International Journal of Engineering & Technology, 7 (2.4) (2018) 196-199

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper

Routing protocols for internet of things: a survey

Tamoghno Romario Bhattacharyya [1] *, Dr. M. Pushpalatha [2]

[1] *School of Computer Science & Engineering, SRM Institute of Science & Engineering, Kattankulathur, India*
[2] *Department of Computer Science & Engineering, SRM Institute of Science & Technology, Kattankulathur, India*
**Corresponding author E-mail: tamoghnobhattacharya47@yahoo.com*

Abstract

The world of wireless sensor network(WSN) is widening day by day and the latest technology in use the Internet of Things known as IOT is the latest craze in it. But the IOT technique and its devices requires routing protocols in situations like low power and lossy networks(LLNs) which brings great challenges. In many and some emergency cases, like in case of large and more data traffic which causes to lead in network congestions and also brings loss in packets and delay. In order to overcome all this problems , many group research and individuals are trying and focusing on different solutions to maximize the throughput for the RPL network. In this paper we will we studying and reviewing some of the different methods that has been taken to maximize the throughput in the network and hence try to come to a conclusion for the future techniques needed to be done.

Keywords: *RPL; Internet of Things; Wireless Sensor Networks*

1. Introduction

The new and latest trend and hype in networks field is the working and exploration of Internet of Things(IOT). The Internet of Things hence consisting of static and mobile objects which are helpful in communications, in sensors and even can help in actuator. But in latest few years and hence there have been few setbacks in this field such as routing with accordance quality of service (QOS) and also transportation which are the few key issues in IoT. So, came Routing Protocol (RPL) for the Low power and Lossy Networks which is an open routing protocol that has been standardized by an organization called IETF ROLL working group started in 2008.Also need to overcome this solutions is to as this IoT and its devices can provide a quantitative leap in sectors like entertainment, logistics, healthcare etc.

As IoT enlarges the new concept of that Internet from a network of homogeneousdevices such as connecting devices to heterogeneous devices suchas consumers electronics with sensor nodes of Wireless Sensor Networks. As learning more about RPL and its working

that it has been architected to be very flexible protocol to provide few basic mechanisms. Now in Low power and Lossy networks (LLNs) the challenges which are impose are low data rates, instability, high loss rate etc. RPL is totally based on the logic of Destination-Oriented Directed Acyclic Graph(DODAG).A DODAG is constructed on the basis of its distance which is virtual in case from each node to another, and also on its rank.

2. An overview of routing protocol

Routing protocol is the main content, which is responsible for the packets to be forwarded from one node to other, and also it uses its own methods to find the best path for getting the best routing path and avoid congestion and obtain maximum throughput. Routing protocol are of two types in Wireless Sensor Network (WSN), which are Proactive and Reactive. In forward routing protocols, it gives the routes even before it is even needed by node or any data. Hence this proactive protocols from time to time exchange its control messages to find routes inside the network as they start the transmission. The other protocol, reactive protocol which provides routes only needed to do. So hence it decides that if a route is needed for data to transmit and also so that the network is not flooded by its queries. Routing protocols are mainly taken up for low power and lossy networks (RPL) which is an IPv6 protocol that has been designed by the IETF routing by ROLL group as an implementation standard. RPL is a vector which is based on distance metrics due to linked state protocols which takes a certain amount of memory that is not suitable for constraints in LLNs. So we can conclude that RPL is a forward routing protocol which start finding its best routes as the RPL network is started.

RPL network is based on tree topology which is also called DAG network. In this network each node has parent which is the starting point for that node. The nodes in the RPL has all the networks down the nodes from top to bottom of the tree. But route aggregation is not recommended in RPL due to several problems such as mobility of nodes and loss in medium and transmission. The most important factor for RPL is path selection method. RPL uses objective functions, routing constraints and routing metrics. RPL mainly uses TCP/IP communications for accessing the internet as it is the standard metrics. RPL also uses the RPL topology, routing metrics, objective functions, timers, control messages and routing mechanism. All the above are used for producing a good RPL network with less congestion and obtain maximum throughput. Although from time to time this metrics and results can be upgraded for more better performance.

