FAULT TOLERANT ROUTING IN MOBILE AD HOC NETWORKS: A SURVEY

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Abstract

The mobile nodes in Mobile Ad hoc Networks dynamically setup a wireless network without the presence of fixed infrastructure. MANET is a self-organizing, self-configuring and instantly deployable multi-hop wireless network. Adversarial conditions are standard in MANET environments, and there are misbehaving nodes that decay the overall performance. MANETs should be fault tolerant to recover even after a failure occurs So the fault-tolerance and reliability of the MANET is an important topic. This survey paper discussed various fault tolerant routing schemes based on Qos, Energy efficient, Security enabled, congestion aware multipath and Swarm intelligence.

Keywords *: MANET, Fault Tolerance.*

1. INTRODUCTION

Routing is currently a challenging and interesting problem due to the dynamic nature of the MANETs infrastructure, e.g., due to nodes joining and leaving the network. For routing, if the source and destination nodes are neighbors, the direct transmission is possible i.e., the nodes are within the wireless range. On the other hand, the transmission is *indirect*, if the source and destination nodes are not within their range of operation [9]. In this case, routing is achieved through a series of multiple hops, with intermediate nodes between the source and the destination nodes serving the purpose of routers for relaying the information in between. The dynamic nature of the topology of MANETs due to the constant migration of nodes leads to routing consideration difficult. The following characteristics of MANETs make their routing further challenging [9]:

1. The frequent mobility of nodes in MANETs may pose to hazardous conditions that can lead to the frequent failure of the nodes and their mutual links.

2.MANETs use wireless medium of transmission of information, and the Wireless media is relatively unreliable, insecure, and quite susceptible to different kinds of errors and unwanted noise.

3. The frequent recharging of the nodes may not always be feasible since MANETs operate with battery-powered nodes, which are normally low powered, and resource constrained. Consequently, all routing algorithms should be energy-efficient, of low complexity, and should be capable of operating under limited bandwidth.

The different types of errors that can occur in MANETs are the following [9]:

1. Transmission errors
2. Node failures
3. Link failures
4. Route breakages
5. Packet loss due to congested nodes/links.

Because of node mobility, the network's topology can alter frequently; nodes can go far away from the transmission range. So, there could possibly be a chance of node failure or link failure and node have to consume more energy in order to exchange the packets from source to desired destination. Due to the failures, the overall performance of the routing will be reduced. Node failure takes place whenever deficiency of power, it leads to path failure in the network. The functionality of any routing protocol can be decrease if the network contain the fault-prone nodes. Making use of greedy routing mechanisms in which every time go to one path, might result in important data losses, when there is a failure of this route in a fault prone environment. However, utilizing all of the available routes will lead to an unwanted amount of overhead on the network. Developing an effective as well as efficient fault-tolerant routing protocol is inherently complicated, because the problem is NP-complete as result the unavailability of exact path information in adversarial environments.

2. FAULT TOLERANCE ISSUES

A. QoS Based Fault Tolerant

Larry C. Llewellyn(2011) modifies a cluster-based QoS routing algorithm for mobile ad hoc networks with the aim of providing fault tolerance, which is a critical feature in providing QoS in the link failure-prone environment of mobile networks. Performance of this new fault-tolerant cluster-based QoS wireless algorithm is evaluated according to failure recovery time, dropped packets, throughput, and sustained flow bandwidth via simulations involving node failure scenarios along QoS paths.

P.ChandraSekhar Reddy (2016) devised protocol called Fault Tolerance QoS Routing Protocol, which has capability to send the data with an alternative route when route break occurs. This protocol gives the better results than Genetic Algorithm(GA) based Energy efficient QoS routing (GAEEQR) protocol in terms of delay, packet delivery ratio, throughput and energy consumption.

B. Swarm based Fault Tolerant

Surendran. S (2015) proposed a QoS constrained fault tolerant ant look-ahead routing algorithm which attempts to identify valid route and look-ahead route pairs which might help in choosing the alternate path in case of valid route failure.
The key aspects of the proposed protocol by L.J.G. Villalba (2010) are the disjoint-link and disjoint-node routes, separation between the regular pheromone and the virtual pheromone in the diffusion process and the exploration of routes, taking into consideration the number of hops in the best routes which the authors have previously found out. The simulation results show that the protocol has lower overhead and higher delivered packet ratio than AntHocNet. Likewise, these results indicate that the routing satisfies multiple and independent quality of service constraints and can deal with faults, which provides better load balancing.

