QOS Analysis in IEEE 802.15.4 and Impact of Flag Mobility on Network Performance in WSN

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ABSTRACT
Wireless Sensor Network (WSN) consists of large number of sensor nodes that are capable of communication, computation and sensing. Inherent limitations of WSN include limited storage, processing and transmission power. As compared to other network topologies, WSN has less communication Protocols mainly Zigbee/IEEE 802.15.4. IEEE 802.15.4 is a new standard, uniquely designed for low rate Wireless Personal Area Network (LR-WPAN), which is developed for applications that demand low throughput. IEEE 802.15.4 was designed for short range, low power, low complexity, low rate and low cost wireless network which provides two way wireless communication technology. For the analysis purpose, we have considered AODV as the Adhoc-routing protocol. Simulation has been carried out by using Qualnet Simulator 6.1. In this paper, we proposed a mobility control scheme and the impact of mobility over the performance of WSN is seen. In this paper, we have designed two scenarios, one is used with Random waypoint Mobility and the other is used by Mobility with Flag. Results of both the mobility schemes are compared to find out which mobility scheme gives overall best services. This paper provides the performance evaluation of quality of service parameters such as total packets received, received throughput, average end to end delay, average jitter and energy consumption as the performance metrics.

Keywords
Wireless Sensor Network, IEEE 802.15.4, AODV, Qualnet 6.1, Mobility Model.

1. INTRODUCTION
A Wireless Sensor Network (WSN) [1] contains hundreds or thousands of sensor nodes. These sensor nodes have the ability to communicate either among each other or directly to an external base station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy [6]. WSN are distributed systems of nodes with sensing, data processing and storage capabilities, wireless communication interfaces and limited power. They are used for surveillance and control applications in a diverse Range of micro and macro environments, such as wildlife habitats, urban environments, technical and biological systems and structures [3].

WSN should support the real time communication with QOS parameters like minimum delay and maximum throughput. Sensors should be able to synchronize the data communication with other nodes and they should be capable to adapt the changes in connectivity due to the failure of nodes or due to scalability [8]. The low rate Wireless Personal Area Network (IEEE 802.15.4/LR-WPAN) [10], known as wireless sensor network specifically designed for low cost , very low power consumption, and low data rate in an ad-hoc self-organizing network. WSN demands large number of tiny smart sensors, deployed in an ad-hoc fashion for the purpose of tracking and surveillance in a terrain through random and dense deployment. Sensor nodes are very small in size but are capable of gathering, processing and communicating information to outside world through intermediate router nodes [9].

In WSN application, there are two types of nodes. One is source node which sense and collect data. Second is sink node to which the collected data is sent [5]. This paper focuses on the performance analysis of wireless sensor network by using two different mobility schemes which are- 1)Random waypoint Mobility and 2) Mobility by using Flag. The Simulations are carried out by using Qulanet Simulator 6.1. Analysis is based on different network metrics such as total packets received, average end to end delay, received throughput, average jitter and total energy consumption.
The rest of the paper is organized as follows: Section II presents the brief overview of IEEE 802.15.4 and description of routing protocol. Section III gives the Methodology. Simulation set-up and performance evaluation is given in section IV. Results are discussed in section V and finally, section VI presents the conclusion.

2. OVERVIEW OF IEEE 802.15.4 AND ROUTING PROTOCOL

2.1 IEEE 802.15.4
It is known as LR-WPAN i.e. Low Rate Wireless Personal Area Network [2]. The Standard gives priority to low power, low rate and low cost. The characteristics of LR-WPAN network are similar to the sensor network. It provides two types of network topologies: the star topology and peer to peer topology [7]. It supports two different device types which can participate in an LR-WPAN network: A full function device (FFD) and a reduced function device (RFD). A Full function Device (FFD) can operate in three modes as- a PAN COORDINATOR, A COORDINATOR, and END DEVICES. An FFD can communicate to RFDs or other FFDs, while RFD can communicate only to an FFD [3].

2.2 Ad-hoc on Demand Distance Vector Routing Protocol (AODV)
AODV [4] is a reactive protocol that initiates routing activities on an “on-demand basis” and are basically designed for highly dynamic wireless mobile adhoc network [10]. It is also called on-demand routing protocol. It uses on demand approach for finding routes. In AODV, source node and the

intermediate node stores the next hop information corresponding to each flow for data packet transmission. Source node floods the nerwork with route request packets (RREQ), to find a route to the destination. When it reaches the destination, a route reply (RREP) is sent back through the same path [6]. A route then is established between source and destination and this pair is maintained as long as needed by the source [10]. If the link is broken, the nodes are then notified with a route error (RRER)
packet. AODV uses a broadcast route discovery and maintenance algorithm.

