Analyzing and Comparing 6LoWPAN, RPL and CoAP Protocols for communication between IOT Nodes

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "**Analysing and Comparing 6LoWPAN, RPL and CoAP Protocols for communication between IOT Nodes**", submitted by Tasnim Ara Choity and Faija Juhin to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering (BSc) and approved as to its style and contents. The presentation has been held on July, 2018.

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We hereby declare that, this project has been done by us under the supervision of **Arif Mahmud, Assistant professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project successfully.

We really grateful and wish our profound our indebtedness to Arif Mahmud sir, Assistant Professor, Department of CSE Daffodil International University, Dhaka.

Deep Knowledge & keen interest of our supervisor in the field of "Networking" to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to Dr. Syed Akhter Hossain, Professor and Head**,** Department of CSE, for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

Abstract

As one of the greatest significant uses of the Internet of things (IOT), the intelligent household is becoming more and more popular day by day. There are many broken nodes in intelligent household which can rise some possible risk, such as snooping, denial of service and others. The method of design and tool of secure nodes for intelligent household built on IoT technology is presented by this paper, besides giving the hardware model of nodes, the organization of key, the contact authentication of network, the communication of encrypted data, and the alarm based on interruption detection and other security machineries are also given here. The outcomes of simulation display that the planned method can successfully improve the performance of the intelligent household from access protection and transmission message is constructed by a test stage in this paper. Besides it can also display how many packets are losing and how many packets are receiving during the communication of the nodes.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

As we know that the modern world is developing day by day. And our daily life is getting much easier. People are getting dependent on intelligent things. The intelligent household is one of the most essential applications of the Internet of things.

The paper absorbed on the Internet of things smooth home wireless sensor network node design these papers have all been concentrated on a research on the software of nodes. This paper presents a design and methods of IoT protocols and their performances and implementation. In this project we have analyzed the IoT nodes communication by 6LoWPAN, RPL and CoAP protocols.

1.2 Motivation

Currently the IoT applications in many features of our daily life are prosperous, and there is also a growing trend in the applications of health care which can gather and upload

Biometrics data to cloud. It's crucial to support the correctness and completeness of biometrics for health care applications. So, there are demands for high reliability messaging services. However, with the growth of the IoT applications, the message traffic will grow up. It's a big challenge for service

Providers to empower their services by scale up their existing equipment [1].

1.3 Objectives

Ordinary physical objects with the recognizable addresses are joined but IoT network which provides intelligent facilities to the users.

There are three important characteristics in IoT that are given below:

a) Ordinary products are digitalized. Which means that ordinary products such as cups, tables, chairs, foods and automobile tires can be independently noticed by means of RFID, bar code and so on.

b) Autonomic workstations are connected. Which means that an autonomic network terminals connect the instrumented physical objects.

c) Therefore, IoT is a classy technology for 21^{st} century [2].

1.4 Expected Outcome

In this project we are expecting that our analysis will show less packet losing during the communication between IoT nodes and more packets will be received by the receiver.

CHAPTER 2
BACKGROUND

2.1 Introduction

The virtual world of information technology mixes flawlessly with the real world of things through the Internet of Things. Everyday situations as well as the real world become more available through computers and networked devices. A more suitable way of life will also be enabled by it. Internet of Things quickly became applicable for industry and end-users [3].

2.2 Related Works

IoT technology is providing a large number of smarter technologies.

Some of the advanced Internet of Things (IoT) related works are given below:

Smart Parking: The main task of this technology is to check the parking space.

Structural Health: It observes the atmosphere and the structure of a building or historical monuments.

Noise Urban Maps: Observing the sound of a city.

Smartphone Detection: Android phones and iphones can be detected through this technology. It works with Wi-Fi or Bluetooth boundaries.

Smart Lighting: This technology provides intelligent illumination in the street.

Waste Management: It helps to uncover of rubbish levels in basins which will enhance the trash collection routes [4].

2.3 Comparative Studies

A comparative analysis on the basis of the Internet of Things architecture from the two types is provided in this part of the paper. They are back-end centralized and front-end distributed. The Internet of Things system wants to be treated by numerous information. The vast popular of the treating information, user requests and others to the back-end data treating server in the Internet of Things is allocated in the back-end centralized method. The method of the Internet of Things in the treating of information to the front of the remote sensing tools, such as M2M and IotA are given in the front-end distribution. This two types of the Internet of Things system can be matched in depth, the analysis and research [5].

2.4 Scope of Problem

Walled Off Internet:

The concept and recurrence of a global IoT can be damaged by Walled Off Internet.

Cloud Attacks:

A huge amount of data are kept in the cloud which is running the IoT. But in future cloud suppliers will be responsible for this kind of war.

Limited AI:

Most of the current AI have significant limits on the market.

Understanding IoT:

The main issue is How to make people understand about the variations of IoT and how to take any solid action against any kind of IoT attacks [6].

2.5 Challenges

Privacy:

Some exclusive challenges when it drives to privacy are granted by Internet of Thins.

Standards:

The security standard of IoT technologies should be increased to stop different types of IoT attacks.

Regulation:

Just like privacy, the Internet of Thins are framed by a number of legal and controlling questions. This also provides some thoughtful review.

Development:

It is the choice of board that IoT challenges is not going to be limited in industrialized countries. IoT has a lot of ability in terms of transporting economic and social aids for developing [7].

CHAPTER 3
REQUIREMENT SPECIFICATION

3.1 Business Process Modeling

Different systems are used for the exhibiting of commercial dealings such as UML Activity diagrams, IDEF, ebXML BPSS. The common features of this systems is their ability for exhibiting the organization of activities, the accomplices twisted in the procedure and the data or messages swapped between them. The BPMN typical was well-known by the BPMI (Business Process Management Initiative) to offer a system that may well with no trouble supposed by all commercial investors. The requirement was recognized by the Object Management Group (OMG) as the typical system for the exhibiting of commercial procedures. So that proposal an outline of the fluency got by business process modeling notations in general and BPMN in specific.

3.2 Protocol Requirements

6LoWPAN:

Straight association to the Internet spending open ideals is authorized by lower power wireless network called 6LoWPAN. Encapsulation and header compression gears are referred by it. The standard has the liberty of frequency band and physical layer. It has the elasticity to complete over several communications stages, counting Ethernet, Wi-Fi and 802.15.4. 6LoWPAN protocol was broadcast in 2007. This protocol shows a most important role in IoT wireless communication as it stand in for IPv6. It shows by auxiliary addresses with diverse lengths, low bandwidth, star and mesh topologies, battery supplied devices, low cost, large number of devices, unknown node positions, high unreliability, and long idle periods during when communications limitations are twisted off to save energy.

RPL:

RPL is network layer protocol is also known as distance vector routing protocol for Low power and Lossy Networks (LLNs) using IPv6. Message confidentiality and truthfulness is cared by RPL. It has been prearranged in such a technique that link layer appliances can be castoff when available and appropriate. RPL's mechanisms can be customized by itself. There are three basic security manners in RPL.

CoAP:

The newest application layer protocol established by IETF for smart devices to attach to Internet is called CoAP. As many devices occur as components in vehicles and buildings with constrained resources, for the variation in power computing, communication bandwidth it tips a lot. Thus lightweight protocol CoAP is wished-for to be used and measured as a replacement of HTTP for being an IoT application layer protocol [8].

3.3 Design Requirements

6LoWPAN Architecture:

The architecture of 6LoWPAN is given below:

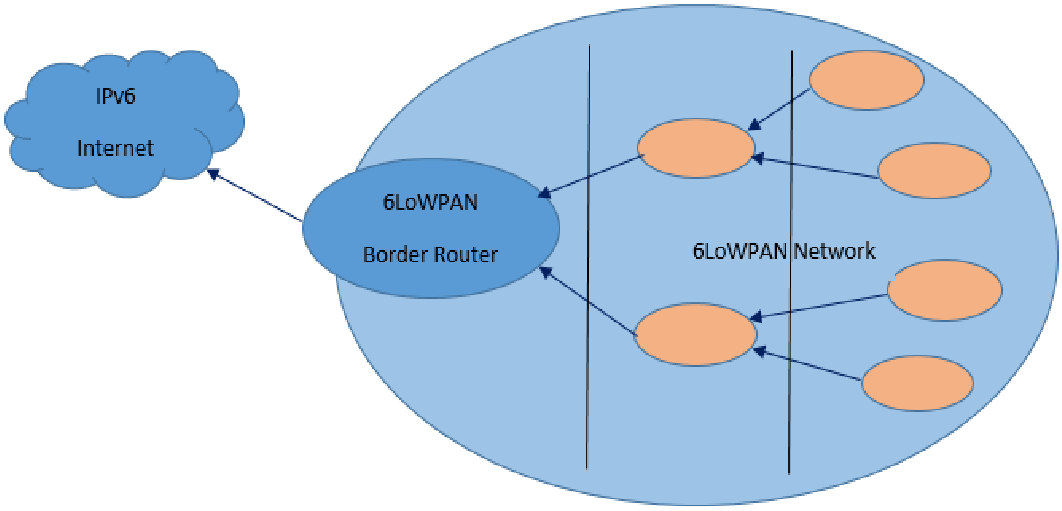

Fig-3.3.1: 6LoWPAN network architecture

Routing-RPL Architecture:

