Performance Analysis of Zigbee Mesh Topology by Varying Trajectory

Arshdeep Singh Baath
Research Scholar,
Department of ECE,
SBSSTC, Ferozepur-152004,
Punjab, India

Amit Grover
Assistant Professor,
Department of ECE,
SBSSTC, Ferozepur-152004,
Punjab, India

ABSTRACT
In this paper the effect on Zigbee mesh topology is analyzed by moving the nodes at different trajectories at different speed. The nodes are moved by using Helbert Space-filling curve, hexagon and outer square trajectory. The effect is analyzed in terms of load, delay and traffic received. Result shows that with change in trajectory the performance changes. Results have been analyzed by keeping 32 nodes fixed and all others moving at speed of 5 m/sec and 7 m/sec. It has been concluded that the hexagon trajectory performs better as compare to square trajectory at speed of 5 m/sec and at 7 m/sec when 32 nodes are kept fixed and all other are moving. Further it has been investigated that while moving 32 nodes and keeping all other fixed, the performance of square trajectory is better at speed of 5 m/sec and the performance of helbert curve is better at speed of 7 m/sec.

Keywords
WSN, ZigBee 802.15, OPNET.

1. INTRODUCTION
For the attributes of self-association, smaller size, minimal cost and adaptability, Wireless sensor networks is intriguing exploration topic, both in military [1, 2] and civilian scenarios[1, 3]. Specifically, remote/ecological observing, reconnaissance of held zones and so forth, are imperative fields of utilization of wireless sensor organizing methods. Normally, low power utilization and ease hardware is required [2, 4, 11]. WSNs belong with the Wireless Personal Area Network (WPAN) sort. Here, "personal" means short range communication [1]. A WSN is a self-designing network of small sensor nodes communicating among themselves utilizing radio signals, and conveyed in quantity to sense, monitor and understand the physical world. ZigBee is an overall open standard for wireless radio networks in the checking and control fields. The standard was produced by the ZigBee Alliance to meet the accompanying essential needs like minimal cost, Integrated insight for network establishment and ultra-low power utilization.

2. ARCHITECTURE
ZigBee has three layers [3, 11]. The top layer is known as the application layer (APL). This layer gives the device its usefulness. Fundamentally, this layer changes over the input into digital information, and/or changes over digital information into output. A single device might run various applications to perform distinctive errands (i.e. reading temperature and humidity). The application layer is on top of another layer called the network layer (NL). The network layer gives ZigBee usefulness and goes about as a buffer between application layer and data link layer (DLL). The network layer is in responsible for network structure, routing, and security, for example, encryption, key administration, and authentication. The data link layer is given by IEEE 802.15.4 standard.

Figure 1: A typical example of ZigBee in Home Automation [5]

3. DEVICE TYPES
ZigBee devices are ordered as Full Functional Devices (FFD) and Reduced Functional Device (RFD). Coordinators and routers are sorted as FFD and end devices are ordered as RFD yet all have the same kind of node model. ZigBee coordinator is the most able device, the coordinator frames the root of the network tree and may extension to different networks. There is precisely one ZigBee coordinator in every network since the device began the system initially. It can store data about the network, including going about as the Trust Center and repository for security keys. ZigBee router can go about as a intermediate router, passing information to different devices. ZigBee end devices contains a usefulness to converse with the parent node (either the organizer or a router), it can’t hand-off information from different devices. This relationship permits the node to be snoozing a lot of the time along these lines giving long battery life. A ZED requires minimal measure of memory, so it can be less costly to manufacturer than a ZR or ZC [6]. The ZigBee standard permits the arrangement of three sorts of system topology: star, tree, and mesh[7, 13], in this research work mesh topology is utilized.

4. MESH TOPOLOGIES
In a network of mesh topology routers and coordinators shape various connections among one another while having end-devices as their children. While more perplexing in its development and operation, mesh topology is characterized by
link/path redundancy which is known to in enhanced robustness and network routing capacity.

5. EXPERIMENTAL SETUP
In this paper the effect of trajectories is analyzed on mesh topology. To analyze this effect different scenarios are used by using Helbert Space-filling curve[14], hexagon and outer square trajectory. In each scenarios 500 nodes are used which are placed randomly over an area of 2000m*2000m. In this area firstly 32 nodes are moving at different speed by using these trajectories and rest is static. In this scenarios nodes move and 8 nodes stopped at each points as shown in fig 3,4,5 and rest moves further. In other scenario 32 nodes are static and other nodes are moving at different speed by using different trajectories. In these scenarios 468 nodes moves and 117 nodes stoped at each point as shown in fig 3,4,5 and rest moved for next point. In each scenario 4 mobile coordinator is used which moves at different speed by using different trajectories. These 4 coordinator moves and 1 coordinator stop at each point . In each scenario 32 routers are used which are placed randomly.

6. RESULTS
Here performance of Mesh is analyzed with the mobility of both ZigBee End Devices and ZigBee coordinator for different trajectories. The result is analyzed in terms of Delay Traffic Received and Load.
6.1 Delay

Fig 6 shows the results of delay for helbert curve, hexagon trajectory and square trajectory when 32 nodes moves with speed of 5 m/sec and 7 m/sec and all other nodes are fixed. Results shown in fig 6 are given in table 1.

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Delay)</th>
<th>Hexagonal Trajectory (Delay)</th>
<th>Square Trajectory (Delay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 m/sec</td>
<td>0.016 sec</td>
<td>0.016 sec</td>
<td>0.019 sec</td>
</tr>
<tr>
<td>7 m/sec</td>
<td>0.018 sec</td>
<td>0.016 sec</td>
<td>0.017 sec</td>
</tr>
</tbody>
</table>

Fig 7 shows the results of delay for helbert curve, hexagon trajectory and square trajectory when 32 nodes are fixed and all other nodes are moving with speed of 5 m/sec and 7 m/sec. Results shown in fig 7 are given in table 2.