3. METHODOLOGY

In this paper, we have designed STAR topology sensor network scenarios with CBR traffic generator under different mobility schemes using Qualnet Simulator 6.1. Qualnet provides a comprehensive environment to design and create the network scenario and analyzed the results through graphs.

3.1 WSN Scenario

The main scenario consists of randomly deployed 18 sensor nodes in star topology. Node 6 acts as the sink node or the PAN coordinator. The sink node is FFD which collects the data from various sensor nodes and transfer it to the external device. Node 7 acts as the external device. The rest of the nodes acts as the end devices or sensor nodes or source nodes. These end devices are RFDs which sense the data in physical environment and transmits the data to sink node. CBR traffic application is used to provide constant data transmission from source to destination. The architecture of WSN scenario is designed as shown below.

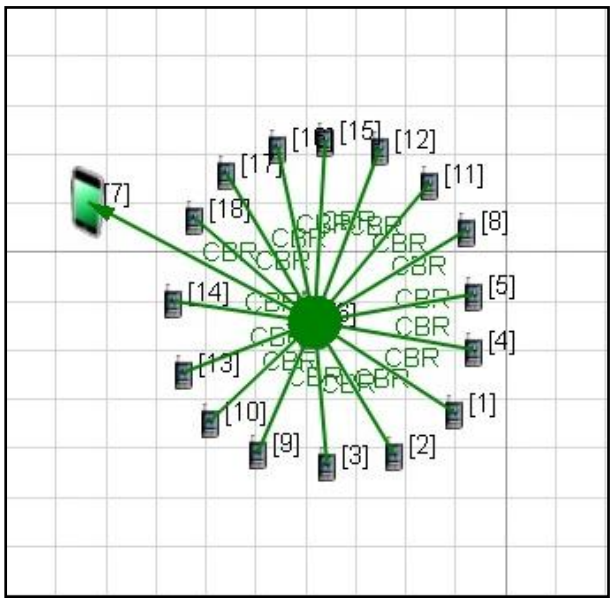

Figure 1: WSN Scenario in Qualnet

4. SIMULATION SETUP AND PERFORMANCE EVALUATION

The network scenario has been simulated in two ways by using two mobility schemes. Two mobility schemes are-

1) Random Waypoint Mobility
2) Mobility by using Flag

4.1 Scenario A- Random Waypoint Mobility Model.

This consists of several sensor nodes called motes. The sink node and the external device are kept static. All the source nodes are made mobile by giving random waypoint mobility. The minimum speed is 0 mps and the maximum speed is 50 mps. Pause time is 30 seconds. The transmission range is 100m. The scenario is designed as shown in figure 2.

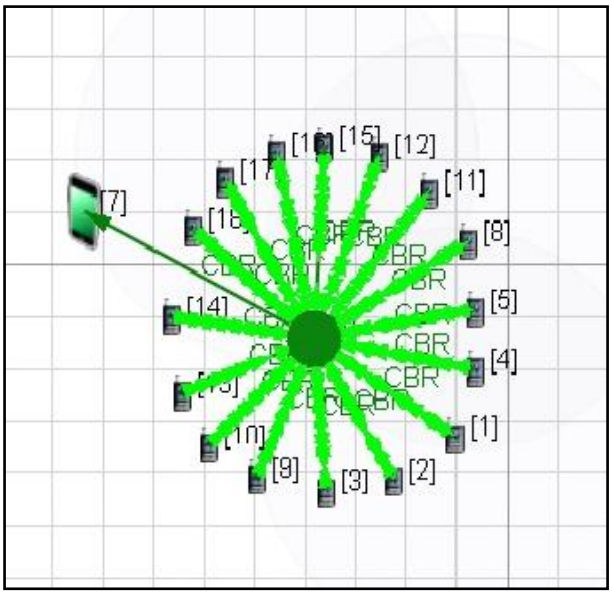

Figure 2: WSN Scenario with Radom Waypoint Mobility

4.2 Scenario B- Mobility with Flag.

This consists of several sensor nodes. The sink node and the external device are kept static. All the source nodes are made mobile by giving mobility using Flag. Flag values can be changed by clicking on the Flag icon and we have taken it as 30 seconds for first flag, 60 seconds for second flag, 90 seconds for third flag and so on. The scenario is designed as shown in figure 3.