The RPL architecture is given below:

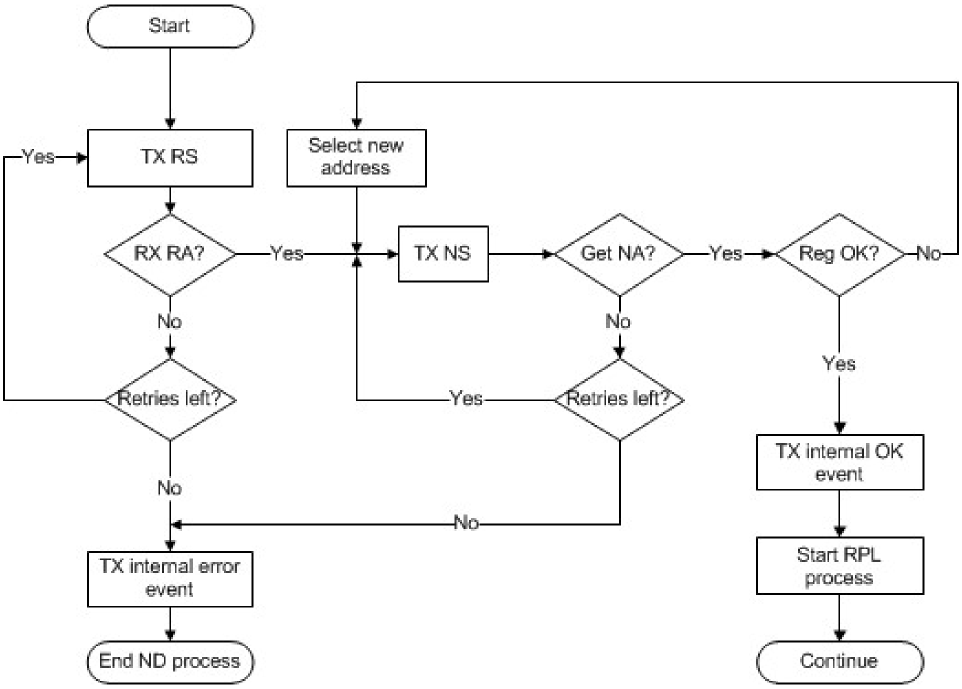

Fig-3.3.2: RPL Architecture

CoAP Architecture:

CoAP cooperative model is related to HTTP's client/server model. The CoAP architecture is given below: [9]

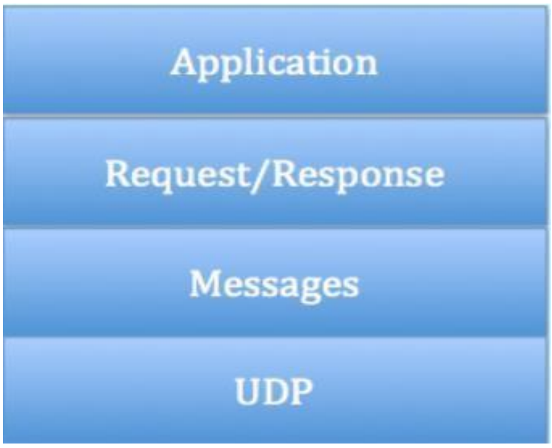

Fig-3.3.3: CoAP Architecture

CHAPTER 4
DESIGN SPECIFICATION

4.1. Design:

6LoWPAN:

Here green node is udp server and yellow nodes are udp client.

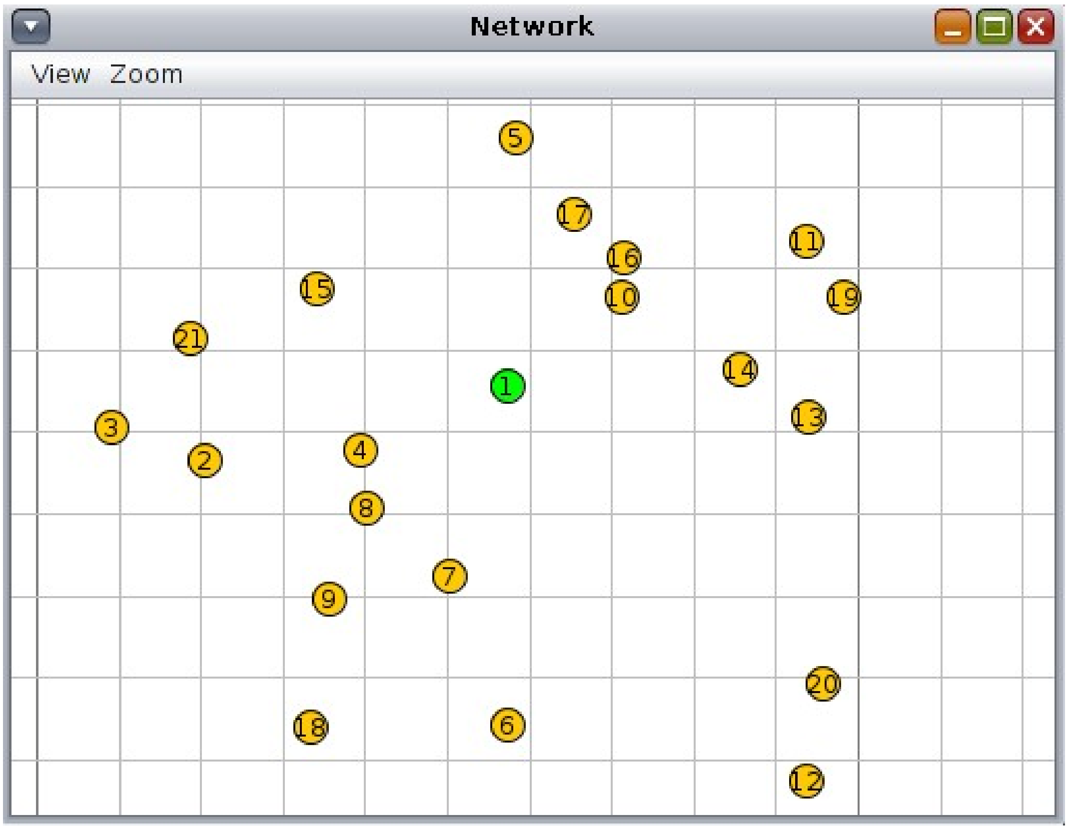

Fig 4.1.1: 6LoWPAN Nodes

RPL:

Here green nodes are unicast sender and yellow nodes are unicast receiver.

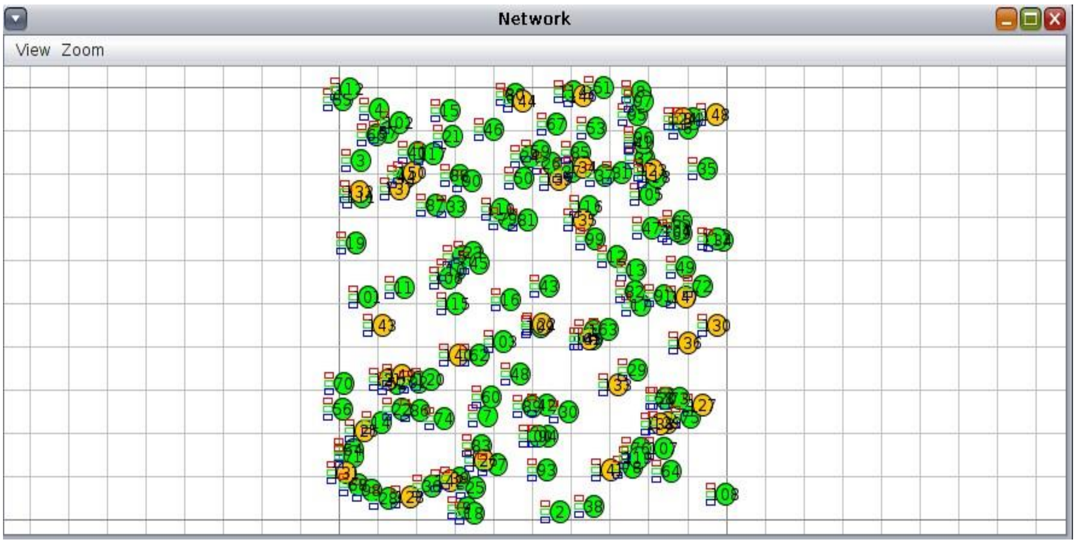

Fig 4.1.2: RPL Nodes

6LoWPAN+CoAP:

Here green nodes are udp server and yellow nodes are udp server and purple nodes are CoAP client and orange noodes are CoAP sender.