C. Energy Efficient Fault Tolerant

Senthilnathan Palaniappan (2015) propose a stable and energy-efficient routing technique. In the proposed method, quality of service (QoS) monitoring agents collect and calculate the link reliability metrics such as link expiration time (LET), probabilistic link reliable time (PLRT), link packet error rate (LPER) and link received signal strength (LRSS). In addition, residual battery power (RBP) is implemented to maintain the energy efficiency in the network. Finally, route selection probability (RSP) is calculated based on these estimated parameters using fuzzy logic. Simulation results show that the proposed routing technique improves the packet delivery ratio and reduces the energy consumption.

P. Manickam (2013) proposed a new protocol AODV-Energy Based Routing (AODV-EBR) protocol for energy constrained mobile ad hoc Networks. This protocol optimizes Ad hoc on demand distance vector routing protocol (AODV) by creating a new route for routing the data packets in the active communication of the network. The proposed protocol efficiently manages the energy weakness node and delivers the packets to destination with minimum number of packets dropped.

D. Congestion Aware Multipath Fault Tolerant

The performance of ad hoc routing protocols will significantly degrade when there are faulty nodes in the network. Packet losses and bandwidth degradation are caused due to congestion and thus, time and energy is wasted during its recovery. The fault tolerant congestion aware routing protocol addresses these problems by exploring the network redundancy through multipath routing**.** Rajkumar, G. (2012) proposed to design a fault tolerant congestion aware multi path routing protocol to reduce the route breakages and congestion losses. The AOMDV protocol is used as a base for the multipath routing. This proposed scheme enables more nodes to salvage a dropped packet.

D Srinivasa Rao (2016) proposed scheme a multipath, multicast routing protocol which works efficiently by selecting route with higher lifetime and it also recovers the lost packets. This protocol considers the link remaining time, hop count remaining energy and control message in order to determine the route lifetime using the Fuzzy Logic. The link remaining time is determined based on the mobility prediction method.

E. Security Enabled Fault Tolerant

William H. Robinson (2013) describes the key challenges to implement fault-tolerant and efficient deployments of collaborative autonomous aircraft to increase operational reliability and performance when performing aerial sensing and assessment. Some challenges are introduced by mobility, such as wireless communication, group navigation, and data collection. Security also represents a challenge during the operation of the MANET. Also consider the effects of limited resources (e.g., real-time processing power, battery packs) available on the aircraft. By understanding both the application context and the resource availability, networked aircraft can reorganize to ensure resiliency for the mission if a resource failure occurs within the network.

Nabil Ali Alrajeh (2016) proposed protocol is inspired from traditional on-demand routing protocols by searching shortest routes from source to destination using default parameters. In case of multimedia applications, the proposed mechanism considers such routes which are capable of providing more data rates having less packet loss ratio. For those applications which need security, the proposed mechanism searches such routes which are more secure in nature as compared to others. Cross-layer methodology is used in proposed routing scheme so as to exchange different parameters across the protocol stack for better decision-making at network layer. Our approach is efficient and fault tolerant in a variety of scenarios that we simulated and tested.