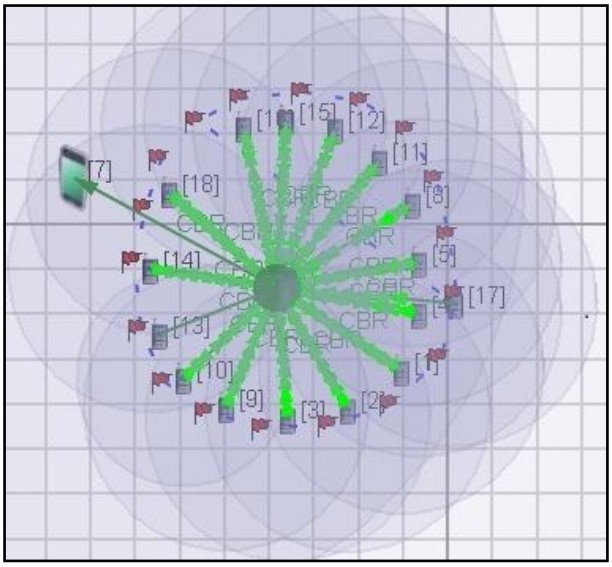

Figure 3: WSN Scenario with Flag Mobility

4.3 Comparison

The two Scenarios are compared to each other. The results are analyzed and we observed that Mobility by using Flag gives overall best services. For our scenario, we have taken 1500m × 1500m dimension of space to perform the simulations and nodes are placed randomly on the space. Multiple CBR (constant Bit Rate) are used as a traffic source and RWP (Random Waypoint) is used as a Mobility Model. We have performed Simulation for 505seconds. Battery Model used in this is Linear Model.

4.4 Simulation Parameters

The parameters taken for sensor network deployment are as indicated in Table 1.

Table 1: Simulation Parameters

Simulation Parameters	Corresponding Values
Area	1500×1500
Application	CBR
Simulation Time	505 seconds
Radio Type	IEEE 802.15.4 Radio
Energy Model	MICA Z
Modulation Scheme	O-QPSK
Packet Reception Model	PHY 802.15.4
CCA Mode	Carrier Sense
MAC Protocol	IEEE 802.15.4
Device Type	Node 1-5- RFD Node 6 & 7 – FFD Node 8-18- RFD
FFD Mode	PAN Co-ordinator
Network Protocol	IPV4
Routing Protocol	AODV
Battery Model	Linear Model
Mobility Model	Random Waypoint
Transmission Range	100m
Antenna Type	Omni-directional

With the help of Simulation Results, Performance of QOS Parameters such as received throughput, average jitter, average end to end delay, and energy consumption are evaluated and analyzed. These Performance Metrics are defined as:-

1) Throughput

It is defined as the information in bits which is received successfully by the destination in an average time. It is measured in bits/second.

2) Average Jitter

It is the variation in the arrival time of the packets at the receiver end.

3) Average End to End Delay

It is the time interval when a data packet generated from source node is completely received to the destination node.

4) Energy Consumed in Transmit Mode

It is the amount of energy consumed by sensor node to transmit the data. It is measured in mWh.

5) Energy Consumed in Receive Mode

It is the amount of energy which is consumed during receiving of data. It is measured in mWh.

5. RESULTS AND DISCUSSION

All the results collected during the simulation are shown on a 2D bar graph.

Fig.4 exhibits the total number of packets received at the server end. From the graph, it is observed that maximum number of packets are received in the case of Mobility with Flag as compared to Random Waypoint Mobility which receives less number of packets. This shows that if we use Flag as Mobility then the results gives best services.

