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Energy Efficient Routing Techniques for Mobile Ad Hoc Networks

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Abstract-

This paper presents energy efficient routing protocols for Mobile Ad-Hoc Network (MANET). Since the nodes in MANET are mobile, the routing and power management become critical issue. Limited power supply is the biggest challenge of an Ad-hoc network so if we want to increase the network lifetime (time duration when the first node of the network runs out of energy) as well the node lifetime then we must have an efficient energy management protocol. An Ad-hoc routing protocol meet all these challenges to give the average performance in every case. Medium Access Control (MAC) protocols have a significant effect on the function and performance of networks. At present, most MAC protocols use the same transmission power when nodes send packets. The deployment of the nodes is asymmetrical in mobile ad-hoc networks, which will bring more energy consumption and unnecessary collisions.

Keywords: Energy Efficient Routing Protocols, MAC Protocol, Proactive, Reactive, Hybrid

I. INTRODUCTION

Communication has become very important for people to exchange information anytime from and to anywhere. With the wide spread rapid development of computers and the wireless communication, the mobile computing has already become the field of computer communications in high-profile link. Mobile Ad-hoc Network usually has a dynamic shape and a limited bandwidth. Routing is one of the key issues in MANETs due to their highly dynamic and distributed nature; the use of mobile networks is growing very fast. In particular, a very large number of recent studies focused on Mobile Ad hoc Networks (MANETs). The performance of a mobile ad-hoc network depends on the routing scheme employed, and the traditional routing protocols do not work efficiently in a MANET. Developing routing protocols for MANETs has been an extensive research area in recent years, and many proactive, reactive and hybrid protocols have been proposed from a variety of perspectives. These protocols try to satisfy various properties, like: distributed implementation, efficient utilization of bandwidth and battery capacity, optimization of metrics, fast route convergence and freedom from loops.

Wireless mobile ad-hoc networks
Are useful in many areas which are as follows:

- Communication in battlefields
- Disaster recovery areas
- Institutions and Colleges
- Traffic Control areas
- Military areas
- Law and order maintenance
- Space and astronomy related projects
- Medical Field
- Conferences and Conventions

II. ENERGY EFFICIENT ROUTING PROTOCOLS

The energy efficient routing may be the most important design criteria for MANETs, since mobile nodes will be powered by batteries with limited capacity. Power failure of a mobile node not only affects the node itself but also its ability to forward packets on behalf of others and thus the overall network lifetime. This paper surveys and classifies numerous energy-efficient routing mechanisms proposed for MANETs. A mobile node consumes its battery energy not only when it actively sends or receives packets, but also when it stays idle listening to the wireless medium for any possible communication requests from other nodes. Thus, energy efficient routing protocols minimize either the active communication energy required to transmit and receive data. Packets or the energy during inactive periods. Optimal routing path that minimizes the total Transmission energy required to deliver data packets to the destination. For protocols that belong to the latter category, each node can save the inactivity energy by switching its mode of operation into sleep/power-down mode or simply turns it off when there is no data to

transmit or receive. This leads to considerable energy savings, especially when the network environment is characterized with low duty cycle of communication activities. However, it requires a well designed routing protocol to guarantee data delivery even if most of the nodes sleep and do not forward packets for other nodes. Another important approach to optimizing active communication energy is load distribution approach.

Two approaches of Energy Efficient Routing Protocol:

1. **To minimize activity Communication Energy**
- Transmission Power Control
- Load Distribution

2. **Minimize inactivity Energy**
- Sleep/Power down mode

To minimize energy consumption of individual nodes, the main goal of the load distribution method is to balance the energy usage among the nodes and to maximize the network lifetime by avoiding over-utilized nodes when selecting a routing path. Power management technique is used to reduce the energy consumed in the wireless ad-hoc network interface of battery powered mobile devices. The design of best possible power management policies needs to explicitly account for the dissimilar performance requirements posed by different application scenarios such as latency, throughput and other performance metrics. Power management techniques have been studied comprehensively in the context of CPU, memory and disk management in the past. The main idea is to switch devices to the low-power state in periods of inactivity As compared with traditional techniques in operating systems, power management in communication devices requires distributed coordination between two (or multiple) communicating entities, as all the entities have to be in the active mode for a successful communication.

III. VARIOUS ROUTING PROTOCOLS IN MANET

1. Table-driven (proactive) routing
This type of protocols maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. The main disadvantages of such algorithms are:

1. Respective amount of data for maintenance.
2. Slow reaction on restructuring and failures.

Examples of proactive algorithms are:
- Optimized Link State Routing Protocol (OLSR)
- Destination Sequence Distance Vector (DSDV)

2. On-demand (reactive) routing
This type of protocols finds a route on demand by flooding the network with Route Request packets. The main disadvantages of such algorithms are:
1. High latency time in route finding.
2. Excessive flooding can lead to network clogging.

Examples of on-demand algorithms are:
- Ad hoc on demand distance vector(AODV)
- Dynamic Source Routing
- Flow State in the Dynamic Source Routing
- Power-Aware DSR-based

3. Hybrid (both proactive and reactive) routing
This type of protocol combines the advantages of proactive and reactive routing. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. The choice of one or the other method requires predetermination for typical cases. The main disadvantages of such algorithms are:
1. Advantage depends on number of other nodes activated.
2. Reaction to traffic demand depends on gradient of traffic volume.

