

Fault Tolerance and Congestion Control in Mobile AD – HOC Networks: A Survey

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Abstract – MANET is dynamic collection of nodes that communicate with each other using wireless connections. The nodes are independent of each other so it is expected that they deviate from their usual behavior. This leads to fault. Fault-Tolerance is an important design issue in the construction of a reliable mobile ad hoc network. Many types of faults can occur in mobile AD – HOC networks such as link failure, end to end delay, node failure, routing overhead, misbehaving nodes, network failure, power and energy consumption etc. Congestion in a network can occur at any interval, it occurs due to traffic in the network. When the number of packets coming to a node is more than buffer capacity, then the node becomes congested and starts dropping packets. Ad – hoc mobile networks are composed of mobile nodes that communicate through wireless medium and they do not have any fixed backbone infrastructure. In these networks, congestion occurs in any intermediate node when data packets travel from source to destination. The network suffers high packet loss and long delay due to traffic, which causes performance degradations of the network. In this paper, we surveyed various methods to provide fault tolerance and congestion control in Mobile AD - HOC Networks. We also compared EDAODV, EDOCR, EDCSCAODV, AODV and DCDR on the basis of packet delivery ratio, end-to-end delay and routing overhead.

Keywords – Mobile AD – HOC Network, Routing protocols, Rollback Recovery, Optimal Path, Adaptive Routing

I. INTRODUCTION

Mobile ad – hoc networks (MANETs) have significantly enhanced the wireless networks by eliminating the need for fixed infrastructure. These networks are formed by nodes that communicate over wireless links without the control of any central administration [1].

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 used to enhance system reliability. Each node performs the role of a node as well as a router. Due to lack of fixed infrastructure faults occur.

Fault tolerance is an important design issue to construct a reliable Mobile AD – HOC Network. Faults like link failure, routing overhead, end to end delay [3], node failure and network failure and power usage are of serious concern. Most existing designs of ad hoc networks are based on the assumption of non-adversarial environments, i.e., each node in the network are cooperative and well behaved.

However, in adversarial environment, misbehaving nodes always exist, and may significantly degrade the routing performance. For example, if a misbehaving node participating in the routing operation drops data packets, then a large number of packets will be lost. In these networks, congestion may occur within any intermediate node when data packets travel from source to destination. They suffer from high packet loss and delay, which causes the performance of a network to degrade [4].

Designing routing protocols poses further challenges when one needs to design routing schemes in the presence of adversarial environments in MANET networks. The need for fault tolerant routing protocols was identified to address routing in adversarial environments, specifically in the presence of faulty nodes, by exploring network redundancies. Whereas multipath routing protocols discovers multiple routes between a pair of source destination nodes. In multipath routing, multiple redundant packets are sent along different paths between a pair of source destination nodes [5].

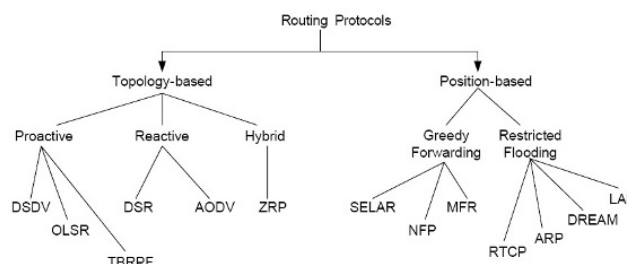


Figure 1 Classification of routing protocols in MANET [3]

II. PERFORMANCE ISSUES IN MANET

A. Routing Overhead

Routing overhead is the traffic of control or HELLO packets in the network. Due to lack of fixed infrastructure, quality of links and node position keeps changing in mobile AD – HOC networks [3]. This leads to higher number of control packets in the network. At network layer, these changes are accommodated by the control packets information of routing protocols and it is called routing overhead. There are various routing protocols present.

Proactive protocols store routing information of the network.

These are table driven protocols. DSDV, OLSR, TBRPF fall under this category. These protocols maintain routing tables which contains path information about nodes [6]. Reactive protocols do not store routing information. These are on demand protocols. When AODV, DSR, AOMDV[4] such kind of routing protocols are used for routing, it sends HELLO packets to find path to destination.[7] It sends HELLO packet every time it wants to do routing. This increases number of control packets and HELLO packets. This leads to increased traffic and hence higher routing overhead. Here, we have compared DCDR, EDAODV, EDCSCAODV, AODV and EDOCR [13]. We compared these two on the basis of packet delivery ratio, routing overhead and end to end delay.

B. End-To-End Delay

End-to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination. In reactive protocols, for routing HELLO packet is sent every time [4]. This leads to increase in traffic in the network. Due to higher traffic and congestion it takes more time for packets to reach from source to destination. Therefore, it increases end-to-end delay [4].

