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Energy Control and Performance Improvement in Wireless Mesh Network through Multipath AODV

Santosh Kumar Soni
Department of Information Technology
Institute of Technology
Guru Ghasidas Vishwavidyalaya
Bilaspur (C.G.) 495009 India
Santoshsoni.77@gmail.com

Dr Manish Shrivastava
Department of Computer Science & Engineering
Institute of Technology
Guru Ghasidas Vishwavidyalaya
Bilaspur (C.G.) 495009, India
manbsp@gmail.com

Abstract: *Mobile Ad Hoc Network (MANET) is a self-organized and infrastructure-less mobile network. Wireless Mesh Networks is self-configuration; self-healing and low cost adhoc network. Ad-hoc On-demand Distance Vector (AODV), in MANETs is an on-demand variation of the distance vector routing protocol. This protocol initiate route discovery only when a route is needed and maintain active routes only while they are in use. Unused routes are deleted. We proposed an approach control power and improve the performance in Wireless mesh multipath network in AODV. Our proposed approach may improve the packet delivery ratio and lower the latency of the network and also provide reliable gratuitous routes.*

1. INTRODUCTION

Designing an effective power control strategy to reduce network energy consumption is very important. Mobile Ad Hoc Network (MANET) is a self-organized and infrastructure-less movable network 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. The representation of MANET network depends largely on its routing protocols which are divided as proactive and re-active routing protocols. In MANET, the main goal is to establish the best path to route packets to its destination while considering the limited resources available in the network which includes, bandwidth, energy, and transmit power [1],[3]. However, due to frequent topology changes associated with nodes movements, the amount of control traffic generated by the routing protocols must be minimized to achieve optimal performance [2]. The big restriction is the confined energy of the batteries. If the network is divided into more than two, and one of the nodes consumes all the energy, that node can no longer participate in the network. In MANET, each mobile node acts as both a router and an end node which is a source or destination, thus the failure of some nodes operation can greatly impede performance of the network and even affect the basic availability of the network, i.e., routing, energy depletion of nodes has been one of the main threats to the availability of MANET. Since the mobile nodes have limited battery power, it is very important to use energy efficiently in MANET.

In WMNs, nodes are comprised of mesh routers and mesh clients. Each node operates not only as a host but also as a router, forwarding packets on behalf of other nodes that may not be within direct wireless transmission range of their destinations. A WMN is dynamically self-organized and self-configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves (creating, in effect, an ad hoc network). This feature brings many advantages to WMNs such as low up-front cost, easy network maintenance, robustness, and reliable service coverage.

Wireless mesh network: WMNs can be broadly categorized into three main types. Infrastructure mesh, client mesh and hybrid mesh. An infrastructure mesh consists of relatively static mesh routers operating in ad-hoc mode. Typically, one or more of these mesh routers act as gateways to the WIRED NETWORK and provide WAN connectivity for the entire WMN. The key difference to traditional wireless LANs is that the wired backhaul is replaced with a wireless multi-hop network infrastructure provided collectively by the MESH ROUTERs. An infrastructure WMN can be thought of as a normal WLAN, formed with the help of Access Points (MESH ROUTERs) connected wirelessly in ad-hoc mode, preferably on a different radio or channel and providing connectivity to the WIRED NETWORK. A client mesh is essentially a pure mobile ad-hoc wireless network with each MESH CLIENT acting as an independent router with no centralized routing control. In client mesh architecture, the network is made up of mobile client devices only, without any dedicated network infrastructure. Consequently, client devices are responsible for implementing network functionality such as routing and forwarding of packets.

One of the key characteristics of WMNs is the ability to self-organize and self-configure, which allows rapid and easy deployment. Since no back-haul wiring infrastructure is required, deployment of WMNs is significantly more cost-effective than traditional wireless network deployments. WMNs an attractive technology for a wide range of applications such as public safety, intelligent transportation systems and building automation. Most traditional ad-hoc routing protocols establish a single path from a source to a destination. It has been shown that multi-path ad-hoc routing protocols, which establish multiple disjoint paths during a single route discovery phase, have a number of benefits. Multi-path protocols typically have a lower overhead, lower packet loss rate and increased reliability compared to their single-path counterparts.

A Hybrid mesh architecture is the most generic and interesting version of a WMN. Hybrid WMNs are formed through the amalgamation of infrastructure and client mesh networks. In this scenario, MESH ROUTERs provide the basic backbone infrastructure and MESH CLIENTs actively participate in the operation of the network. Mobile clients can, therefore, provide a dynamic extension of the more static infrastructure part of the network.

2. RELATED WORK

Jin Jong [1] this article, propose that the enhanced AODV routing protocol which is improve the networks lifetime in MANET. One improvement in AODV protocol is to maximize the network lifetime by applying an Energy Mean Value algorithm which considerate node energy-aware. We attempted to extend the entire network lifetime by adjusting RREQ delay time according to the data acquired from comparison between node’s energy states and the entire network's Energy Mean Value.

In [2], a comprehensive attempt has been made to compare the performance of two on-demand reactive routing protocols DSR and AODV, along with the proactive DSDV protocol. A simulation model with MAC and physical layer models have been used to study interlayer interactions and their performance implications. The general observation from the simulation is that, for application-oriented metrics such as packet delivery fraction and delay, DSR performs higher than the DSDV and AODV. DSR consistently generates less routing load than AODV.

In [3], a new routing method for improved quality of service in mobile ad hoc networks is presented. The routing approach guarantees the shortest feasible data transmission subject to the accuracy of estimating energy related functions. Due to the limited amount of energy on the nodes of an adhoc network, some paths do not ensure a reliable data transmission. We presented a polynomial time algorithm that finds a path along which a given amount of data is transmitted in minimum amount of time. We have also extended the algorithm to take into consideration the displacement function of each mobile node in the network.

