Routing Table Management using Dynamic Information with Routing Around Connectivity Holes (RACH) for IoT Networks

Chavi Kapoor
Department of Computer Science and Engineering
Lovely Professional University
Punjab, India
ch.kapoor01@gmail.com

***Abstract*--The internet of things (IoT) is the popular wireless network for data collection applications. The IoT networks are deployed in dense or sparse architectures, out of which the dense networks are vastly popular as these are capable of gathering the huge volumes of data. The collected data is analyzed using the historical or continuous analytical systems, which uses the back testing or time-series analytics to observe the desired patterns from the target data. The lost or bad interval data always carries the high probability to misguide the analysis reports. The data is lost due to a variety of reasons, out of which the most popular ones are associated with the node failures and connectivity holes, which occurs due to physical damage, software malfunctioning, blackhole/wormhole attacks, route poisoning, etc. In this paper, the work is carried on the new routing scheme for the IoTs to avoid the connectivity holes, which analyzes the activity of wireless nodes and takes the appropriate actions when required.**

Keywords--Blackhole attack, Delay Optimization, IoT routing, Path Recovery.

I. INTRODUCTION

Internet of things (IoT) combines a certain number of sensor node for incorporation of the network. Internet of Thing (IoT) network is created such that it gives continuous data and investigation of low-level information in threatening conditions. [9] The IoT sensor nodes speak with each other without physical system through radio flag. [3] The remote systems function as transmission media among a few gadgets. Internet of things gadgets are self-controlled and can adapt to the wireless network scenarios automatically. The hubs of remote system are made out of limited memory, sensor, a radio handset and adequate power source, for example, battery. IoT is an extraordinary kind of ad-hoc network system. [16].

The correspondence or data given by IoT is required to have information respectability, the information which is exchanged by the sender is not tempered or changed on the way from sender to collector. [2] In the remote system, time synchronization is normal with the end goal that there is nonattendance of deferral in parcels when it is exchanged between two hubs.

Classified data is foreseen in remote systems which signifies specific data must be kept from endowed outsider. [6].

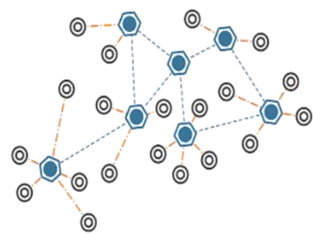

Fig. 1. An example of internet of things

An Internet of Things network is an accumulation of IoT sensor nodes, which develops a system utilizing radio correspondence in a self-governing and circulated way. [5] Nodes are dispersed over a particular field, and can gather and transfer data about nature, keeping in mind the end goal to give fine-grained perceptions of a marvel. [14] A sensor hub is ordinarily outfitted with at least one sensor that is utilized to catch occasions from the earth, a simple advanced converter, a radio handset, a focal preparing unit with constrained computational capacities, a little measure of memory and a battery control supply. Sensor gadgets work together with each other so as to perform fundamental operations, for example, detecting, correspondence and information preparing [21].

In the latest analysis on IoT, researchers try to seek out and overcome the constraints of IoT networks like restricted energy resources, energy consumption by location, the high price of transmission, and restricted process capabilities [25], the energy consumption isn't a problem, the price of transmission is comparatively low cost, and network nodes have plenty of processing power. [6] Routing approaches that have worked therefore well for ancient networks over twenty years won't be sufficient for this new generation networks.

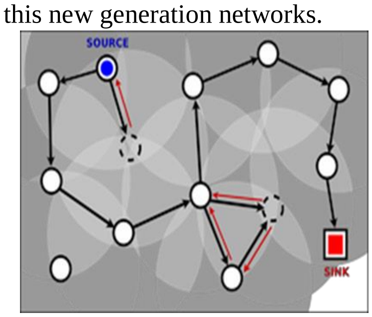

Fig. 2. The simple representation of wireless directed towards Base Station or Sink Node

Besides increasing the time period of IoT nodes, it's best to distribute the energy dissipated across the IoT network to reduce maintenance and maximize overall system performance. [9] A communication protocol which includes synchronization between peer nodes induce some overhead of putting in place communication. IoT routing protocols or cluster to work out whether or not the advantages of a lot of advanced routing algorithms overshadow the extra management messages every node should communicate. [9,17] Every node might build the foremost wise call on communications choices if they'd complete information of the complete configuration and also the levels of all the nodes within the offered network.

