

# Quality of Service and Communication Technologies for Wireless Multimedia Sensor Networks

BOUDHIR Anouar Abdelhakim, *IEEE Member*, BOUHORMA Mohammed, BENSLIMANE Abderrahim, *Computer Sciences Department, ERIT ,FST of Tangier Morocco, University of Avignon LIA France*

**Abstract — In The recent years, the wireless technology knows an exponential growth, which has an impact on developing and improving the field of telecommunications beyond the means of transmission wire to the radio frequency communication. Growth due to emergence of new standards and technologies (Infrared, Wi-Fi, Bluetooth, UMTS, WiMAX, Zigbee, UWB ...).The choice of technology from multiple ones, according to the needs and a range of situations is very important. In this context, this article illustrates state of the art of wireless sensors multimedia networks and compares the quality of service offered by the technologies Zigbee and Ultra Wide Band “UWB” when sending a multimedia stream in such networks.**

**Key Words —** WMSNs, UWB, ZigBee, NS2

## I. INTRODUCTION:

The establishment of wireless networks in various domains knew an amazing success. In front of this progress several researches are followed to enlarge the range of its use. Networks of wireless sensors are a particular Ad hoc network, integrated with an active applications allowing control, surveillance and help to decision.

The role of sensors is the detection of the relevant quantities, monitoring and collecting the data, assessing and evaluating the information, formulating meaningful user displays, and performing decision-making and alarm functions are enormous.

Nowadays, tendency is towards the collection of sound and visual information called "Multimedia". This heavy information, which is able to slow the load of network, affect its life, will have to be routed by taking account all constraints that a network of traditional sensor have, like Integrity of data, Energy, security...

Various technologies appeared in sensors networks and assure the communication differently, this difference comes especially in the given quality of service and solutions given to constraints.

In this document we study the quality of service of technologies Zigbee and UWB (Ultra Wide Band) as well as the consumption of energy for a multimedia flux using the simulator NS2. This to solicit the adapted technology to the transmission of Multimedia flux in WMSN(Wireless Multimedia Sensor Network).

## II. WIRELESS SENSOR NETWORKS:

WSN are composed of group of sensors. These sensors are organized in fields “sensor fields” (fig.1) [01] each of these sensors has the capacity to collect data and to transfer them to the Sink through an architecture multi-hop. The collected data are transmitted by internet or by satellite to the host computers in order to be analyzed for giving and making decisions.

A sensor or mote is composed of a processor, a memory, a transmitter/ receiver radio, an embedded system composed of a unit of sensing and a battery. This component can be in sleep mode or listen only to the traffic. The unit of transmission is the unit which uses most energy compared to others units constituting a sensor (fig.2) [02].

The energy consumed during transmission of  $l$  bits between two nodes (Sender and receiver) is expressed by:

- *Energy Consumed on Sending* [02]:

$$E_{Tx}(l, d) = E_{Tx} - E_{elec}(l) + E_{Tx} - E_{amp}(l, d)$$

$$E_{Tx}(l, d) = E_{elec} * l + E_{amp} * l * d^2$$

- *Energy Consumed on Receiving* [02]:

$$E_{Tx}(l, d) = E_{elec} * l$$

Where:

- $E_{elec}$ : Energy Consumed by electronic component,
- $l$ : Size of packet,
- $d$ : Distance between the sender and the receive,
- $E_{amp}$ : amplification factor.

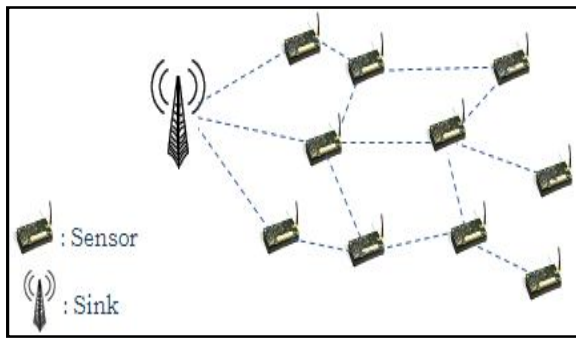


Fig.1: Architecture of Wireless Sensor Network

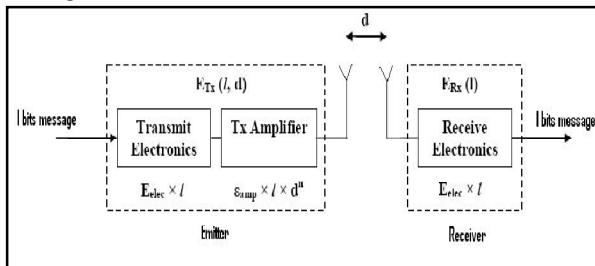


Fig.2: Energy Consumption on transmitting [02]