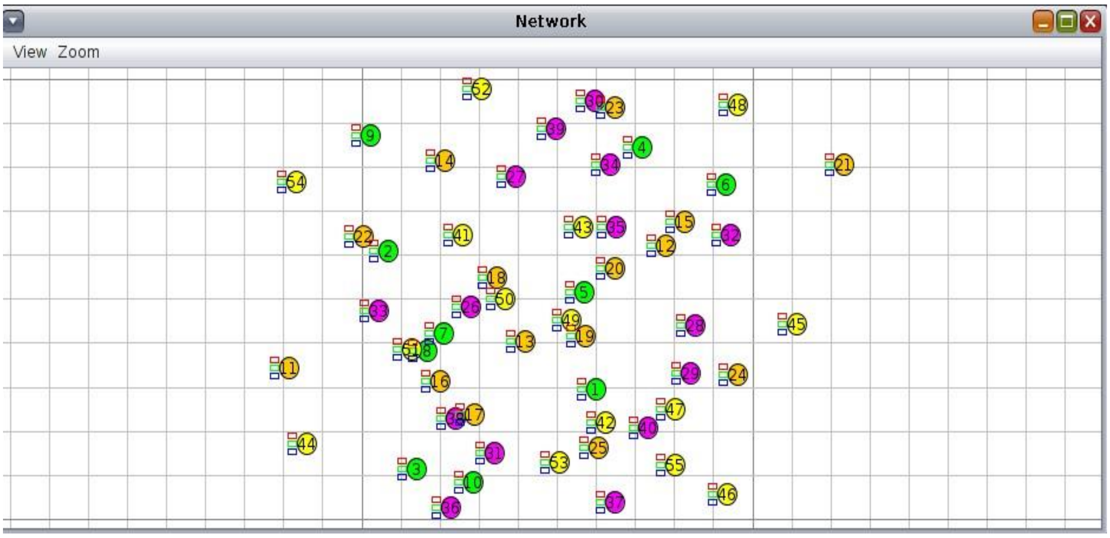

Fig 4.1.3: 6LoWPAN+CoAP Nodes

RPL+CoAP:

Here green nodes are unicast sender and yellow nodes are unicast receiver and purple nodes are CoAP client and orange nodes are CoAP sender.

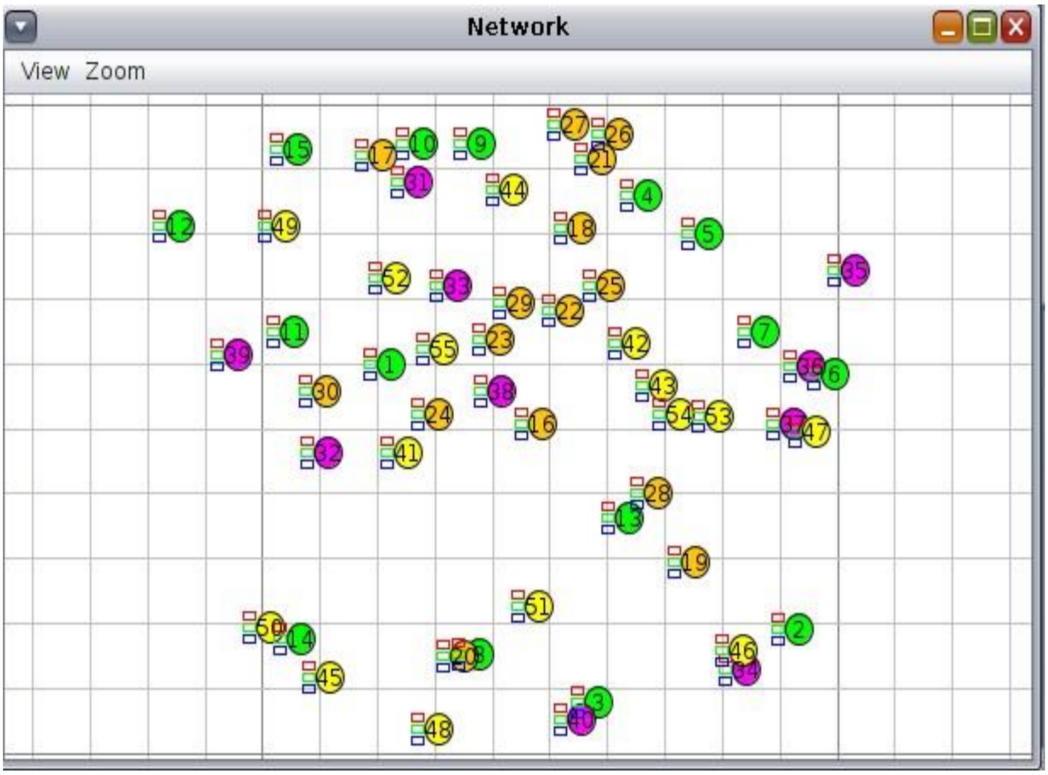

Fig 4.1.4: RPL+CoAP Nodes

CHAPTER 5
IMPLEMENTATION AND TESTING

5.1. Testing Implementation

Graph-1: In this graph initially we've shown only 17 nodes and which protocol performed better with this 17 nodes. We drew the graph on the basis of total packet and received packet.

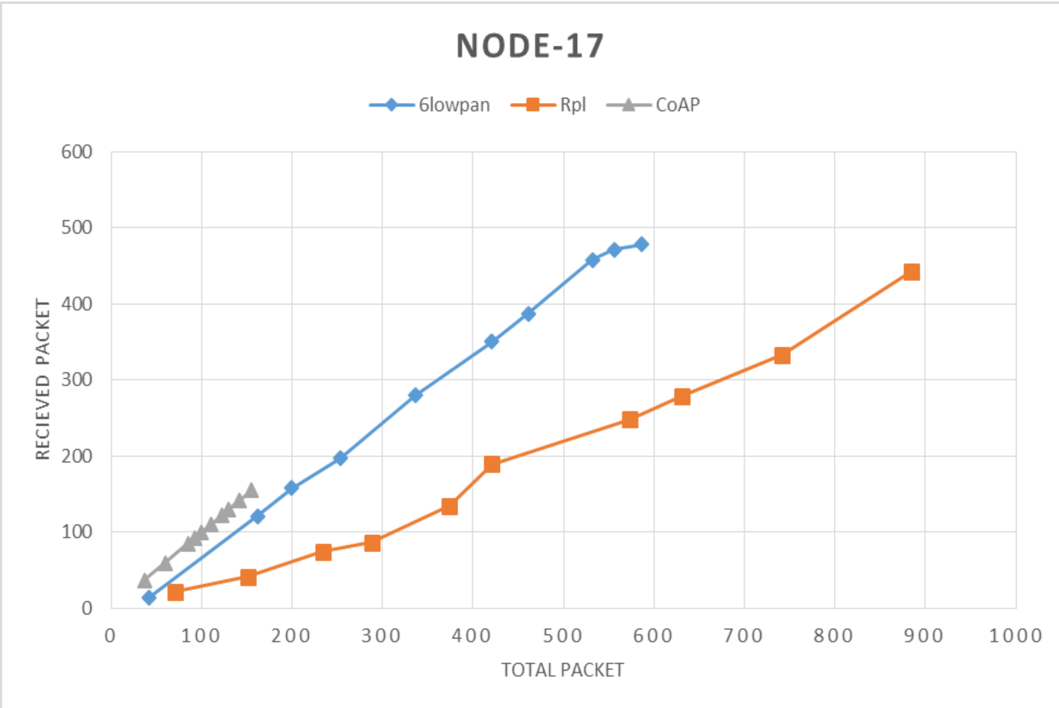

Fig 5.1.1: Graph-1

Here we can see that CoAP's packet transfer rate is good but it is slow. On the other hand RPL's packet loss rate is very high but its packet transfer rate is very fast. For this we can say that according to time and packet transfer rate 6LoWPAN is better than RPL and CoAP.

Graph-2: In this graph we've shown 150 nodes and which protocol performed better with this 150 nodes. We drew the graph on the basis of total packet and received packet.