The project simulation starts with the simulation of an IoT topology, that handles the dynamic number of nodes. The IoT topology experiences the incorporation of routing, that will upgrade the connectivity of the network in the existence of connectivity holes. Afterwards, a new mechanism is examined for its performance with the suitable parameters.

II. Literature Review

Dai et al. [1] proposed the workload through a mesh network, load balancing reduces the hot spots in the sensor array and increases the life of the energy of the mesh network. In this article, the author designed a node-centric algorithm that builds a network load balancer shaft asymmetric architecture sensors. Pau Closas[2] in this paper, the subject of control of the network topology using a totally distributed algorithm is considered in wireless networks. While the proposed disseminated calculation is outlined using the concepts of game theory to implement a non-helpful diversion, organize availability is possible on the basis of asymptotic results of network connectivity. Al-Karaki et al.

[3] Wireless mesh networks contains minor sensing nodes with computation and wireless communication capacities. Many routing, power management, and data dissemination protocols have specifically been outlined for mesh networks where energy awareness is a critical design problem. Harilton da S. Araújo et al. [4] presented a protocol to minimize energy usage in the network by changing protocol named as Directed Diffusion routing protocol.

The proposal uses a Geocast method to repair all the broken paths and by reconstructing a new routing tree so that cost of energy can be decreased. The proposal assessment shows the method to use the Routing Method Geocast Rectangular (RGRM) and the method to pick the routes. It gives a positive outcome to diminish the energy consumption in the network.

III. Experimental Design

The internet of things (IoTs) is the most popular networks for the data collection across many real-time applications in military, weather, healthcare, etc. The IoTs are connected using the ad-hoc architecture, where all of the nodes are connected in the infrastructure less paradigm, which does not include the regions fixed base station node. The nodes are connected and managed using the ad-hoc cluster centres, which are elected from the nodes connected in the given cluster. The connectivity failures often occur in the IoT networks, which eventually degrades the IoT performance due to the increase in convergence delay. The network convergence is the procedure of repairing or finding the alternative path in the case of node or path failure. The data packets are lost during the network convergence due to the non-availability of active path. This eventually degrades the network performance, hence this work has been carried to reduce the convergence delay by working on the quick discovery of alternative paths around the connectivity holes (failure nodes) in the given network segment. The route discovery functioning, and information management of available paths is performed under routing table management based upon dynamic information (RTMDI) method, which uses RACH to recomputed the paths around the connectivity holes, which is given in the following section:

Algorithm 1: Routing around connectivity holes (RACH) scheme

Step 1: Plot the network topology with N nodes, where N denotes number of nodes

Step 2: Run the neighbor discovery model to localize the network nodes

Step 3: Record the node degree of the nodes in the given network segment

Step 4: Mark the CDS nodes in the given network segment, which has the higher degree in each semi-cluster in the network

Step 5: Compute the most dominating node in the given clusters, which are elected as the cluster heads (CH) for the respective clusters

Step 6: Discover the path between the source and the target nodes

Step 7: Observe the queue based properties from the target needs by using path availability assessment method

Step 8: If all queue parameters Dequeue, Enqueue and Droptail satisfies the requirements, run the path discovery

a. Verify the physical availability of the target nodes
b. Check the minimum availability of the queues
c. Return the node availability flag information

Step 9: If the node availability flag marks true:

a. Discover the path between source and the target nodes
b. Segment the network path into multiple semi-paths, one for each cluster

Step 10: Otherwise:

a. Deny the node from the path

Step 11: When the path reaches the destination node

a. Save the final path to the respective cluster edges
b. Save the final path to source and destination nodes

Step 12: Run the path between two nodes to exchange the data between them

Step 13: Continuously scan the path nodes using the method described in Step (8)

Step 14: If the node availability flag marks false

a. Remove the node from the path
b. Mark the node not available in RTMDI
c. Get the cluster of the failure node
d. Extract the edge nodes of the target cluster
e. Run the RACH algorithm to rediscover the path.

IV. RESULT ANALYSIS

This work is displayed using the MATLAB platform, that can easily work on an oridinary desktop or laptop with 4 GBs of RAM and dual-code processor (i3/i5 or above). The Hard Disk Drive (HDD) space required to install MATLAB is under 10 GBs.The values of throughput are observed for both existing and proposed models, as it is shown in figure 3. The significant difference has been observed between the existing and proposed models at all of the events.

