Volume 3, Issue 3, March 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Fault Tolerance in Mobile ad hoc Network: A Survey

D.Maheshwari[1]
Ph.D Research Scholar in Computer Science
Bharathiar University
Coimbatore, India

A.Dhanalakshmi[2]
Research Scholar, M.Phil Computer Science
Dr.N.G.P Arts and Science College
Coimbatore, India

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 protocol. 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]Khazaei 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 atleast two paths between sources to destination. Link failure occurs in one path immediately select another path.

Shaji et.al [27] [29] 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 reliability.

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

occur, overcome this problem [18] provide 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 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.

ACKNOWLEDGEMENT

The first author thanks the management of Dr.N.G.P. Arts and Science College for providing career opportunity as Head of the Department for Department of Computer Technology and also thank Dr.R.Nedunchezhian,Sri Ramakrishna Engineering College for the guidance . The second author thanks the management of Dr.N.G.P. Arts and Science College for providing opportunities to pursuing MPhil Computer Science.

REFERENCES

[1] Ruchi Tuli and Parveen Kumar ," The Design and Performance of a Check pointing Scheme for Mobile Ad Hoc Networks", Advances in Parallel Distributed Computing Communications in Computer and Information Science, Volume 203, pp 204-212, 2011.

[2] S. Singh, N.Rajpal and A.K.Sharma, " K-fault tolerant in Mobile Ad Hoc Network under cost constraint", 3rd International Conference on Electronics Computer Technology (ICECT) , Volume -6 ,Page(s) 368 - 372 , April 2011.

[3] Jipeng Zhou and Chao Xia, "A Location-Based Fault-Tolerant Routing Algorithm for Mobile Ad Hoc Networks ", WRI International Conference on Communications and Mobile Computing, Volume 2 ,Page(s) 92 – 96,Jan 2009.

[4] R. Melamed, I. Keidar and Y. Bare, "Octopus: a fault-tolerant and efficient ad-hoc routing protocol ", 24th IEEE Symposium on Reliable Distributed Systems, Page(s) 39 - 49 ,OCT 2005.

[5] O. Riganelli, R. Grosu, S.R. Das, C.R. Ramakrishna, and S.A. Smolka., " Power Optimization in Fault-Tolerant Mobile Ad Hoc Networks ",11th IEEE Conference on High Assurance Systems Engineering Symposium, Page(s): 362 - 370 ,Dec 2008.

[6] M. Khazaei and R. Berangi, "A multi-path routing protocol with fault tolerance in mobile ad hoc networks " , 14th International CSI Computer Conference, Page(s): 77 – 82, Oct. 2009.

[7] Rabindra Kumar Shial, K. Hemant Ku Reddy and K. L. Narayana, "An Optimal RPC Based Approach to Increase Fault in Wireless Ad-Hoc Network", Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering Volume 84, pp 372-382, 2012.

[8] S. Chandrasekaran, S. Udhayakumar, U. Mohan Bharathy,and D. Jitendra Kumar Jain, " Trusted Fault Tolerant Model of MANET with Data Recovery ",4th IEEE International Conference on Intelligent Networks and Intelligent Systems(ICINIS), Page(s):21-24, 2011.

[9] R.E.N. Moraes, C.C. Ribeiro and C. Duhamel, "Optimal solutions for fault-tolerant topology control in wireless ad hoc networks " IEEE Transactions on Wireless Communications, Volume:8 , Issue: 12 ,Page(s): 5970 - 5981 ,December 2009.