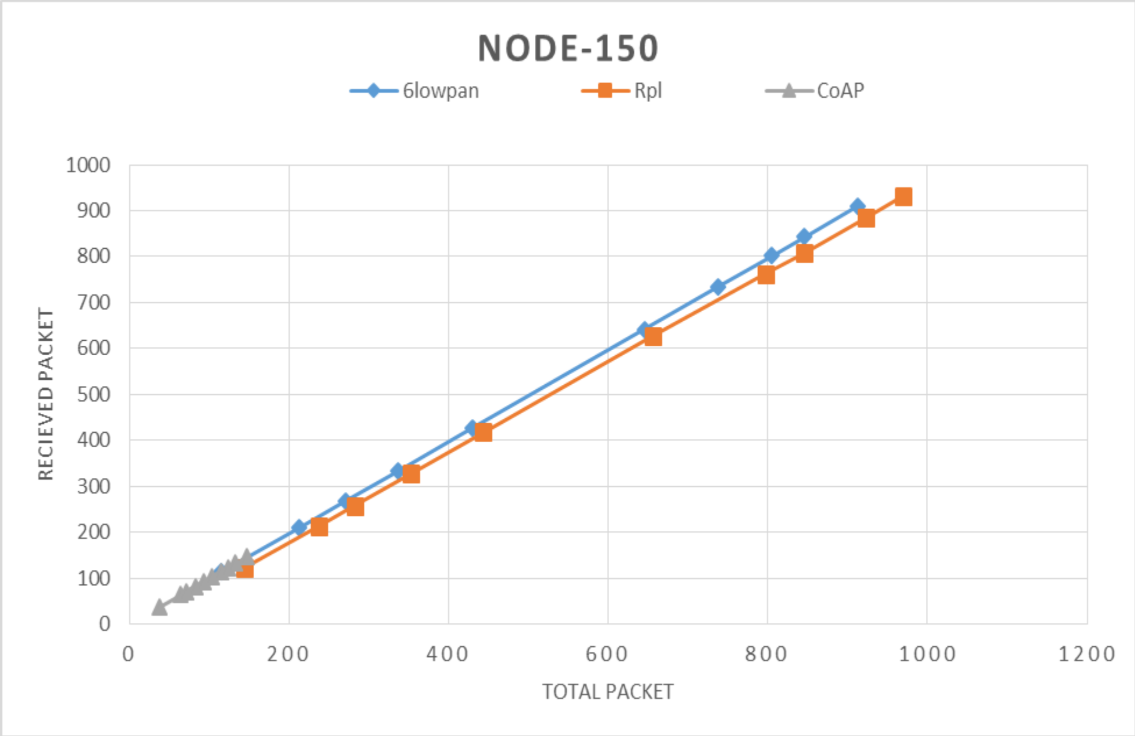

Fig 5.1.2: Graph-2

In this graph we can see that these 150 nodes and all protocols are performing almost same. But 6LoWPAN's packet transfer rate is little bit better than RPL and CoAP's packet transfer rate.

Graph-3: In this graph we've shown the combination of 6LoWPAN-CoAP and RPL-CoAP with 55 nodes. And we drew the graph on the basis of total packet and received packet.

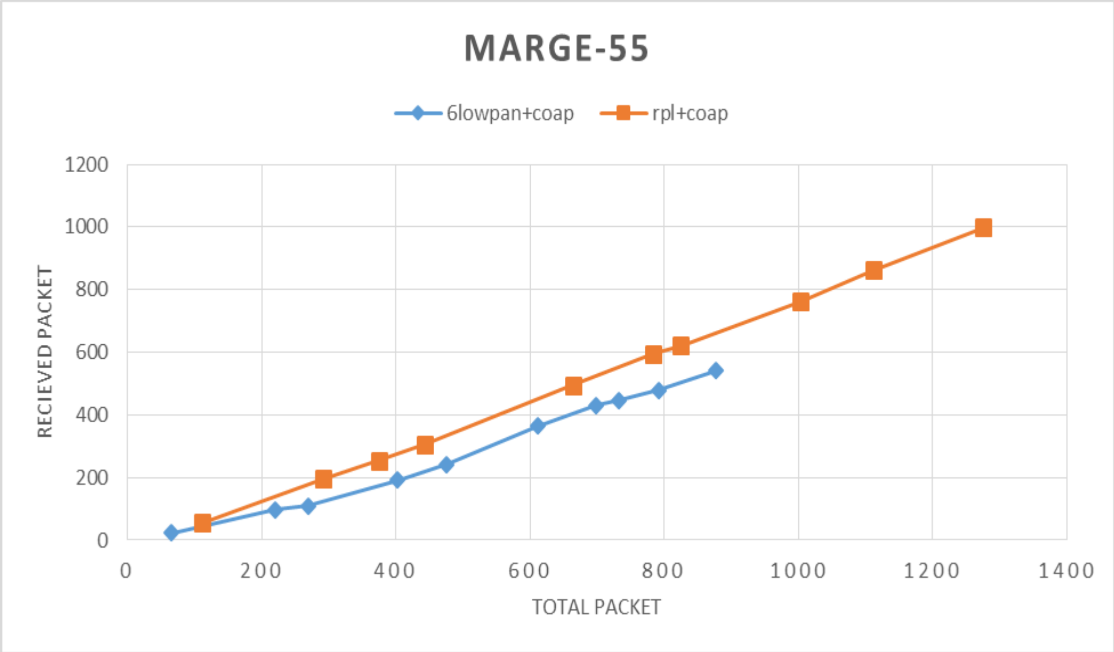

Fig 5.1.3: Graph-3

As we know RPL protocol is very fast but at the same time it losses so many packets. But when we combined CoAP and RPL in the same platform then its packet transfer rate became so fast but packet loosing rate became low.

Graph-4: In this graph we took different number of nodes and we made the time constant for 5min. We drew the graph on the basis of total packet and received packet.

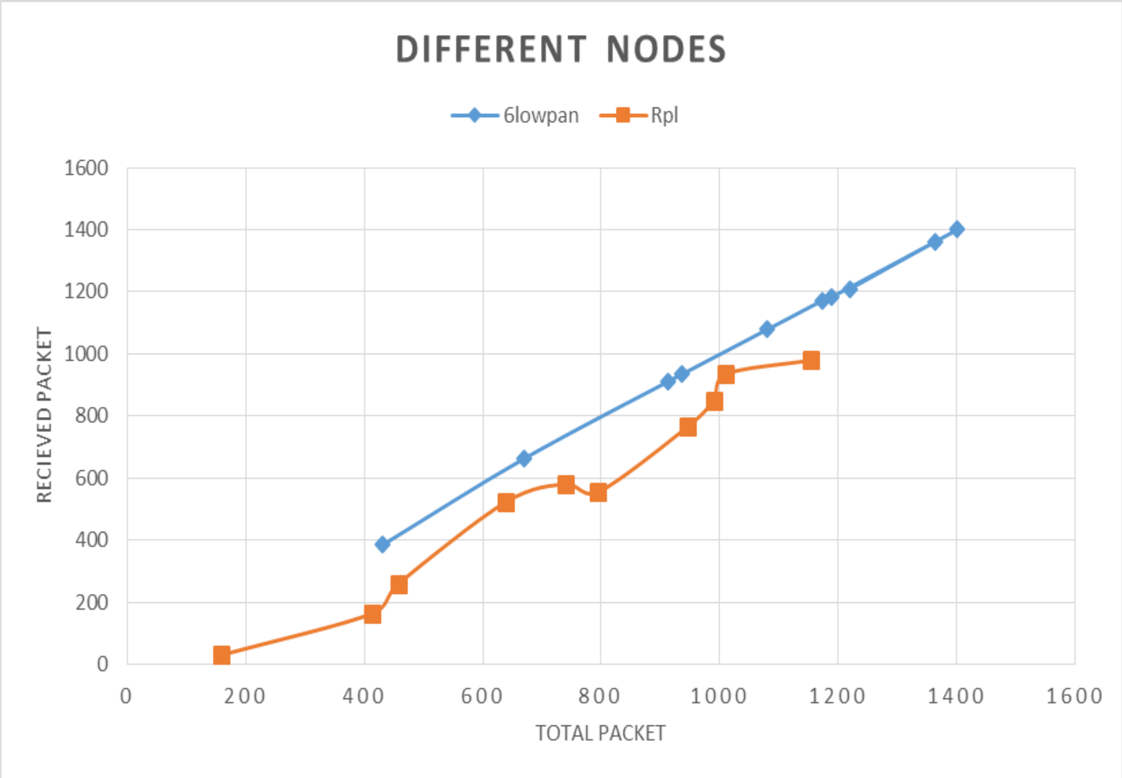

Fig 5.1.4: Graph-4

Here we can see that in a fixed time limitation with different numbers of node 6LoWPAN's packet transmission rate is better than RPL. But in 5min CoAP is not able to transfer any packets.

Graph-5: In this graph we've changed the transmission range of packets. We took the range as 10m. We drew the graph on the basis of total packets and received packets.