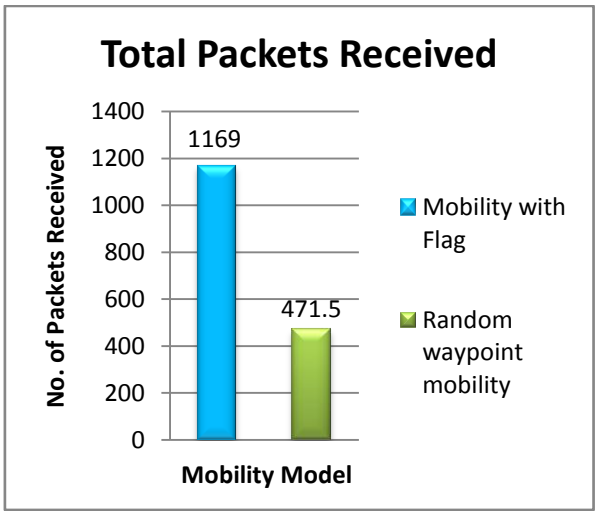

Figure 4: Total Packets Received

Fig.5 shows the received throughput. It is maximum in case of Flag Mobility and minimum in case of Random Waypoint Mobility. This shows that choosing Flag as Mobility gives best services.

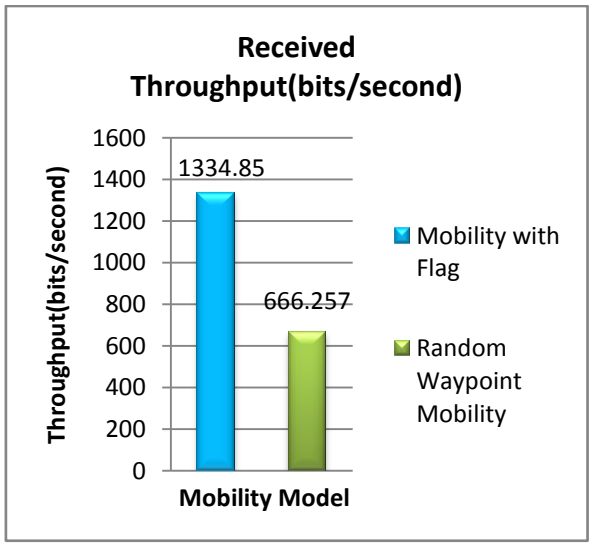

Figure 5: Received Throughput

Fig. 6 shows Average End to End Delay. It is observed that the scenario designed with Flag as Mobility shows minimum end to end delay and hence, this provides best network performance for WSN as compared to Random Waypoint Mobility which shows maximum delay.

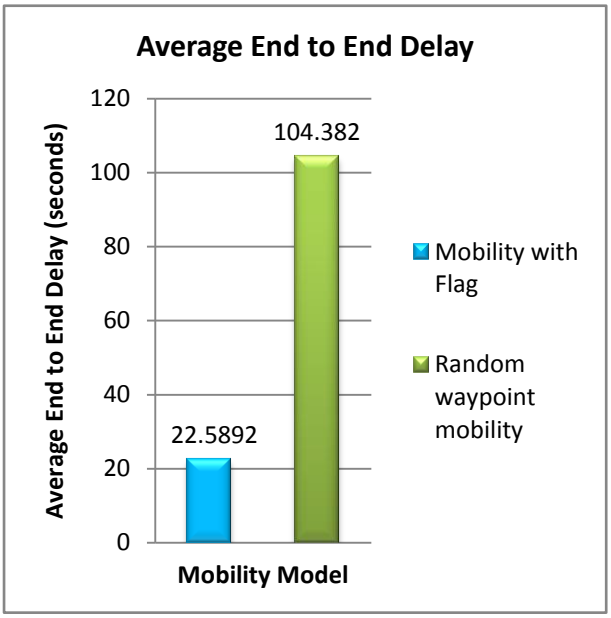

Figure 6: Average End to End Delay

Fig. 7 shows Average jitter. It is seen that maximum jitter is obtained when we use Flag as Mobility while the scenario designed with Random Waypoint Mobility shows minimum jitter. Hence, best performance is given by the use of Flag as Mobility.

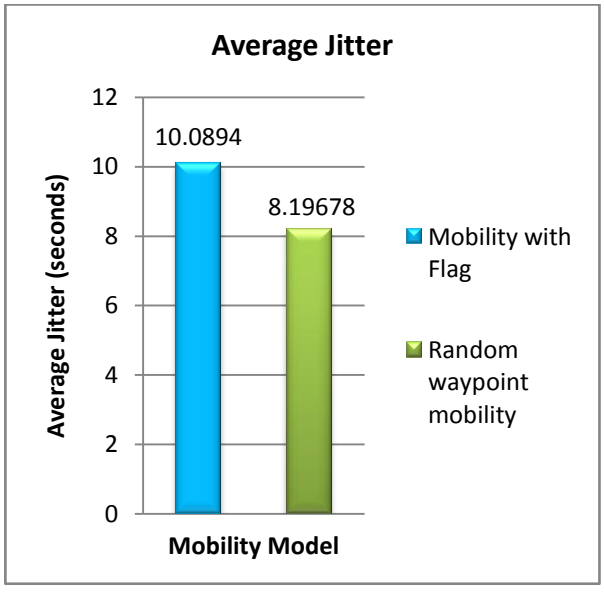

Figure 7: Average Jitter

Fig.8 shows energy consumed in Transmit Mode. It is measured in mWh. From the graph, it is clear that more energy is consumed in transmit mode when we use Flag as Mobility as compared to Random Waypoint Mobility which shows minimum energy consumed.

