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Investigate the impact of ICMP on the performance of RPL routing protocol for IOT

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Abstract Internet is a Best Effort model, if IPv4 is replaced by IPv6 the number of connections available is more than the required it supports QoS then IOT came into existence. In this paper we investigate the impact of de-facto parameters of ICMP value and the performance of routing protocol RPL by using cooja simulator with contiki operating system. By varying the ICMP values the performance and energy consumed value are varied for different network scenarios. Experimental results reveals that ICMP values from 40 to 50 give the optimum performance and low energy consumption to enhance the network performance.

1.Introduction

The world is trending towards the ICT tools in which devices/things are needed to be connected wired/wirelessly with internet is called Internet of Things. In advent of the IPv6 the number of connections available are more , so things/devices (may or may not include the computers) have uniquely addressable and ubiquitous presence made IOT more advisable. WSN the heart of IOT having sensing actuating capability with limited power and bandwidth makes for a scope of Personal Area Networks(PAN) with low power like Low PAN. In traditional networks routing protocols plays a key role for enhancing the performance but in contrast with Low PAN a bit more importance to be provided for the Routing Protocol.

RPL is a best routing protocol accompanying the Pv6 for Personal Area Networks with Low Power proposed by IETF. Traditional Routing protocol like OSPF, AODV and OLSR etc which are highly suitable for dynamic network topology are not adaptable for energy, bandwidth and computational capability constraint networks supporting IPv6.

RPL uses the Reactive routing methodology with an asymmetric approach construct a spanning tree. Here we are using and DAG (Directed Acyclic Graph) towards the destination means Destination oriented Directed Acyclic Graph (DODAG). By using the DODAG approach the data transfer takes place from source node (leaf node) to destination node (root/sink node). The best path to traverse the data can be obtained with the implementation of the objective function. The objective function plays a key role in determing the best optimal path. RPL consists of two objective functions Zero objective Function (OF0) using the minimum hop count to find out the best path to the root node, Minimum Rank Hysteresis Objective Function (MHROF) uses the value ETX (estimation transmission count) on the route path to find out the optimal path.

RPL builds the DODAG basing on the ICMPv6 control messages. The DODAG Information Object (DIO) is broadcasted down the network and mention its specification whether it may be storing (or) non-storing node (Root node) any new nodes interested in joining that node. DODAG information Solicitation (DIS) a new child node requesting to join a DODAG. DODAG Advertisement Object (DAO) a node in DODAG went to displace to another Sub-DODAG basing on the parameters of Objective function, request from the existing node. DODAG Acknowledgement given form the parent node to child node. All these control message plays a key role in the formation of the DODAG. The control message flow is shown in the Fig 1

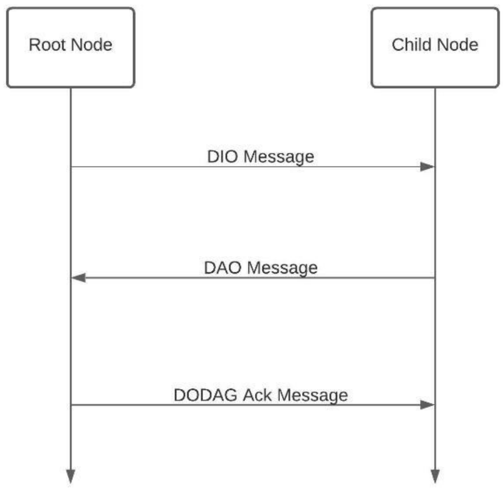

Fig 1 ICMP Message Flow for RPL

2. Literature Review

Wail mardinin et al [1] considered the performance metrics like power and pdr of the RPL considering both objective functions. In varying the ICMP time Intervals with respect to Tx Ratio on power and pdr with respect to different Network Scenarios.

Hussien et al [2] analysed the power and pdr of RPL basing on the two objective functions in grid and random topology by varying the Rx ratio in various network conditions.

