International Journal of Computer Science Trends and Technology (IJCST) – Volume 5 Issue 5, Sep – Oct 2017

RESEARCH ARTICLE OPEN ACCESS

A Survey of Energy Efficient Routing Protocols for Mobile ADHOC Networks Using Random Cast Algorithm

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ABSTRACT

This paper presents a survey on energy efficient routing protocols for Mobile ad hoc networks. Mobile ad hoc networks (MANETs) are autonomously self organized networks without any fixed infrastructure. MANETs are deployed for emergency situation. In a mobile ad hoc network, nodes move randomly; therefore the topology may change rapidly and in unpredictable manner. Nodes in a MANET normally have limited transmission ranges, limited battery power and some nodes cannot communicate directly with each other. There may be multiple hops in a routing path hence every node in a MANET has the responsibility to act as a router. Reducing networks energy consumption and extending nodes lifetime are two important issues in MANET. This paper is a survey of active research work on routing protocols for MANET.

Keywords:-

I. MOBILE AD HOC NETWORKS (MANET)

In MANETs, a network is formed dynamically through the cooperation of an arbitrary set of independent nodes. There is no prearrangement regarding the specific role each node should assume. Instead, each node makes its decision independently, based on the network situation,

Without using a pre-existing network infrastructure. Ad hoc networks have the characteristics such as dynamically changing topology, weak physical protection of nodes, the absence of centralized administration and high dependence on inherent node cooperation. When the topology keeps changing, these networks do not have a well defined boundary and thus network based access control mechanism such as firewalls are not directly applicable. The major concern in MANET is the conservation of energy due to the limited lifetime of mobile devices.

Dynamic Source Routing (DSR) Protocol

DSR [1] is a source routing protocol. In DSR the source node starts and takes charge of computing the routes. When a node S wants to send messages to node D, it firstly broadcasts a route request (RREQ) which contains the destination and source node's identities. Each intermediate node that receives RREQ will add its identity and rebroadcast it until RREQ reaches a node who knows a route to D or the node D. Then a reply (RREP) will be generated and sent back along the reverse path until S receives RREP. When S sends data packets, it adds the path to the packet's headers and starts stateless forwarding. During route maintenance, S detects the link failures along the path. If it happens, it repairs the broken links. Otherwise, when the source route is completely broken, S will restart a new discovery.

Overhearing in MANET

Overhearing [2] means a node picks up packets that are destined for other nodes. Wireless nodes will consume power unnecessarily due to overhearing transmissions of their neighboring nodes. Wireless nodes consume power unnecessarily due to overhearing the transmissions of their neighbors. This is often the case in a typical broadcast environment. For example, as the IEEE 802.11 wireless protocol defines, receivers remain on and monitor the common channel all the time. Thus the mobile nodes receive all packets that hit their receiver antenna. Such scheme results in significant power consumption because only a small number of the received packets are destined to the receiver or needed to be forwarded by the receiver. DSR gathers the route information through overhearing. Overhearing improves the routing efficiency in DSR by Eaves dropping other communications to gather route information but it spends a significant amount of energy.

Stale Route links Problem in DSR

The wireless link is broken due to node mobility and upstream node propagates a RERR packet to remove stale route information from route caches of the nodes. Sometimes route caches often contain stale route information for an extensive period of time. Now, overhearing could make the situation even worse. This is because the Dynamic Source Routing (DSR) generates more RREP packets for a route discovery to offer alternative routes in addition to the principal one. While the primary route is checked for its validity during the communication between the source and the destination, alternative routes may remain in route cache unchecked even after they become stale. This applies also for all their neighbors because they learned and kept them by means of unconditional overhearing which is node S transmits packets to node D through a precompiled routing path with three intermediate nodes but in this case each and every node overhears the transmission which results in the energy consumption as well as less network lifetime.

Mobile adhoc network (MANET) consists of collection of wireless nodes that have a significantly lower capacity than wired networks [1]. MANETs are typically used in military applications, law enforcement, disaster recovery, emergency search and rescue operations. Due to its constantly changing environment and bandwidth constraint, supporting Quality of Service (QoS) is a challenging task. QoS routing is the process of providing end-to-end and loop free path to ensure the necessary QoS parameters such as delay, bandwidth, probability of packet loss, delay variance (jitter), etc. Energy conservation is another QoS attribute which is taken into consideration.

