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Energy Efficient Modeling of Wireless Sensor Networks Based on Different Modulation Schemes Using QualNet

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Abstract

This paper account for the analysis of energy consumption in existing energy models of Wireless Sensor Network (WSN) based upon different modulation techniques. There are two main energy models preferred in Wireless Sensor Network, MICA MOTES and MICAZ. So here, we have investigated the more energy efficient energy model under different modulation schemes. So we can simply find the better energy model as well as the better modulation scheme to efficiently utilize the energy in WSN. Finally it has been found that, based upon the modulation schemes; mica z performs better than mica mote energy model.

Keywords: WSN, Energy Models: MICA MOTES, MICAZ And Modulation Schemes: OQPSK, BPSK, ASK.

1. Introduction

Wireless Sensor Network (WSN) has gained importance in the last few recent years, in practical as well as research fields, due to their numerous advantages as the sensor nodes can be programmed for quite specific tasks. We can also say that when human approach gets restricted, sensor node comes in action.

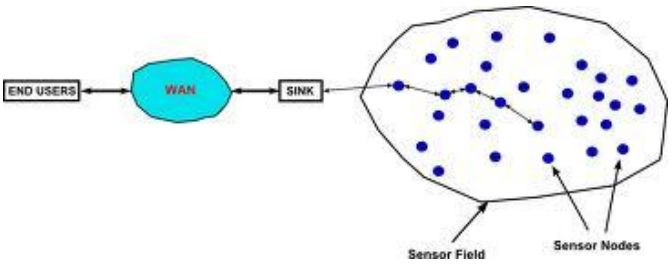

Fig.1 Typical Wireless Sensor Network

The fig.1 shows a simple architecture of wireless sensor network. A node within the network gives information to the server node; from there it travels through higher level for processing. Unlike the wire line networks, the wireless channel has several unique characteristics that need to be taken into account when designing wireless networks [1], [2].

Since the resources are always limited and the major one being the energy or the battery life of the sensor nodes. Wireless sensor networks use battery-operated computing and sensing devices [3]. So we need to design the entire network keeping in mind that we use this energy carefully. One such parameter that may affect the consumption of energy is Modulation Schemes. Talking about the digital modulation schemes, we have considered O-QPSK, BPSK and ASK(Amplitude Shift Keying) [4]. So here, we are trying to find out how to select an appropriate modulation schemes for sensor networks in different energy models, as these do affect the overall energy consumption.

2. Theory: Brief Survey on the Energy Models

There are basically two energy models: MICA MOTES and MICAZ.

MICA MOTES:

MICA mote is a commercially available product that has been used widely by researchers and developers. MICA motes are available to the general public through a company called Crossbow.The MICA mote uses an Atmel Atmega 128L processor running at 4 megahertz which is an 8-bit microcontroller that has 128 kilobytes of onboard flash memory to store the mote's program. This CPU is about as powerful as the 8088 CPU found in the original IBM PC (circa 1982). The big difference is that the Atmega consumes only 8 milliamps when it is running, and only 15 micro amps in sleep mode [5], [6].This low power consumption allows a MICA mote to run for more than a year with two AA batteries (a battery can produce about 1,000 milliamp-hours). At 8 milliamps, the Atmega would operate for about 120 hours if it operated constantly. MICA motes come with 512 kilobytes of flash memory to hold data. They also have a 10-bit A/D converter so that sensor data can be digitized.The final component of a MICA mote is the radio. It has a range of several hundred feet and can transmit approximately 40,000 bits per second. When it is off, the radio consumes less than one micro amp. When receiving data, it consumes 10 milliamps. When transmitting, it consumes 25 milliamps. Conserving radio power is the key to long battery life.

All of these hardware components together create a MICA mote.

MICA Z:

The MICA Z is a 2.4 GHz Mote module used for enabling low-power, wireless sensor networks.

As MICA MOTE is a 3rd generation device used for enabling low power, WSN available in 2.4 GHz and 868/916 MHz, MICA Z offer a 2.4 GHz, IEEE/ZIGBEE 802.15.4 and is a tiny Wireless Measurement System. It is specifically designed for deeply embedded sensor networks. Maximum data rate is 250 Kbps; modulation schemes used are O-QPSK. Transmit and receiving power is 19 and 17mA [6].