A.S Joseph et al [3] mentioned that they are QoS metrics of RPL in cooja simulator using the measure Wireshark. They are trying to measure power, pdr, throughput, convergence time, latency ETX and control Overhead.

L.Lassouaouni et al [4] mentioned that they are trying to analyse energy values of RPL in two scenarios a scenario with no packet loss and another scenarios with 40% packet loss and trying to compare the energy consumed by it.

G.Y.Liu et al [5] mentioned that with the vast grown of WSN and high data rates and maintaining the minimum energy consumption is an key issue. They illustrated about networks of OFDMA type, techniques of MIMO etc., have been mentioned for communication to improve the efficiency of the energy.

X.Liu et al [6] mentioned that relative comparative study of routing protocol like LOADng, geographical algorithms and RPL in a network which have multi-hop connectivity. The analysed the metrics like power, pdr, ETX and Link Quality Data etc.,

M.Zhao et al [7] mentioned that in P2P a route to be discovered between the two peers by maintaining the throughput to obtain an reliable route which is a cost consuming process. Here in this paper they have proposed an energy efficient –RPL with respect to based on region called ER-RPL by retaining the reliability

Kumar et al[8] mentioned that by implementation of various variants of trickle, m-trickle, i- trickle and elastic trickle using the RPL and compared all the variants with benchmark trickle algorithm with the factors power and packet delivery ratio

3.Simulator Used:

Cooja-2.7 using the contiki OS was a graphical based simulator to simulate the wireless networks. Network basically consists of nodes like sky, Tmote, Zoletria with native c code embedded with in it. The simulator was running from the physical layer to the application layer and having the collect view for each which measures all the performance metrics. The Fig 2 shows the graphical view of Cooja environment

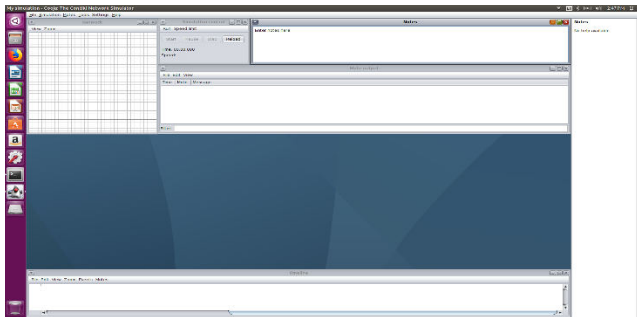

Fig 2 Cooja Simulator Environment

3. Performance Indicators

The objective function takes all the consideration of network topology to obtain optimal path in any DODAG. Here they are some parameter considered to analyse the RPL in various Network Scenarios the following are the parameters to be considered

a) **Power:** The power consumed by the node in a network for its sensing communicating with root node, computing the data obtained and actuating according to it. Here the power consumed is measured in mW.

b) **PDR:** PDR is known as Packet Delivery Ratio. It is number of packets received by a node in a network in according to the total number of packets sent
Pdr=(no of packets received)/(total packet send)

4. Parameter of Simulation

Cooja simulator under the UGDM environment considering the Sky mote deployed in the Wireless Environment. Here we are considering 20, 30, and 40 according to various network densities and considering a single sink node and trying to varying the Tx ratio of 50%, 60% and 70%. Here we are trying vary ICMP intervals form 10, 20, 40 and 60 seconds. The above mentioned scenarios will be simulated in Random and Linear Topologies shown in the Table 1and Fig 3

Cooja Simulation Specifications

Specification	Value
Model	UGDM
Seed	Random
Network Size	100X100
Mote	Sky Mote
Simulation time	300 Sec
Topology	Random,Linear
Objective Function	OF0
ICMP Intervals	10,20,40,60 Sec
Speed	Random Speed
Tx Ratio	50%,60%,70%
Rx Ratio	100%