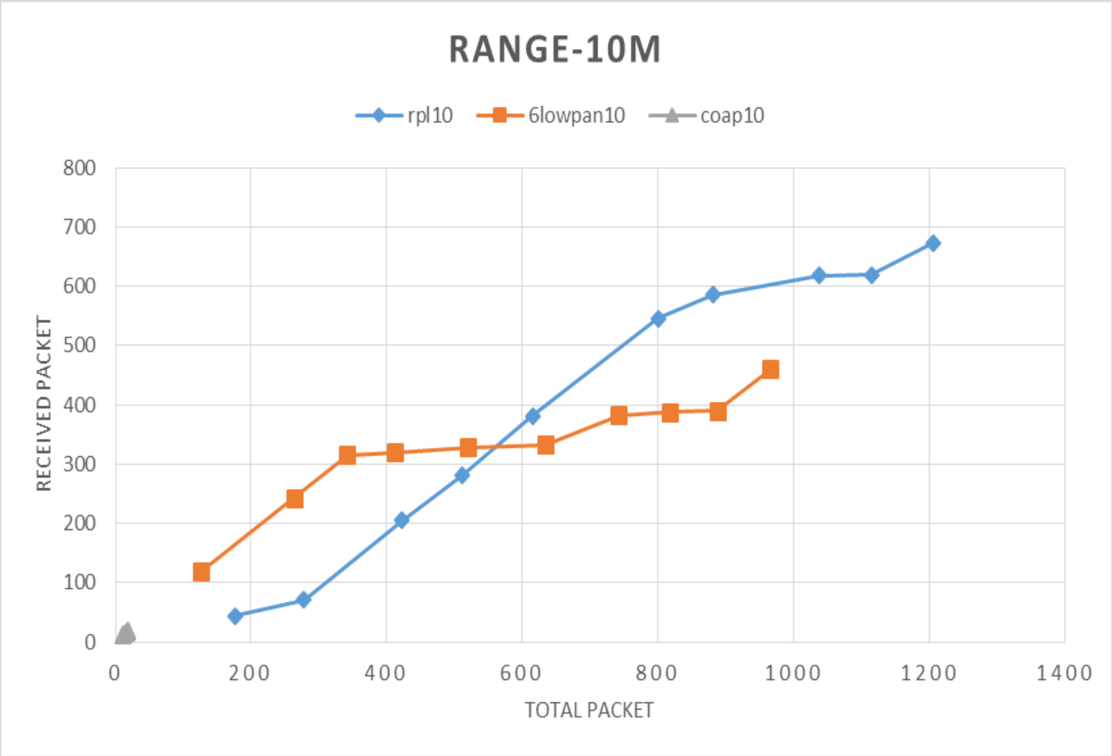

Fig 5.1.5: Graph-5

Here we can see that CoAP is as slow as before and 6LoWPAN has better transmission rate. But at some point of time RPL's packet transmission rate became better than 6LoWPAN's packet transmission rate.

Graph-6: In this graph we've changed the transmission range of the packets. We took the range as 50m. We drew the graph on the basis of total packets and received packets.

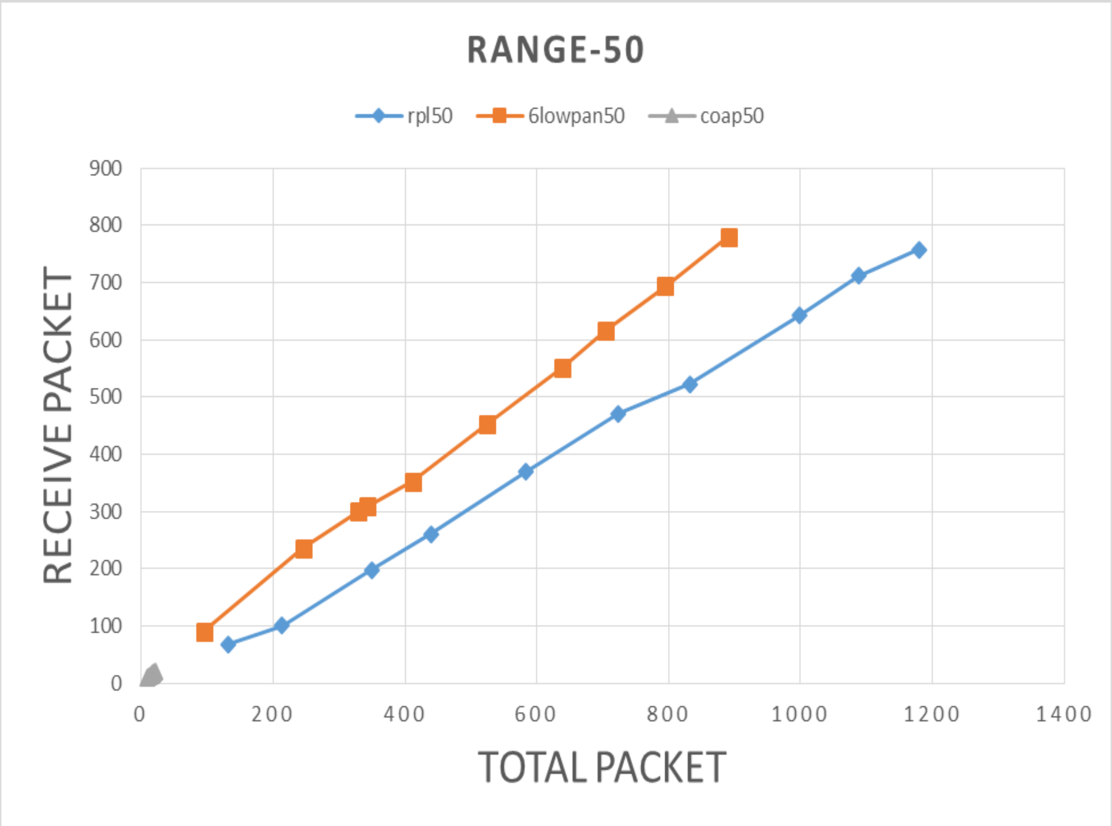

Fig 5.1.6: Graph-6

Here we can see that CoAP is as slow as before. But 6LoWPAN's packet transmission rate is better than RPL's packet transmission rate.

Graph-7: In this graph we've changed the transmission range of packets. We took the range as 100m. We drew the graph on the basis of total packets and received packets.

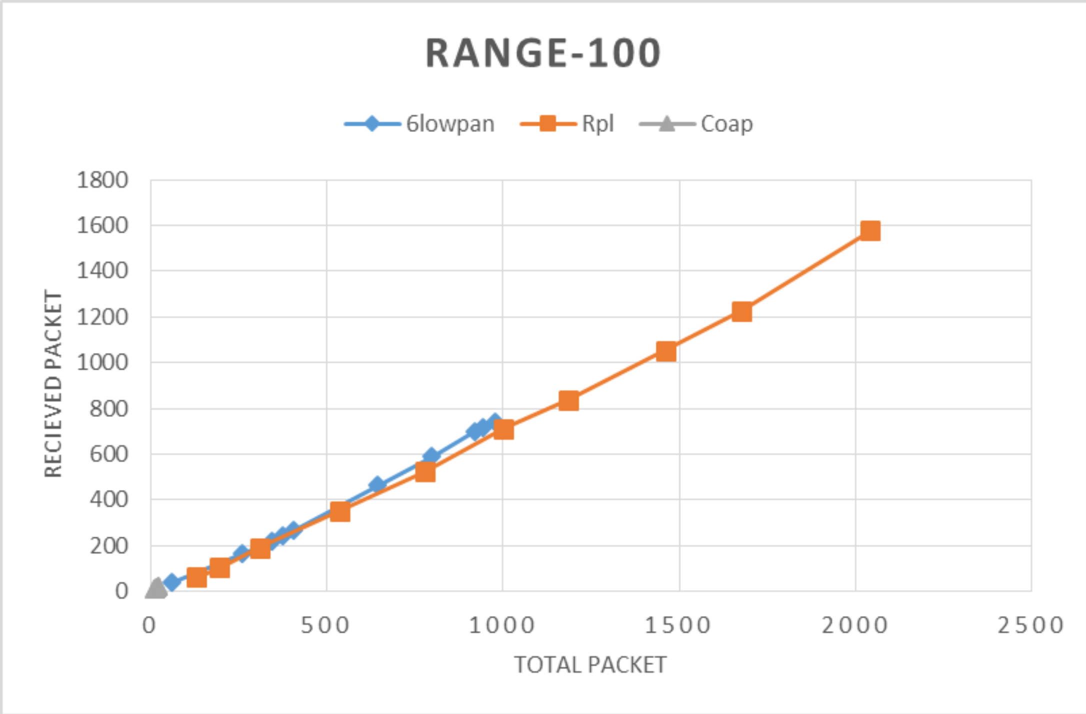

Fig 5.1.7: Graph-7

Here we can see that CoAP is as slow as before. But 6LoWPAN's packet transmission rate and RPL's packet transmission rate are quite same in 100m range.

Graph-8: In this graph we've changed the transmission range of packets using 6LoWPAN protocol. We took the range as 10m, 50m and 100m. We drew the graph on the basis of total packets and received packets.