### III. MULTIMEDIA WIRELESS SENSOR NETWORKS:

The technology development in electronics contributed to the availability of miniaturized materials with low cost such as CMOS cameras and microphones which helped more the development of wireless multimedia sensor networks (WMSN), devices that are able to retrieve multimedia content such as the ubiquitous audio and video, still images, and data from environmental sensors.

Wireless multimedia sensor networks will not only reinforce the networks of sensors such as monitoring, home automation and environmental monitoring, but will also enable several new applications like monitoring networks multimedia, storage of potentially activities, control systems traffic, medical surveillance environmental monitoring, location services, industrial process control...

### IV. THE QUALITY OF SERVICE:

In telecommunication networks, the goal of QoS is to reach a better behavior of communication for the content which must be properly routed, and network resources are used optimally [03].

Generally, researches on QoS in wireless networks in several key areas; models of QoS differentiation at the MAC layer (Medium Access Control) protocols for signaling and routing with QoS. The need of QoS can be specified into measurable parameters in terms of:

-End to End Delay:

$$EED = \frac{\text{Time spent to deliver packets}}{\sum \text{received packets}}$$

-Bandwidth:

$$BW = \text{packets size} \times \frac{\sum \text{Received packets}}{\text{End Time Simulation}}$$

-Packet delivery ratio.

$$PDR (\%) = 100 \times \frac{\sum \text{Received packets}}{\sum \text{sent packets}}$$

### V. TECHNOLOGIES EMERGED IN WIRELESS SENSOR COMMUNICATION:

Many technologies are allowed to wireless transmission of information. Each represents a different use, according to its characteristics (transmission speed, maximum flow, Cost of infrastructure cost of equipment connected Security, Flexibility of installation and use, power consumption and autonomy ...).

#### a. Zigbee Technology:

Zigbee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the Zigbee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. Zigbee is targeted at radio-frequency (RF) applications such as industrial control and monitoring, wireless sensor networks, asset and inventory tracking, intelligent agriculture, and security would benefit from such a network topology that require a low data rate, long battery life, and secure networking.

Zigbee builds upon the physical layer and medium access control defined in IEEE standard 802.15.4 for low-rate WPAN's. The specification goes on to complete the standard by adding four main components: network layer, application layer, Zigbee device objects (ZDO's) and manufacturer-defined application objects which allow for customization and favor total integration.

Zigbee operates in the industrial, scientific and medical (ISM) radio bands; 868 MHz in Europe, 915 MHz in the USA and Australia, and 2.4 GHz in most jurisdictions worldwide. (fig.3) [04]

BAND	COVERAGE	DATA RATE	CHANNEL NUMBERS
2.4 GHz	ISM Worldwide	250 kbps	11-26
868 MHz	Europe	20 kbps	0
915 MHz	ISM Americas	40 kbps	1-10

Fig.3: The three frequency band for IEEE 802.15.4 standard

#### b. UWB Technology:

Ultra Wide Band (UWB) technology based on sending pulses of energy low power over a wide frequency band is able to communicate wirelessly as an indoor short-range high-speed communication. One of the most exciting characteristics of UWB is that its

bandwidth is over 110 Mbps (up to 480 Mbps) which can satisfy most of the multimedia applications, especially in wireless sensor networks, such as audio and video delivery in home networking and it can also act as a wireless cable replacement of high speed serial bus such as USB 2.0 and IEEE 1394

UWB works via chip-based radios that modulate signals across the entire available ultra wideband spectrum, which in the US is from 3.1 to 10.6 GHz (fig.4) [06].

