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IMPROVISATION OF THE QUALITY OF SERVICE IN ZIGBEE CLUSTER TREE NETWORK

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***Abstract*- ZigBee is one of the most widely used standards in Wireless Sensor Network. It has many features such as low-cost, low-power etc. It supports various topologies like STAR, MESH and Cluster Tree.**

III.

In case of ZigBee Cluster Tree Network topology, due to the rigid routing and poor bandwidth utilization, it becomes difficult to handle the increased traffic load. Due to these problems a need to develop a new framework arose.

In our work we will be using an Adoptive Parent Based Framework along with Distributed Algorithm-PPR, that will help to improve the quality of services of ZigBee Cluster Tree Network.

***Keywords*- ZigBee topologies, routing, Adoptive framework, distributed algorithm, improvisation of quality of services.**

I. INTRODUCTION

ZigBee is a technology which is based on the services provided by IEEE 802.15.4 standard. Primary uses of this technology include network formation, communication and applications. ZigBee provides realistic and feasible solutions for the implementation of low data rate and minimum cost and less energy usage [2]. ZigBee is a nothing but the concept of hierarchical modeling of a network. Network consists of three types of devices which represents the nodes in the network. Those devices are – coordinator, router and end devices. In ZigBee by using these devices in a particular manner and fashion, we get three different topologies namely STAR, MESH and CLUSTER-TREE topology [9]. This paper mainly focuses on the concept of cluster tree topology, its problems and then the new framework that will increase the quality of ZigBee Cluster Tree Network.

II. LITERATURE SURVEY

In this section we have mentioned the findings and opinions of different authors about ZigBee Technology. Those are as follows:

Nowadays sensor networks are playing an important role in various application areas. This is a result of a latest advancement in wireless sensor technology [10]. ZigBee is an example of such technology. According to the authors of reference paper [1], ZigBee is an unique communication standard which is beneficial for low-rate, low-power and lowcost connections in less expensive, portable and mobile devices. The work in reference paper [2], highlights the reasons behind the acceptance and deployment of ZigBee in the consumer applications. It also defines the various routing techniques to reduce the power loss problems in ZigBee. Reference paper [3] suggests reconfigurable architecture that will help to improve ZigBee performance by distributing equivalent load among its data blocking heads on the basis of leftover energy. Another way to achieve greater performance through the ZigBee is to consider two different network scenarios such as sparse network and dense network; and then compare the performance of both the networks [4]. The work in reference paper [5] establishes requirements that the traffic load conditions in the network must be tested in real time. The authors of this paper have suggested the use of an enhanced adoptive parent framework which will give better performance in case of heavy traffic load also. Since routing protocols and routing techniques are the necessary aspects for the success of any wireless communication network, in ZigBee also it becomes necessary to take into account the different routing protocols, compare them and if necessary apply new

algorithms each on them. It will improve the performance of the network [6]. Further regarding to the routing, a hierarchical routing scheme based on MAC association process can also provide the various benefits in a sensor network [7]. Though ZigBee is widely used technology, it has some deficiencies related to effective bandwidth utilization and data delivery ratio. According to the authors of reference paper [8], DBS (distributed beacon scheduling) can overcome these problems. From the reference papers [1] and [9], we can observe that the use of an Adoptive Parent Framework is beneficial for the improvisation of ZigBee Cluster network. In our paper, we also have focused on the use of an Adoptive Parent Based framework along with the use of distributed algorithm to optimize the effective performance in ZigBee Cluster Tree network. The reminder of this paper is organized is as follows: 3. Introduction to Cluster tree network. 4. Factors that affects the quality of service. 5. Proposed System. 6. Experimental results. 7. Conclusion

III. INTRODUCTION TO CLUSTER TREE NETWORK TOPOLOGY

A. Cluster tree network topology is a special case of tree topology. As shown in figure (1) parent node and child node forms a cluster. Each cluster gets identified with its unique cluster ID. In this tree each node is at the particular level. Such as level 0 is assigned to PAN coordinator and nodes at level 1 are children and so on. These levels are nothing but the distance in terms of the hops from source to relevant sink. This topology is widely used because of its power saving operations.