One of the key research problems in MANETs is routing. The routing protocols establish an efficient route between two nodes so that messages can be delivered in an effective way. Numerous protocols have been developed for MANETs [2]. Such protocols must deal with the typical limitations of these networks, such as low bandwidth, high power consumption, and high Error rates. AODV (Adhoc On demand Distance Vector) is a reactive routing protocol for ad hoc and mobile networks [3][4] that maintains routes only between nodes which need to communicate. The routing messages do not contain information about the whole route paths, but

Only about the source and the destination. Hence, the size of the routing messages is reduced. It

Uses destination sequence numbers to specify how fresh a route is, which is used to grant loop freedom.

A Mobile Ad Hoc Network (MANET) is a set of mobile nodes that perform basic networking functions like packet forwarding, routing, and service discovery without the need of an established infrastructure. All the nodes of an ad hoc network depend on each another in forwarding a packet from source to its destination, due to the limited transmission range of each mobile node's wireless transmissions. There is no centralized administration in ad hoc network. It guarantees that the network will not stop functioning just because one of the mobile nodes moves out of the range of the others

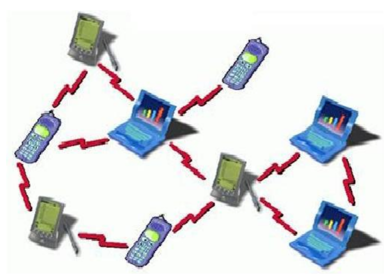

Figure.1**Mobile Ad-hoc Network (MANET)**

As nodes wish, they should be able to enter and leave the network. Multiple intermediate hops are generally needed to reach other nodes, due to the limited range of the nodes. Each and every node in an ad hoc network must be keen to forward packets for other nodes. This way, every node performs role of both, a host and a router. The topology of ad hoc networks is dynamic and changes with time as nodes move join or leave the ad hoc network. This unsteadiness of topology needs a routing protocol to run on each node to create and maintain routes among the nodes. Routing in a MANET is fundamentally different from traditional routing found on infrastructure networks. Routing in a MANET is based on many factors including dynamic topology, selection of router nodes, and initiation of request and specific fundamental characteristic that could act as a heuristic in finding the path quickly and efficiently. The low resource availability needs efficient utilization and hence the motivation for optimal routing in ad hoc networks. Also, the highly dynamic nature of these networks imposes severe restrictions on routing protocols specifically designed for them, thus motivating the study of protocols which aim at achieving routing stability.

II. RELATED WORK

The energy computation based on Gossip Sleep Protocol has been discussed as below.Zygmunt J. Haas et al [4] proposed a gossip based approach, where each node forwards a message with some probability, to reduce the overhead of the routing protocols. They stated that gossiping can reduce control traffic up to 35% when compared to flooding. This reduces the energy consumption. But, retries increase latency in large networks. So, the timeout period will have to be large so as to allow the message to propagate throughout the network. XiaobingHou et al [5] proposed a novel energy saving scheme, termed the Gossip-based sleep protocol (GSP). With GSP, each node randomly goes to sleep for some time with gossip sleep probability p. When the value of p is small enough, the network stays connected. GSP does not require a wireless node to maintain the states of other nodes. It requires few operations and scales to large networks. Two versions of GSP, one for synchronous networks and one for asynchronous networks are proposed. But, the sleep mode may increase the length and the failure rate of a path. The advantages of the GSP approach through both simulations and analysis is discussed in this paper. Mubashir Husain Rehmani [6] et al gives a full report about working of AODV routing protocol in ns-2.Sunho Lim et al [7] proposed a new communication mechanism, called Random
Cast, through which a sender can specify the desired level of overhearing. They have made a prudent balance between energy and routing performance. So, it reduces redundant rebroadcasts for a broadcast packet and thus saves more energy. AL-GabriMalek et al [8] addressed a new solution to reduce the energy consumption of an individual node. They have proposed two approaches: transmission power control and load distribution to reduce the power consumption. In this work, they stated that if weaker transmission power is selected, it makes the topology sparse. So, partitions are introduced in the network and produces high end-to-end delay due to a larger hop count.

