Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 2, Issue. 4, April 2013, pg.309 – 316

RESEARCH ARTICLE

Exigent Vulnerability in Mobile Ad-hoc Network and Solutions in Context of Energy Optimization with Clustering Technique

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Abstract— Mobile ad-hoc network is collection of mobile nodes that are physically located at various location and there interconnections between nodes are capable of changing on a continual basis. Energy is a limiting factor in success of any mobile ad-hoc network. In Mobile ad-hoc network, mobile devices are mainly operated by battery so energy optimization is an important issues in MANET. Both minimization of power and other QoS requirements like delay, throughputs are have to be take care properly. Without affecting the QoS we should conserve the energy of mobile nodes but it is very complex to overcome from this. Power consumption can be reduced at device level, at transmission level or may be by using optimized power aware routing protocol. In this paper we have given a brief description of basic aspects of mobile ad hoc network and studied various power saving techniques in mobile ad hoc network & given a comparative analysis of these techniques. In this paper we also suggest an approach for energy conservation by CBIR.

Key Terms: - Mobile ad-hoc networks; Cluster Based Information Routing (CBIR) Protocol; Cluster Head (CH)

I. INTRODUCTION

The wireless technology is blended with our personal and professional life in the form of mobile telephony, wireless fidelity (Wi-Fi), Bluetooth, telemedicine and so on. Now days, we are completely dependent on these type of device and applications for our comfort and necessity. Variety of wireless network exists ranging from most popular Infrastructure based cellular networks, to most recent and advanced ad hoc and sensor networks [1]. Mobile ad hoc network (MANET) is a decentralised network, which consists of mobile nodes that use a wireless interface to send & receive packet data.

Mobile nodes are connected by wireless links without any pre-established infrastructure. The topology of MANET is not static and depends upon the mobility of nodes. Mobile Ad Hoc networks are useful in many areas such as, vehicular network, Communication in front line, Disaster recovery areas, agro sensing, Institutions and Colleges, Space and astronomy related projects, pollution monitoring and Medical Field[1]. Mobile Ad Hoc networks have also some challenges like Limited wireless transmission range, broadcast nature of the wireless medium, hidden terminal and exposed terminal problems, packet losses due to transmission errors and mobility, stimulated change of route, Battery constraints and security problem [2,3]. The power level affects many features of MANET including the throughput of network. Power control also affects the delay time. Transmission power also influences the important metric of energy consumptions. Therefore the energy efficient

protocol is must to increase the lifetime of node as well as the lifetime of network [4]. So the designed Ad Hoc routing protocol must meet all these challenges to give the average performance in every case.

Routing is a process of finding an optimal path from source to destination. Optimal means a path which covers maximum criteria for an efficient path. Routing is happened in two phases. First select all the path from source to destination then in second phase choose the appropriate path among them. This survey paper describes how these protocols are selecting energy efficient routes. In MANET routing has various issues like availability of nodes, energy of nodes which are limited in nature because of battery power supply. The key solution for the above requirements is energy efficient routing protocols [5].

Optimization of Energy can be achieved in one of two ways:

- Saving energy during active communication.
- Saving energy during idle times within the communication.

The first targets the techniques used to support communication in an ad hoc network and is typically achieved through the use of energy-efficient MAC and routing protocols. The second focuses on reducing the energy consumed when the node is idle and not participating in communication by placing the node in a low-power state.

II. RELATED WORK

This section is an exhaustive study on energy efficient protocols published in different journals, conferences proceedings and book chapter's .which has proposed so much innovation and new ideas in this field. Here we can classify previous work in three different categories such as power save based, topology control based and power control based.

A. power save based- According to IEEE 802.11[6] standard protocols have two types of power managements. Power save (PS) mode for infrastructure based wireless network. And alternative is freelance basic service set power saving referred to as IBSS note mode that is for infrastructure-less networks. The power saving mechanism is implemented using the access points in the network. But this is not suitable for ad hoc network environment since there is no central coordinator like access point.

B. topology control based- A Distributed power efficient protocol SPAN [7] is used to select the co-ordinator from the nodes of network. These co-ordinator nodes always stay in active mode and perform multi-hop packet routing. And remaining nodes are in standby mode to optimize the energy uses by the nodes.

c. Power Control Based Protocol- Power control MAC (PCM) [8] achieves energy conservation without affecting the throughput of network by using the technique of distributing different types of transmission power . DATA and ACK packets are transmitted using minimum power while RTS/CTS packets are transmitted using maximum power.

The author Sahoo [8] proposed a distributed transmission power control protocol for wireless network to achieve energy conservation at the level of node. This protocol uses the concept of distributed algorithm for making power optimization hierarchy topologies without using the local information of nodes and provides a simple way to keep the network on account of changing the transmission power.