Table 1 Parameter for Simulation

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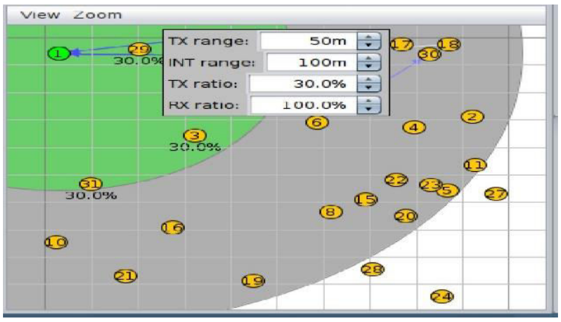

Fig 3(a) 30 Nodes with Random Network Topology

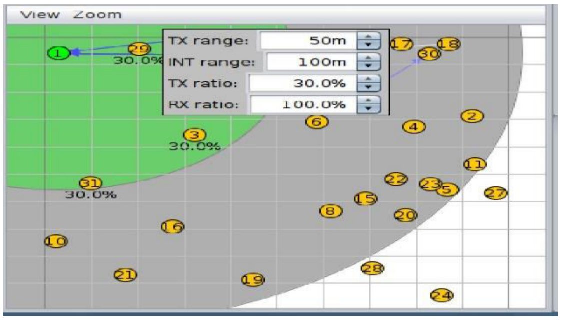

Fig 3(b) 30 Nodes with Linear Network Topology

5. Discussion on Results

In this paper experiments were simulated on 20,30 and 40 by varying the Tx Ratio from 50% ,60% and 70% with respect to ICMP intervals for 10,20,40 and 60sec and the power and PDR is observed in Random and Linear Networks shown in figures