3. Conclusion

After going through all papers on the Routing Protocol and its techniques that have been discussed and implemented so far and surveying the ways to solve the problems , it is found that more

research can be done on maximizing the throughput of the network and find mutliple paths for sending the data's. So, it can be proposed that for maximizing the throughput we can implement new factors and put new algorithms for new paths that too for avoiding the congestion.

4. Related work

OlfaGaddour and AnisKoubaa[1] has studied the RPL Protocol in brief , they have studied the important features of the RPL's routing protocol which will provide the new researchers in future more comprehensive learning of the protocol and its functions. Their study mainly consisted of the working of RPL , its implementation using DODAG and its composition. They also studied the design objectives,network model, its protocol specification, its control messages, the DODAG construction, the RPL network management, its Loop avoidance and detection, Quality of Service(QoS) technique and also the security of the network. Hence depending on this factors they have made a RPL performance evaluation. The performance evaluation they have measured by the factors of Power consumption, DAG convergence time, packet loss, packet delay and fault tolerance. At last they have concluded that security is immature in RPL and more new mechanisms are needed for purposeful management for a good network management. In adjoining to this also they have mentioned that the configuration of the security methods in RPL for processing the packets is an open issue to be sorted out.

OanaIova, Gian Pietro Picco, TimofeiIstomin and CsabaKiraly [2] has analysed the RPL as it is the Routing standard for the Internet of Things or not. They have throughlly studied the the working of the RPL network, its traffic patterns, its network using DODAG. They also did a survey whether RPL live up to its expectations or not? The analysis and the survey was done on the factors like Traffic pattern , as its original requirements and its current status, then another factor as Mobility, how its original requirements are and how its current status is and the development will be. Another factors are like Resource Heterogeneity, Reliability, Robustness, and Scalability. All this factors are evaluated on the same basis of current status and original requirements. The paper also made a quote on the the challenges ahead for the RPL in IoT. And also they have discussed about new approaches to new network designs and new wireless technologies and also they have discussed about the expectations and future about the RPL.

Hua-Mei Xin and Kun Yang[3] has described the Routing Protocol analysis for the Internet of Things as how the some of the routing mechanism already existing such as DRS,OLSR and AODV and compare their individual performances in IoT environments. All the mechanisms which were studied on the protocols that are Ad Hoc On-Demand Distance Vector Routing, Dynamic Source Routing and Optimized Link State Routing. All this protocols have been measured on the performance metrices such as Routing Overhead, Throughput, Average End to End Delay.The simulations have been carried out on all this protocols using this mertices and results have been found. The conclusion made by them is that they made future requirements to evaluate this protocols further on the impact of variable speed and location information's of nodes. They have also argued for a novel protocol for future improvement in the network and its performance.

Quan Le, Thu Ngo-Quynh and ThomazMagedanz[4] has proposed a multipath approach for RPL with three schemes such as Fast Local Repair (FLR), Energy awareness Load Balancing (ELB) and the last one is the combination of the earlier two i.e. FLR-ELB. All this schemes where tested and then new integrated modified Ipv6 communication of IoT for wireless network was implemented in OMNET++ simulator. They also the RPL techniques deeply and then introduced the Multipath Approach. The new approach was evaluated on the basis of the three schemes they formulated earlier, it calculated using the DODAG, its InstanceID, DODAGVersion, MinHopRankIncrease and DODAGID. Later the performance evaluation was done on signal propagation model which had given successfulloutcomes for hidden and exposed terminal node problems. They also calculated the network-layer overhead using the DIO and the paths of it. End-to-End Delay, Half node dead and Packet delivery rate.Conclusion made by them was the third scheme of both combined FLR-ELB had maintained a well balanced network and produced good results within a limited effect period. But still more improvement to the solution can be made.