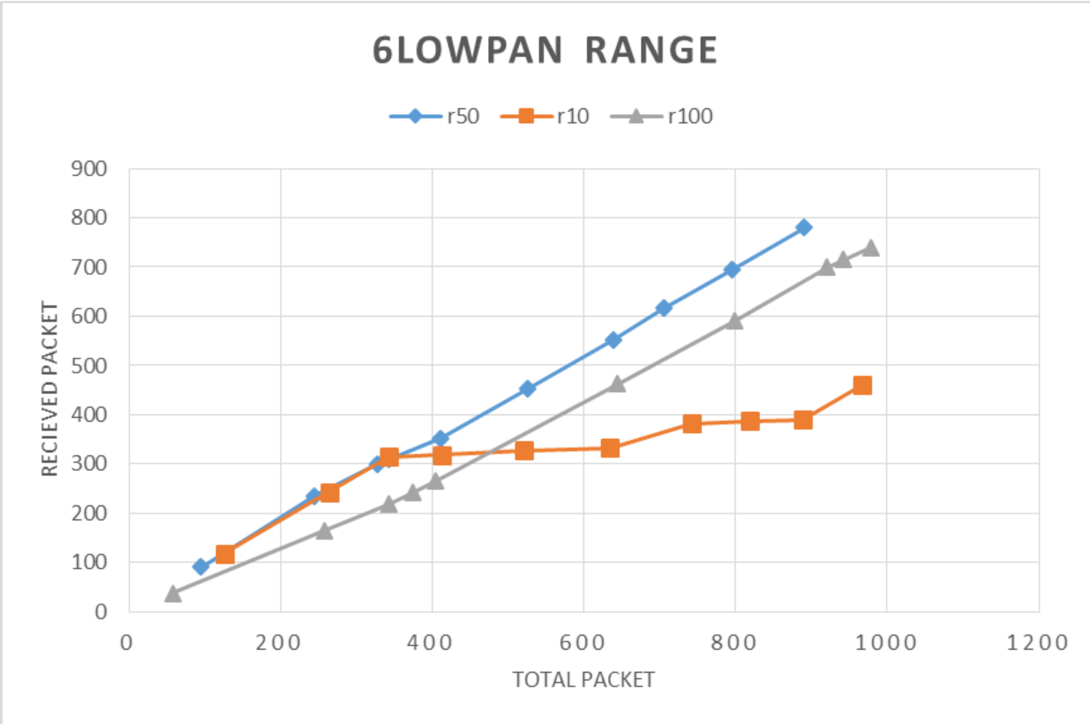

Fig 5.1.8: Graph-8

Here we can see that 50m of transmission range gave better transmission rate of packets. 10m and 100m of transmission range caused more packet loss and it became slow during packet transferring.

Graph-9: In this graph we've changed the transmission range of packets using RPL Protocol. We took the range as 10m, 50m and 100m. We drew the graph on the basis of total packets and received packets.

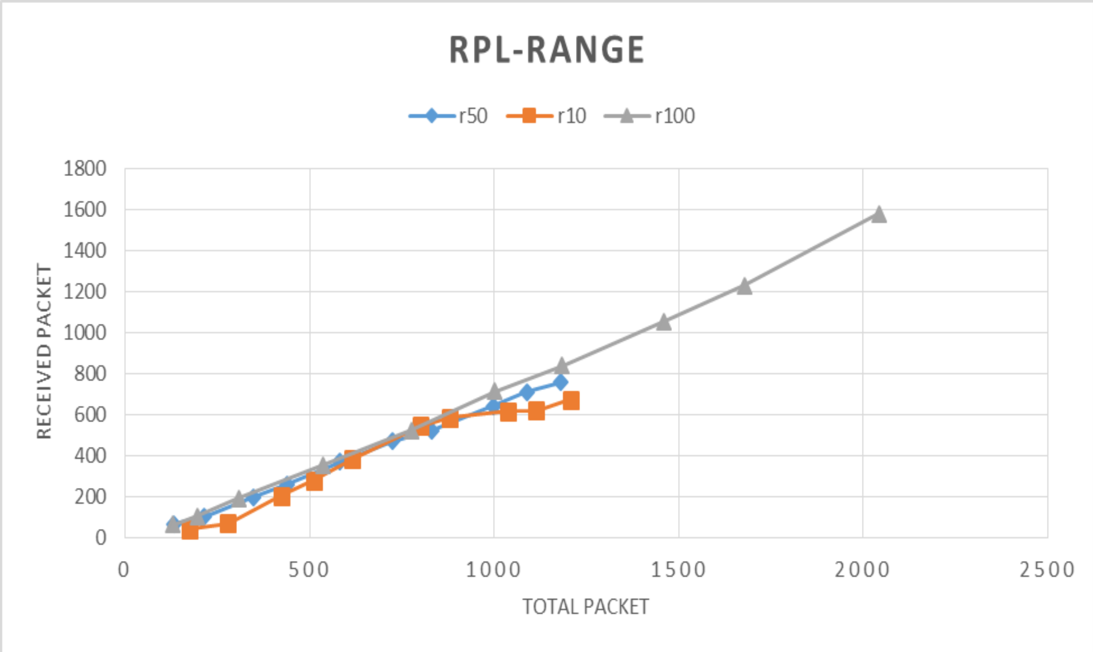

Fig 5.1.9: Graph-9

Here we can see that all the transmission range of RPL transferred almost same number of packets. But in range of 100m it showed that the packet transfer rate became faster than other ranges.

Graph-10: In this graph we've changed the transmission range of packets using CoAP Protocol. We took the range as 10m, 50m and 100m. We drew the graph on the basis of total packets and received packets.

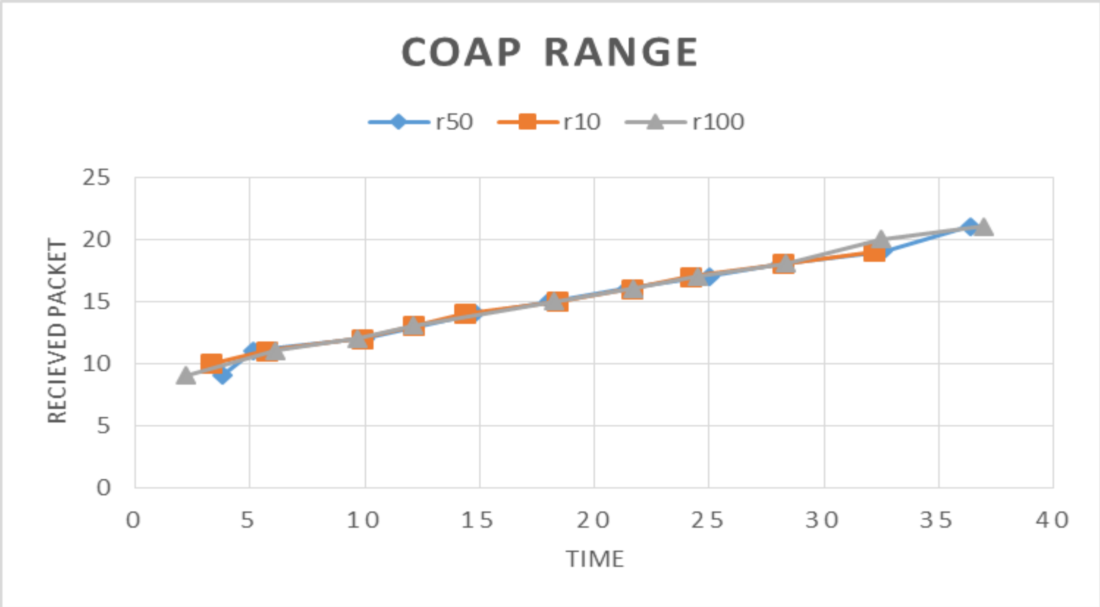

Fig 5.1.10: Graph-10

Here we can see that all the transmission range of CoAP transferred almost same number of packets. But in range 100m and 50m it showed that the packet transfer rate became faster than 10m range.

Graph-11: In this graph we've shown the combination of 6LoWPAN-CoAP with different range as 10m, 50m and 100m. And we drew the graph on basis of packet transmission time and received packet.