III. RELATED WORK

In [7], they proposed an algorithm to ensure fault tolerance in mobile ad – hoc network. This scheme combines check pointing with controlled sender based message logging to deliver a low overhead by using rollback recovery procedure [7]. The sender based logging requires processes to log their sent messages in the limited volatile memory as the recovery process at a recipient node may need messages to be replayed from the log. In the hierarchical architecture of the clustered network, different check pointing techniques are used within the clusters. The recovery of a mobile host is fully asynchronous because it does not require any other node to rollback. They considered various scenarios of recovery of mobile host.

Case 1: The crashed node recovers and affiliates to the same BN as before failure. The recovery related data of the MH are available at the current BN and hence, no control messages are required.

Case 2: A failed node affiliates to a different BN upon recovery [7]. The check pointing and recovery method is integrated with the routing protocol of the network and hence, the protocol does not need any control messages at the time of check pointing. Moreover, the performance of the check pointing protocol improves as the network traffic increases since a higher number of z-cycles are detected online.

In[8] optimal path routing is used, the path maintaining active connection for longer duration is identified and further transactions to the destination are made via this path.

Also message dropping that occurs due to selfish nodes are reduced using the path trace algorithm.

Input: Message to destination through the optimal path.

Output: Acknowledgement from destination.

Algorithm: [8]

Step 1: The message from the source is send via the identified optimal path to the destination

Step 2: The selfish nodes are present in the optimal path are detected and these nodes are rectified

Step 3: Path Trace Algorithm is used in order to identify selfish nodes and reduce message dropping.

In [12] Back propagation Algorithm: Error back propagation training algorithm, which is an iterative gradient descent algorithm and is a simple way to train the multilayer feed forward neural networks.

Neural network equipped with learning automata: The learning automata is based on the observation of the random response of the neural network and it adapted one of BP parameters.

In [13] DCDR is a unicast routing protocol for Mobile AD – HOC Network. It reduces Network congestion by reducing the unnecessary flooding of packets and it finds a congestion-free path between the source and the destination. When a source host wants to transmit a data packet to a destination, the DCDR protocol constructs congestion – free set (CFS) to connect one-hop and two-hop neighbors. Then the source initiates the route discovery procedure using the CFS to identify a congestion-free path from the source to the destination. The objective of DCDR is to find congestion – free route between source and destination. In doing so, the overhead and flooding of packets reduces [13].

Congestion in a network can occur at any interval, when the number of packets coming to a node is more than its buffer capacity, the node becomes congested and starts losing packets. EDAODV (early detection congestion and control routing AODV) is used to detect the congestion in advance and find a non congested alternate path bi directionally [13].

According to them, DCDR performs better than EDAODV, EDCSCAODV, AODV and EDOCR [13]. This early congestion detection technique is a queue management algorithm with an optimization of the random early detection (RED) model that makes use of direct measurement congestion status in advance in a network.

In [14] the conventional hop count routing technique does not adapt well to the mobile nodes. Several routing methods use message exchanges like hello packets or data packets for the counter node mobility. These methods do not change the routes unless the link of the current route is broken, instead of taking precautions and make sure the link would not be broken. Genetic Algorithm based Congestion Aware Routing Protocol employs the data rate, quality of the link MAC overhead. Congestion aware fitness function is used in genetic algorithm to fetch the congestion reduced routes. It is possible to forecast quality of link and discard the links with the lower signal strengths from route selection using the received signal strength from physical layer [14].

IV. PARAMETERS CONSIDERED FOR SIMULATION

Protocols	DCDR, EDOCR, EDCSCAODV, EDAODV and AODV.
Performance metrics	Packet Delivery ratio, end-to-end delay, routing overhead.
No. of nodes	10, 20, 30, 40, 50
Simulator	Ns – 2.35
Language	O – TCL

Table 1 Parameters

V. COMPARATIVE ANALYSIS OF PERFORMANCE

Protocol	Packet Delivery Ratio	End to End Delay	Routing Overhead
DCDR	Highest	Lowest	Lowest
EDOCR	< DCDR	>DCDR	>DCDR
EDCSCAODV	<EDOCR	>EDOCR	>EDOCR
EDAODV	Low	High	High
AODV	Lowest	Highest	Highest

Table 2 Performance Analysis

DCDR performs better than EDAODV, EDCSCAODV, AODV and EDOCR. DCDR has higher packet delivery ratio than other protocols. Its end to end delay and no. of control or HELLO packets i.e, routing overhead is lower as compared to the other protocols. Due to high packet delivery ratio, more number of packets reaches the destination in DCDR as compared to other protocols. End to end delay is less, which means that time taken or delay to reach the packet from source to destination is less.