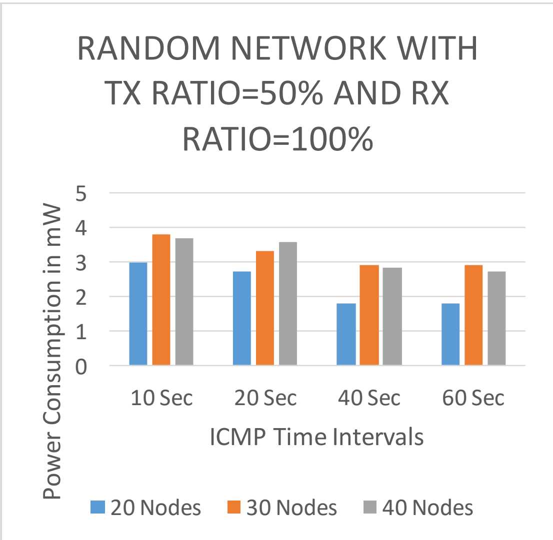

Fig 4(a) Power for Random network with Tx Ratio=50% and Rx Ratio=100%

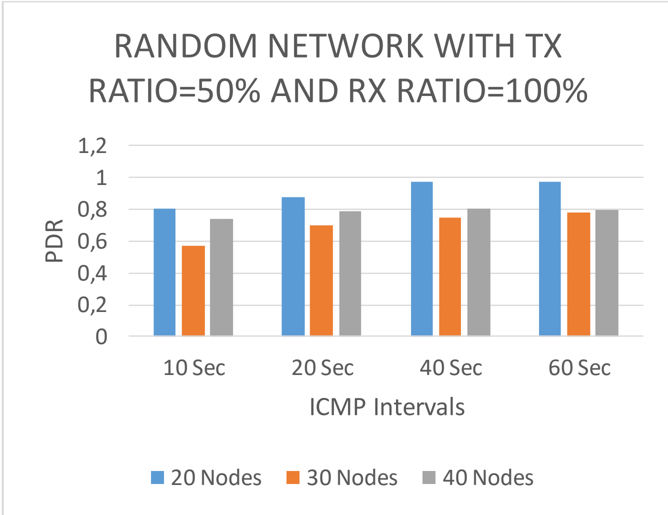

Fig 4(b) PDR for Random Network with Tx Ratio=50% and Rx Ratio=100%

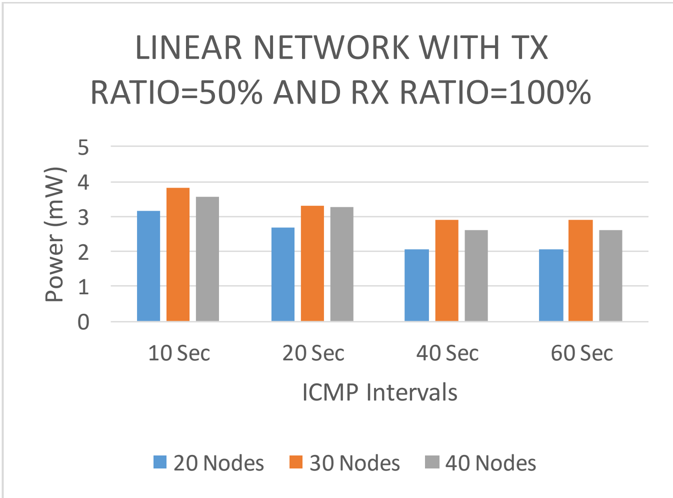

Fig 4(c) Power for Linear Network with Tx Ratio=50% and Rx Ratio=100%

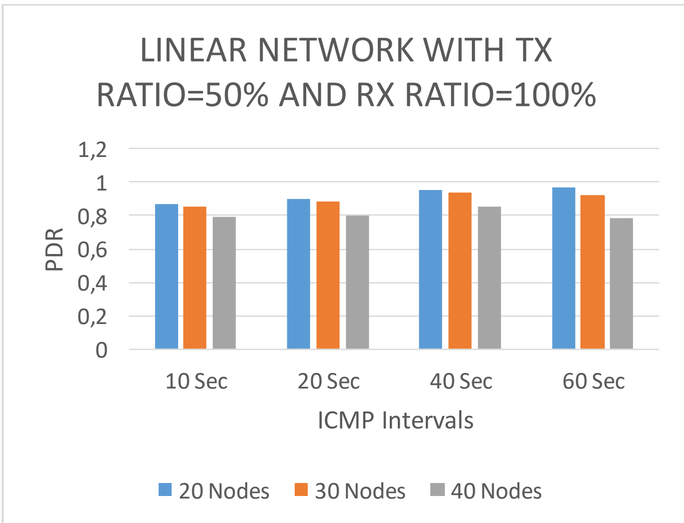

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Fig 4(d) PDR for Linear Network with Tx Ratio=50% and Rx Ratio=100%