III. FEATURES OF MOBILE AD HOC NETWORK

In Mobile ad-hoc network nodes are absolve to move at random and organize themselves arbitrarily; so, the network's wireless topology might amendment rapidly and erratically. So MANET is formed dynamically by various autonomous systems of mobile nodes so they do not require any fixed infrastructure, such as a base station, for their operation. There are numerous features of Mobile ad-hoc Network some of them are as follows-

Distributed operation

There is no central authority to control of network operations so the management and control of the network is distributed among the various nodes of network. These nodes are involved in implement functions like security and routing.

Autonomous and infrastructure-less

In MANET each node operates in distributed peer-to-peer mode, acts as an independent router and generates independent data. Network management has to be distributed across different nodes, which brings additional difficulty in fault detection and management.

Dynamic network topology

Since the nodes are mobile the topology among the terminals may dynamic with time and spontaneously due to mobility. The mobile nodes in the network dynamically establish routing among themselves as they move about forming their own network on fly.

Network scalability

Currently, accepted network management algorithms were mostly designed to work on fixed or relatively small wireless networks [9]. Scalability is significant to the triumphant deployment of huge nodes and change according to need.

Energy constrained operation

In MANET processing power is limited in each node, which cause limits services and applications. It is a bigger issue in mobile ad hoc networks because, as each node is acting as an end system and a router at the same time, additional energy is required to forward packets from other nodes.

Multi-hop routing

In MANET mobile nodes are act itself as a router so in these kind of networks no default router available, every node forwards each other's packets to facilitate information sharing between mobile hosts.

Light-weight terminals

In MANET nodes required optimized algorithms and mechanisms that implement the computing and communicating functions because nodes of ad hoc network are mobile devices with less CPU processing capability, small memory size, and low power storage.

IV. SOME CHALLENGING VULNERABILITY IN MANET

MANET is a lot of vulnerable than wired network. A number of the vulnerabilities are as follows:-

Limited Transmission Range- In wireless networks the radio band will be limited and hence data rates it can offer are much lesser than what a wired network can offer. Variable low capacity links exists as compared to wireless network which are more susceptible to external noise, interference and signal attenuation effects.

Broadcast nature of wireless medium – The broadcast nature of the radio channel, that is, transmissions made by a node are received by all nodes within its direct Transmission range.

Routing problem- The network topology in an ad hoc wireless network is highly dynamic due to the movement of nodes.Dynamic topology and changeable nodes membership may disturb the trust relationship among nodes. This dynamic behaviour could be better protected with distributed and adaptive security mechanisms.

Packet loss due to transmission errors- Communication links in an ad hoc network are unstable such that running conventional protocols for MANETS over a high loss rate will suffer from severe performance degradation. However, with high error rate, it is very much difficult to deliver a packet to its destination.

Energy Efficiency problems-Battery constraint – This is one of the limited resources that form a major constraint for the nodes in an ad hoc network. Several problems. A node in mobile ad-hoc network may behave in a selfish manner when it is finding that there is only limited power supply. So only MANET nodes has to optimally use this resource.

Ease of snooping (Security Problems)- The radio channel used for ad hoc networks is broadcast in nature and is shared by all the nodes in the network. So an attacker can easily snoop the data being transmitted in the network. The attacks include Eavesdropping impersonation; tempering, replay and Denial of Service (DoS) attack.

Cross layer Problem- Cross-layer design can significantly improve the performance of mobile ad-hoc networks (MANETs). Recent efforts have shown that significant performance benefits exist in undertaking a cross-layer design that is by optimizing functionality across the layers.

V. CLASSIFICATION OF ROUTING TECHNIQUES

. Transmission power control, load distribution and Power Management are the approaches to minimize the energy on active communication. The goal of active communication-time energy conservation is to reduce the amount of energy used by individual nodes as well as by the aggregation of all nodes to transmit data through the ad hoc network. And other is sleep/power-down approach is used to minimize energy during inactivity.

Circumstances	Name of approach	objective
Minimize Active Communication Energy	Transmission Power Control	The total Transmission Energy decreased by avoiding low energy nodes.
	Load Distribution	Distribute load to energy comfortable nodes
	Power Management	Minimize the energy consumption by with separate channels for information and management
Minimize Inactivity Energy	Sleep/Power-Down Mode	Minimize energy Consumption when node is in an idle state

Table 1: Techniques of energy optimized routing protocols.

The protocols are designed based on the energy related metrics like energy consumed per packet to provide the minimum power path which is used to minimize the overall energy consumption for delivering packet. The next important metric is inconsistency in node power levels which is a simple indication of energy balance and in turn it can be used to extend network lifetime.