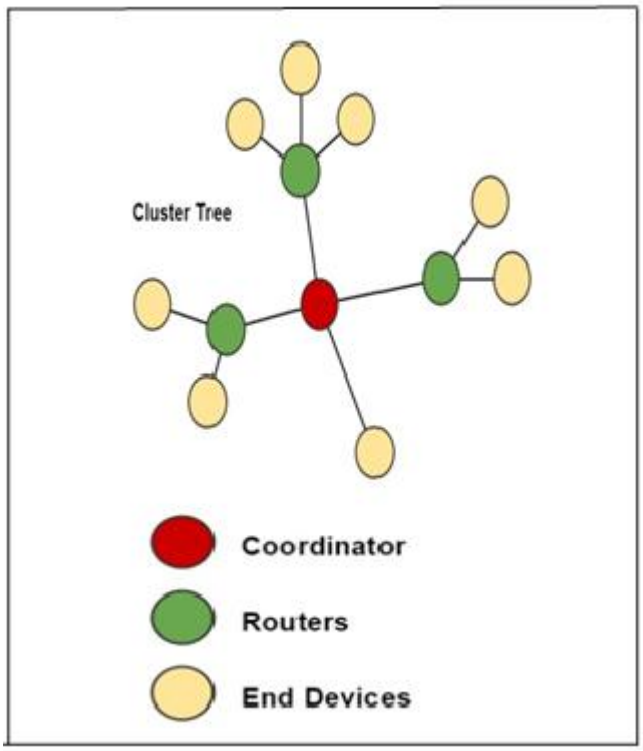

Figure 1.Cluster Tree Network Topology.

IV.FACTORS THAT AFFECTS QUALITY OF SERVICE

Though this topology is widely used, there are some factors that affect quality of services provided by this network. Some of the main factors are rigid routing protocols, link failure etc. It means that we cannot rely on a particular link to transfer the data successfully every time. In other words we can say that effective and successful data delivery is not guaranteed. And if such thing happens then it may also become difficult to recover that data completely. Ultimately it will affect the quality of services provided by the ZigBee Cluster Tree Network.

V. PROPOSED SYSTEM

In order to overcome the effect of the factors mentioned above, here we suggests to use a new framework called Adoptive Parent Based Framework as well as distributed Algorithm. In this new framework we have modeled the system as a vertex constraint maximization flow problem. After that we have tried to solve this problem by using Adoptive Parent Based Framework along with Distributed Algorithm called – PPR (PULL PUSH RELABLE).

A. Vertex Constraint Maximum Flow Problem

While considering the system in terms of vertex constraint maximum flow problem, we will formulate the network as a directed graph, such as G = (V, E), where V represents the routers in the network and E represents the possible communication links between pairs of routers. In this flow network, each vertex u € V is associated with non-negative capacity. In this network, we will consider the two vertices:

1) A source‘s’ (sender)
2) A sink’t’ (receiver)

A flow in a vertex-constraint flow network G with respect to a
source s and a sink t is a real-value function $f : V \times V \rightarrow R$ that satisfies the following three properties:

- Capacity constraint: $\sum u\in V \{f(u,v)| f(u,v) > 0\} \leq \hat{} c(v),\forall v \in V$.
- Skew symmetry: $f(u,v) = -f(v,u),\forall u,v \in V$.
- Flow conservation: $\sum u\in V f(u,v) = 0,\forall v \in V - \{s,t\}$.

The value of a flow f is defined as the total net flow into the sink, i.e., $\sum u\in V f(u,t)$. A maximum flow is a flow of maximum value. In the vertex-constraint maximum flow problem, given a vertex-constraint flow network G with source s and sink t, the objective is to find a maximum flow f from s to t in G.

B. Adoptive Parent Based Framework

Since in this framework, child nodes are obtaining to the required bandwidth from its original parent as well as from an adoptive parent to handle the sudden increase in data load, this framework is called as an Adoptive Parent Based Framework. This feature of the above framework will help us to improve the quality of service in ZigBee. The three important factors of this framework are as follows:

- GTS capacity – it indicates the router’s available GTS slot.
- Node depth - represents the length of the uplink path from a router to the sink (i.e., the PAN coordinator).
- Path similarity -it indicates the degree of overlap between the uplink paths from the original parent router and from an adoptive-parent router candidate to the sink.

Requirements that need to fulfill by candidate router to become a parent:

- They must have available GTS capacity
- Their depth must be lower than that of original parent router

Priorities by which a candidate router gets selected as a parent router:

- The lowest depth
- The smallest path similarity with the original parent

C. Distributed algorithm (PPR)

Here we have used Distributed Algorithm to improve the quality of service because it gives better performance as compared to Centralized Algorithm. An added advantage of this algorithm is that it reduces the latency.
While applying this algorithm we have considered the network as a directed graph. The three main operations of
PPR algorithm are:-

1. PULL Operation: In this a child router can pull the required bandwidth from its original as well as adoptive parents.

2. PUSH Operation: In this operation a child can push back the unwanted or leftover bandwidth to its original as well as adoptive parents.