Examples of hybrid algorithms are:
- ZRP (Zone Routing Protocol)

4. Hierarchical routing protocols
With this type of protocol the choice of proactive and of reactive routing depends on the hierarchic level in which a node resides. The routing is initially established with some proactively prospected routes and then serves the demand from

additionally activated nodes through reactive flooding on the lower levels. The choice for one or the other method requires proper attributation for respective levels. The main disadvantages of such algorithms are:

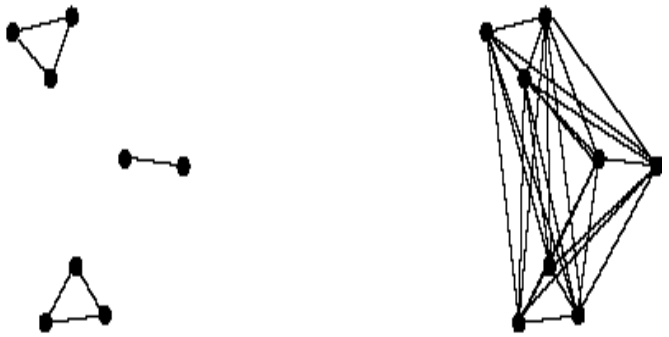
1. Advantage depends on depth of nesting and addressing scheme.
2. Reaction to traffic demand depends on meshing parameters.

Examples of hierarchical routing algorithms are:

- CBRP (Cluster Based Routing Protocol)
- FSR (Fisheye State Routing protocol)

IV. TRANSMISSION POWER CONTROL

Transmission Power Control is each node determines an appropriate transmission power level to ensure that the transmitted packet is received correctly. A higher network capacity can be achieved by transmitting packets to the nearest neighbor in the forward progress. It improve network throughput. Increase the lifetime of mobile nodes, but also increase the number of hops to the destination. Adversely impact the connectivity of the network, and, potentially, partitioning the network. Transmission power control is an active line of study in mobile ad hoc networks (MANETs). Several MAC protocols employing this technique have been proposed. PCMA (Power Controlled Multiple Access) is a MAC protocol which provides communication at minimum propagation ranges, allowing spatial reuse. Agawam et al. proposed a distributed power control algorithm for MANETs. Medium access control (MAC) protocols, for example, modify transceiver parameters and the topology of the network in order to reduce energy consumption. One of the transceiver's parameters is the transmission power. Transmission Power Control (TPC) techniques improve the performance of the network in several aspects. First, power control techniques improve the reliability of a link. Upon detecting that link reliability is below a certain threshold, the MAC protocol increases the transmission power, improving the probability of successful data transmissions. Second, only nodes which really must share the same space will contend to access the medium, decreasing the amount of collisions in the network .This enhances network utilization, lowers latency times and reduces the probability of hidden and exposed terminals. Finally, by using a higher transmission power, the physical layer can use modulation and coding schemes with a higher bit/baud ratio, increasing the bandwidth in the presence of heavy workloads, or decreasing it to maximize energy savings.



(a) Low transmission power. (b) High transmission p

V. LOAD DISTRIBUTION

A vital part of the optimal network is the load distributing. Job completion becomes complex, if huge load is given to the nodes with less processing capabilities and which do not have any means to share the load. There is a possibility of load imbalance due to that the computing/processing power of the systems are non-uniform as few nodes maybe idle and few will be overloaded. A node which has high processing power finishes its own work quickly and is estimated to have less or no load at all most of the time. So, in the presence of under-loaded nodes, the need for overloaded nodes is undesirable .Multi-path routing can balance the load better than the single path routing in ad hoc networks, where the first selective shortest paths are used for routing. This is possible only for the networks having a huge number of nodes between any source-destination pair of nodes. It is infeasible to build such a system it is economical for discovering and maintaining a large number of paths. Load balance is not improved by using multiple shortest path routes instead of a single path. So, for a better load balanced network distributed multi-path load splitting strategies need to be carefully designed .Load balancing is a methodology to distribute workload across multiple paths, to achieve optimal resource utilization, maximize throughput, minimize response time, increase network life time, and avoid overload. Using multiple paths with load balancing, instead of a single path, may increase reliability through redundancy. The load balancing service is usually provided by dedicated software or hardware, such as a multilayer switch or a Domain Name System server. Load balancing techniques may have a variety of special features as:

• Asymmetric Load: A ratio can be manually assigned to cause some paths to get a greater share of the workload than others.

• Priority Activation: The workload is distributed according to paths priority as the size of free bandwidth and number of hops

VI. SLEEP/POWER DOWN MODE

This is the load adaptive techniques where network elements/subsystems are powered off during periods of reduced network load. Such techniques are particularly interesting for the entrance segment which is characterized by low utilization. The combination of large contribution to the overall network power consumption and low utilization involves large potential for exploiting such load adaptive techniques. This approach is only feasible to a certain level and in contrast to another principle for increased energy efficiency which is increased integration. Integration (e.g. electronic and photonic integration) can decrease the maximum power consumption of network elements by increasing the sharing of subunits within the network element. The finite wake-up time of systems and components reduces the energy savings of cyclic low power modes. A calculation of average power consumption at 50% traffic load as a function of average off-period length taking into account the penalty from the wake-up time.

VII. CONCLUSION

This paper concludes that there is not a single protocol which can give the best performance in ad-hoc network.

Performance of the protocol varies according to the variation in the network parameters, as we know that in ad-hoc network properties continuously vary. Sometimes the mobility of the node of the network is high while sometimes energy of the node is our prime concern. So, we will choose the protocol in such a way that which perform best for that particular type of network. That's why we have surveyed many types of conventional protocols and their modification which includes energy efficiency. Energy efficiency is one of the main problems in a MANET, especially in designing a routing protocol

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