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Parent Selection for IPv6 Enabled Routing Protocol for Low Power Lossy Network.

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ABSTRACT: RPL (IPV6 Routing Protocol for Low power lossy network) is a network layer routing protocol. It is considered as best routing protocol for Internet of Things (IoT). The packet size and techniques used in RPL are designed in such a way to support low powered devices. RPL was developed by Internet Engineering Task Force (IETF) work group and still it is in design phase. RPL construct a loop less tree to maintain all the nodes. The parent selection is the backbone of RPL protocol. In parent selection rank calculation play a vital role. In this paper an extensive survey is done about RPL. The various techniques used in RPL are studied in this paper. The performance of RPL protocol is examined using cooja simulator. The working of RPL tested using Contiki enabled sky motes under cooja environment. The heterogeneity of network density and mote type are the major factors considered to examine RPL in terms of Energy efficiency, Packet Delivery Ratio and Response time.

Key words: RPL, RPL Routing, IoT, LLN, Cooja.

I. INTRODUCTION

IPv6 Routing Protocol for Low- Power Lossy Network (RPL) is a distance vector routing protocol. It is one of the evident protocol for low power lossy network. It is designed to work from sink node to the child node (Top-bottom approach). The sink node acts as a destination or a collecting point for all the child nodes. RPL establish the network by the formation of Destination Oriented Directed Acyclic Graph (DODAG). The sink node act as the root for DODAG. RPL maintains the rank property to avoid cycle or loops in the network .The rank in RPL is calculated by the various Objective Functions (OF) like OF0, OF1, OF2,…etc. OF0 is the default Objective Function which is used in RPL. It calculate the rank based on the Expected Transmission Count (ETX). RPL uses three various control protocol packets namely DODAG Information Object (DIO), DAO Advertisement Object (DAO) and DAO Acknowledgement (DAO ACK). The sink node initiates DODAG construction by broadcasting DIO.

The nodes which does not participate in any DODAG will respond to the DIO immediately by sending the DAO as shown in figure 1.

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If the nodes participates in any other DODAG then it will check, the rank of the parent node and the rank in the received DIO. The node will accept the received DIO, when the parent rank is greater than that of the received rank by sending the DAO. The root node receives the DAO and sends the acknowledgement as the token of acceptance. Once, the node receives the DAO Acknowledgement.

It saves the node as the parent node and compute its own rank based on the OF function.

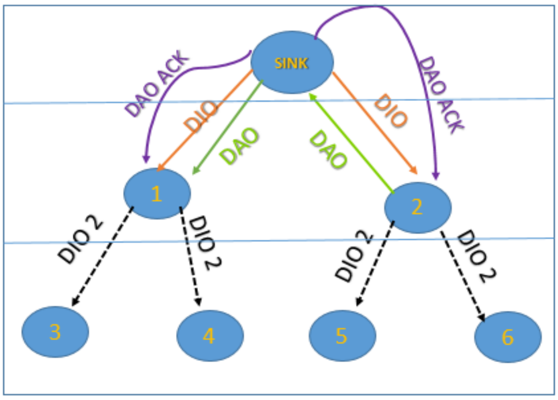

Figure 1: DOGAG construction in RPL

This process of DODAG construction is iterated based on Trickle Timer (TT). In RPL, the routing is performed by two methods/ways Storing and Non –Storing. In Storing method, the parent node should be aware of their children and grandchildren, whereas in non-storing method, the root node alone is aware of the child node. Destination Oriented DAG Information Object **(DIO)** carries the information to build the topology including the root unique identifier, routing metrics rank and other parameters. Destination Oriented DAG is a special kind of DAG where each node wants to reach a single destination with the unique identity. The size of DODAG ID is mentioned in DIO control message structure as shown in figure 2. Here the figure 3 shows the structure of DAO.

<table>
<tr><th colspan="4">PRL INSTANCE</th><th>VERSION NUMBER</th><th colspan="2">RANK</th></tr>
<tr><td>G</td><td>O</td><td>MOP</td><td>Prf</td><td>DTSN</td><td>Flags</td><td>Reserved</td></tr>
<tr><td colspan="7">DODAG ID
(128 bit)</td></tr>
</table>

Figure 2: Structure of DIO control message

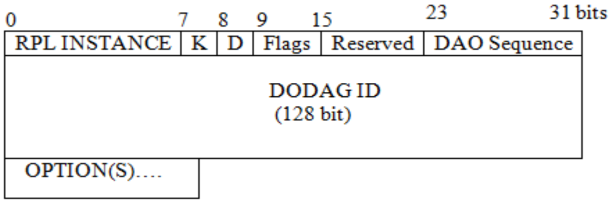

Figure 3: Structure of DODAG ID

II. RELATED WORKS

RPL performs ineffectively with regards to throughput and flexibility to organize elements. To address this issue, we create BRPL, an expansion of RPL, giving a reasonable methodology that enables clients to easily consolidate any RPL Object Function (OF) with backpressure steering. BRPL utilizes two novel calculations, QuickTheta and QuickBeta, to help time-fluctuating information traffic burdens and hub portability separately [1]. We execute BRPL on Contiki OS, an open-source working framework for the Internet of Things. It demonstrates that BRPL works flawlessly with RPL and accomplishes noteworthy execution Improvement as far as system throughput with 60% parcel misfortune decrease at least In versatile system.

