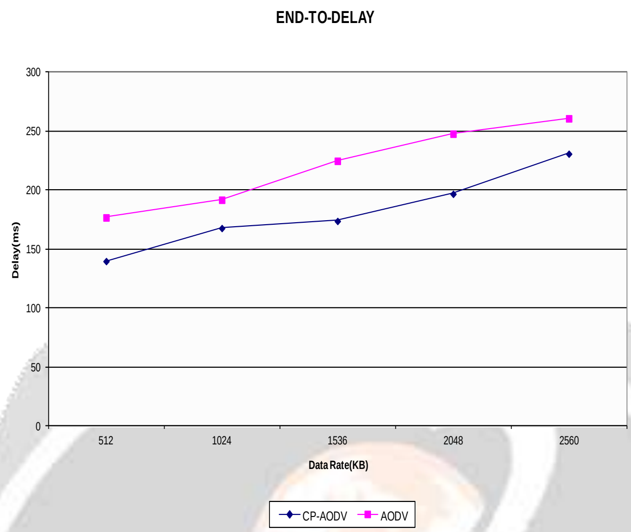

Fig.1 End-To-End Delay

Fig.1 displays the average end-to-end delay of three algorithms with varying average traffic load. As increase in network average load, the average end-to-end delay of three algorithms will increase. In Fig.1, we can see that PC-AODV provides an obvious lower network delay compared with AODV. Under the same conditions, PC-AODV can reduce the delay from 9ms to 125ms compared with other protocols.

Packet Delivery Ratio

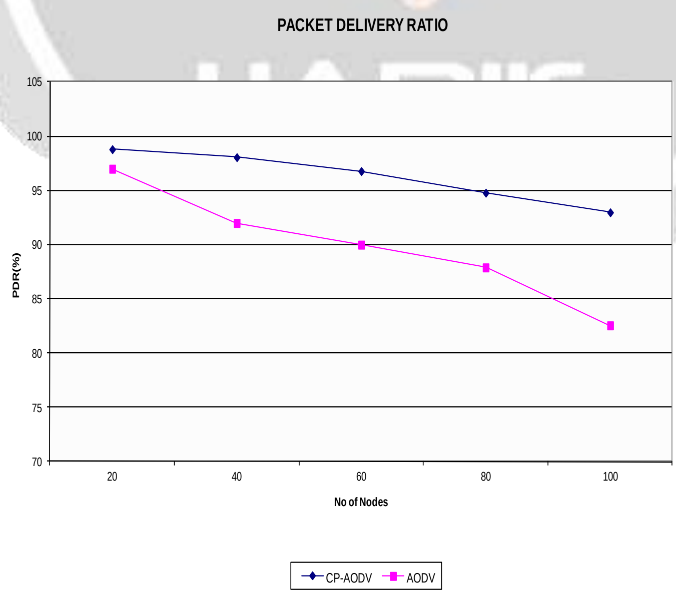

Fig. 2 Packet Delivery Ratio

Fig.2 indicates the packet delivery ratio of two algorithms for the case when the average load is varied from l000 Kbps to 4000Kbps. For all approaches, there is a decrease in packet delivery ratio when the load increases. The results shown in Fig.2 indicate that packet delivery ratio of PC-AODV is higher than of AODV under the same conditions.

Network Lifetime and Residual Energy

Fig.3 and Fig.4 shows the network residual energy and the life time of two algorithms at different traffic load respectively. When there is only small traffic load, three protocols almost achieve the same the network lifetime and the residual energy. As increase in network average load, all the protocols show significantly degradation in both network lifetime and residual energy. The results in Fig.3 indicate that the network lifetime of PC-AODV is higher than AODV under the same conditions.

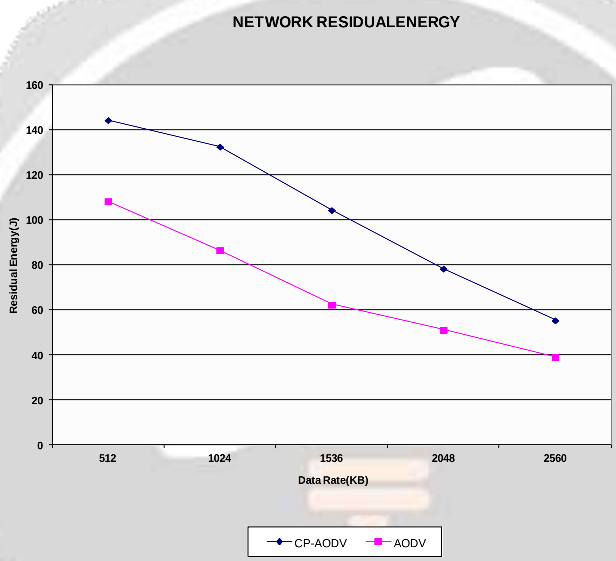

Fig .3 Network Residual Energy

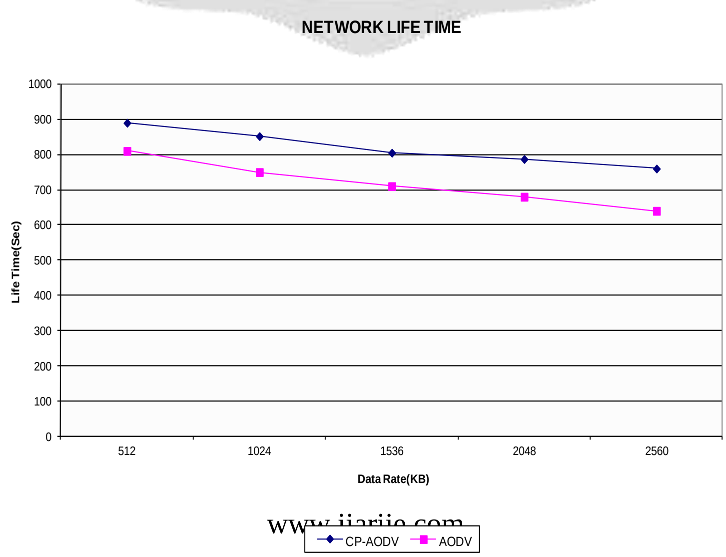

Fig. 4 Network lifetime

At the same time, the results in Fig.3 indicate the residual energy of PC-AODV is more than of AODV in the same circumstances. This is because AODV does not take measures to network energy consumption, and just uses the default maximum power to transmit data will consume more energy. Some nodes of burdening heavy flow excessively consumed their energy, thus the corresponding residual energy is less and the network lifetime is shortened due to uneven energy consumption.

4. CONCLUSIONS

This work proposes an on-demand routing algorithm based on power control. This algorithm builds different routing entries according to the node power levels on demand, and selects the minimum power level routing for data delivery. In addition, PC-AODV uses different power control policies to transmit data packets, as well as control packets of network layer and MAC layer. Simulation results show that our algorithm cannot only reduce the average communication energy consumption, thus prolong the network lifetime, but also improve packet delivery ratio and average end-to-end delay. It is a needed approach to incorporate routing protocols with power control in ad hoc networks.

6. REFERENCES

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