TABLE 1: Comparison of Different Techniques According to Their Characteristics

S.No	Technique	Node failure	Link or Network failure	Simulator Used
1	An Efficient Routing scheme for reliable path establishment among Mobile Devices in Heterogeneous Networks (**SFUSP) (2010)**	✓	×	Ns 2.34
2	A Novel Permission-based Reliable Distributed Mutual Exclusion Algorithm for MANETs (2010)	✓	✓	-
3	An Efficient and High Scalable Key Distribution Scheme for Mobile Ad Hoc Network Through Mining Traffic Meta-data Patterns (2010)	✓	×	Ns2
4	Cross-Layer Design to Merge Structured P2P Networks over MANET (2010)	×	✓	Ns2
5	An ant swarm-inspired energy-aware routing protocol for wireless ad-hoc networks (2010)	×	✓	GloMoSim
6	Trusted Fault Tolerant Model of MANET with Data Recovery (**(TFT) (2011)**	✓	✓	-
7	Localized Fault-tolerant Spanner Based Topology Control in Wireless Networks (k-FTtS) (2011)	✓	×	-
8	Link availability prediction-based reliable routing for mobile ad hoc networks (LBRP) (2011)	×	✓	GloMoSim
9	Route Failure Management Technique for Ant Based Routing in MANET (2011)	✓	×	Ns2
10	Time Delay Reduction in MANETs using Improved Fault Tolerant Routing Protocol (IFTMR) (2012)	✓	✓	MATLAB
11	An Optimal Rpc Based Approach To Increase Fault Tolerance In Wireless Ad-Hoc Network (2012)	✓	✓	-
12	CORP: An Efficient Protocol to Prevent Data Loss in Mobile Ad-Hoc Networks (2013)	×	✓	MATLAB
13	Fault Tolerant Hierarchical Multicast Routing Protocol (FTHMRP) (2013)	✓	✓	MATLAB
14	An Energy Efficient Cluster Head Selection For Fault tolerant Routing In Manet (2013)	×	✓	NS2
15	Swarm Optimized Multicasting For Wireless Network (2013)	×	✓	OPNET
16	Hybrid ACO Routing Protocol for Mobile Ad Hoc Networks (2013)	×	✓	NS3
17	Design of New Fault Tolerant Multipath Routing Protocol for Mobile Ad hoc Networks(**(FTMRP)) (2014)**	✓	✓	NS2
18	BeeIP – A Swarm Intelligence based routing for wireless ad hoc networks (2014)	×	✓	Ns2
19	A new link lifetime estimation method for greedy and contention-based routing in mobile ad hoc networks (2014)	×	✓	OPNET 14.5
20	EigenTrust-based non-cooperative game model assisting ACO look-ahead secure routing against selfishness (2014)	✓	✓	Ns2
21	Defending Against Collaborative Attacks by Malicious Nodes in MANETs: A Cooperative Bait Detection Approach **(CBDS)** (2015)	✓	×	QualNet 4.5
22	Survivability Analysis with Border Effects for Power-aware Mobile Ad Hoc Network (2015)	✓	×	-
23	QOS-DHT Based Fault Tolerant Routing Mechanism for Improving Link Stability in MANET (2015)	×	✓	Ns2
24	Routing discovery Mechanism based on Fault Tolerance in Container yard Environment (2016)	✓	×	-

25	Efficient Routing Algorithm using sectorized Antenna for Mobile Adhoc Networks (EAODVSA) (2016)	✓	×	-
26	An Effective (FD-E-TOHIP) Fault Detection Enabled E-TOHIP for Mobile Ad-Hoc Networks (2016)	✓	✓	Ns2
27	An Energy Entropy-Based Minimum Power Cost Multipath Routing in MANET (EEPMM)(2016)	✓	✓	Ns2
28	An Optimized Approach on Link Stability with Load Balancing in MANET using Balanced Reliable Shortest Route AOMDV (BRSR_AOMDV)(2016)	×	✓	Ns2
29	Performance Analysis of Malicious Node Detection and Elimination Using Clustering Approach on MANET (2016)	×	✓	Ns2
30	Performance Evaluation of Re-Routing based Hybrid ACO-PSO based Routing Algorithm for MANETS (2016)	✓	×	MATLAB 2013a
31	Improved multicast routing in MANETs using link stability and route stability (2016)	×	✓	EXata/Cyber v2.0

3. CONCLUSION

Mobile Ad Hoc networks is a dynamic environment which due to frequently mobile wireless nodes experiences communication failures due to network partitioning, and nodes failures exhibiting different faulty actions temporary or longlasting arising out of glitches related to hardware or software. As the mobile nodes are mostly resource constrained, in case of faulty nodes packets forwarding could be lead to further complications. Hence in designing a robust mobile ad hoc network fault tolerance plays a major role. In this survey paper, we discuss some of the fault tolerant routing schemes which are node failure, link/Network failure or both.