Seyedreza et. Al. [2] are tending to the issue of parcel misfortune and influence exhaustion in a RPL-based system under overwhelming and exceedingly unique burden. We address this issue in three stages, setting mindful target work (CAOF), which processes the position, thinking about the setting of the hub. CAOF additionally abstains from roaring group marvel by slow moving from a high position an incentive toward the genuine position esteem. Second, known as setting mindful steering metric (CARF) which considers the status of outstanding force and line usage of parent chain toward the root in a recursive way while decreasing the impact of upstream guardians as it gets more remote down the way. Through extensive assessments, we demonstrate that this measurement prompts a superior choice about the best possible parent in a system with high traffic dynamicity, instead of choosing simply dependent on the parent rank. In third, we present another parent determination component, which chooses the best parent dependent on CARF. Assessment uncover upgrades in system lifetime while diminishing bundle misfortune in examination with standard of RPL.

The author endeavored to adjust the heap in a system. We keeps the issue of surging towards a reasonable parent, which faces coordinate with precariousness and high control message rate issue. The author demonstrated that CLRPL out performs RPL essentially, while not forcing an IETF (Internet Engineering Task Force) has proposed guidelines that empower IPV6 based sensor systems. In particular, IETF 6LOWPAN and move working gatherings created gauges for exemplifying IPV6 datagrams in 802.15.4 edges. Neighbor Discovery and Routing which permits sensor systems to trade IPV6 datagrams with web has. The creators utilizes BLIP (Berkeley Low Power IP) and TINY RPL executions in TINY-OS 2.X. Neighbor Discovery and Routing which permits sensor systems to trade IPV6 datagrams with web has. The creators utilizes BLIP (Berkeley Low Power IP) and TINY RPL executions in TINY-OS 2.X [3].

Several issues, Relevant to the framework engineers and institutionalization gatherings, which can improve the proposed standard execution. IETF (Internet Engineering Task Force) Roll WG is as of now in the last strides of particular of RPL .It is the new directing convention for low power and lossy systems. RPL may utilize layer two and layer three systems for neighbor reachability support. RPL depends on 6LOWPAN neighbor revelation, a form of the IPV6 neighbor disclosure which is improved for LLNS (Low Power and Lossy Systems) [4].

IOT gadgets are producing a ton of information nowadays, it might cause traffic clog in system. Yichao et. al.[5] proposed a Content Centric Routing (CCR) procedure to fathom traffic blockage in a system. In this procedure the steering ways are controlled by substance. It corresponds the information to middle of the road hand-off hubs for handling. It likewise totals the middle of the road information. CCR is a circulated methodology which considers traffic decrease gain accomplish over solid correspondence. In light of the setting of message, every hub builds a different directing passage for every setting by utilizing dependable correspondence connects to hubs which are fit for preparing total information. CCR decreases traffic and dormancy. It likewise dispenses with information repetition.

Routing convention for improved productivity in remote sensor systems. The Arati Manjeshwar and Dharma P. Agrawal proposed a formal grouping of sensor organize dependent on their methods of capacity, as proactive or responsive systems. We are presenting new vitality proficient convention, TEEN (Threshold touchy vitality productive sensor organize convention) for responsive systems. Youngster is appropriate for basic applications [6]. It's very productive for vitality utilization and reaction time. It enables client to control vitality utilization and precision. After assessed its execution for straightforward temperature detecting application. In vitality effectiveness it has been seen to outperformance existing traditional sensor organize.

The main aim is to improve the performance and security of the network. Performance and security of the network can be improved by converting single path routes to multiple path routes by using multiple path routing algorithm. We can predict the failure in the link or the network by using link state algorithm. Performance of the routing protocols decreases when the network size increases. There will be delay in delivering packets if the nodes access the same link. SE-AODV protocol reduces the delay as compared to AODV protocol. SE-AODV protocol replies to the first node from which the RREQ (Route Request) has been sent, whereas AODV protocol has to inform all the nodes with the RREP (Route Reply) in order to find the shortest path [7] . Hence SE-AODV protocol increases the performance by reducing the delay in delivering the packets to the destination.in RPL various enhancement are made till to date, in which few are tabulated in table 1.