[10] Yang Qin and Kong Ling Pang, " A Fault-Tolerance Cluster Head Based Routing Protocol for Ad Hoc Networks", IEEE Vehicular Technology Conference, Page(s): 2472 – 2476, May 2008.
[11] Sun.Ruozi ,Wang.Yue, Yuan.Jian, Shan.Xiuming and Ren.Yong, "Topology control algorithm using fault-tolerant 1-spanner for wireless ad hoc networks Tsinghua Science and Technology", Volume: 17, Issue: 2, Page(s): 186 -193 , April 2012.
[12] Larry C. Llewellyn, Kenneth M. Hopkinson and Scott R. Graham, " Distributed Fault-Tolerant Quality of Wireless Networks" IEEE Transactions On Mobile Computing, VoL. 10, No. 2, February 2011.
[13] Bernd Thallner, Heinrich Moser and Ulrich Schmid ,"Topology control for fault-tolerant communication in wireless ad hoc networks ", Wireless Networks, Volume 16, Issue 2, pp 387-404 , February 2010.
[14] B.J Oommen and S. Misra., "A Fault-Tolerant Routing Algorithm for Mobile Ad Hoc Networks Using a Stochastic Learning-Based Weak Estimation Procedure", IEEE International Conference on Wireless and Mobile Computing, Networking and Communications, Page(s): 31 - 37 ,June 2006.
[15] Sudip Misra, P. Venkata Krishna, Akhil Bhiwal, Amardeep Singh Chawla, Bernd E. Wolfinger and Changhoon Lee , "A learning automata-based fault-tolerant routing algorithm for mobile ad hoc networks", The Journal of Supercomputing , Volume 62, Issue 1, Page(s) 4-23, October 2012.
[16] B.John Oommen and Sudip Misra ,"Fault-tolerant routing in adversarial mobile ad hoc networks: an efficient route estimation scheme for non-stationary environments", Telecommunication Systems,Volume 44, Page(s) 159-169, June 2010.
[17] R.K. Sahu, R.Saha.R and N.S. Chaudhari, "Fault Tolerant Reliable Multipath Routing Protocol for Ad Hoc Network ", Fourth International Conference on Computational Intelligence and Communication Networks , Page(s) 117-121, Nov 2012.
[18] Giuseppe Anastasi, Alberto Bartoli and Flaminia L. Luccio ," Fault-Tolerant Support for Reliable Multicast in Mobile Wireless Systems: Design and Evaluation", Wireless Networks , Volume 10, Issue 3, pp 259-269, May 2004.
[19] Md.Ehtesamul Haque and Ashikur Rahman , "Fault Tolerant Interference-Aware Topology Control for Ad Hoc Wireless Networks", Ad-hoc, Mobile, and Wireless Networks ,Lecture Notes in Computer Science Volume 68, pp 100-116,2011.
[20] L. Demoracski," Fault-tolerant beacon vector routing for mobile ad hoc networks ", 19th IEEE International Parallel and Distributed Processing Symposium, April 2005.
[21] Sheng Xu , S.Papavassiliou and L. Zakrevski, " Fault-tolerant cluster-based routing approach in wireless mobile ad hoc networks", IEEE VTS 54th Conference on Vehicular Technology, Volume: 4 ,Page(s): 2613 – 2617, 2001.
[22] Yuan Xue and K. Nahrstedt, "Fault tolerant routing in mobile ad hoc networks", IEEE Conference on Wireless Communications and Networking, 2003, Volume: 2 ,Page(s): 1174 – 1179, March 2003.
[23] Ching-Hua Chuan and Sy-Yen Kuo, "Cache management of dynamic source routing for fault tolerance in mobile ad hoc networks", International Symposium on Dependable Computing, Page(s): 199 - 205 ,2001.
[24] F. Corradini, R. Gagliardi, M. Papalini, A. Polzonetti and O. Riganelli, "On the fault tolerance of mobile ad hoc networks", 30th International Conference on Information Technology Interfaces, Page(s): 827 – 832, June 2008.
[25] Rana E. Ahmed, "A Fault-Tolerant Routing Protocol for Mobile Ad Hoc Networks", Journal of Advances in Information Technology, VOL. 2, no.2, May 2011.
[26] M. Nazeeruddin, G. Parr and B. Scotney, "Fault - Tolerant Dynamic Host Auto-configuration
Protocol for Heterogeneous MANET", 14th IST Mobile & Wireless Communication, 2005.
[27] R.S. Shaji, Dr.R.S. Rajesh and B. Ramakrishnan, "A Fault-tolerant Scheme for Routing Path Re-establishment for reliable communication in Heterogeneous Networks", International Journal of Scientific & Engineering Research, Volume 1, Issue 3, ISSN 2229-5518 , December-2010.
[28] Swati Saxena and Dr. Madhavi Sinha, "Statistical study of performance metrics of Adaptive Fault Tolerant Replication Routing Protocol for MANET", International Journal on Computer Science and Engineering (IJCSE), Vol. 4 No. 11 Nov 2012.
[29] R.S. Shaji, Dr.R.S. Rajesh and B. Ramakrishnan, "SFUSP: A Fault-tolerant Routing Scheme for path establishment among Mobile Devices in Pervasive Spaces", Journal of Computing, Volume-2, Issue 11, ISSN 2151 – 9617, Nov.2010.
[30] Adeluyi, O. Jeong-A Lee, "SMiRA: A bio-inspired fault tolerant routing algorithm for MANETs",
International Conference on ICT convergence (ICTC), Page(s): 78 – 84, Oct.2012.
[31] Daisuke Kasamatsu, Yuta Kawamura, Masahiro Oki, and Norishiko Shinomiya, "Broadcasting Method Based on Topology Control for Fault-Tolerant MANET", 31st International Conference on Distributed Computing Systems Workshops, ISBN: 978-0-7695-4386-4, 2011.
[32] Murat Demirbas, Anish Arora, Vineet Mittal and Vinodkrishnan Kulathumani, "A Fault-Local Self-Stabilizing Clustering Service for Wireless Ad Hoc Networks", IEEE Transaction on Parallel and Distributed Systems, Vol.17, No.9, September 2006.
[33] Ning Li and Jennifer C. Hou," Localized Fault-Tolerant Topology Control in Wireless Ad Hoc Networks", IEEE Transaction on Parallel and Distributed Systems, Vol.17, No.4, April 2006.
[34] Zizhong Chen and Jack Dongarra, "Algorithm-Based Fault Tolerance for Fail-Stop Failures", IEEE Transaction on Parallel and Distributed Systems, Vol.19, Issue.12, Pages- 1628- 1641, Dec. 2008.
[35] Imrich Chlamtac, Marco Conti and Jennifer J.-N. Liu," Mobile ad hoc networking: imperatives and challenges", Ad Hoc Networks, 2003.
[36] Weigang Wu, Jiannong Cao and Jin Yang , "A fault tolerant mutual exclusion algorithm for mobile ad hoc