Zhenfei Wang, Liying Zhang, ZhiyunZheng and JunfengWang[5] have discussed on an better RPL Protocol for Wireless Sensor Networks. They have designed a IRPL (Improved RPL) protocol to improve the original RPL. Also LCI (Life Cycle Index) was proposed for best path selection function. This index was calculated on various factors such as node energy, throughput, data rate, energy consumption rate, link quality and congestion detection factor. Depending on this factors it also optimized the calculation of the method of rank assigning. Their simple rule lies in redesigning one of parent node and its selection strategy. But the strategy of selecting the best parent node depends upon the improved index. Also they have proposed a multipath method by using the DODAG structures and use it in solving the congestion network problem. The simulation made by them shows that the scheme proposed by them yield good performance in basis of packet delivery ratio, end-to-end delay, network load and energy consumption. The new measure mode-lifecycle index (LCI) that finds the base of the path in advance. According to the researchers the LCI gives better results with the factors and also the multipath for congestion problem.

YadTahir,Shusen Yang and Julie McCann [6] have developed a BRPL, which is an extension to RPL, that is based on backpressure-based optimization for RPL operations. As more and more experimental results stated in poor stats in throughput and adaptation in network forms. The BRPL mainly allows the programmers to combine any of the RPL Object Function (OF) for backpressure routing. It uses two algorithms i.e.,QuickBeta and QuickTheta, for supporting the node mobility and data traffic load. The implementation has been done in the Contiki operating system.Using the cooja simulator they have tested and constructed evaluation results for both real site experiments. This experiments are based on FIT IoT-LAB tests and are on large computation simulations. This evaluations have given the advantages of BRPL which is as not fully dependent on backward compatibility with RPL and BRPL running devices at same time. It also manages to improve the network throughput and more adaptability to the network. An interesting direction for future work to know more on one or more simultaneous DAGs in BRPL and RPL.

OanaIova, FabriceTheoleyre and Thomas Noel[7] has studied and designed an energy balancing routing protocol which will maximize the lifetime of the constraint nodes. Now to improve the network to its fullest lifetime, then each node should be consuming the same amount of energy. The proposal was Expected Lifetime metric which will be having residual time of a node. They also designed a mechanism to study and detect the energy nodes and how to spread traffic load equally among all the nodes. Hence to avoid abnormality in the network and problem of convergence, they also proposed a multipath network. They exploited the DAG order and structure of the routing to forward the traffic to all the parent nodes. So this leads to better routing and reduce the number of DAGs configured. Also for future work they have learned to do a same multipath for energy-balancing version way. However they state that the metric will have convergence result in a similar amount of time.

Weisheng Tang, Xiaoyuan Ma, Jianming Wei and Jun Huang[8] have proposed a congestion avoidance multipath routing protocol which uses composite metric depending upon routing based RPL ,and they named it as CA-RPL. Then they have also proposed a routing metric for RPL that will be minimizing the average delay in the DAG root. And also weight of each path is to be calculated using four metrics which are latency, Packet loss rate, Packet Reception number and Application Scenario and its simulation environment. All this simulations are explained and performed in Con-

tiki. The simulation results show that the proposed CA-RPL reduces the average time delay by more about 25% compared to as normal RPL and also has 15% reduction in case of packet loss measure. Also it alleviates that the network congestion which has poor link quality and large traffic can be improved using CA-RPL for better performances in LLNs. For future works and conclusion they have urge to test this in Tmote sky devices and run them in realistic scenarios. They also would like to test the battery life for the devices for more optimization of LLNs for mutlisinking and mobile nodes purpose.

GhadaGlissa, AbderrezakRachedi and ArefMeddeb[9] have analyzed and proposed a new routing protocol which is more secure and hence named it as Secure-RPL (SRPL). The main task of this protocol is that any node should not misbehave from changing control messages maliciously. Hence this process need to be done without disturbing the network by a wrong topology and the also without effecting the rank of the nodes. They have introduced a new way rank threshold method along with chain request techniques which will deal with attack such as internal ones like black hole, selective forwarding, sinkhole attacks etc. Also the paper reflects on the security and challenges of the RPL. Simulation of the SRPL depicts a resistant and robust to all kinds of attacks which are based on manipulation of the routing protocol metrics. They also have changed the position of the DODAG which constitutes the RPL. Introducing the new SRPL has impacted the rank manipulation by rank thresholding and chain authenticating. Simulation also shows a very useful resulting sign in protecting the network against the attcks in the network. Also for future works more improvement can be done in SRPL as for later needs and criteria.