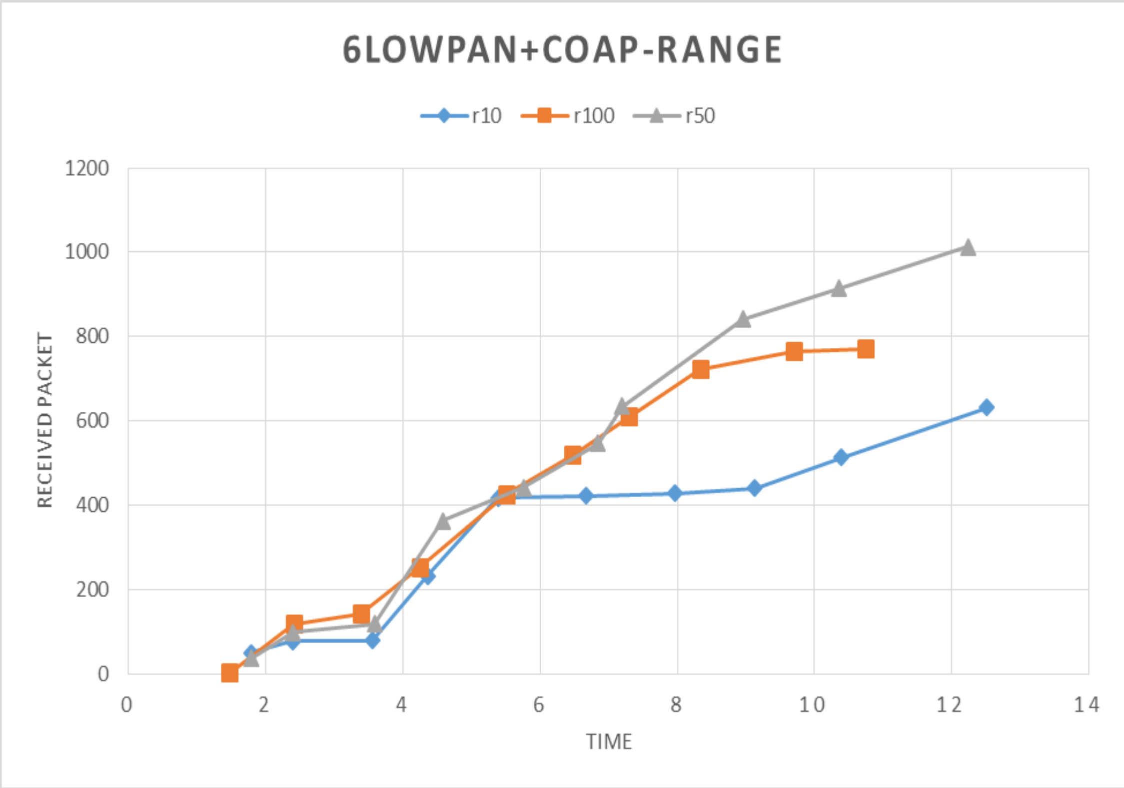

Fig 5.1.11: Graph-11

Here we can see that range of 50m gave better transmission rate of packets than 10m and 100m of transmission range. Because 10m and 100m transmission range caused more losses of packets and became slow during packet transfering.

Graph-12: In this graph we've shown the combination of RPL-CoAP with different range as 10m, 50m and 100m. And we drew the graph on basis of packet transmission time and received packet.

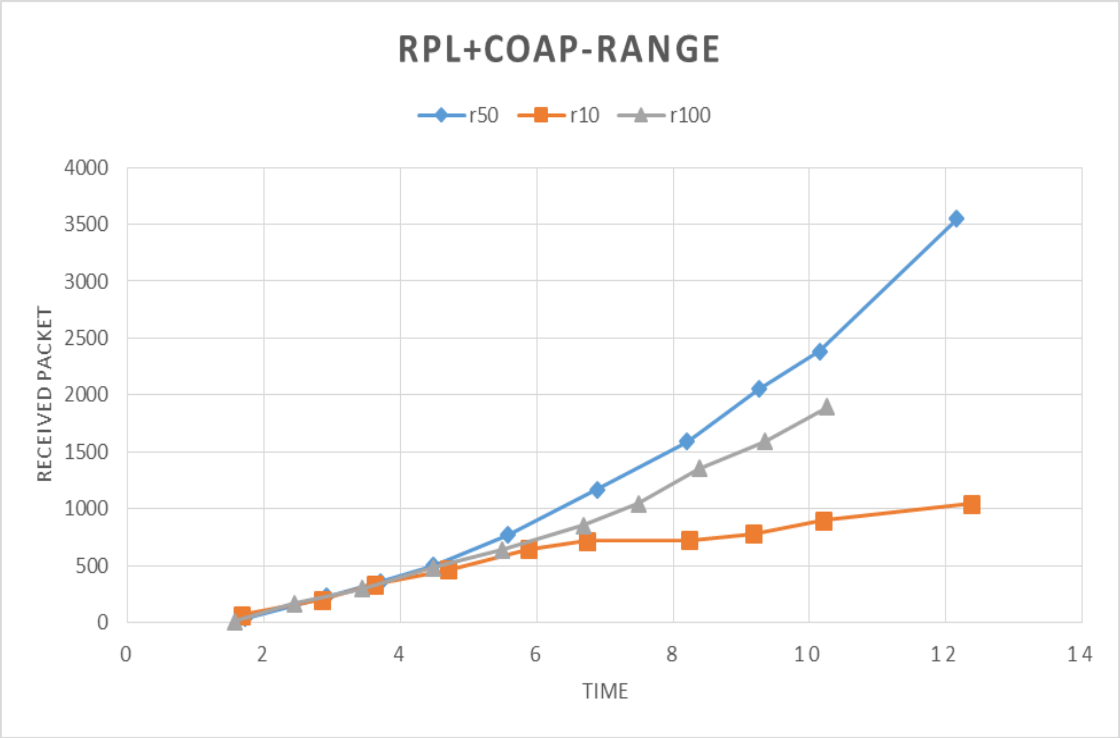

Fig 5.1.12: Graph-12

Here we can see that range of 50m gave better transmission rate of packets than 10m and 100m of transmission range. Because 10m and 100m transmission range caused losses of packets and became slow during packet transfering.

Graph-13: In this graph we've shown the combination of 6LoWPAN-CoAP and RPL-CoAP with different packet transmission range. Here the transmission range was 10m. And we drew the graph on the basis of packet transmission time and received packet.

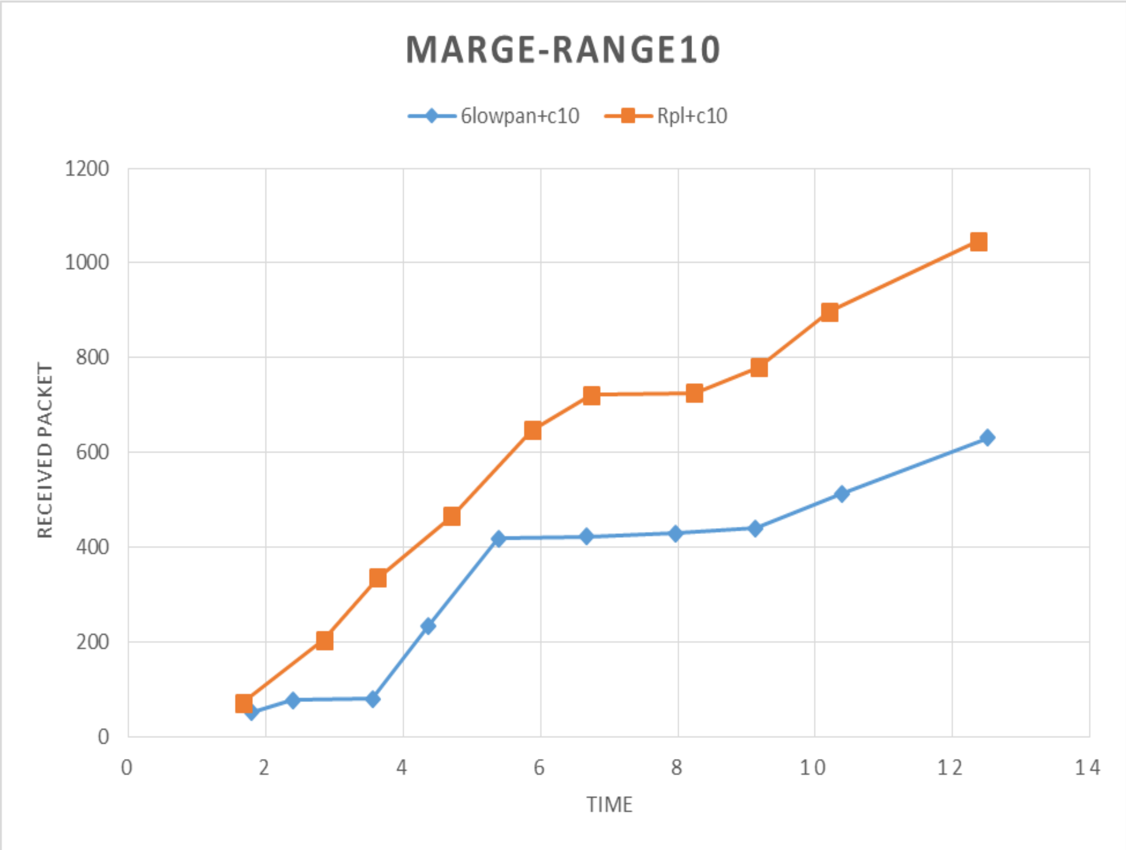

Fig 5.1.13: Graph-13

As we know RPL protocol is very fast but it caused so many packet losses but when we combined CoAP and RPL in the same platform then it really transferred packet so fast and packet loosing rate also got reduced. Here we can see that in transmission range of 10m RPL+CoAP was performing better than 6LoWPAN+CoAP.