Shibo Wu et al [9] proposed a set of probabilistic multipath routing algorithms, which generate braided multi paths based only on local information to overcome drained nodes on these paths which results in short network life when the communication in the network is unevenly distributed. This probabilistic multipath routing contributes up to an additional 30% to network lifetime. AmulyaRatna Swain et al [10] have addressed reduced rate of average energy consumption for each node as they are able to put more number of nodes to sleep condition.

One critical issue for almost all kinds of portable devices supported by battery powers is power saving. Without power, a mobile device will become useless. Battery power is a limited resource, and it is believed that battery technology is not likely to progress as fast as computing and communication technologies do. Hence, increasing the lifetime of batteries is an important issue, especially for a MANET node, power is utilized from batteries only. Power saving is an important issue. It has been taken for critical analysis for almost all kinds of portable devices. All such devices are operated by battery powers. A mobile device will become no use when its power gets drained. But, battery technology has not been advanced as like computing and communication technologies. Battery power is a limited resource. For functioning of a MANET node, batteries are only the reliable source.

Analysis for the power conserving issue in MANET nodes can generally be categorized as follows:

• Importance on Transmission power: In wireless communication, based on transmitted power, some of the parameters like bit error rate, transmission rate, and inter-radio interference are computed. But, these parameters attributes are different from each other. In [2], power control is

Implemented to reduce interference and improve throughput on the MAC layer.

Determination of transmission power on each mobile host, decides to select the best network topology is discussed in [11-13]. Based on power adjustment, network throughput can be increased. The concerned issue for packet radio networks is analyzed in [14].

• Routing based on remaining Power: Routing protocol depends on the remaining power in each node. The solution has been addressed based on Power-aware and other various power cost functions [15-19]. In [15], a mobile host's battery level is computed. It has been compared with the preset threshold value. If it falls below a certain threshold, it will not forward packets for their hosts. A mixed network scenario which consists of battery powered and power plugged hosts is considered in [16].Heuristic clustering approaches for two multi-casting are addressed in [17] for two different distributed methods. This is used to minimize the transmission power. In [18], five different metrics for battery power consumption are discussed. Ref. [19] includes the hosts' lifetime and computed power metric for a distant one for solution.

• Routing based on Low Power mode: All solutions are resulted to formulate wireless devices which can be operate on low-power sleep modes. A radio of IEEE 802.11, which has a power-saving mode [20], only needs to be awake periodically. A mobile host in HIPERLAN allows defining power saving mode to its own active period. An active node may conserve powers by

Turning off its equalizer according to the transmission bit rate. Comparisons addressing the power-saving mechanisms of IEEE 802.11 and HIPERLAN in ad hoc networks are presented in [21]. A hybrid characteristic of multi-hop communication, unpredictable mobility, battery- power, and no clock synchronization mechanism is considering for MANETs.

We consider MANETs as being characterized by multi-hop communication, unpredictable mobility, no plug-in power, and no clock synchronization mechanism. In particular, the last characteristic-synchronization would complicate the problem since a host has to predict when another host will wake up to receive packets. Thus, the protocol must be asynchronous.

In mobile ad hoc networks, few authors suggested solutions for bandwidth estimation. QoSAODV [5] estimates available bandwidth per node. To estimate the available bandwidth, the

Authors calculate a metric called BWER (Bandwidth Efficiency Ratio) which is the ratio between the numbers of transmitted and received packets. In [6], bandwidth estimation is enhanced by considering collisions and back off. In this, value of the available bandwidth on a link depends on both channel utilization ratios and the idle period synchronization. Also, the collision probability is estimated and integrated to the available bandwidth estimation. QoS-aware routing protocol [1] incorporates unused bandwidth estimation and an admission control scheme. But there is no measure to predict a route break.

In the protocol AAC (Adaptive Admission Control), each node estimates its local used bandwidth by adding the size of sent and sensed packets over a fixed time period [7]. It solves intra-flow contention problem by estimating the contention count of nodes along a QoS path. In [8], the authors have considered idle times of both the sender and the receiver to achieve more accuracy.