Hyung-Sin Kim, Hongchan Kim, JeongyeupPaek, and Sae-woongBahk [10] have investigated the load balancing and congestion problem in the RPL network. Specially they have shown packet lost are due to traffic and leads to congestion which leads to serious load balancing problem. Hence to tackle this problem they have proposed a very simple but effective queue utilization based RPL known as (QU-RPL) which will achieve equal load balancing and then improve the end-to-end packet delivery performance then compared to other standard RPL. They also verify all their experimental findings through a real testbed over LLNs. As they have identified that all this routing concentrates on small sets of packets hence they introduced QU-RPL through broad methods on actualtestbeds with TinyRPL, and so their proposal has given less packet loss at the queues, rather achieving good results in end-to-end packet delivery.

Hayder A.A. Al-Kashoash,Yaarob Al-Nidawi and Andrew H. Kemp[11] has studied and proposed a new RPL routing metric which helps in buffer collection known as Buffer Occupancy which will reduce the number of lost packets due to buffer overload and hence resulting in congestion. Also they have introduced a new function called Congestion-Aware Objective Function(CA-OF). This proposed metric function also a objective function works more efficiently in congestion by less node paths with less traffic. By simulating the results the performance of RPL increases and less congestion are found due to packet delivery ratio, energy consumption, lost packets and throughput in random. This funtion was tested in contiki 2.7 and compare the objective functions.The simulated results also shows that CA-OF chose a less congested path from leaf node to the destination node. So it improves the network performance automatically and shoots up the throughput of the network. Also they have argud for implementing a new control system algorithm which will use both resource control and traffic control, and thereby support higher applications in future.

W Xie , M Goyal, H Hosseini, J Martocci, Y Bashir,EBaccelli and A Durresi[12] have studied the DAG network in RPL, following they started via simulations for time to converge to be stable, also hoping for a loop free state by rank increase operation. After evaluating this routes they discuss on some important measures that can be done to avoid loops and avoid congestion and reach a stable state using rank increasing operation. As on evaluation on the DAG network new network topologies was on stable state and had loop free state hence this results where reported at earliest and a loop avoidance strategy was stated which will disable the sub DAG networks which increases the rank. Also they have mentioned that such loop avoidance methods cannot be recommended on DAG based routing.

HarithKharrufa, Hayder Al-Kashoash, Yaarob Al-Nidwai, Maria Quezada Mosquera and A.H.Kemp[13] has investigated the working of RPL in the dynamic network environment and hence then presented different enhanced RPL for various applications with characteristics such as diverse network and mobility purposes. The implementation carried out by them are using new dynamic objective function (D-OF) to enhance the end-to-end delay, energy consumption, packet delivery ratio to maintain loop avoidance and packet overhead. They have also proposed a controlled reverse trickle timer which is based on the received signal strength identification (RSSI) to have minimum overhead and ask the objective function to detect the nodes and to carry out the decisions. The simulations are done using the cooja simulator in mobile scenario for mutli-hop routing. The results they formulated has higher PDR and low energy consumption then compared to existing protocols. Also they have mentioned the optimization of objective function has to be done for improvement in mobile devices and will produce high network output and yield perfect results.

5. Figures

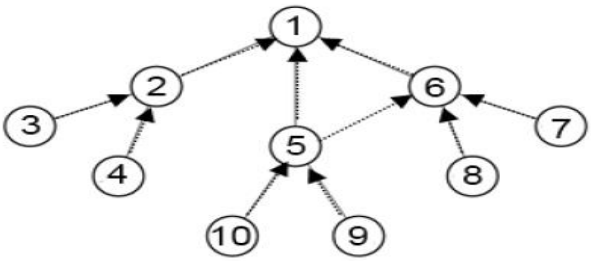

Fig. 1:.A RPL Network Topology.

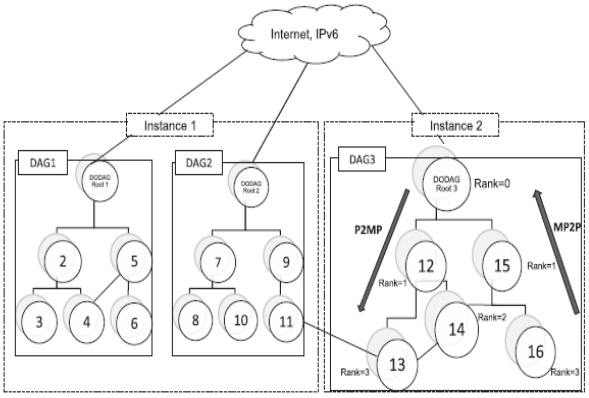

Fig. 2:.RPL Network with Three Dodges within Two Instances.