Some of the important applications are:

• Indoor Building Monitoring and Security

• Acoustic, Video, Vibration and Other High Speed Sensor Data

• Large Scale Sensor Networks (1000+ Points)

Material and Methodology: Simulation Environment

QualNet has incomparable speed, fidelity and scalability, which makes it an easy working tool for modelers to study and analyze different networks through quick model setup and easy scenario creation according to ones visualization. These models provide developers a strong library on which experiment with new network functionality can be carried out.

QualNet Scenario:

Scenario implemented in the following figure consists of 10 nodes. Each individual node is identified as Node1 to node10. Fig 2 is the snapshot of the scenario deployed in QualNet. Node2-10 is the source nodes that sensed and sent the data message to the sink node. The events sensed by the sensor channel are propagated across the network through the wireless channel, node1 acting as sink node (PAN coordinator) that collects and sense the data and transfer it to the external device.

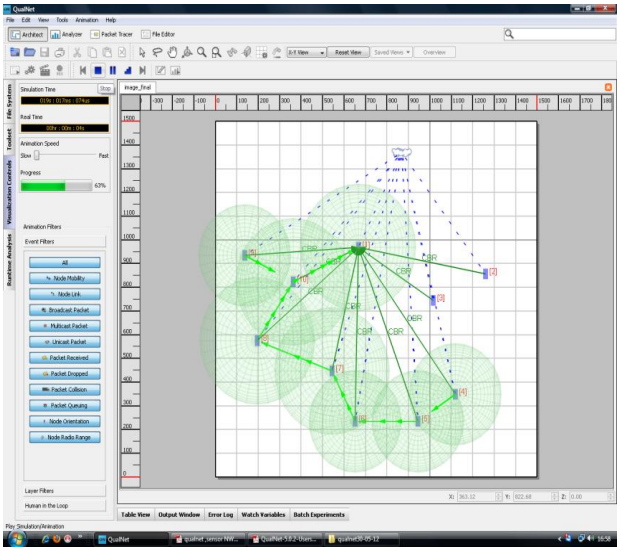

Fig.2 WSN Scenario in QualNet

Scenario Parameters:

The following table gives a brief description of the various simulation parameters used.

Table 1 Simulation parameters

Simulation Parameters	Corresponding Values
Radio Type	IEEE 802.15.4
MAC Protocol	IEEE 802.15.4
Routing Protocol	AODV
Network Protocol	IPv4
Modulation Scheme	O-QPSK
Packet Reception Model	PHY802.15.4
Energy Model Specification	MICA MOTE/MICA Z
Device Type Node1	FFD (PAN Coordinator)
Device Type Node2-10	RFD

3. Results and Discussion:

The results for the above study have been categorized as follows:

Energy Consumed in Transmit Mode:

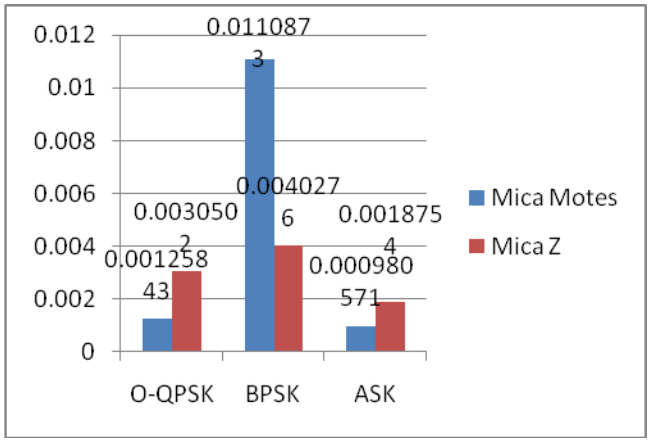

Fig.3 Comparison during Transmit mode

In transmit mode, Mica Mote models performs well with ASK and O-QPSK modulation schemes. From the graph, it is clear that in this energy model, BPSK modulation requires high energy for transmission.

