Effect of Nodes Mobility using different Trajectories

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ABSTRACT
In this paper the effect of mobility of nodes at different trajectories have been analyzed on zigbee Mesh topology. Different Trajectories used are Helbert space-filling curve, hexagon trajectory and square trajectory. The effect is analyzed in terms of Throughput, Packet Loss and Media Access Delay. Results have been analyzed once by keeping 32 nodes fixed and all others moving at speed of 5 m/sec and 7 m/sec and secondly by moving 32 nodes at speed of 5m/sec and 7 m/sec and keeping all other nodes fixed. When 32 nodes are kept fixed and all other nodes are moving it has been concluded that the hexagon trajectory performs better as compare to square trajectory. Further it has been investigated that when 32 nodes moves and all other nodes are kept 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
Zigbee is a wireless sensor network standard which suited for the family of Low-Rate Wireless Personal Area Networks (LR-WPANs 250 Kbps), allowing network creation, management, and data transmission over a wireless channel with the highest possible energy savings [1]. The standard was produced by the ZigBee Alliance to meet the accompanying essential needs like minimal cost, Integrated insight for network set-up and message routing and simple establishment of ultra-low power utilization [2]. The Zigbee is based on the IEEE 802.15.4 standard, which employs a non-persistent Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) Medium Access Control (MAC) protocol and operates in the 2.4 GHz band (similarly to the IEEE 802.11 standard[3]).

ZigBee nodes send out data in range of 10-75 meters, which is used the RF communication, to make this communication three types of ZigBee nodes are used i.e. coordinator, router, and end device[4,5].

ZigBee coordinator: In each sensor network only one coordinator node is used, to make a communication for ZigBee. This sensor node is responsible for initializing the network, select the suitable channel and permit other devices to connect to its network[6,7].

ZigBee Router: Router is used to pass a information data in sensor network, and also capable to connect to other router, or an end device. Router functions are only used in a ZigBee topology[6,7].

ZigBee End Device: These nodes utilize the communication in router or a coordinator. An end device connected to the network through either a router, or directly to the coordinator[6,7].

2. 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[8,9,10,11].

3. 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[12,13,14], 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 468 nodes moves and 117 nodes stoped at each points as shown in fig 3,4,5 and rest moved for next point. In other 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.

4. RESULTS
Here performance of Mesh is analyzed with the mobility of both ZigBee End Devices and ZigBee coordinator for different trajectories. The result is analysed in terms of Packet loss, Throughput and Media Access Delay.

4.1 Packet Loss

![Fig 3: Helbert curve](image1)

![Fig 4: Square Trajectory](image2)

![Fig 5: Hexagon Trajectory](image3)

![Fig 6: Packet loss when 32 nodes moves](image4)

![Fig 7: Packet loss when 32 nodes fix](image5)
Fig 6 shows the results of Packet loss 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 5 are given in table 1.

### Table 1: Packet loss when 32 nodes moves

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Packet Loss)</th>
<th>Hexagonal Trajectory (Packet Loss)</th>
<th>Square Trajectory (Packet Loss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>246 packets/Sec</td>
<td>250 packets/Sec</td>
<td>242 packets/Sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>238 packets/Sec</td>
<td>250 packets/Sec</td>
<td>242 packets/Sec</td>
</tr>
</tbody>
</table>

Fig 7 shows the results of Packet loss 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 6 are given in table 2.

### Table 2: Packet loss when 32 nodes fix

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Packet Loss)</th>
<th>Hexagonal Trajectory (Packet Loss)</th>
<th>Square Trajectory (Packet Loss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>210 packets/Sec</td>
<td>204 packets/Sec</td>
<td>204 packets/Sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>204 packets/Sec</td>
<td>204 packets/Sec</td>
<td>204 packets/Sec</td>
</tr>
</tbody>
</table>

### 4.2 Throughput

Fig 8 shows the results of Throughput 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 7 are given in table 3.

### Table 3: Throughput when 32 nodes moves

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Throughput)</th>
<th>Hexagonal Trajectory (Throughput)</th>
<th>Square Trajectory (Throughput)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>185,478 bits/sec</td>
<td>181,519 bits/sec</td>
<td>156,236 bits/sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>194,119 bits/sec</td>
<td>181,519 bits/sec</td>
<td>163,732 bits/sec</td>
</tr>
</tbody>
</table>

Fig 9 shows the results of Throughput 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 8 are given in table 4.

### Table 4: Throughput when 32 nodes fix

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Throughput)</th>
<th>Hexagonal Trajectory (Throughput)</th>
<th>Square Trajectory (Throughput)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>663,440 bits/sec</td>
<td>1,020,176 bits/sec</td>
<td>691,765 bits/sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>1,020,176 bits/sec</td>
<td>1,020,176 bits/sec</td>
<td>799,234 bits/sec</td>
</tr>
</tbody>
</table>
4.3 Media Access Delay

Fig 10: Media Access Delay when 32 nodes moves

![Image](image1.png)

Table 5: Media Access Delay when 32 nodes fix

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Media Access Delay)</th>
<th>Hexagonal Trajectory (Media Access Delay)</th>
<th>Square Trajectory (Media Access Delay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>0.013 sec</td>
<td>0.013 sec</td>
<td>0.016 sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>0.015 sec</td>
<td>0.013 sec</td>
<td>0.015 sec</td>
</tr>
</tbody>
</table>

Fig 11: Media Access Delay when 32 nodes fix

![Image](image2.png)

Table 6: Media Access Delay when 32 nodes fix

<table>
<thead>
<tr>
<th>Speed</th>
<th>Helbert Curve (Media Access Delay)</th>
<th>Hexagonal Trajectory (Media Access Delay)</th>
<th>Square Trajectory (Media Access Delay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m/sec</td>
<td>0.013 sec</td>
<td>0.015 sec</td>
<td>0.011 sec</td>
</tr>
<tr>
<td>7m/sec</td>
<td>0.015 sec</td>
<td>0.015 sec</td>
<td>0.012 sec</td>
</tr>
</tbody>
</table>

5. 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 Throughput, Packet Loss and Media Access Delay. Results have been analyzed once by keeping 32 nodes fixed and all others moving at speed of 5 m/sec and 7 m/sec and secondly by moving 32 nodes at speed of 5m/sec and 7 m/sec and keeping all other nodes fixed. When 32 nodes are kept fixed and all other nodes are moving it has been concluded that the hexagon trajectory performs better as compare to square trajectory. Further it has been investigated that when 32 nodes moves and all other nodes are kept 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.

6. REFERENCES


