Fault Tolerance in Mobile ad hoc Network: A Survey

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Abstract—Fault-Tolerance is an important design issue to construct a reliable mobile ad hoc network. Many types of faults may occur in mobile network such as link failure, node failure, misbehaving nodes, network failure, power and energy consumption etc. This paper mainly aims in surveying the research articles by combining them together to find the fault tolerant research problem in mobile ad hoc networks. In this paper many approaches has been taken into account and presented their key ideas.

Keywords -- wireless network, mobile ad hoc network, fault tolerance.

I. INTRODUCTION

Mobile Ad Hoc Network is a type of wireless ad hoc networks. It is a collection of mobile nodes which can dynamically exchange information between nodes without any centralized infrastructure. Due to node mobility the topology of the network can change frequently, nodes can move away from the transmission range. So, there may be a chance of node failure or link failure and node have to consume more energy to transfer the packets from source to destination. The performance of the routing will be decreased because of the failures. Node failure occurs when lack of power it causes route failure in the network.

The application of MANETs is varied, choice from small, stationary networks that are controlled by power resource to comprehensive dynamic networks. The application of MANETs need well organized distributed algorithms to decide the network association, routing, and link scheduling though determining a feasible routing path and message delivery. Relevant issues such as changeable wireless link excellence, fading, path loss, topological changes and power exhausted. The network could be capable to flexibly modify the routing paths to improve these problems.

In [35] Chlamtac et.al presents a inclusive summary of the MANET with important functionality, challenges and problems. It includes the characteristics, applications, design constraints, and capabilities of the network. This will be helpful in development of wireless technology in future. Garg et.al [44] presented an overview of Mobile ad hoc network and discussed about the routing protocols, attacks, and failures. Finally proposed a solution and suggestion for the future research. Fault tolerance is a significant property in MANETs and reliability of a resource may not assure. The fault tolerant approach is used in possibly prevent the malfunctioning node will affect the overall task of the network. Fault tolerance is ability to react the unpredicted hardware and software failures. Once the failure occurs it can be corrected or completed.

II. LITERATURE REVIEW

A. Fault Tolerance in Node Failures

Every node in the network can communicate straightaway with the other nodes be located in the transmission range. For communication with the nodes, that node is not lie within the particular range, the nodes uses the middle node to pass the information to the hop. Incase, the node is not in the transmission range node failure will occur. To overcome the node failure many algorithms and protocols to be used in the MANET.

In [3] Zhou,Xia proposed location based fault tolerant routing algorithm (FTRA). In this algorithm based on geographical location information networks divided in to grid. Fault may occur the proposed algorithm select alternate route from unused at hop in normal routing path, the route selection depends upon location information of its neighbors grids. In [10] Qin and Pang proposed fault-tolerance cluster head based (FTCH) routing protocol reduce misbehaving node in the network. Faulty node occurs the proposed protocol provide packet delivery fraction guarantee and reduce routing overhead. The performance analysis of FTCH compared with MMMH, AODV and DSR.

Rouzi et.al[11] introduce a graph called fault-tolerant 1-spanner. It is used to protect minimum energy paths. Also called as k-Fault-Tolerant 1-Spanner it generated minimum energy path tree for failed node set. To remove the failed nodes in the network the initial network will get energy form it. Modified Cluster-based QOS routing algorithm [12] with the goal of providing fault tolerance in QoS. This algorithm evaluate node failure based on failure recovery time, throughput, dropped packet and flow bandwidth.

Oommen and Misra introduced a learning – based weak estimation method [14][16] to find the misbehaving nodes in the network In adversarial environment a fault node occurs to search network redundancies. Misra et.al [15] proposed a learning automata based fault-tolerant routing algorithm (LAFTRA) to identify the misbehaving nodes in the
network. Fault node occurs Learning Automata Theory used to select the path and reduce overhead of the network. In [20] presents extended Fault-Tolerant Beacon Vector Routing (BVR) method. Introduced two techniques NetRec and ManRec to prevent the multiple failures in nodes.

In [22] propose an End-to-End estimation Fault Tolerant Routing Algorithm (E2FT) for misbehaving nodes. Route estimation and Route selection are the two process used to choose multiple path to packet delivery and also increase the accuracy of estimation. In [23] introduce cache management method to raise the TCP throughput by avoiding the host failures in the network by respond directly from the DSR cache. Nazeeruddin et. al [26] propose a distributed agent based dynamic host auto-configuration technique. Every node has address, the IP addresses can be allocate to the new node, without check with further address agents. This protocol handles message losses and node failure.

B. Fault Tolerance in Link Failures and Network Failures

Fault tolerance in Link failure and Network failure in MANETs can occur due to the fully or partially failed components in the network because of malfunction otherwise natural disaster. The node can move away from the cluster link failure will occur. So, avoid this failures lot of approaches has been proposed.

Melamed et. al [4] proposed Octopus a fault-tolerant and efficient position-based routing protocol is suitable for failure prone environments. In this protocol frequently update node location using flexible state and achieves low location update overhead by using novel aggregation technique. Octopus applicable for fixed node density and not raise the network size. In [6] Khazaeei and Berangi increase the data transfer and fault tolerance by creating backup path between source and destination during route reply, route maintenance and local recovery.

Chandrasekaran et.al [8] proposed a model Trusted Fault Tolerant (TFT) used in Location Aided Routing (LAR) protocol. LAR focused link faults, high mobility, node congestion and capacity of buffers. The Location fault occurs the destination node move away from source. The proposed model considers that node is selfish or misbehaving node. It improves the location awareness and node trust level based on recovery of the lost packet. In [25] Rana and Ahamed proposed a new fault tolerant routing protocol extends of DSR protocol. In this protocol identify at least two paths between sources to destination. Link failure occurs in one path immediately select another path.