This is less in DCDR as compared to other protocols [13]. Routing overhead is less in DCDR. This means that it chooses the least congested path instead of shortest path. Therefore its performance is better than the other protocols. Network characteristics and issues like congestion and route failure must be detected and remedied with a reliable routing mechanism as discussed in related work. It is important to handle fault and congestion in Mobile AD – HOC Network to improve performance by increasing packet delivery ratio and decreasing end – to – end delay and routing overhead.

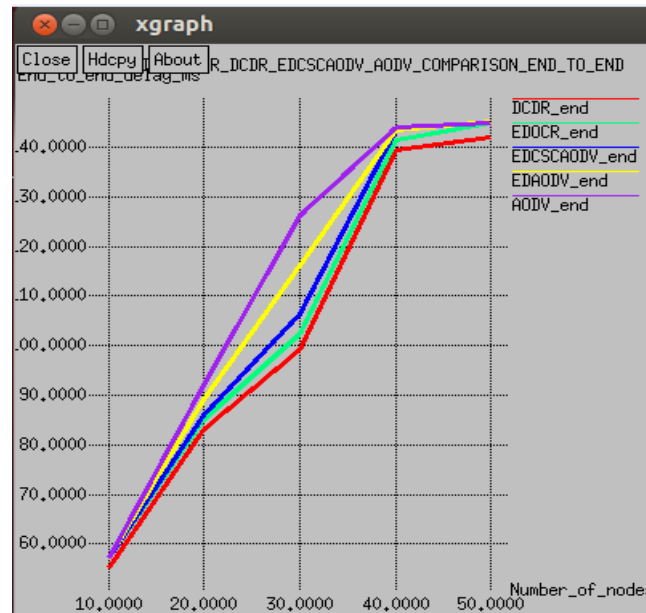


Figure 1 Comparison of DCDR, EDAODV, EDCSCAODV, AODV and EDOCR on the basis of end to end delay

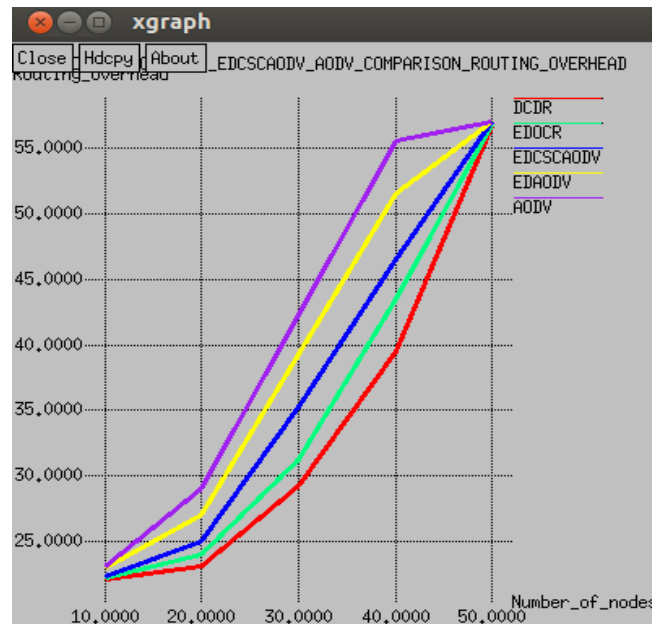


Figure 2 Comparison of DCDR, EDAODV, EDCSCAODV, AODV and EDOCR on the basis of routing overhead.



Figure 3 Comparison of DCDR, EDAODV, EDCSCAODV, AODV and EDOCR on the basis of packet delivery ratio

VI. CONCLUSION

We conclude that, DCDR performs better than EDAODV, EDCSCAODV, AODV and EDOCR. DCDR has higher packet delivery ratio. Its end to end delay and no. of control or HELLO packets i.e, routing overhead is lower as compared to other protocols. Network characteristics and issues like congestion and route failure must be detected and remedied with a reliable routing mechanism. It is important to handle fault and congestion in Mobile Ad – HOC Network to improve performance by increasing packet delivery ratio and decreasing end – to – end delay and routing overhead. Therefore, for fault tolerance and congestion control DCDR is better than EDAODV, EDCSCAODV, AODV and EDOCR [12].