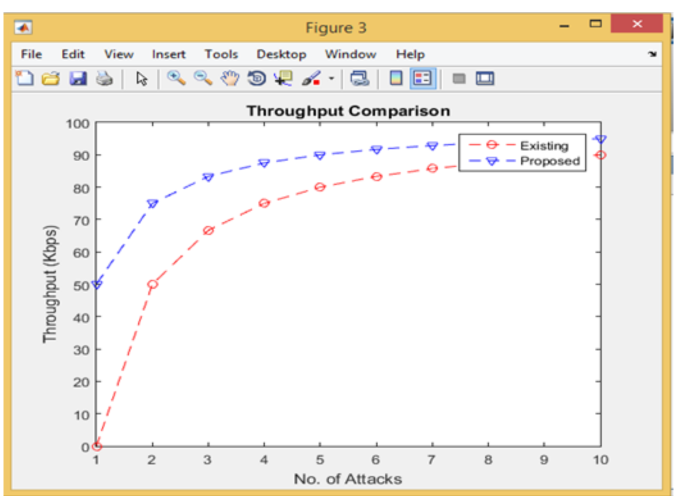

Fig. 3. The comparative analysis based upon throughput is shown in this figure

The figure 3 considers the comparison of existing and proposed model on the basis of the throughput parameter. The improvement of the proposed model is considerably higher than the existing model on all of the events, except the first event. The first event for the existing model is described with value 0, which is due to the non-existent traffic at given event. However, in the random explanation, the proposed model is observed with 90 Kbps against the 80 Kbps in the existing model on the 5th event. On 10th event, the proposed model's observation of 95 Kbps against 90 Kbps of existing models. The proposed model is observed with the average value of nearly 85.35 Kbps against the existing model (70.71 Kbps), which shows the high efficiency of the proposed model in transmitting the data between the wireless nodes.

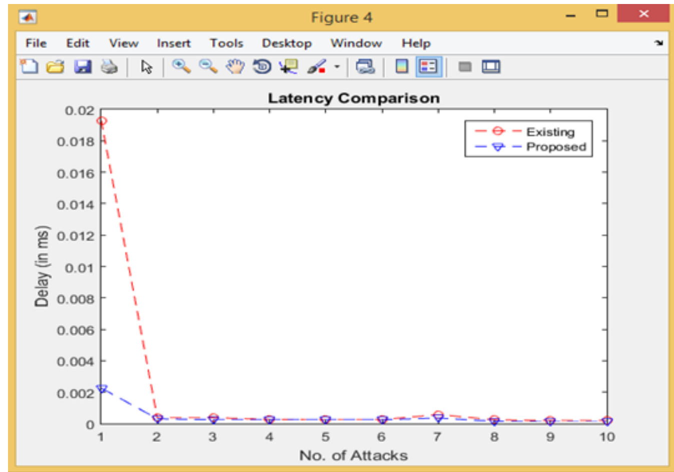

Fig. 4. The comparative analysis based upon latency is shown in this figure

The maximum value of latency for the existing model is observed at 0.019 seconds in comparison with proposed model (0.0023 seconds). The existing model is observed with 0.000182 seconds of latency against the 0.00012 seconds of the proposed model. This shows the certain improvements in the proposed model on the basis of the latency. The above figure describes the clear comparison between the existing and proposed models. The proposed and existing models are significantly identical after the first event. However, the proposed model is consistently observed significantly lower than (or almost equal to) the existing model. This shows the significant performance of the proposed model in comparison with the existing model.