Similarly, Mica Z models performs good with ASK and O-QPSK modulation schemes, while transmit energy requirements increases with BPSK.

Energy Consumed in Receive Mode:

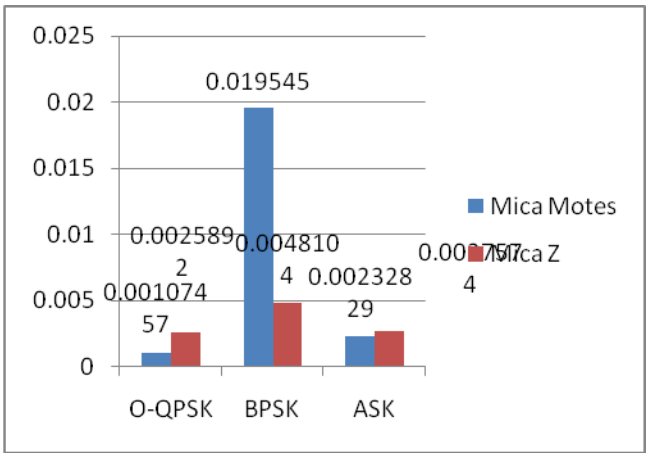

Fig.3 Comparison during Receive mode

In receive mode, Mica Mote models performs well with O-QPSK and ASK modulation schemes. From the graph, it is clear that in this energy model, BPSK modulation requires highest energy for reception.

Similarly, Mica Z models performs good with ASK and O-QPSK modulation schemes, while receive energy requirements increases with BPSK.

Energy Consumed in Ideal Mode:

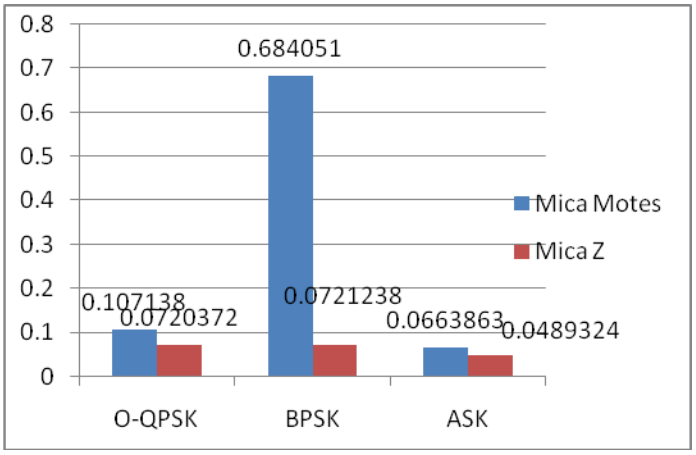

Fig.3 Comparison during Ideal mode

In receive mode, Mica Mote models performs well with ASK and O-QPSK modulation schemes. From the graph, it is clear that in this energy model, BPSK modulation requires highest energy in ideal condition.

Similarly, Mica Z models perform well with ASK modulation scheme, while energy requirements increases for O-QPSK and BPSK.

4. Conclusion:

With the graphs enclosed along with the manuscript in the previous section, following conclusions can be drawn out. We have firstly created a scenario with ten nodes. The first one act as the sink node or the PAN coordinator and the rest of the 9 nodes are source nodes. Taking the two models: MICA MOTES and MICA Z, and three modulation schemes: ASK, BPSK and O-QPSK, further discussion has been carried out.

- Energy Consumed in Transmit Mode: When mica motes is implemented, least energy consumption is occurs with ASK and then after O-QPSK modulation schemes. Same is the case with mica z models.
- Energy Consumed in Receive Mode: When mica motes is implemented, least energy consumption is occurs with O-QPSK and then after ASK modulation schemes. Same is the case with mica z models.
- Energy Consumed in Ideal Mode: For both the models, the most energy efficient modulation scheme is ASK followed by O-QPSK.
- Energy Consumed in overall scenario: Performance of mica motes is very poor with BPSK and is best with O-QPSK. Whereas for mica z, ASK offers most optimum energy consumption.
- If in an application, BPSK is the only and compulsory modulation scheme to be used, then mica z should be preferred over mica motes.

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