Table 1: RPL Techniques and Parameters

S.No	Author Name	Protocol	Technique	Parameters
1	A K M Mahmudul Hoque [8]	RPL	NDN, NLSR	Robust, secure

2	P. Thubert, Ed [9].	RPL	OF	Optimization
3	Ines El Korb [10]	RPL	ME-RPL	packet Delivery Ratio, Routes Stability
4	Thomas Clausen [11]	RPL	CE-RPL	Number of DIO
5	T. Winter, Ed [12].	RPL	P2P, P2MP	Reduction of data loss, efficiency
6	Thomas Clausen [13] [14]	RPL	PF, PPF	efficiency
7	JP Vasseur [15]	RPL	P2P	control traffic, path efficiency

III. RESULTS AND DISCUSSION

The simulation is carried out using cooja simulator. The performance of RPL is examined under varied simulation environment. Cooja is one of the evident tool for simulating low power networks. In cooja various types of nodes are available and it is called as mote types. Sky mote and Z1-mote are widely used for performance analysis. In this work, the performance of RPL is measured using sky mote and Z1 mote. In cooja the mote range is defined as two types. Interference range and Transmission range. The simulation is carried out under varied range. The other parameters considered for simulation is tabulated in table 2.

Table 2 : Simulation Parameters

Parameter	Value
Simulator	Cooja (Instant Contiki 2.7)
Number of Motes	10, 50, 100
Radio Range	50, 100
Radius medium	UDGM Distance Loss
Mote start-up delay	1000 ms
Random seed	123,456

The simulation is carried out with 5 sink motes (node) and 45 sender nodes under three types of node positioning, namely random positioning, linear positioning and ellipse positioning as shown in figure: 4 (a),(b),(c.)

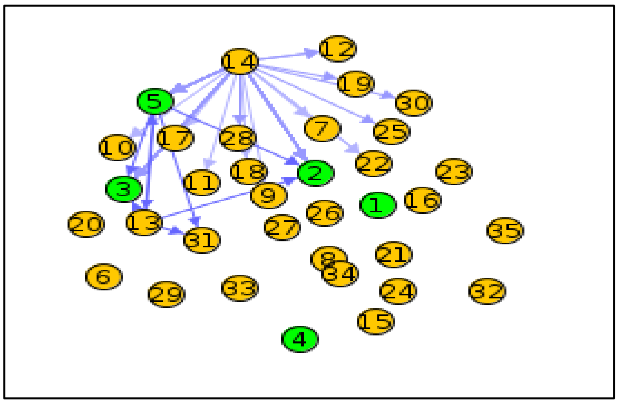

Figure 4 (a): Random Topology with 50 motes

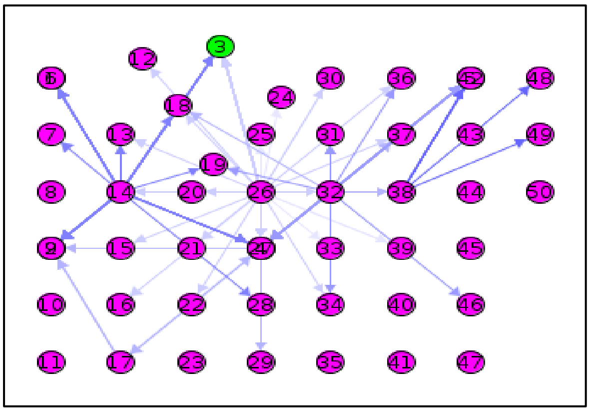

Figure 4 (b): Linear Topology with 50 motes

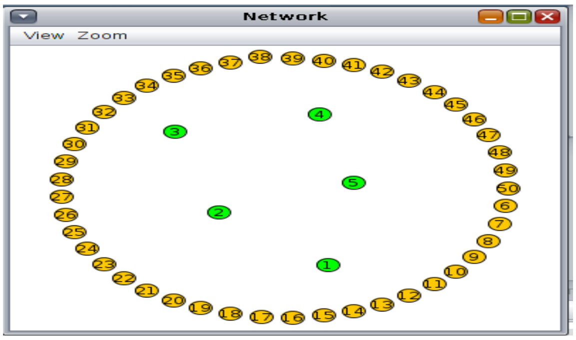

Figure 4 (c): Ellipse Topology with 50 motes

Figure 5 shows the radio range of mote 1, outer circle indicates interference range and the inner circle indicates transmission range. Neighbours are the nodes that are inside the transmission range.

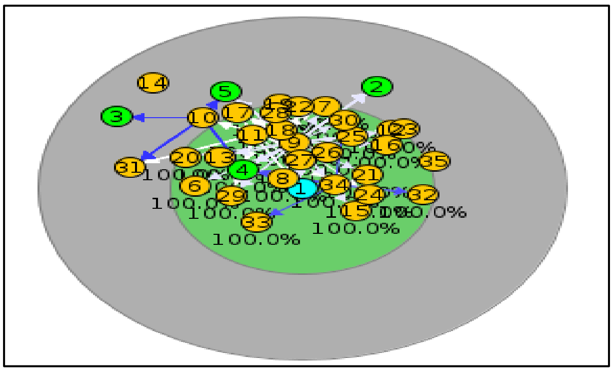

Figure 5: Radio range of mote 1.