Unfortunately, they have not considered the back off periods in the estimation technique. Also, more accurate solutions are required to overcome hidden terminal problem. In [9], they have proposed a cross-layer framework to support QoS multicasting and estimate available bandwidth using the passive listening method. Passive Listening method is an efficient way to estimate Available bandwidth with no extra control overhead. In [5], to improve the accuracy of available bandwidth estimation, they presented a protocol called ABE-AODV (Available Bandwidth estimation). The main components of this protocol are estimating node's emission capabilities, Link's available bandwidth, idle time synchronization between source and destination, evaluating Collision probability and bakeoff mechanism. Then they have estimated the available bandwidth by considering the above components into account. The authors have not considered the overhead due to back off mechanism.

Since the channel is shared by all the nodes, there is a chance for collision. To reduce collision, bakeoff algorithm is proposed. In MILD (Multiple Increase and Linear Decrease) [10], when collision occurs, CW (Contention Window) size is multiplied by 1.5 and decreased by 1 for a successful transmission. MILD performs well when the network load is heavy. In BEB (Binary Exponential Backoff) [11], nodes use the same CW value regardless of number of nodes. So lot of collisions occurs and throughput is reduced. At the beginning of each slot a node transmits if its bakeoff timer has expired. Otherwise depending on the channel state (idle or busy), the node will count down the back off counter by 1 or will be frozen at a value. Such an algorithm is embedded in IEEE 802.11 DCF. It has the following drawbacks. First, CW is doubled upon failure regardless of the type of failure and second is after a successful transmission of packet, CW size is reset to CWmin, thus forgetting its knowledge of the current congestion level in the network [12]. Exponential Increase Exponential Decrease (EIED) algorithm [13] and LMILD scheme (Linear/Multiplicative Increase Linear Decrease) [14] Out-perform BEB and MILD algorithms for a wide range of network sizes. In DIDD [15] back off algorithm (Double Increment Double Decrement) CW decreases smoothly after a successful packet transmission. It achieves better performance than BEB. Log based back off algorithm is introduced in [16] to improve the throughput performance. Pipelining Concept is discussed in [17] for scheduling packet transmissions. To reduce the channel idle time and overhead associated with collision, log based pipelined back off algorithm is proposed. Wireless adhoc networks use a wide range of energy conserving techniques. In DPSM [18] (Dynamic Power Saving Mechanism) scheme, the ATIM (Adhoc Traffic Indication Map) Window size is adjusted dynamically based on current network conditions.

A NPSM [19] (New Power Saving Mechanism) introduces some parameters indicating amount of data in each station. In (ODPM) (On Demand Power Management) [20], soft state timers are set or refreshed on-demand based on control messages and data transmission. Nodes that are not involved in data transmission may enter into sleep state to save energy. Energy is saved by integrating routing and MAC layer functionality. The protocol discussed in [21] extends doze time and reduces contention, retransmission and improves channel utilization. It also provides quality of service support. In [22], number of AM (Active Mode) nodes is reduced based on backbone probability. TITAN (Traffic-Informed Topology-Adaptive Network) improves ODPM in which PS nodes sleep for longer duration and saves energy [23].

Rcast [22] implements randomized overhearing but not randomized rebroadcast. Dorsey and Siewiorek [9] discussed a fast wakeup mechanism for route discovery to reduce latency. In Random cast algorithm [22], sender can specify the desired level of overhearing in order to saveEnergy and reduce redundant rebroadcasts to improve the performance. It is integrated with DSR
(Dynamic Source Routing) routing protocol. In DSR, route caches often contain stale route Information. It broadcasts more control packets which waste channel capacity and energy. Another cause of excessive energy consumption is redundant rebroadcasting. Redundant Rebroadcasts increases network traffic as well as wastes energy resource for transmitting and receiving the broadcasts. To overcome these limitations, AOMDV (Adhoc On demand MultipathDistance Vector) routing protocol is proposed for energy efficient method.

The distributed nature and dynamic topology of Wireless Sensor Networks (WSNs) [4] introduces very special requirements in routing protocols that should be met. The most important feature of a routing protocol, in order to be efficient for WSNs, is the energy consumption and the extension of the network's lifetime. During the recent years, many energy efficient routing protocols have been proposed for WSNs. In this paper, energy efficient routing protocols are classified into four main schemes: Network Structure, Communication Model, Topology Based and Reliable Routing.

Energy awareness for computation and protocol management is becoming a crucial factor in the design of protocols and algorithms. On the other hand, in order to support node mobility, scalable routing strategies have been designed and these protocols try to consider the path duration in order to respect some QoS [7] constraints and to reduce the route discovery procedures. Often energy saving and path duration and stability can be two contrasting efforts and trying to satisfy both of them can be very difficult. In this paper, a novel routing strategy is proposed. This proposed approach tries to account for link stability and for minimum drain rate energy consumption.

