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Ultra-Wide Band Modelling and Measurements

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Abstract— Ultra-Wide Band (UWB) is a wireless technology that has been developed to provide a solution to the low data problem in the Wireless Personal Area Network. UWB devices operates over a wide bandwidth within a range of 10 m, resulting in a data rate on the level of several hundred megabits/s. We have analysed the performance of UWB by using INET simulator to obtain the effect of hosts mobility on the Bit Error Rate (BERR) with the existence of LOS and NLOS channels.

Keywords— Wireless Network, Ultra-Wide Band, Bit Error Rate, and Omnet++.

I. Introduction

Wireless Personal Area Network (WPAN) is centered around user workspace that typically extends up to 10m in all directions [1, 2]. The main characteristics* of WPAN are: low-cost, low power, short range and very small size. The IEEE 802.15 working group has defined three classes of WPANs that are differentiated by data rate, battery drain and Quality of Service(QoS). These classes are:

1. IEEE 802.15.3: The IEEE 802.15.3 is designed for high data rate WPAN and suitable for multi-media applications that require very high QoS [3].
2. IEEE 802.15.1/Blueetooth: The 802.15.1 is designed for medium rate WPANs for handling a variety of tasks ranging from cell phones to PDA communications and provides QoS suitable for voice communications [4].
3. IEEE 802.15.4: IEEE 802.15.4 is designed for low rate WPANs and it is intended to serve a set of industrial, residential and medical applications with very low power consumption [5].

Ultra Wide Band is a wireless technology that provides a solution to the low data problem in the Wireless Personal Area Network communication. UWB devices operate within a 10 m rang over a wide bandwidth, and could provide data rate on the level of several hundred megabits/s. The first standard for UWB was released in year 2002 and it was IEEE 802.15.3. This standard does not offer high data rate for wireless services and applications. IEEE 802.15.3a has been proposed for high data rate UWB standardization. Advantages of UWB are as follows [5]:

- UWB is able to offers very high data capacity, up to several gigabits/s,
- Use of a license-exempt frequency band.
- The output power of UWB is low at the level of less than 1 mW. However, it reaches a few hundred milli watts of wireless LAN APs.
- Resilient to distortions.

This paper illustrates the effect of host mobility on the performance of UWB. The Bit Error Rate (BERR) was measured as we varied the distance between the hosts in UWB environment with the existence of LOS and NLOS. The INET simulator can provide us with the tools to simulate with NLOS and LOS [6].

For NOLS, INET simulator can simulate the existence of obstacles between nodes to obtain NLOS scenario. For LOS, the INET simulator assumes no obstacles exist between nodes. Additionally, the INET [6] simulator can simulate the mobility of host and the hosts can be mobilized in a speed of any value.

The rest of this paper is organized as follows: Section two presents the research methodology. In Sections three , our simulation results are presented after conducting a series of experiments. Section four is the conclusion.

II. RESEARCH METHODOLOGY

In order to run our simulations scenario on UWB simulation tools were required. There were several simulation tools that could have been used. Examples of these tools are: Global Mobile Information Systems Information Library (GloMoSim) [8, 9] , Optimised Network Engineering Tools (OPNET) [10], Network Simulator (NS-2) [11] and Omnet++ [12]. Omnet++ can support a large number of network components such as different applications, protocols, and traffic models.

```
network = ieee802154a
sim-time-limit=120 s # 30s for 10000 packets
ieee802154a.**.coreDebug = false
ieee802154a.playgroundSizeX = 200 m
ieee802154a.playgroundSizeY = 200 m
ieee802154a.playgroundSizeZ = 200 m
ieee802154a.connectionManager.pMax = 1000 mW
ieee802154a.connectionManager.sat = -100 dBm
ieee802154a.connectionManager.alpha = 2.0
ieee802154a.connectionManager.carrierFrequency = 4500MHz
ieee802154a.node[*].mobility.speed =0.2mps
ieee802154a.node[*].nic.phy.timeRXToTX = 0.00021 s
**.battery.voltage = 3.3V
**.battery.resolution = 10s
**.battery.publishDelta = 0.1
ieee802154a.node[*].appl.headerLength = 32bit
ieee802154a.node[*].appl.trafficParam = 1s
ieee802154a.node[0].appl.nodeAddr = 0
ieee802154a.node[1].appl.nodeAddr = 1
**.mobility.speed = 2mps
```

Fig. 1: The configuration file *omnetpp.ini*.

Omnet++ is a public-source, and modular simulation framework that is mostly applied to the domain of network simulation and other distributed systems. Various Internet protocol model have been developed on the top of Omnet++ such as INET [6] and Castalia [13].

We have used in this paper INET simulator to conduct our experiments on UWB. The INET Framework is an open-source communication networks simulation package [6]. The INET Framework contains models for several wired and wireless networking protocols, including UDP, TCP, SCTP, IP, IPv6, Ethernet, PPP, 802.11, MPLS, OSPF, and many others [6].