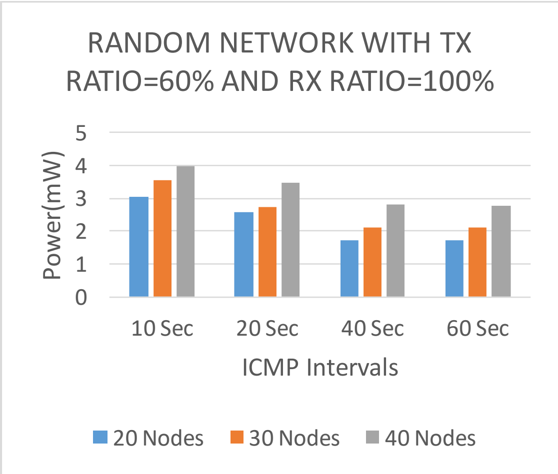

Fig 4(e) Power for Random Network with Tx Ratio=60% and Rx Ratio=100%

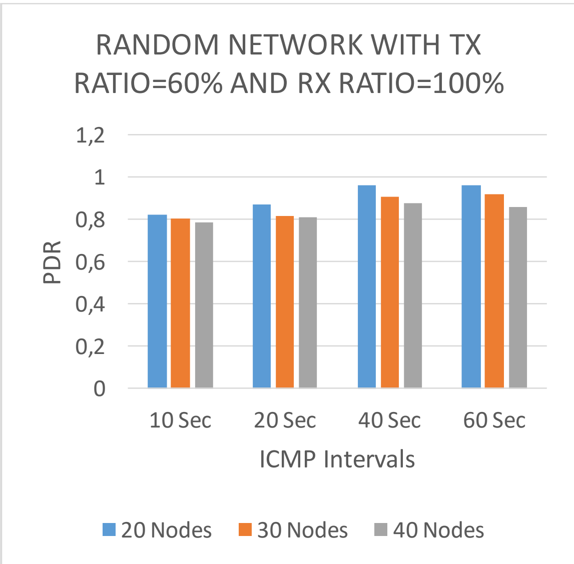

Fig 4(f) PDR for Random Network with Tx Ratio=60% and Rx Ratio=100%

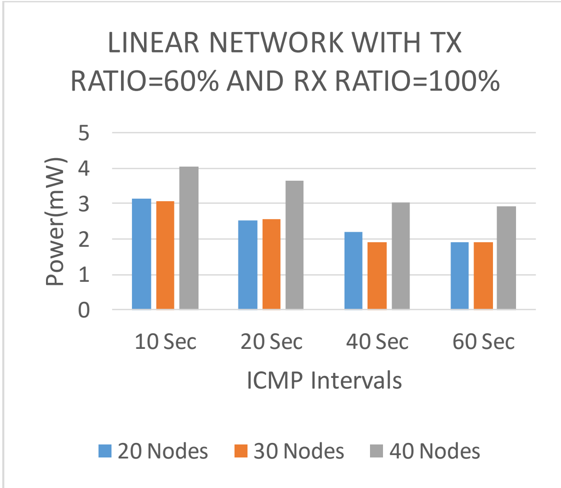

Fig 4 (g) Power for Linear Network with Tx Ratio=60% and Rx Ratio=100%

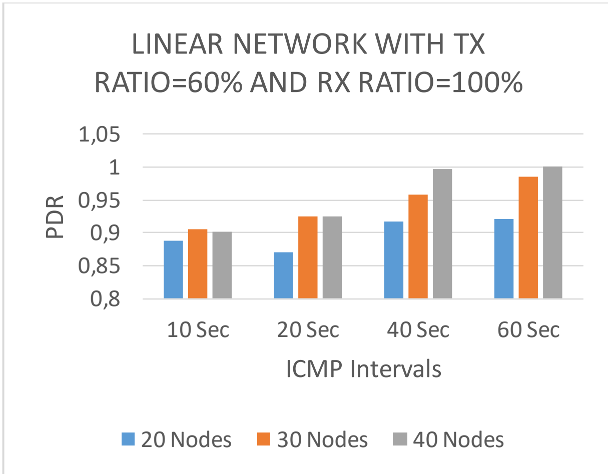

Fig 4(h) PDR for Linear Network with Tx Ratio=60% and Rx Ratio=100%

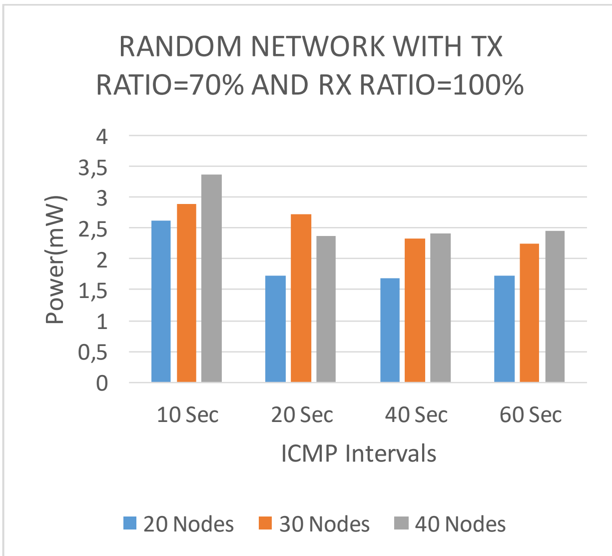

Fig 4(i) Power for Random Network with Tx Ratio=70% and Rx Ratio=100%

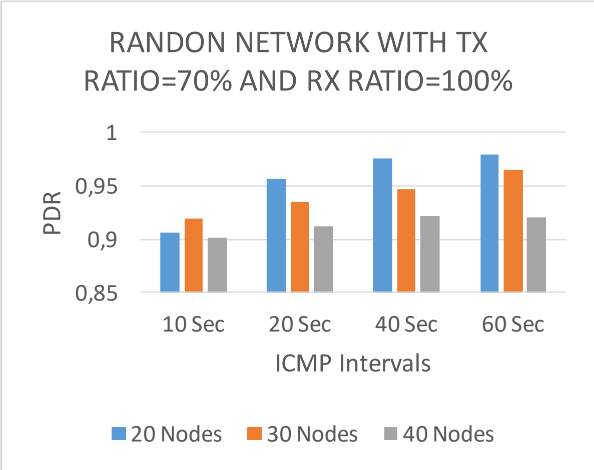

Fig 4(j) PDR for Random Network with Tx Ratio=70% and Rx Ratio =100%

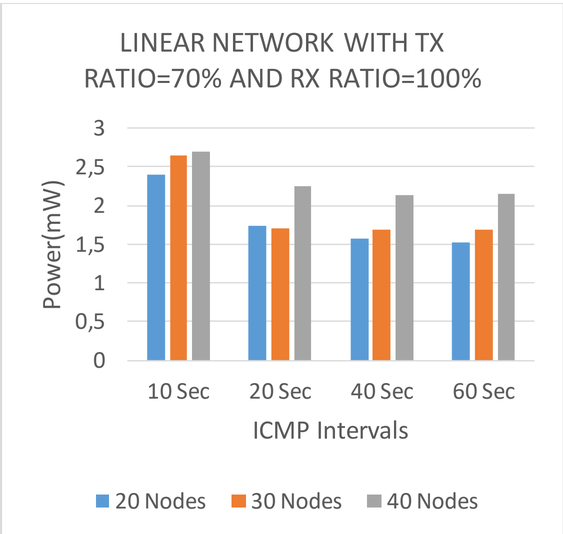

Fig 4(k) Power for Linear Network with Tx Ratio=70% and Rx Ratio=100%