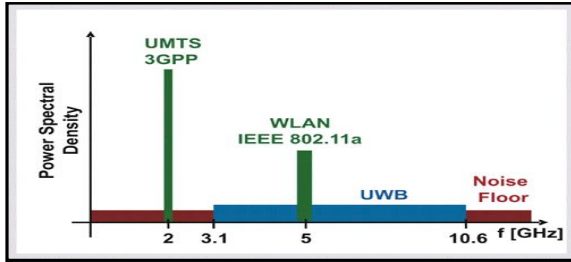


Fig.4: Frequency Spectrum in UWB technology

Table1 [05] summarizes the main differences among the four technologies. Each one is based on an IEEE standard.

Obviously, UWB and Wi-Fi provide a higher data rate, while Bluetooth and Zigbee give a lower one. In general, the Bluetooth, UWB, and Zigbee are intended for WPAN communication (about 10m), while Wi-Fi is oriented to WLAN (about 100m). However, Zigbee can also reach 100m in some applications.

## VI. SIMULATION AND RESULTS:

### a. ENVIRONMENT OF SIMULATION

The simulation tool used is the NS2 simulator dedicated to wireless networks and considered a crucial asset search.

The version of ns2-allinone-2.29 [07]used, incorporate into the architecture of the MAC layer (mac.cc / mac.h) and physical (phy.cc / phy.h) modules and standard IEEE.802.15.4 supporting radio pulses compliant to IEEE 802.15.3 UWB which adds to its MAC layer modules DCC-MAC layer (mac-ifcontrol\*. (cc, h) ) and physical layer (interference-phy\*. (cc, h) ) by implementing the NOAH protocol that allows direct communications (unlike AODV, DSR, ...) between wireless nodes, or between base stations and mobile nodes. It can simulate scenarios where multi-hop routing is undesirable.

\*Mac IFcontrol [07]: Defines the MAC layer for UWB, functions of transmission, queue management, control packets and listening mode etc.

\*Interference-phy [07]: defines possible states (reception, transmission, listen or hang) and manages the time to listen and reception etc.

### b. PARAMETERS OF SIMULATIONS

In order to evaluate the quality of service, the simulations treat a comparative metric subject to two different multicast protocols AODV [08], [09] and DSR [08],[09] for Zigbee technology and protocol NOAH for UWB parameters as mentioned below. The simulation results are drawn from the files "tr" generated and analyzed by file "awk".

Standard	Bluetooth	UWB	Zigbee	Wi-Fi
IEEE Spec.	802.15.1	802.15.3a	802.15.4	802.11a/b/g
Frequency band	2.4 GHz	3.1-10.6 GHz	868/915 MHz,2.4 GHz	2.4 GHz ; 5GHz
Max Signal rate	1 Mb/s	110Mb/s	250 Kb/s	54 Mb/s
Nominal range	10 m	10 m	10-100 m	100 m
Nominal TX power	0-10 dBm	-41.3 dBm/MHz	(-25)-0 dBm	15 – 20 dBm
Number of RF channels	79	(1-15)	1/10;16	14 (2.4 GHz)
Channel bandwidth	1MHz	500 MHz – 7.5 GHz	0.3/0.6 MHz;2MHz	22 MHz
Modulation Type	GFSK	BPSK, QPSK	BPSK, 0-QPSK	BPSK, QPSK
Spreading	FHSS	DS-UWB, MB-OFDM	DSSSS	COFDM, CCK, M-QAM
Basic Cell	Piconnet	Piconnet	Star	DESSS, CCK, OFDM
Extension of the basic cell	Scatternet	Peer to Peer	Cluster tree, Mesh	BSS
Max number of cell nodes	8	8	>65000	ESS
Encryption	E0 Stream Cipher	AES Block cipher	AES Block cipher	2007
Authentication	Shared secret	CBC-MAC (CCM)	CBC-MAC (ext. CCM)	RC4 Stream Cipher, AES
Data Protection	16-bit CRC	32-bit CRC	16-bit CRC	WPA2
				32-bit CRC