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Delay)</th>
<th>Hexagonal Trajectory (Delay)</th>
<th>Square Trajectory (Delay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 m/sec</td>
<td>0.018 sec</td>
<td>0.019 sec</td>
<td>0.017 sec</td>
</tr>
<tr>
<td>7 m/sec</td>
<td>0.020 sec</td>
<td>0.020 sec</td>
<td>0.018 sec</td>
</tr>
</tbody>
</table>

6.2 Traffic received

Fig 6 shows the results of delay for helbert curve, hexagon trajectory and square trajectory when 32 nodes moves with speed of 5 m/sec and 7 m/sec and all other nodes are fixed. Results shown in fig 6 are given in table 1.

Fig 7 shows the results of delay for helbert curve, hexagon trajectory and square trajectory when 32 nodes are fixed and all other nodes are moving with speed of 5 m/sec and 7 m/sec. Results shown in fig 7 are given in table 2.
Figure 9: Traffic received when 32 nodes Fix

Fig. 8 shows the results of Traffic received for helbert curve, hexagon trajectory and square trajectory when 32 nodes move with speed of 5 m/sec and 7 m/sec and all other nodes are fixed. Results shown in Fig. 8 are given in Table 3.

Table 3: Traffic received when 32 nodes moves

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Traffic received)</th>
<th>Hexagonal Trajectory (Traffic received)</th>
<th>Square Trajectory (Traffic received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>46000000 bits/sec</td>
<td>45000000 bits/sec</td>
<td>46000000 bits/sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>49000000 bits/sec</td>
<td>44000000 bits/sec</td>
<td>45000000 bits/sec</td>
</tr>
</tbody>
</table>

Fig. 9 shows the results of Traffic received for helbert curve, hexagon trajectory and square trajectory when 32 nodes are fixed and all other nodes are moving with speed of 5 m/sec and 7 m/sec. Results shown in Fig. 9 are given in Table 4.

Table 4: Traffic received when 32 nodes Fix

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Traffic received)</th>
<th>Hexagonal Trajectory (Traffic received)</th>
<th>Square Trajectory (Traffic received)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>46000000 bits/sec</td>
<td>54000000 bits/sec</td>
<td>41000000 bits/sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>53000000 bits/sec</td>
<td>54000500 bits/sec</td>
<td>42000000 bits/sec</td>
</tr>
</tbody>
</table>

6.3 LOAD

Represents the total load (in bits/sec) submitted to 802.15.4 MAC by all higher layers in all WPAN nodes of the network.

Figure 10: Load when 32 nodes moves

Fig. 10 shows the results of Load for helbert curve, hexagon trajectory and square trajectory when 32 nodes move with speed of 5 m/sec and 7 m/sec and all other nodes are fixed. Results shown in Fig. 10 are given in Table 5.

Figure 11: Load when 32 nodes Fix

Fig. 11 shows the results of Load for helbert curve, hexagon trajectory and square trajectory when 32 nodes move with speed of 5 m/sec and 7 m/sec and all other nodes are fixed. Results shown in Fig. 11 are given in Table 6.
Table 5: Load when 32 nodes moves

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Load)</th>
<th>Hexagonal Trajectory (Load)</th>
<th>Square Trajectory (Load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 m/sec</td>
<td>110000 bits/sec</td>
<td>110000 bits/sec</td>
<td>125000 bits/sec</td>
</tr>
<tr>
<td>7 m/sec</td>
<td>130000 bits/sec</td>
<td>110000 bits/sec</td>
<td>120000 bits/sec</td>
</tr>
</tbody>
</table>

Fig 11 shows the results of Traffic received for helbert curve, hexagon trajectory and square trajectory when 32 nodes are fixed and all other nodes are moving with speed of 5 m/sec and 7 m/sec. Results shown in fig 11 are given in table 6.

Table 6: Load when 32 nodes Fix

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Load)</th>
<th>Hexagonal Trajectory (Load)</th>
<th>Square Trajectory (Load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 m/sec</td>
<td>380000 bits/sec</td>
<td>400000 bits/sec</td>
<td>320500 bits/sec</td>
</tr>
<tr>
<td>7 m/sec</td>
<td>400000 bits/sec</td>
<td>400500 bits/sec</td>
<td>330000 bits/sec</td>
</tr>
</tbody>
</table>

7. CONCLUSION AND FUTURE SCOPE

In this paper, the effect of trajectories is analyzed on mesh topology by moving nodes at different speed. To analyze the effect 500 nodes are used which are placed randomly and some nodes move by using different trajectories at different speed. Trajectories used are helbert Space-filling curve, hexagon and outer square trajectory. The performance is analyzed in terms of Delay, load, and traffic received. Results show that with change in trajectory the performance changes. Results have been analyzed by keeping 32 nodes fixed and all others moving at speed of 5 m/sec and 7 m/sec. It has been concluded that the hexagon trajectory performs better as compare to square trajectory at speed of 5 m/sec and 7 m/sec when 32 nodes are kept fixed and all others are moving. Further it has been investigated that while moving 32 nodes and keeping all other fixed, the performance of square trajectory is better at speed of 5 m/sec and the performance of helbert curve is better at speed of 7 m/sec. Results also show with increase in speed performance increases.

8. REFERENCES


International Journal of Computer Applications (0975 – 8887)
Volume 138 – No.2, March 2016