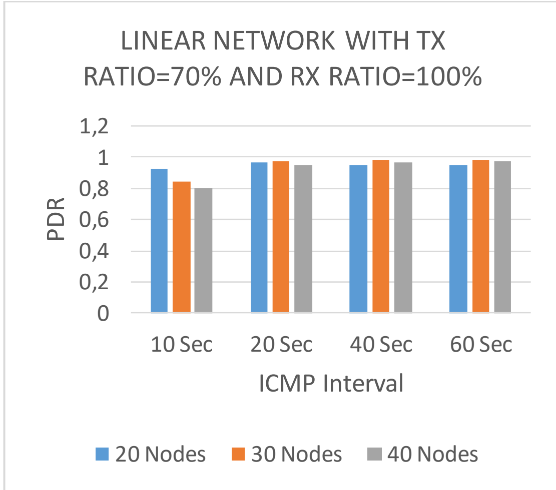

Fig 4(l) PDR for Linear Network with Tx Ratio=70% and Rx Ratio=100%

From the above graphs we can infer that power and PDR are converging in ICMP time intervals from 40 to 60 seconds.

6. Conclusion and Future Scope

In this paper we are investigating the impact of Power consumption and Packet Delivery Ratio of the sink node by varying the network size, transmission Ratio and ICMP time interval Range. By varying the ICMP time interval from 10sec, 20sec, 40sec and 60sec it is observed that at ICMP time interval 40sec and 60sec there is a convergence of power and PDR.

By applying the soft computing approach we need to apply a fine tuning of ICMP time intervals to obtain dynamic values in regards with network scenarios.

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