Table 1: COMPARISON OF THE BLUETOOTH, UWB, ZIGBEE, AND WI-FI PROTOCOLS

The following table summarizes the simulation parameters used for the Zigbee and UWB technologies:

Technology	ZigBee	UWB
Protocol	AODV / DSR	NOAH
Mac /phy	802_15_4	802_15_3
Chanel	Wireless Channel	InterferencePhy
Propagation	TwoRayGround	PropTarokh
Topology	80*80	20*20
Traffic	TCP/FTP	TCP/ FTP
Number of nodes	7 - 25 - 101	7 - 25 - 101
RtPower	0.00075 w	0.00075 w
TxPower	0.00175 w	0.00175 w
Initial Energy	1000 j	1000 j
Sleep Energy	0.00005j	0.00005j

Table 2: Parameters used in Zigbee and uwb simulations

### c. RESUALTS AND DISCUSSION

The following figures illustrate a comparison based on the results of previous simulations show the benefit of UWB in the delivery of a high rate of packets with a wide bandwidth and a delay start to finish while consuming a minimum of Energy for less dense networks:

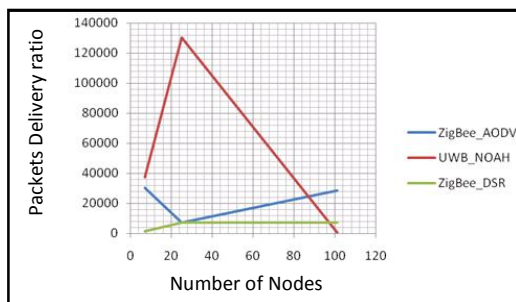


Fig.5: Packets Delivery Ratio

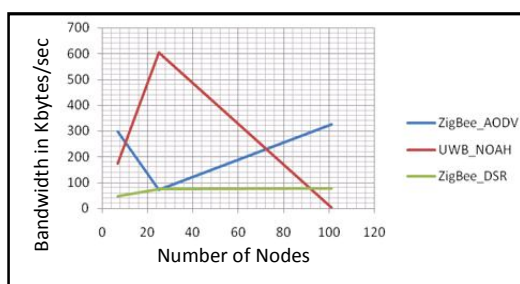


Fig.6: Bandwidth

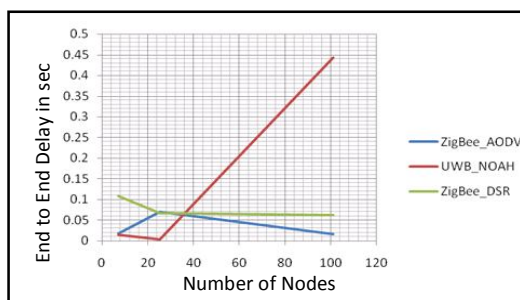


Fig.7: End to End Delay

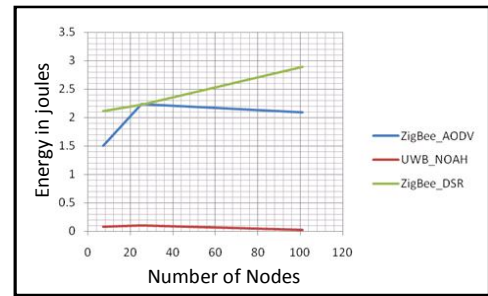


Fig.8: Energy Consumption

With the simulation parameters mentioned, the UWB technology offered a considerable quality of service for a sensor network with less density of network when sending media streams. Indeed, this technology has gives a good results compared to those of the Zigbee technology especially for a network average of 25 nodes which promotes greater use of these sensors for the transfer of multimedia data in less dense networks and topology moderately small.

### VII. CONCLUSION:

In this work, several metrics, already presented, were evaluated to examine the performance of communication established by the IEEE 802.15.3a standard (UWB) over the IEEE 802.15.4a standard (Zigbee) for multimedia streams. Furthermore, we found that the tests and simulations made in terms of QoS (packets delivery ratio, bandwidth and delay from end-to-end) and on the consumption of energy, have shown that the UWB technology responds well performance criteria desired. Indeed, this technology can be placed favorably compared to Zigbee for audio-visual transmitting at medium range and low-density network.

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