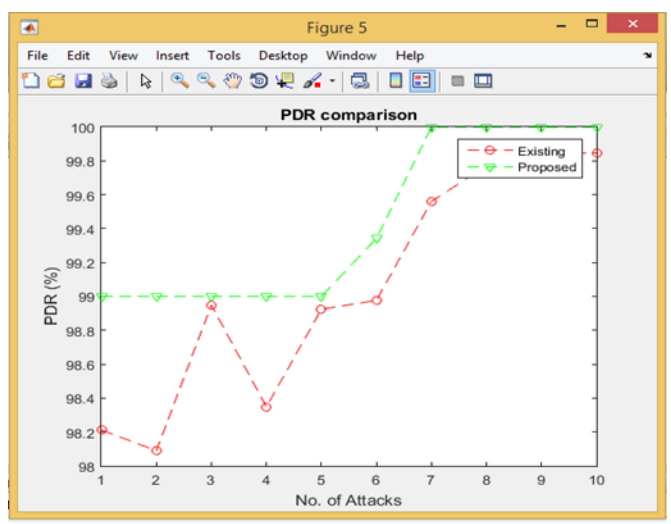

Fig. 5. The comparative analysis based upon PDR is shown in this figure

The figure 5 considers the comparison of existing and proposed model on the basis of the PDR parameter. The minimum PDR based comparison proves the efficiency of proposed model (99%) against the existing (98%) on the standard IoT simulation. The improvement of the proposed model is considerably higher than the existing model on all of the events. However, in the random explanation, the proposed model is observed with 99% against the 98.924435% in the existing model on the 5th event. On 10th event, the proposed model's observation of 99.999% against 99.844745% of existing models.

V. Conclusion

The proposed model is designed using the routing table management based upon dynamic information (RTMDI), which targets the routing around connectivity holes (RACH). The RACH scheme is designed to detect the connectivity-hole nodes as earliest as possible to minimize the data loss intervals. The RACH scheme coupled with RTMDI is designed to speed up the routing discovery procedure, which can compute the backup paths with minimized convergence delay. The proposed model is learnt to improve the performance in comparison than existing model, which is evident by the observed results. The proposed model's PDR is recorded at average greater than 99%, which is significantly higher than approx 98% of existing models. The average throughput of the proposed model is observed better with 85.35 kbps against the existing model of 70.71 kbps. The end-to-end transmission delay of proposed model is observed below 0.01 seconds on all of the recording intervals, which significantly lower than peak recorded at 0.05 seconds in existing models. Also, the average transmission delay proposed model is recorded at 0.0004 seconds, which is certainly improved than 0.0021 seconds of existing model.

VI. Future Scope

In the future, this model can be further improved with complex RACH method with more rules for trust calculation among the network nodes. The ontology described over node information, network performance, type of service and other parameters can be used with machine learning for classification of sensor nodes.

References

[1] Dai, H., & Han, R. (2003, December). A node-centric load balancing algorithm for wireless mesh networks. In Global Telecommunications Conference, 2003. GLOBECOM'03. IEEE (Vol. 1, pp. 548-552). IEEE.

[2] Closas, P., Zamora, A. P., & Rubio, J. A. F. (2009, April). A game theoretical algorithm for joint power and topology control in distributed WMN. In Acoustics, Speech and Signal Processing, 2009. ICASSP 2009. IEEE International Conference on (pp. 2765-2768). IEEE.

[3] Al-Karaki, J. N., & Kamal, A. E. (2004). Routing techniques in wireless mesh networks: a survey. Wireless communications, IEEE, 11(6), 6-28.

[4] Araújo, Harilton da S., Wagner LT de Castro, and Raimir Holanda Filho. "A proposal of self-configuration in Wireless Sensor Network for recovery of broken paths." In Sensors Applications Symposium (SAS), 2010 IEEE, pp. 245-250. IEEE, 2010.

[5] Ben Alla, S., Ezzati, A., Beni Hssane, A., & Hasnaoui, M. L. (2011, April). Hierarchical adaptive balanced energy efficient routing protocol (HABRP) for heterogeneous wireless mesh networks. In Multimedia Computing and Systems (ICMCS), 2011 International Conference on (pp. 1-6). IEEE.

[6] Briles, S., Arrowood, J., Turcotte, D., & Fiset, E. (2005, May). Hardware-In-The-Loop Demonstration of a Radio Frequency Geolocation Algorithm. In Proceedings of the Mathworks International Aerospace and Defense Conference.

[7] Byers, J., & Nasser, G. (2000). Utility-based decision-making in wireless mesh networks. In Mobile and Ad Hoc Networking and Computing, 2000. MobiHOC. 2000 First Annual Workshop on (pp. 143-144). IEEE.

[8] Agah, A., Asadi, M., & Das, S. K. (2006). Prevention of DoS Attack in Mesh networks using Repeated Game Theory. In ICWN (pp. 29-36).

[9] Dufwenberg, M., & Kirchsteiger, G. A theory of sequential reciprocity. Games and economic behavior, 47(2), 268-298.

[10] Han, Z. (2012). Game theory in wireless and communication networks: theory, models, and applications. Cambridge University Press.

[11] Ishmanov, F., Malik, A. S., & Kim, S. W. (2011). Energy consumption balancing (ECB) issues and mechanisms in wireless mesh networks (WMNs): a comprehensive overview. European Transactions on Telecommunications, 22(4), 151-167.