However, the power level can be controlled by the node to reduce energy consumption. Such *power control* must be performed in a careful manner since it can directly affect the quality and quantity of communication in the network. Second, energy is consumed at every node that forwards data through the network. Such costs can be minimized using *energy-aware routing* protocols.

VI. ENERGY REDUCING TECHNIQUE

(a)Energy-Aware Routing

Routing protocols for ad hoc networks generally use hop count as the routing metric, which does not necessarily minimize the energy to route a packet [10]. Energy-aware routing addresses this problem by finding energy-efficient routes for communication. At the network layer, routing algorithms should select routes that minimize the total power needed to forward packets through the network, so-called *minimum energy routing.* However, minimum energy routing may not be optimal from the point of view of network lifetime and long-term connectivity, leading to energy depletion of nodes along frequently used routes and causing network partitions. Therefore, routing algorithms should evenly distribute forwarding duties among nodes to prevent any

one node from being overused (i.e., *capacity aware routing*). Hybrid protocols explore the combination of minimum energy routing and capacity-aware routing to achieve energy efficient communication while maintaining Network lifetime.

(b)Cluster Based Routing

The power-saving and the power-consumption features of nodes influence network operations when the source nodes establish routing paths to destination nodes in ad hoc networks. we considered the factors of broadcast storms and energy issues. This type of routing has two different parts: clustering and routing.

Clustering

In the clustering scheme, there are two components: cluster establishment and cluster maintenance.

(1)Cluster Establishment

The state of every node is unassigned when each node located randomly. Every node broadcasts a "hi" message (including its ID information and power information) to gather information about a neighbouring node that is one hop away; the broadcasting node then waits a short time. After a short time, nodes can calculate the weight value of each node according to E q. 1 and broadcast the value. Then, every node waits a short time again before receiving the weight values of neighbouring nodes. Afterward, if there are any non-member nodes whose weights value is greater than the node that takes no action and simply waits. If no node has a weight value greater than the weight value of the node, the node changes the identity into a cluster head and invites every node to join the cluster as a member for one hop.

A node broadcasts its information to cluster heads when the node joins the cluster. Every cluster head maintains a table where all member nodes' information is stored.

$$Wi = (\alpha * di\ ) + [(1 - \alpha) * (pi\ /10)] \qquad \text{-------(1)}$$

where α denotes the weight ratio of *di* and *pi* ; *i* denotes the node ID; *di* denotes the number of neighbouring nodes; and *pi* denotes power as a percentage, *pi* = 1 ∼100(%).

(2)Cluster Maintenance-

The life of nodes and networks, there are two conditions under which a cluster head will discharge: (1) The cluster head changes to an unassigned state such that the cluster has no members; and (2) when the power of the cluster head is smaller than the set value, the node
discharges the cluster-head state.

The set value is calculated according to Eq.2. The set value provides a value to cluster heads; then, the cluster heads determine whether the node should be discharged the cluster head or not. Equation 2 is as follows:

$$set\_value = \frac{\Sigma\, power\ i}{N} \cdot \frac{N\text{-}1}{N} \qquad \text{-----} \qquad (2)$$

Where N denotes the number of all nodes in a cluster, including the cluster head; and *power i* denotes the energy (as a percentage) of node *i* .

(3)Routing in Cluster

We divide the routing protocol into route discovery and route maintenance.

3.1 Route Discovery- when a source node needs a route path leading to a destination, the node transmits an RREQ packet to a cluster head. After the cluster head receives the RREQ packets, the cluster head employs the limited flooding broadcast to deliver the packets.

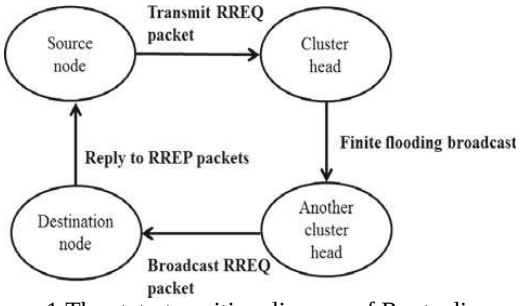

Figure 1:The state-transition diagram of Route discovery

3.2 Route Maintenance- When a node finds that a routing

Path has been severed; the node will transmit an RERR packet to the cluster head. When the cluster head receives the RERR (Route Error) packet, it uses a partial-recovery scheme to identify another path to the destination. This partial recovery scheme is based on cluster-head nodes. the cluster head sends the RERR packet to the source node directly, and the source starts using the candidate routing path for the direct delivery of data. In this way, we can deliver data to destinations both quickly and cost-effectively.