3. RELABLE Operation: When neither PULL nor PUSH are possible, then child node performs RELABLE operation.

All the three procedures are executed on each vertex in the tree.

D. Basic Architecture

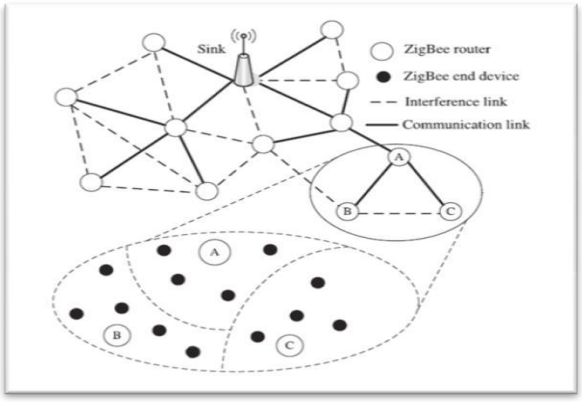

Figure2. Basic System Architecture [1]

VI. EXPERIMENTAL RESULTS

For the development of this solution we have followed the following steps:

1. ZigBee network environment parameter definition
2. ZigBee wireless simulation topology.
3. Show the movements between the nodes
4. Perform the routing by using source and destination nodes concept

5. Then apply the Distributed Algorithm (PPR)
6. Analyze the quality of service.

We have used MATLAB as an implementation platform for our system due to its network based features. In real time this Zigbee device will send the signal to the system via Zigbee medium and then network is analyzed. Same thing we are doing in MATLAB. But instead of using hardware, we have used MATLAB for the design of Zigbee model. Here we are testing the behavior of network by applying different network sizes and number of nodes. Also we are analyzing the quality of service based on

- Throughput,
- Latency,
- Average end to end delay.