[12] Machado, R., & Tekinay, S. (2008). A survey of game-theoretic approaches in wireless mesh networks. Computer Networks, 52(16), 3047-3061.

[13] MacKenzie, A. B., & DaSilva, L. A. (2006). Game theory for wireless engineers. Synthesis Lectures on Communications, 1(1), 1-86.

[14] Meshkati, F., Poor, H. V., & Schwartz, S. C. (2007). Energy-efficient resource allocation in wireless networks. Signal Processing Magazine, IEEE, 24(3), 58-68.

[15] Park, G. Y., Kim, H., Jeong, H. W., & Youn, H. Y. (2013, March). A novel cluster head selection method based on K-means algorithm for energy efficient wireless mesh network. In Advanced Information Networking and Applications Workshops (WAINA), 2013 27th International Conference on (pp. 910-915). IEEE.

[16] Petrovic, D., Shah, R. C., Ramchandran, K., & Rabaey, J. (2003, May). Data funneling: Routing with aggregation and compression for wireless mesh networks. In Mesh network Protocols and Applications, 2003. Proceedings of the First IEEE. 2003 IEEE International Workshop on (pp. 156-162). IEEE.

[17] Reddy, Y. B., & Srivathsan, S. (2009, June). Game theory model for selective forward attacks in wireless mesh networks. In Control and Automation, 2009. MED'09. 17th Mediterranean Conference on (pp. 458-463). IEEE.

[18] Sakarindr, P., & Ansari, N. (2007). Security services in group communications over wireless infrastructure, mobile ad hoc, and wireless mesh networks. Wireless Communications, IEEE, 14(5), 8-20.

[19] Sarkar, S., & Datta, R. (2014, February). A secure and energy-efficient stochastic routing protocol for wireless mobile ad-hoc networks. In Communications (NCC), 2014 Twentieth National Conference on (pp. 1-6). IEEE.

[20] Alain Bertrand, B., & Jean Frédéric, M. (2010). An energy-efficient clique-based geocast algorithm for dense mesh networks. Communications and Network, 2010.

[21] Shi, H. Y., Wang, W. L., Kwok, N. M., & Chen, S. Y. (2012). Game theory for wireless mesh networks: a survey. Sensors, 12(7), 9055-9097.

[22] Upadhyayula, S., & Gupta, S. K. (2007). Spanning tree based algorithms for low latency and energy efficient data aggregation enhanced convergecast (dac) in wireless mesh networks. Ad Hoc Networks, 5(5), 626-648.

[23] Wagner, R., Sarvotham, S., Choi, H., & Baraniuk, R. (2005). Distributed multiscale data analysis and processing for mesh networks. RICE UNIV HOUSTON TX DEPT OF ELECTRICAL AND COMPUTER ENGINEERING.

[24] Xu, J. Q., Wang, H. C., Lang, F. G., Wang, P., & Hou, Z. P. (2011, June). Study on WMN topology division and lifetime. In Computer Science and

Automation Engineering (CSAE), 2011 IEEE International Conference on (Vol. 1, pp. 380-384). IEEE.

[25] Yadav, S., & Lakhani, K. (2013). A Cluster based Technique for Securing Routing Protocol AODV against Black-hole Attack in MANET. International Journal of Distributed and Parallel Systems, 4(2), 17.

[26] Yu, Y., Li, K., Zhou, W., & Li, P. (2012). Trust mechanisms in wireless mesh networks: Attack analysis and countermeasures. Journal of Network and Computer Applications, 35(3), 867-880.

[27] Zhao, L., Zhang, H., & Zhang, J. (2008, March). Using incompletely cooperative game theory in wireless mesh networks. In Wireless Communications and Networking Conference, 2008. WCNC 2008. IEEE (pp. 1483-1488). IEEE.

[28] Murugeswari, R., S. Radhakrishnan, and D. Devaraj. "A multi-objective evolutionary algorithm based QoS routing in wireless mesh networks." Applied Soft Computing 40 (2016): 517-525.

[29] De Domenico, Manlio, Antonio Lima, Marta C. González, and Alex Arenas. "Personalized routing for multitudes in smart cities." EPJ Data Science 4, no. 1 (2015): 1.

[30] Zhou, Anfu, Min Liu, Zhongcheng Li, and Eryk Dutkiewicz. "Cross-layer design with optimal dynamic gateway selection for wireless mesh networks." Computer Communications 55 (2015): 69-79.