REFERENCES

1. R S Shaji , "An Efficient Routing scheme for reliable path establishment among Mobile Devices in Heterogeneous Networks" , (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 1 (5) , 2010, 355-362.
2. Murali Parameswaran, "A Novel Permission-based Reliable Distributed Mutual Exclusion Algorithm for MANETs", 978-1-4244-7202-4/10 ©2010 IEEE.
3. S. Ramachandram, "An Efficient and High Scalable Key Distribution Scheme for Mobile Ad Hoc Network Through Mining Traffic Meta-data Patterns", 2010 Fourth International Conference on Network and System Security.
4. Sudip Misra, " An ant swarm-inspired energy-aware routing protocol for wireless ad-hoc networks ", The Journal of Systems and Software 83 (2010) 2188–2199.
5. Nadir Shah, "Cross-Layer Design to Merge Structured P2P Networks over MANET", 2010 16th International Conference on Parallel and Distributed Systems.
6. L.J.G. Villalba, "Bio-inspired routing protocol for mobile ad hoc networks", IET Commun., 2010, Vol. 4, Iss. 18, pp. 2187–2195.
7. Ruozi Sun, "Localized Fault-tolerant Spanner Based Topology Control in Wireless Networks", 2011 Cross Strait Quad-Regional Radio Science and Wireless Technology Conference.
8. Chandrasekaran S, "Trusted Fault Tolerant Model of MANET with Data Recovery", 2011 Fourth International Conference on Intelligent Networks and Intelligent Systems.
9. B. John Oommen, Fault-Tolerant Routing in Mobile Ad Hoc Networks, Mobile Ad-Hoc Networks: Protocol Design, Prof. Xin Wang (Ed.), ISBN: 978-953-307-402-3, InTech 2011.
10. Q. Han, "Link availability prediction-based reliable routing for mobile ad hoc networks ",IET Commun., 2011, Vol. 5, Iss. 16, pp. 2291–2300.
11. S.B.Wankhade, "Route Failure Management Technique for Ant Based Routing in MANET", International Journal of Scientific & Engineering Research Volume 2, Issue 9, September-2011.
12. Larry C. Llewellyn," Distributed Fault-Tolerant Quality of Wireless Networks", Ieee Transactions On Mobile Computing, Vol. 10, No. 2, February 2011.
13. Rajkumar, "Time Delay Reduction in MANETs using Improved Fault Tolerant Routing Protocol", CARE Journal of Applied Research (ISSN 2321-4090).
14. Mr. K.L.Narayana, "An Optimal Rpc Based Approach To Increase Fault Tolerance In Wireless Ad-Hocnetwork", International Journal on AdHoc Networking Systems (IJANS) Vol. 2, No. 2, April 2012.
15. Rajkumar, G.," Fault Tolerant Congestion AwareRouting Protocol for Mobile Adhoc Networks", Journal of Computer Science 8 (5): 673-680, 2012.
16. Ganapathy Mani," CORP: An Efficient Protocol to Prevent Data Loss in Mobile Ad-Hoc Networks", 2013 27th International Conference on Advanced Information Networking and Applications Workshops.