The paper presents Multicasting through Time Reservation using Adaptive Control for Energy efficiency (MC-TRACE) [5], an energy-efficient real-time data multicasting architecture for mobile ad hoc networks. MC-TRACE is a cross-layer design, where the medium access control layer functionality and the network layer functionality are performed by a single integrated layer. The basic design philosophy behind the multicast routing part of the architecture is toEstablish and maintain an active multicast tree surrounded by a passive mesh within a mobile ad hoc network.

In mobile ad hoc networks (MANETs), every node overhears every data transmission occurring in its vicinity and thus, consumes energy unnecessarily. However, since some MANET routing protocols such as Dynamic Source Routing (DSR) [6] collect route information via overhearing, they would suffer if they are used in combination with 802.11 PSM. Allowing no overhearing may critically deteriorate the performance of the underlying routing protocol, while unconditional overhearing may offset the advantage of using PSM.

We assume that mobile nodes operate as the IEEE 802.11 PSM for energy-efficient medium access and use AODV for discovering and maintaining routing paths. Section A summarizes the AODV routing protocol. It also discusses the stale route and load unbalance problem in AODV and argues that unconditional overhearing is the main reason behind them. Section B explains the IEEE 802.11 PSM.

AODV Protocol Overview

The AODV routing protocol is a reactive routing protocol; therefore, routes are determined only when needed. Hello messages may be used to detect and monitor links to neighbors. If Hello messages are used, each active node periodically broadcasts a Hello message that all its neighbors receive. Because nodes periodically send Hello messages, if a node fails to receive several Hello messages from a neighbor, a link break is detected. When a source has data to transmit to an unknown destination, it broadcasts a Route Request (RREQ) for that destination. At each intermediate node, when a RREQ is received a route to the source is created. If the receiving node has not received this RREQ before, is not the destination and does not have a current route to the destination, it rebroadcasts the RREQ. If the receiving node is the destination or has a current route to the destination, it generates a Route Reply (RREP). The RREP is uncast in a hop-by-hop fashion to the source. As the RREP propagates, each intermediate node creates a route to the destination. When the source receives the RREP, it records the route to the destination and can begin sending data. If multiple RREPs are received by the source, the route with the shortest hop count is chosen. As data flows from the source to the destination, each node along the route updates the timers associated with the routes to the source and destination, maintaining the routes in the routing table. If a route is not used for some period of time, a node cannot be sure whether the route is still valid; consequently, the node removes the route from its routing table.

If data is flowing and a link break is detected, a Route Error (RERR) is sent to the source of the data in a hop-by-hop fashion. As the RERR propagates towards the source, each intermediate node invalidates routes to any unreachable destinations. When the source of the data receives the RERR, it invalidates the route and reinitiates route discovery if necessary.

III. CONCLUSION

In MANET, mobile nodes are moving randomly without any centralized administration. Due to that, the nodeconsumes more energy unnecessarily. In this paper, we havedeveloped demand based energy efficient with cross layerapproach which attains minimum energy consumption to themobile nodes. In the first phase of the scheme, minimumenergy consumption is achieved using DBEE algorithm. Ituses three factors called utility factor, energy factor, mobility factor to favor packet forwarding by maintainingminimum energy consumption for each node. In first phase, all the redundant nodes are removed. We have demonstratedthe energy estimation of each node. In second phase, thestele route problems are avoided using the Cross layerapproach. By simulation results, we have shown that theDBEE - CLA achieves good packet delivery ratio whileattaining low delay, overhead, minimum energyconsumption than the existing schemes Random cast and802.11 PSM while varying the number of nodes andmobility. The unique characteristics of MANETs make routing a challenging task. Mobility of nodes causefrequent route failure. As a result of these, an effective routing protocol has to adapt to dynamic Topology and designed to be bandwidth and energy efficient. Log and pipelined concepts help to Reduce the channel idle time and collision overhead. In order to reduce energy consumed byoverhearing nodes, probability based method is implemented. Results presented in this articleConfirmed that the proposed method outperforms the existing method in terms of QoS parameters.

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