networks", Journal of Pervasive and Mobile Computing , Volume 4, Issue 1,Pages 139-160, Elsevier Science Publishers , February 2008.
[37] A.W. Krings. and Z. Ma. Z.,"Fault-Models in Wireless Communication: Towards Survivable Ad Hoc Networks ",IEEE Conference on Military Communications, Page(s): 1 – 7,October 2006.
[38] Mourad Elhadef, Azzedine Boukerche and Hisham Elkadiki , "A distributed fault identification protocol for wireless and mobile ad hoc networks ",Journal of Parallel and Distributed Computing Volume 68, Issue 3, Pages 321–335 ,March 2008.
[39] Yiyuan Gong and A.S. Fukunaga, "Fault tolerance in distributed genetic algorithms with tree topologies", IEEE Congress on Evolutionary Computation,Page(s): 968 – 975, May 2009.
[40] M. Pushpalatha, Revathi Venkataraman, Rishav Khemka and T. Rama Rao, "Fault tolerant and dynamic file sharing ability in mobile ad hoc networks", IEEE International Conference on Advances in Computing, Communication and Control, Pages 474-478, 2009.
[41] Indranil Saha, Lokesh Kumar Sambasivan, Subhas Kumar Ghosh and Ranjeet Kumar Patro, "Distributed fault-tolerant topology control in wireless multi-hop networks", Journal of Wireless Networks ,Volume 16, Issue 6, Pages 1511-1524, August 2010.
[42] S. Chandrasekaran, Shanmugam, Udhayakumar, U. Mohan Bharathy and D. Jitendra Kumar Jain, "Trusted Fault Tolerant Model of MANET with Data Recovery", IEEE 4th International Conference on Intelligent Networks and Intelligent Systems, Pages 21-24,201.
[43] Taesoon Park and Kwangho Kim, "Fault-Tolerance for the Mobile Ad-Hoc Environment", Journal of IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences, Volume E91-A Issue 1, Pages 413-416,January 2008.
[44] Vinit Garg, Manoj Kr.Shukla, Tanupriya Choudhury and Charu Gupta, "Advance Survey of Mobile Ad-Hoc Network", International Jpurnal on Computer science and Technology (IJCST), Vol. 2, Issue 4, Oct - Dec. 2011.
[45] en.wikipedia.org/wiki/Mobile_ad_hoc_network.