Shaji et.al [27] proposed a novel Self-eliminating Fault-tolerant based Un-interrupted reliable Service switching mobile Protocol (SFUSP) it includes the task of clustering and self elimination to creates a reliable route in heterogeneous network and identify the link break in early. Adeluyi and Lee present [30] a Spiral Millipede-inspired Routing Algorithm (SMiRA). It uses a resource light technique and bio-inspired approach, which is decrease the routing overhead and improved fault tolerance in link failures. Mutual Eclusion (MUTEX) algorithm [36] used to tolerate link or host failure using the time out based method.

In [39] investigates communication failure in grid based topology using distributed genetic algorithm also use simple retry and reroute protocol to solve the communication failure in the network. In [42] proposed a Trusted Fault Tolerant (TFT) model based on Location Aided routing protocol along with user recovery features. It covers link failures during packet forwarding and location failures.

C. Fault Tolerance in Transmission Power and Energy

Transmission power and energy is an important issue in Mobile Ad Hoc Networks. Much research had performed in this problem. Battery is commonly used in the network, the power is used for the route selection, discovery and repair the failures in the link of the network.

Riganelli et.al [5] proposed fully distributed and predictive control used to optimizing transmission power and life time of k connected Mobile ad hoc Network. Shial et.al [7] proposed to increase fault tolerance by optimize the node distance of the wireless network to reduce power consumption of each node.

Moraes et.al [9] introduce an algorithm for topology control and reduce number of link in the network automatically it reduce the power consumption. Optimize this problem in to 4 variants that is input graph of the topology in to symmetric or asymmetric and result graph into unidirectional and bidirectional. Also introduce three integer programming formulations for the k-connected networks. The resulting topology is a K-fault tolerant.

Fault-tolerant distributed topology control algorithm [13] maintains a k-regular and k-node-connected with energy efficient multi-hop communication. Builds a hierarchy of clusters, based on node density and reliable ault tolerant communication between cluster members. Corradini et.al [24] considers a k-connected transmission power assignment problem. The problem addressed by minimizing the power utilization in decision-theoretic point of view. Kasamatsu et.al [31] proposed a broadcasting method depend on topology control. This method accomplished the task of lowering power consumption and tolerable reliable.

Li and Hou [33] proposed a Fault-tolerant Local Spanning Subgraph (FLSS) algorithm. This algorithm protects k – vertex connectivity and minimizes the transmission power. Saha et.al [41] proposed a distributed algorithm for marinating minimum possible power to all nodes will result in k-connected network topology. By using k-optimal vertex disjoint path, a node adjusts its power to reach all the nodes in the network.

D. Fault Tolerance in Other Approaches

In [1] Tulip and Kumar proposed minimum process checkpoint scheme using Cluster Based Routing Protocol (CBRP). Non-blocking coordinated checkpoint algorithm used in this scheme. This algorithm takes minimum number of nodes in cluster act as a checkpoint.

Singh et.al [2] proposed a novel algorithm using NxN matrix and K-FT topology tackle the fault identification between the participating nodes using cost. This algorithm achieves optimal resource utilization and fairness. Sahu et.al [17] proposed new routing technique called as Leaf Routing, which uses multipath routing with limited flooding to enhance the consistency during transfer of packets. The wireless coverage may be shortened and message losses could
occurrence problem [18] provides a protocol for reliable multicast within a group of mobile hosts. That communicate with a wired infrastructure.

To prevent the fault tolerant in wireless ad hoc network [19] to build minimum interference path to maintain centralized and distributed local information. Xu et al. [21] proposed a routing algorithm in the combination of position-based routing and fault-tolerant routing techniques. In this combined algorithm reduce overhead and increase operational effectiveness. The demerit of this algorithm is routing deadlock.

In [28] analyze the Adaptive Fault Tolerant Replication (AFTR) routing protocol. It handles the time constrained messages to identify the fault in a network. In [32] presented a fast, local clustering service (FLOC). It splits the networks into equal size cluster without overlapping and using stretch factor to find the cluster locality and fault locality. In [34] introduce a matrix matrix multiplication algorithm based on the checksum relationship of the computational result. This algorithm is maintains the checksum information in the middle of the computation from that reveal the fail-stop process failures tolerate without check pointing and message logging.

Ad hoc and sensor networks use cross-monitoring scheme [37] to achieve reliability and survivability in the fault detection and correction model. This paper introduces a protocol distributed self-diagnosis protocol, called Dynamic-DSDP [38]. It finds hard and soft faults in a fixed amount of time. In [40] file replication technique used mobile ad hoc network for sharing the files. In [43] focus on check pointing recovery service, it saves recovery information by reducing the frequency of disk access.

III. FINDINGS

Many literatures are analyzed for fault tolerance in this paper and give the general idea of these findings. Most of the research carried out the problem in the course of node failures, transmission power and energy. Some of the research for link failures and network failures in the network and also the location failures. Very few approaches reviewed based on the check pointing, message logging and reducing overhead. Fault Tolerance is used to enhance the system reliability.

IV. CONCLUSION

Fault tolerance is a major research issue in the Mobile Ad Hoc Networks. This paper presented a survey of different fault tolerance algorithms and protocols developed for MANETs. From this survey paper, the researchers can obtain what are all the failures occur and the various techniques and protocols to overcome the problems such as node failure, link failure, network failure, transmission power, energy etc. The surveyed protocols and algorithms showed here can improve the performance in terms of reliability, throughput, and life time.

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