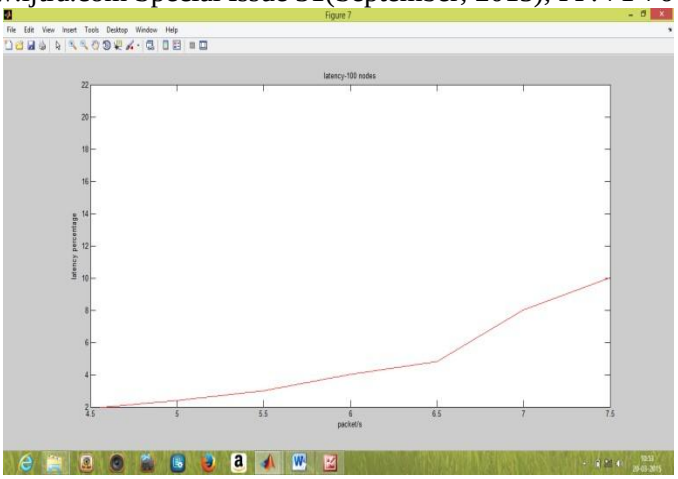

Figure. 6.2(a) shows latency for the network size = 100

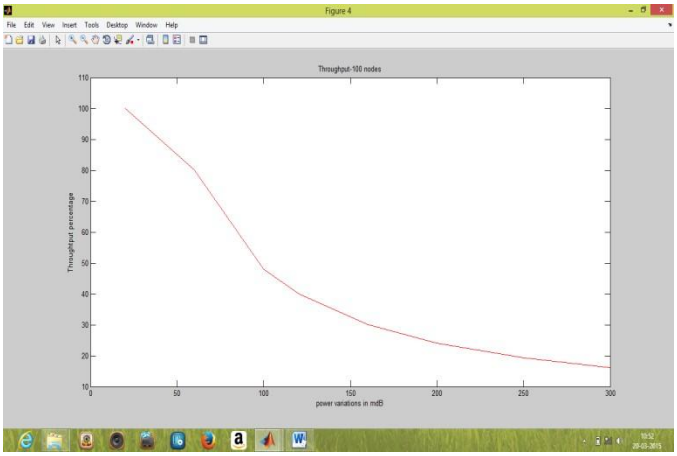

Figure. 6.1(a) shows throughput for the network size = 100

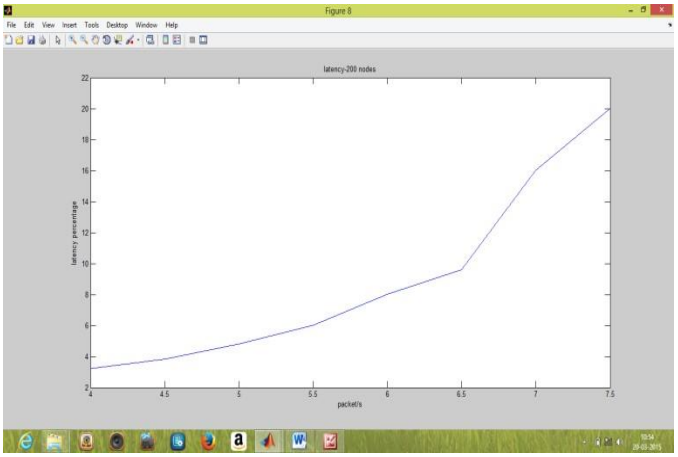

Figure. 6.2(b) shows latency for the network size = 200

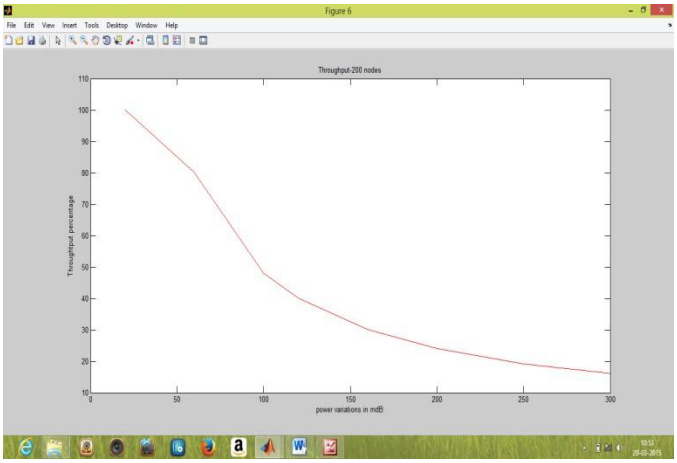

Figure. 6.1(b) shows throughput for the network size = 200

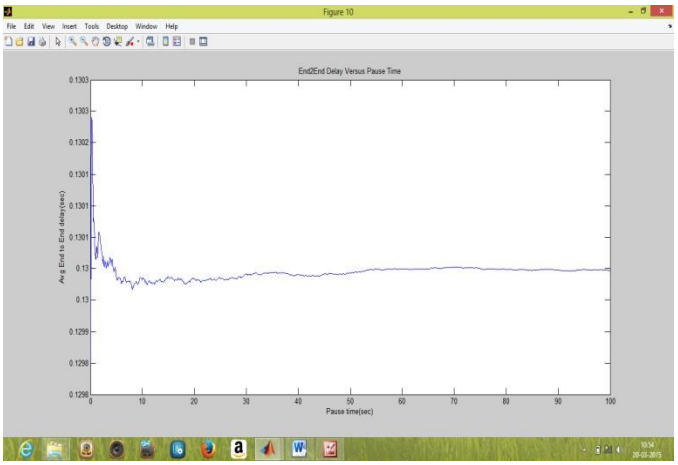

Figure. 6.3 shows graph of average end to end delay

Figure 6.1(a) and 6.1(b) shows the effect on network throughput with respect to power variation for network size of 100 and 200 nodes respectively. If more power variation is there, then throughput will also get drop. For the larger network power variation will be more; hence rate of throughput drop will also be more.

Figure 6.2(a) and 6.2(b) shows the latency for network size of 100 and 200 nodes respectively. For larger network latency will be more.

Figure 6.3 shows the average end to end delay in the network.

VII. CONCLUSION

ZigBee is a widely used standard suitable for low rate, low cost and low power saving operations for wireless sensor network applications. It mainly supports three topologies namely-Star, Mesh and Cluster Tree.

In case of cluster tree, due to the rigid routing protocol and poor utilization of bandwidth, desired level of quality of services cannot be achieved.

Therefore in the proposed solution, we have used a new framework known as Adoptive Parent Based Framework and Distributed Algorithm-PPR. This new approach provides desired level of quality of service by improving the throughput and reducing the network latency.

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