VII. PROPOSED ENERGY EFFICIENT TECHNIQUE IN CBIR

In communication techniques there are many states that have many rules of energy consumption. These states are sending packet, receiving packet, discarding packet, idle time and sleep time [11]. Energy consumption for idle and sleep state for sending and receiving packet is calculated with the following formula [12].

$$Energy\ Consumption = K * size\ (byte) + D \quad \text{---- (3)}$$

K and D are two constants which are determined by hardware, using protocol and speed of sending and Receiving information.

CBIR may be a robust/scalable routing protocol for MANETs and superior to the present ways (e.g. the overhead of it is less than and throughput of it is more than of AODV [13]. CBIR is a routing protocol designed for medium to massive mobile ad-hoc networks. The protocol divides the nodes of the ad hoc network into a number of Neighbour Table and a Cluster Adjacency Table. Neighbour Table is a conceptual data structure that it employs for link status sensing and cluster formation. Cluster Adjacency Table keeps information regarding adjacent clusters for Adjacent Cluster Discovery. These tables are updated by the periodic Hello Messages (HM).

In CBIR, routing is predicated on source routing. Cluster structure is exploited to reduce the flooding traffic throughout route discovery phase, so it is increasing the network connectivity. Supported cluster membership, information kept at each cluster head, Inter-cluster routes are dynamically discovered. primarily, in Route Discovery, only cluster heads are flooded with Route Request Packets (RREQ) in seek for a source route. Every cluster head node forwards an RREQ packet one time and it never forwards it to a node that has already appeared within the recorded route. It proactively acquires its intra cluster topology information through the exchange of hello messages and reactively acquires the route information inter cluster.

An example of an ad hoc network is shown in Figure2. Nodes are organized in clusters, every of that incorporates a CH (Cluster Head).

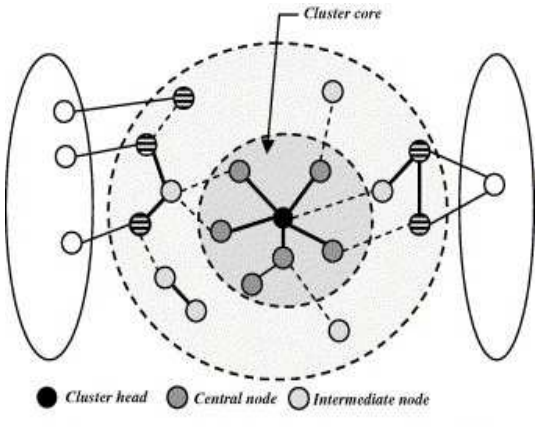

Figure 2: A cluster based ad hoc network

Unlike the other on-demand routing protocols, In CBIR the nodes are organized in an exceedingly hierarchy. As almost in all hierarchical protocols, CH coordinates the information transmission between clusters. The advantage of CBIR is that only CHs exchange routing data, thus the amount of management overhead transmitted through the network is far less than the traditional flooding methods. However, as in any other hierarchical routing protocol, there are overheads related to with cluster formation and maintenance. This is because some nodes may carry inconsistent topology information due to long propagation delay [14]. A neighbour table in each node of CBIR keeps the information regarding link states (unidirectional or bi-directional) and also the state of its neighbours. A CH keeps data of its close clusters, additionally to the data of all members in its cluster. The data includes the CHs of close clusters and entry nodes connecting it to the close clusters [15].

VIII. CONCLUSION

A Mobile ad hoc network (MANET) is an assortment of nodes which will communicate with each other without any mounted networking infrastructure. Energy efficiency is in an exceedingly problem in a MANET, especially in designing a routing protocol. We viewed a number of the recent work done in mobile ad hoc network considering energy because the key issue. It's found that almost all of the study discusses the energy issue at data link and network layer. We discuss completely different energy efficient protocol supported power management and topology management approach. We also suggest energy efficient techniques for MANET point of view. Route request minimization technique can be done by implementing logical grouping; power management techniques reduce the transmission power of a node whereas topology management approach will increase the network longevity by satisfying network constraints.

In this paper, we have an inclination to surveyed and classified kind of energy aware routing techniques. Every technique has its own assumptions and completely different objectives and different methodologies within the implementation. For example, within the transmission power management approach the ability level is important however the cost is not considered. The load distribution approach is economical to enhance the energy imbalance drawback. There are completely different channels for sending information and management packets to reduce the energy consumption in power management approach but it increase the network traffic. The sleep/power-down mode approach is completely different from the opposite approaches because it focuses on inactivity energy. CBRP could be a powerful and ascendable routing protocol for ad hoc network. As compared to AODV that is a standard protocol, the overhead of CBIR is in smaller amount and throughput of CBIR over of AODV.

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