Graph-14: In this graph we've shown the combination of 6LoWPAN+CoAP and RPL+CoAP with different packet transmission range. Here the transmission range was 50m. And we drew the graph on the basis of packet transmission time and received packet.

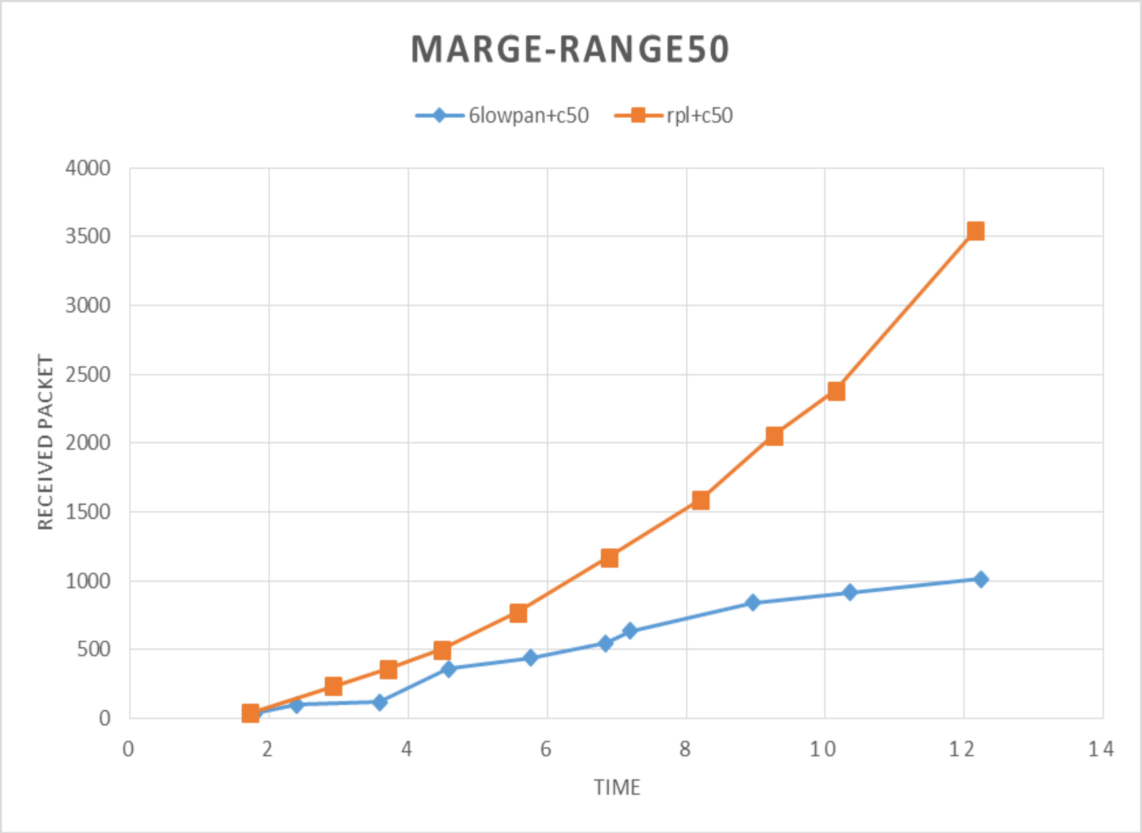

Fig 5.1.14: Graph-14

As we know RPL protocol is very fast but it also causes so many packet loss but when we combined CoAP and RPL in the same platform then it really transfered packet so fast and packet loosing rate also got reduced. Here we can see that in transmission range of 50m RPL+CoAP was performing better than 6LoWPAN+CoAP.

Graph-15: In this graph we've shown the combination of 6LoWPAN+CoAP and RPL+CoAP with different packet transmission range. Here the transmission range was 100m. And we drew the graph on the basis of packet transmission time and received packet.

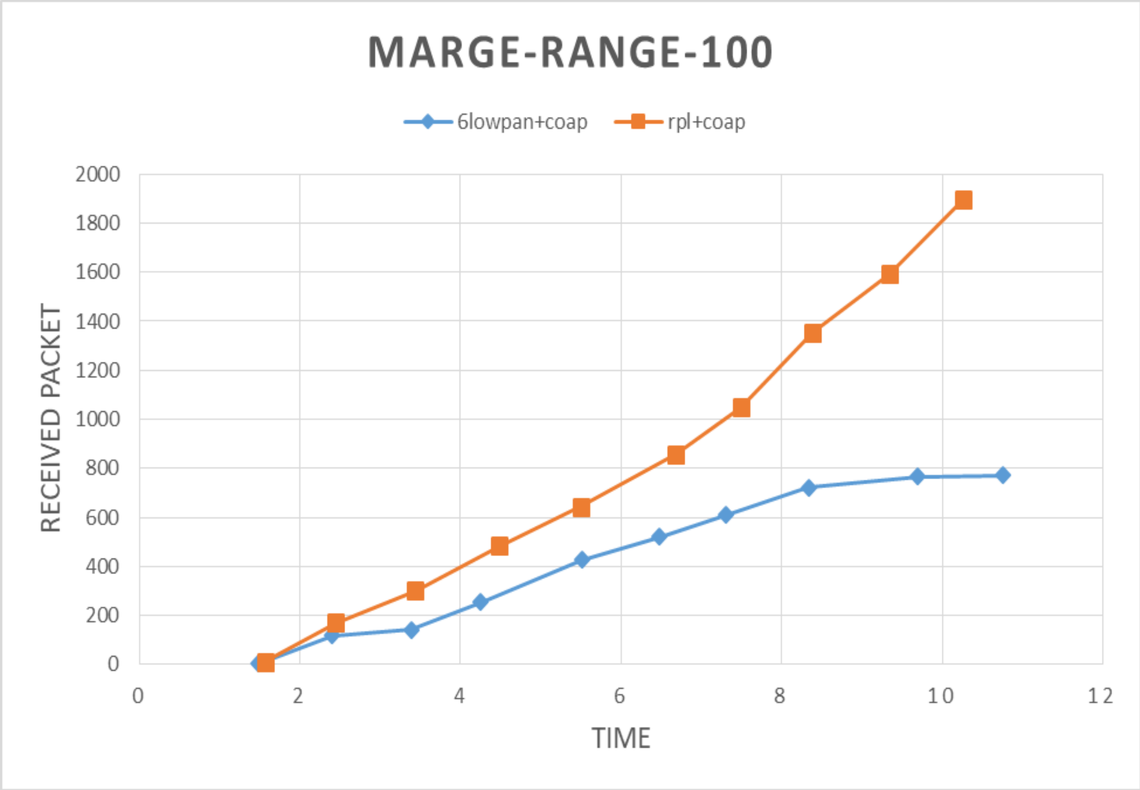

Fig 5.1.15: Graph-15

As we know RPL protocol is very fast but it also losses so many packets but when we combined CoAP and RPL in the same platform then it really transferred packet so fast and packet loosing rate also got reduced. Here we can see that in transmission range 100m RPL+CoAP was performing better than 6LoWPAN+CoAP.

5.2. Test Results and Reports

By analyzing and comparing this above graph we can say that in individual way 6LoWPAN is a better option for choosing IoT protocol. Because it is fast and also its packet loosing rate is low. But on other hand RPL is much faster than 6LoWPAN but its packet loosing rate is very high.

But when we combine CoAP and RPL together than we can see the huge difference between 6LoWPAN and CoAP combination. If we want to build a better network then the network should be built by the combination of CoAP and RPL protocols.

CHAPTER 6
CONCLUSION AND FUTURE SCOPE

6.1 Conclusion:

In the area of networking research, IoT is a developing area for the combination of different devices over the internet. Since small devices are connected via internet, there are problems of power, memory, energy etc. So IoT supports for these controlled devices communication. In this report, studied about the IoT protocol stack and understood about the different protocols used at different layers for the efficient communication of devices through the Internet. Also studied about the different dissemination protocols used in IoT that demands for the need of quickly and efficient data dissemination in the constrained network. The main goal of this project was to find best communication protocol. The thesis focused on investigating a solution of finding best communication among three protocols 6LoWPAN, RPL,CoAP and find the best communication path
Between the nodes.

6.2 Future Scope:

(i) Personal and Home Applications
(ii) Health Care
(iii) Utilities and Services
(iv) Enterprise Applications
(v) Industrial Automation Applications [10].

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