17. G.Sruthi," Fault Tolerant Hierarchical Multicast RoutingProtocol (FTHMRP)", 2013 International Conference on Advanced Computing and Communication Systems (ICACCS -2013), Dec. 19 – 21, 2013, Coimbatore, INDIA
18. A.E.Narayanan, "An Energy Efficient Cluster Head Selection For Faulttolerant Routing In Manet", International Journal of Engineering and Technology (IJET), Vol 5 No 2 Apr-May 2013.
19. Dr. N. Shanthi, "Swarm Optimized Multicasting For Wireless Network", Life Science Journal 2013;10(4s).
20. D. Rupérez Cañas, "Hybrid ACO Routing Protocol for Mobile Ad Hoc Networks", International Journal of Distributed Sensor Networks Volume 2013, Article ID 265485, 7 pages.
21. P. Manickam," A Highly Adaptive Fault Tolerant Routing Protocol For Energy Constrained Mobile Ad Hoc Networks", Journal of Theoretical and Applied Information Technology 30th November 2013. Vol. 57 No.3.
22. William H. Robinson, "Resilient and Efficient MANET Aerial Communications for Search and Rescue Applications", 2013 International Conference on Computing, Networking and Communications, Invited Position Papers.
23. D Srinivasa Rao, "Design of New Fault Tolerant Multipath RoutingProtocol for Mobile Ad hoc Networks", Proceedings of International Conference on Circuits, Communication, Control and Computing (I4C 2014).
24. Myra S. Wilson, "BeeIP – A Swarm Intelligence based routing for wireless ad hoc networks", Information Sciences 265 (2014) 23–35.
25. Hadi Noureddine," A new link lifetime estimation method for greedy and contention-based routing in mobile ad hoc networks", Telecommun Syst (2014) 55:421–433.
26. Surendran Subbaraj, "EigenTrust-based non-cooperative game model assisting ACO look-ahead secure routing against selfishness", EURASIP Journal on Wireless Communications and Networking 2014, 2014:78.
27. Jian-Ming Chang," Defending Against Collaborative Attacks by Malicious Nodes in MANETs: A Cooperative Bait Detection Approach", Ieee Systems Journal, Vol. 9, No. 1, March 2015.
28. Zhipeng Yi, "Survivability Analysis with Border Effects for Power-aware Mobile Ad Hoc Network", UIC-ATC-ScalCom-CBDCom-IoP 2015.
29. Dr.T.N.Ravi "QOS-DHT Based Fault Tolerant Routing Mechanism for Improving Link Stability in MANET", IJCTA 2015.
30. Surendran. S**,"** An ACO Look-Ahead Approach to QOS Enabled Fault- Tolerant Routing in MANETs**",** China Communications • August 2015.
31. Senthilnathan Palaniappan," Energy-efficient stable routing using QoS monitoring agents in MANET" EURASIP Journal on Wireless Communications and Networking (2015) 2015:13.
32. Shibo Xu," Routing discovery Mechanism based on Fault Tolerance in Container yard Environment", IEICE – The 18th Asia-Pacific Network Operations and Management Symposium (APNOMS) 2016
33. Sachin Dubey," Efficient Routing Algorithm using sectorized Antenna for Mobile Adhoc Networks ", 978-9-3805-4421-2/16/ 2016 IEEE.
34. N. Sabiyath Fatima," An Effective (FD-E-TOHIP) Fault Detection Enabled E-TOHIP for Mobile Ad-Hoc Networks", Indian Journal of Science and Technology, Vol9(40),DOI:10.17485/ijst, October 2016
35. Baolin Sun," An Energy Entropy-Based Minimum Power Cost Multipath Routing in MANET", International Journal of Grid and Distributed Computing Vol. 9, No. 2 (2016), pp.169-180.
36. D. Maheshwari," An Optimized Approach on Link Stability with Load Balancing in MANET using Balanced Reliable Shortest Route AOMDV (BRSR_AOMDV)", Indian Journal of Science and Technology, Vol9(4),DOI:10.17485/ijst/2016/v9i2/70487, January 2016.
37. S. Gopalakrishnan," Performance Analysis of Malicious Node Detection and Elimination Using Clustering Approach on MANET", Circuits and Systems, 2016, 7, 748-758 Published Online May 2016 in SciRes.
38. Shivani Sharma," Performance Evaluation of Re-Routing based Hybrid ACO-PSO based Routing Algorithm for MANETS" , International Journal of Computer Applications (0975 – 8887) Volume 142 – No.13, May 2016.
39. Vijay Laxmi, "Improved multicast routing in MANETs using link stability and route stability", Int J Commun Syst 2016; 1–15.
40. Dr.P.ChandraSekhar Reddy," Fault Tolerance QoS Routing Protocol for MANET", 2016 IEEE 6th International Conference on Advanced Computing.
41. Channabasayya Mathad, "Mobility Aware Fault Tolerant Multipath Multicast Routing Protocol for MANET" International Journal of Computer Science and Information Security (IJCSIS), Vol. 14, No. 4, April 2016.
42. Nabil Ali Alrajeh," Adaptive Cross-Layer Multipath Routing Protocol for Mobile Ad Hoc Networks", Hindawi Publishing Corporation Journal of Sensors Volume 2016, Article ID 5486437, 18 pages.