RPL uses different types of routing metrics, Expected Transmission Count (ETX) is one of the commonly used metrics. It is calculated using number of packets received and number of packets sent ration. The figure 6 shows the the relation between sink and the sender mote. In this figure mote 1 is sink and other motes are sender motes. The link indicates relation between motes with the EXT value of 16.0

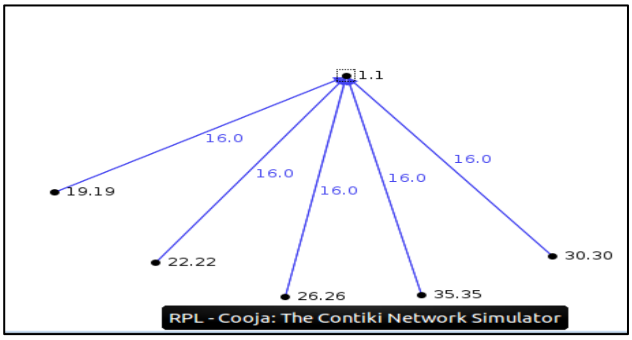

Figure 6: Network graph with ETX.

The power consumption is one of the main challenge in low power lossy Networks. It is analysed by different consumption modes that are Low Power Mode (LPM), CPU Power, Radio Transmission Power and Radio Listen Power as shown in figure 7. The average power consumption is shown in figure 8.

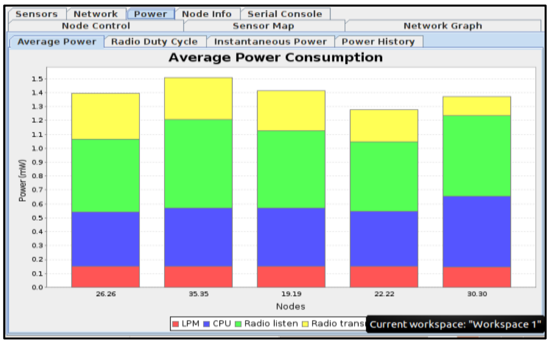

Figure 7: Summary of power usage.

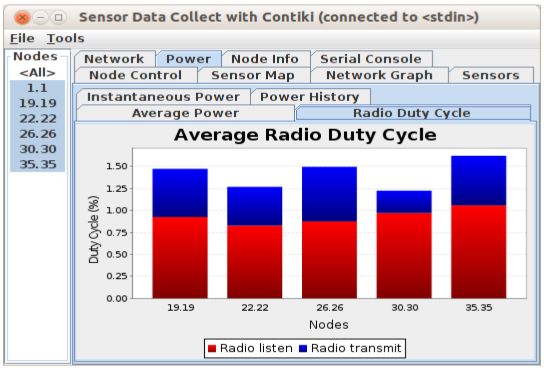

Figure 8: Average power consumption.

The simulation is carried out under different node positioning and the results are shown in figure.

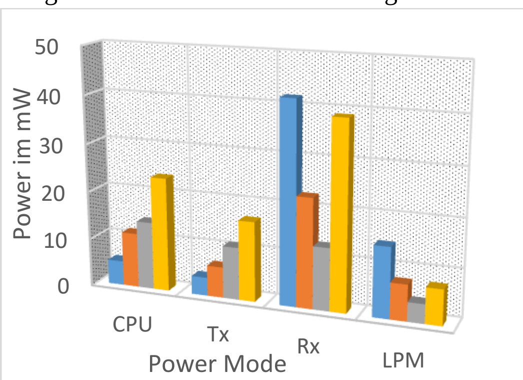

Figure 9: Power consumption of 50 motes in RPL.

IV. CONCLUSION:

RPL is one of the evident routing protocol for constrained devices. In general, it has two types of routing methods namely Storing and Non-Storing. The basic functionality in RPL is DODAG construction. DODAG ID is the unique identifier to identify each and every DODAG. In the construction of DODAG, parent selection is carried-out based on the ranking method. The node should select the parent whose rank should always be greater than its own rank. This property leads to construct loopless or (acyclic) DAG. The rank calculation is carried-out based on the ranking metric which is called as Objective Function (OF). In RPL, to achieve Quality of Service (QoS) in routing many techniques were proposed. The parent selection is one of the major technique. Which is used to improve the routing quality. Various routing techniques in RPL are studied in this paper. The routing technique and the parameters achieved are reviewed. The simulation is carried out under different node placement. The result shows that listen power is more in all the scenarios. This issue can be addressed in future work.

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