REFERENCES

- [1] Senthilkumaran, T., Sankaranarayanan, "Early detection congestion and control routing in MANET", In: Proceedings of the Seventh IEEE and IFIP International Conference on Wireless and Optical Communications Networks (WOCN 2010), Srilanka, pp. 1–5.
- [2] Khamayseh, Y., Obiedat, G., Yassin, M.B., 2011. "Mobility and load aware routing protocol for ad hoc networks", J. King Saud Univ. – Comput. Inf. Sci. 23 (2), 105–111.
- [3] Mitul K. Patel, Vasundhara V. Uchhula, Bannishikha Banerjee, "Comparative Analysis of Routing Protocols in MANET Based on Packet Delivery Ratio using NS2", IJARCSSE, Volume 3, Issue 11, November 2013.
- [4] Mitul K. Patel, Vasundhara V. Uchhula, Bannishikha Banerjee, "Comparative Evaluation of AODV, DSDV and AOMDV based on end-to-end delay and routing overhead using Network Simulator ", IJCSIT, Vol. 5 (2) , 2014, 1638-1641
- [5] Parul Aggarwal, "A Study on achieving Fault Tolerance in Mobile Ad-Hoc Networks (MANETs)", Volume 4, No. 12, December 2013
- [6] C.E. Perkins and E.M. Royer, "Ad hoc on-demand distance vector routing", Proceedings of the IEEE Workshop on Mobile Computing Systems and Applications (WMCSA), pp. 90–100, 1999.
- [7] I Parmeet Kaur Jaggi, Awadhesh Kumar Singh, "Rollback recovery with low overhead for fault tolerance in mobile ad hoc networks", Computer and Information Sciences (2015). Sci. 39, 350-364.
- [8] Sindhuja M, Selvamani K, Kannan A, Kanimozhi S, "Delay Tolerance in Wireless Networks through Optimal Path Routing Algorithm", ICC-2015, Sci. 48, 401-407.
- [9] Costa, C. Mascolo, M. Musolesi, and G.P. Picco, "Socially- Aware Routing for Publish-Subscribe in Delay-Tolerant Mobile Ad Hoc Networks", IEEE J. Selected Areas Comm., vol. 26, no. 5, pp. 748-760, June 2008.
- [10] Z. Li and H. Shen, "Utility-Based Distributed Routing in intermittently Connected Networks", Proc. 37th Int'l Conf. Parallel Processing (ICPP '08), 2008.
- [11] Xinbing Wang ; Sihui Han ; Yibo Wu ; Xiao Wang. "Coverage and Energy Consumption Control in Mobile Heterogeneous Wireless Sensor Networks", Automatic Control, IEEE Transactions on Volume:5, Issue: 4, 2013.
- [12] Maryam Ghiasi, Abbas Karimi, "Fault Diagnosis method for Mobile Ad – hoc network by using smart neural networks, Procedia Computer Science, 42(2014), 222-227.
- [13] T. Senthilkumaran, V. Sankaranarayanan, "Dynamic congestion detection and control routing in ad hoc networks", King Saud University, (2013) 25, 25–34.

- [14] S.Santhosh Baboo, B.Narasimhan, “Genetic Algorithm based Congestion Aware Routing Protocol (GA-CARP) for Mobile Ad Hoc Networks”, *Procedia Technology* 4 (2012) 177 – 181.
- [15] T. Senthil Kumaran, V. Sankaranarayanan, “Early congestion detection and adaptive routing in MANET”, *Egyptian Informatics Journal* (2011) 12, 165–175.
- [16] Siva Ram Murthy C, Manoj BS “Ad hoc wireless networks – architectures and protocols”, Pearson Edu 2007.
- [17] Duc A, Tran, Harish Raghavendra, “Congestion adaptive routing in mobile ad hoc networks”, *IEEE Trans Parallel Distrib Syst*, 2006;17(11):16–28.
- [18] Milena Radenkovic, Andrew Grundy, “Efficient and adaptive congestion control for heterogeneous delay tolerant networks”, *Ad Hoc Networks* 10 (2012) 1322–1345.
- [19] E.M. Daly, M. Haahr, “Social network analysis for information flow in disconnected delay-tolerant MANETs”, *IEEE Transactions on Mobile Computing* (2008) 606–621.
- [20] C. Ahn and R. Ramakrishna. “A genetic algorithm for shortest path routing problem and the sizing of populations.” *IEEE Transactions on Evolutionary Computation*, Vol. 6 no.6, pp.566–579, 2002.
- [21] Yanping Teng, Haizhen Wang, Mei Jing, Zuozheng Lian, “A Study of Improved Approaches for TCP Congestion Control in Ad Hoc Networks”, *Procedia Engineering* 29 (2012) 1270 – 1275.
- [22] D.B. Johnson, D.A. Maltz, and J. Broch, “DSR: The dynamic source routing protocol for multihop wireless ad hoc networks”, *Ad Hoc Networking*, 2001, pp. 139–172.
- [23] Floyd, S., Jacobson, V., 1993. “Random early detection gateways for congestion avoidance”. *IEEE/ACM Transactions on Networking* 1 (4), 1993, 397–413.