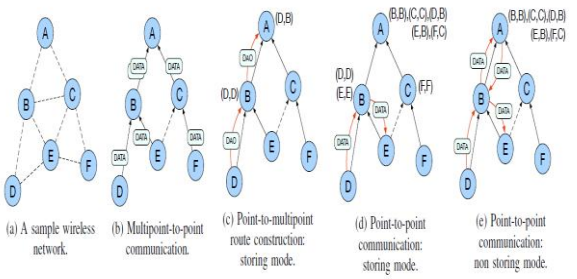

Fig. 3: Routing Process IN RPL.

References

[1] Olfa Gaddour, Anis Koubaa, RPL in a nutshell: A survey, Computer Networks, 56(2012), 3163-3178.

[2] Oana Iova, Gian Pietro Picco, Timofei Istomin, Csaba Kiraly, RPL, the Routing Standard for the Internet of Things… Or Is It? IEEE COMMUNICATIONS MAGAZINE, 2016, Volume: 54, Issue: 12, 16-22.

[3] Hua-Mei Xin, Kun Yang, Routing Protocols Analysis for Internet of Things, second International Conference on Information Science and Control Engineering, 2015, 447-450.

[4] Quan Le,Thu Ngo-Quynh,Thomaz Magedanz, RPL-based Multipath Routing Protocols for Internet of Things on Wireless Sensor Networks,International Conference on Advanced Technologies for Communications,2014,424-429.

[5] Zhenfei Wang, Liying Zhang,Zhiyun Zheng,Junfeng Wang,An Optimized RPL Protocol for Wireless Sensor Networks, IEEE 22nd International Conference on Parallel and Distributed Systems,2016, 294-299.

[6] Yad Tahir,Shusen Yang,Julie McCann, BRPL: Backpressure for High-Throughput and Mobile IoTs,IEEE Transactions on Mobile Computing, 2018,V olume:17, Issue:1,29-43.

[7] Oana Iova,Fabrice Theoleyre,Thomas Noel,Using mutliparent routing in RPL to increase the stability and the lifetime of the network, AdHoc Networks, 2015,1-18.

[8] Weisheng Tang,Xiaoyuan Ma,Jun Huang,Jianming Wei, Toward Improved RPL: A Congestion Avoidance Multipath Routing Protocol with Time Factor for Wireless Sensor Networks,Journal of Sensors, Volume 2016,Article ID 8128651, 11 Pages.

[9] Ghada Glissa, Abederrezak Rachedi,Aref Meddeb, A Secure Routing Protocol Based on RPL for Internet of Things, IEEE Global Communications Conference, 2016, 1-7.

[10] Hyung-Sin Kim,Hongchan Kim,Jeongyeup Paek,Saewoong Bahk,Load Balancing Under Heavy Traffic in RPL Routing Protocol for Low Power and Lossy Networks, IEEE Transactions on Mobile Computing,Volume.16,No.4,April 2017,964-979.

[11] Hayder A. A. Al-Kashoash,Yaarob Al-Nidawi,Andrew H.Kemp,Congestion-aware RPL for 6LOWPAN Networks, Wireless Telecommunications Symposium,2016,1-6.

[12] Weigao Xie,Mukul Goyal,Hossein Hosseini,Jerald Martocci,Yusuf Bashir,Emmanuel Baccelli,Arjan Durresi,Routing Loops in DAG-Based Low Power and Lossy Networks, 24th IEEE International Conference on Advanced Information Networking and Applications,2010,888-895.

[13] Harith Kharrufa,Hayder Al-Kashoash,Yaarob Al-Nidawi, Maria Quezada Mosquera,A.H.Kemp, Dynamic RPL for Multi-Hop Routing in IoT Applications,13TH Annual Conference on Wireless On-demand Network Systems and Services,2017,100-103.