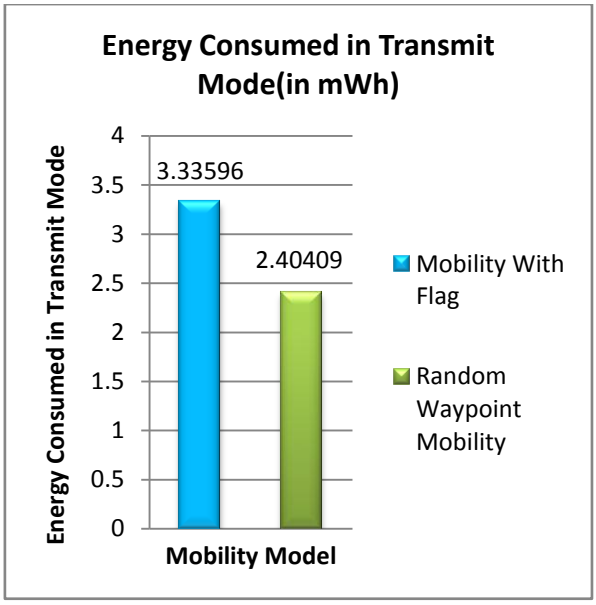

Figure 8: Energy Consumed (mWh) in Transmit Mode

Fig. 9 shows Energy Consumed in Receive Mode. It is measured in mWh. It is observed that more energy is consumed in receive mode when we use Flag as mobility as compared to Random Waypoint Mobility.

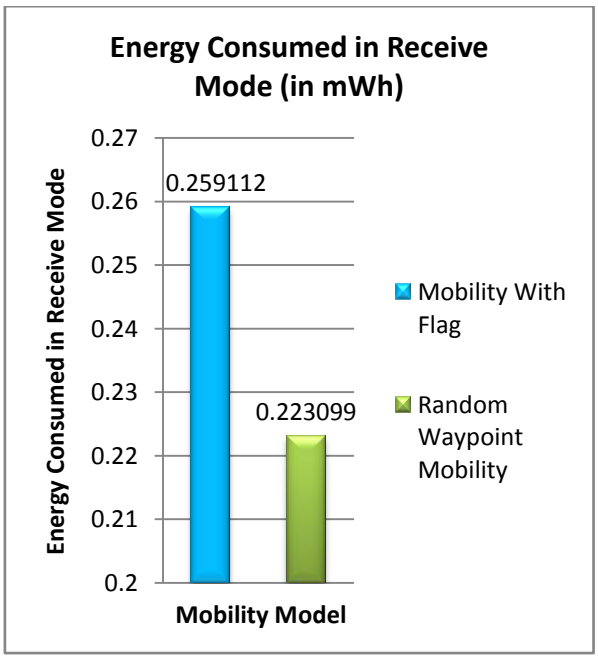

Figure 9: Energy Consumed (mWh) in Receive Mode

6. CONCLUSION

In this paper, we have analyzed several QOS parameters such as throughput, average jitter, average end to end delay and energy consumption for sensor network. For wireless sensor network (WSN), we know that there should be maximum throughput and minimum delay. We have compared the two scenarios (A&B) on the basis of Random Waypoint Mobility and Mobility by using Flag respectively. Qulanet 6.1 is used for the analysis of network performance parameters with reactive routing protocol like AODV. The results analyzed conclude that, when we use Flag as Mobility then we meet the

requirements of WSN i.e. maximum throughput and minimum end to end delay. Hence, it is clear that by using Flag as mobility gives overall best services and improves the overall network performance of the system.

The future work will focus on analyzing the QOS parameters for wireless sensor network so that the network performance can be improved by changing the several simulation parameters. The parameters can be modulation scheme, energy model, battery model and antenna type.

7. REFERENCES

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