A simulation model was built by using both Omnet++ and INET to obtain the effect of hosts mobility on the Bit Error Rate (BERR) with the existence of LOS and NLOS channels. A configuration file named *omnetpp.ini* was built which is shown in figure 1.

III. SIMULATION RESULTS

We have used INET simulator to conduct our experiments to study the effect of LOS and NLOS on the number of erroneous bit as we varied the distance between the hosts. Also, we allowed the hosts to be move in two different speeds: 2 meter/s and 0.2 meter/s as shown in tables 1 and 2. We conducted our experiments with the following parameters:

1. The number of hosts was two and the simulation parameters that was input to the Omnet++ simulator were shown in figure 1.
2. The simulation was executed for 120 seconds and each host is sending 1000 packets.
3. The distance between the two host was changed at each run with the following values: 25, 50, 75, and 100 meters.

The experiments were conducted for two channel models (LOS and NLOS) by using the INET simulator and Omnet ++ so that the difference between a Line of Sight and a Non Line of Sight environment can be seen.

Table 1 shows the results as the two hosts are moving in a speed equal to 2 Meter per Second. The results show that the BERR is increasing as the distance between the two hosts increases. Additionally, the number or erroneous bits with LOS is much less compared to LOS. In comparison to table 1, table 2 shows that the BERR is decreasing as the two hosts are moving in a speed equals to 0.2 meter/second for both LOS and NLOS channels.

Table 1: The Host moves in 2 meter/Second

Type of Channel	Total Received bits	Erroneous bits	Distance between nodes (m)
LOS	27360	264	25
NLOS	30000	13141	25
LOS	26160	2463	50
NLOS	26160	12588	50
LOS	26400	1515	75
NLOS	29040	13100	75
LOS	24000	2052	100
NLOS	33360	15980	100

Table 2: The Host moves in 0.2 meter/Second

Type of Channel	Total Received bits	Erroneous bits	Distance between nodes (m)
LOS	28320	99	25
NLOS	30000	9174	25
LOS	25680	102	50
NLOS	28080	9458	50
LOS	31200	111	75
NLOS	28320	5736	75
LOS	25680	101	100
NLOS	32160	11218	100

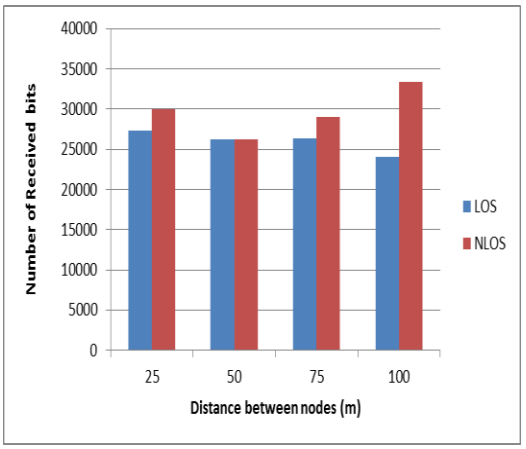

Fig. 2: Total number of received as the nodes move in a speed equals to 2 meter/s

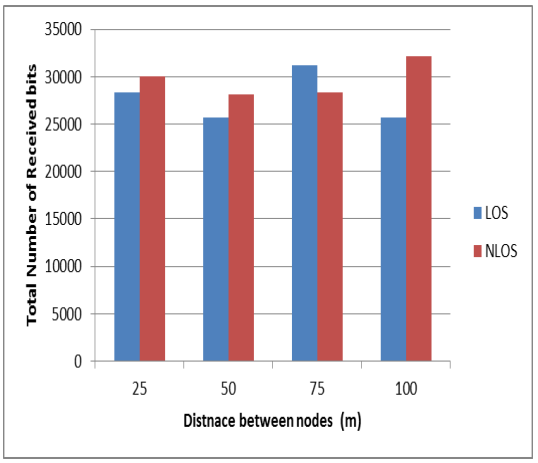

Fig. 3: Total number of received as the nodes move in a speed equals to 0.2 meter/s

Figure 2 and 3 show the number of received bits as we varied the distance between the two hosts. It is obvious that the total number of received bits is higher LOS than those measured for NLOS. Additionally, the speed of hosts mobility does not affect the number of received bits.

IV CONCLUSIONS

We have analysed the performance of UWB by using Omnet++ and INET simulator to obtain the effect of distance between hosts and hosts mobility on the BERR with the existence of LOS and NLOS channels.. We noticed that the number of erroneous bits increased as the distance between the hosts increased. We noticed that as the host moves in faster speed the number of erroneous bits increased. For both scenarios, the LOS channel experience less number of erroneous bits.

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