In [4], controlling ambient noise and optimizing the performance of DSR and AODV routing protocols as the received signal strength determined if the transmitted packet is valid or treated as noise based on the pre-defined received signal threshold. The technique was simulated using random way point mobility model with 40 CBR sources each generating 4 packets per second with a simulation time of 900 seconds. The results showed that AODV and DSR routing protocols were optimized to obtain a higher throughput, lower end-to-end delay and lower network load compared to the previous related research works[1],[3].

In [5], simulation study of the impact of wireless channel on Dynamic Source Routing (DSR) protocol performance at microwave carrier frequencies above 2 GHz. Simulation results show that at microwave carrier frequencies above 2 GHz, when the two-slope path loss model is used for channel modeling, the breakpoint distance affect the end-to-end throughput of the DSR protocol in Mobile Wireless Ad Hoc Network (MANET), whilst at frequencies below 2 GHz the end-to-end throughput for the free space and the two-slope path loss model was the same.

In [6] paper, we consider power control as network layer problem in wireless mesh networks. The network connectivity between nodes is determined by their communication range which in *turn can be controlled by adjusting the transmit power level. We showed that when the links are* TDM scheduled, increasing power levels of nodes results into increased throughput in case of many representative topologies and traffic pattern.

In [7] paper, the related energy control mechanisms for adhoc & sensor networks are introduced. Considering the QoS requirement such as maximum network capacity, minimum network radius and guaranteed network connectivity, a distributed non-cooperative game algorithm to power control for ad hoc & sensor networks is presented. The existing and uniqueness of Nash equilibrium for the algorithm is also proved in this paper. Simulation results show that using minimum transmitting power can get high energy efficiency at the cost of longer average latency, lower network capacity and higher interference.

In [8] paper, an on-demand routing algorithm based on cross-layer power control termed as CPC-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, CPC-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 can not only reduce the average communication energy consumption, thus prolong the network lifetime, but also improve average end-to-end delay and packet delivery ratio.

In [9] paper Introduced transmission power optimization algorithm based on various nearest neighbor distances algorithm. Transmission node is informed of neighbor node locations in its maximum transmission range through network location management or other means. Then it measures node density and calculates the optimal transmission power in current network with free space model and two way propagation model. NS2 simulation results show that this algorithm increases network throughput, and increase packet delay time and it reduces network power consumption in dense region, as well as the proportion of isolated nodes and network fragmentation in sparse region.

3. PROPOSED METHODOLOGY

We proposed an approach to control power and improve the performance in Wireless mesh multipath network in AODV.

Step 1: Create a data structure local information table which consists of nearest node ID, distance between nodes, and the interference power in neighbor node at time t.

Step 2: A new field to save the value of node interference power is added to HELLO message.

Each node adds its interference power value in HELLO message and send HELLO message to its neighbors period.

Step 3: When a node receives HELLO message from its neighbors, it will refresh its local information table and compute its payoff value according equation

$$u_i(p_i, p_{-i}) = \mu \log_2(1 + SIR_i) - c(p_i)$$

Step 4: When a node wants to send message, it will search its local information table and select maximum payoff to compute a transmit power according to equation

$$p_i = \frac{\mu h_{ik}}{ln2} - \frac{\sigma(t)^2 + p^i_{infer}(t)}{h_{ik}(t)}$$

to transmit the message.

To implement the proposed model, we are planning to use NS-3 simulator in a physical topology area of 600m x 400m using a random way point mobility model.

This can used Wireless channel/Wireless Physical, Propagation Model is Two-ray Ground reflection Model, Queuing Model is Drop-Tail/Priority Queue and MAC protocol which is 802.11.

Our simulation provides the following performance metrics.

1) Packet Loss. This is the number of packets t hat were lost due to unavailable or incorrect routes, MAC layer collisions or through the saturation of Interface Queues

(2) Packet Delivery Percentage. It is the ratio between the numbers of packets received by the application layer of destination nodes to the number of packets sent by the application layer of source nodes.

3) Routing Packet Overhead. This is the ratio between the total number of control packets generated to the total number of data packets received during t he simulation time.

4) Average Latency. The mean time (in seconds) taken by the data packets to reach their destinations.

5) Path Optimality. The ratio between the numbers of hops of the shortest path to the number of hops in the actual path taken by the packets.

6) Throughput: This is the total number of successful received bits at the destination nodes for the entire simulation period

7) Network Load: The total traffic (bits/sec) received by the network layer from the higher MAC that is accepted and queued for transmission.

8) End-to-End Delay: This includes all possible delays caused by buffering during route discovery time, queuing at the interface queue, retransmission, and processing time.

9) Aggregate Goodput. It is the total amount of application layer data in bps that is successfully transmitted in the network.

Our proposed approach may improve the packet delivery ratio and lower the latency of the network and also provide reliable gratuitous routes. It may control the power of multipath WMN network.

4. CONCLUSIONS

A mobile ad-hoc network (MANET) is composed of a group of mobile, wireless nodes which cooperate in forwarding packets in a multi-hop fashion without any centralized administration. Applications of MANETs occur in situations like battlefields, major disaster areas, and outdoor assemblies. AODV mixes the properties of DSR and DSDV. Routes are discovered as on-demand basis and are maintained as long as they are required. We proposed an approach to control power and improve the performance in Wireless mesh multipath network in AODV. Our proposed approach may improve the packet delivery ratio and lower the latency of the network and also provide reliable gratuitous routes.

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