IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 11, Issue 1, Ver. III (Jan. - Feb .2016), PP 97-100
www.iosrjournals.org

Performance Analysis of Various Modulation Schemes for Achieving Energy Efficient Communication over Fading Channel for Wireless Sensor Network

Mustafa Hussain[1], RashedulHaque Chowdhury[2],MdRakibul Hassan[3*],MohammadAsif Hossain[4],Sarwar Jahan[5],Mohammad Hanif Rahman[6]

[1]Assistant Professor
[2]M.S TE
[3]Instructor
[4]Senior Lecturer
[5]Senior Lecturer
[6]M.S TE
Department of Electronics and Communication Engineering, East West University,Bangladesh
**School of Signals, Signal Training Centre and School (STCS)*

***Abstract**: Wireless Sensor Network (WSN) holds the potential to open domains to distributed data acquisition. Minimizing the consumption of energy in a wireless sensor network application is crucial for effective realization of the intended application in terms of cost, lifetime and functionality. In this paper, we have tried to find out the average lifetime of the batteries calculated for BPSK, QPSK and QAM transmission over different channel models as a function of link distance. Here each modulation is operated at its Optimal SNR. We have also found that, for long transmission distance BPSK,QPSK are optimal choices but as the transmission distance shortens the optimal modulation size grows to 16-QAM even to 64 QAM.*
***Keywords**: WSN, Battery Life time , BPSK,QPSK,16-QAM,64-QAM,Optimal SNR, Rayleigh, AWGN.*

I. Introduction

Wireless Sensor Networks (WSN) are distributed data acquisition system consisting of numerous Wireless Sensor Nodes. The fast deployment, self- organization and fault tolerance characteristics of wireless sensor networks make them a very promising sensing technique for environmental, military and health applications [1].The types of phenomenon that can be sensed include light, humidity,acoustics, temperature, imaging, seismic activity, any physical phenomenon that will motive a transducer to respond. Sensor node consists of sensors, processor, memory, communication system, mobilizer,power units and position finding system. WSN collects data from target area and then forwards towards a base station (B.S) or infrastructure processing node. A BS and/or sensor nodes may be a fixed or mobile. WSNs may consist of up to thousands of nodes, which can be introduced in very high density, in homes, highways, buildings,infrastructures and cities for monitoring and/or controlling purposes. Figure 1 reproduces a schematic diagram of sensor node components and WSN[2].

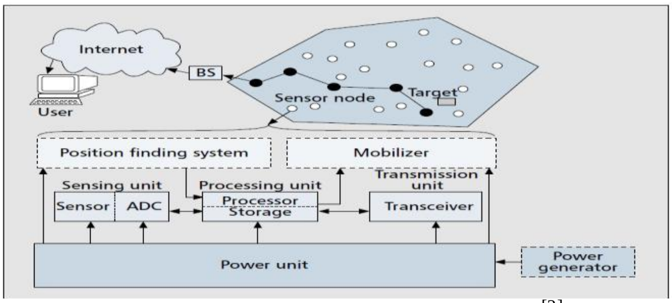

Fig.1.The components of a sensor node and WSN[2]

Wireless Sensor Network lifetime depends on the distribution of power among nodes in addition to average power consumption. Requirements on size and cost of the nodes pose vital constraints to the problem. In fact, battery depletion has been identified as one of the primary reason of lifetime limitation of these networks, and replacing them regularly is impractical in large networks or may even be impossible in hostile environments[3].

When the communication system is power- limited (as in WSN), the common notion is to choose low- order modulations such as BFSK or BPSK, which has a low SNR requirement for achieving a desired bit error rate [4]. These modulations are, in fact, the ones used in commercially available low-power transceivers like the TI CC1000 [5] or CC2420 [6].often used for WSN applications. Nevertheless it has been shown that the above notion leads to suboptimal operation for short link distances [7]-[9].

Optimal SNR & Transceiver Life time Model

We have tried to determine the total energy that is necessary for transferring one bit of data successfully, without error, in a point-to-point packet-switched wireless communication link (e.g. between two sensor nodes). We assume that every frame transmitted in the forwarddirection is matched by a feedback frame in the *reverse* direction, which acknowledges correct reception or requests a re-transmission(10). We also assume that the irradiated power is determined by the transmitter based upon knowledge of the statistics of the signal-to-noise ratio (SNR)atthedecisionstageoftheintendedreceiver. Wefurther assume that all frames in both directions are always detected and that all feedback frames are decoded without error. That's why we have determined the Optimal SNR values for different random channel model.

Optimal SNR

For obtaining Optimal SNR we have used the Minimum Optimal SNR Equation[11].

$$\lambda \left(\frac{P_{\mathrm{el}}}{A_{\mathrm{total}}} + \bar{\gamma}_0 \right) \frac{d\bar{P}_{\mathrm{s}}}{d\bar{\gamma}} (\bar{\gamma}_0) - \bar{P}_{\mathrm{s}}(\bar{\gamma}_0) + 1 = 0 \qquad (1)$$

It is to be noted that the only parameters that influence Minimum Optimal SNR level $\bar{\gamma}_0$ arethemeansymbolerrorrate, $\bar{P}(\bar{\gamma})$, thenumberof payloadsymbolsperframe, λ, andtheratiobetweenthepower consumptionofelectroniccomponents, P_{el}, andthecoefficient A_{total}, which is proportional to the irradiated power. Equation (1) can be used to find the optimal SNRfor different random channel models(12).

Transceiver Lifetime

To illustrate transceiver life time, let us consider a simple network composed by two wireless sensor nodeswith parameters as given in Table I. The nodes exchange 20 kbits of data every 3 minutes. Each node is powered by anideal 1.2 Volt AA battery with a 2000 mAh initial energy charge.

Table1. Low Power Device Parameters

Parameter	Description	Value
R_{s}	Symbolrate	20 kBaud
L	FramePayload	98bits
O	Overhead	30bits
E_{st}	Start-up energy	0.125 nJ
α	Path-losscoefficient	3.5
A	Channelloss	30 dB
η	PAefficiency	0.35%
$P_{\mathrm{el,tx}}$	Tx electric powerconsumption	98.2 mW
$P_{\mathrm{el,rx}}$	Rx electric powerconsumption	112.5 mW
M_{l}	Linkmargin	40 dB

II. Simulation & Analysis

A. Simulation

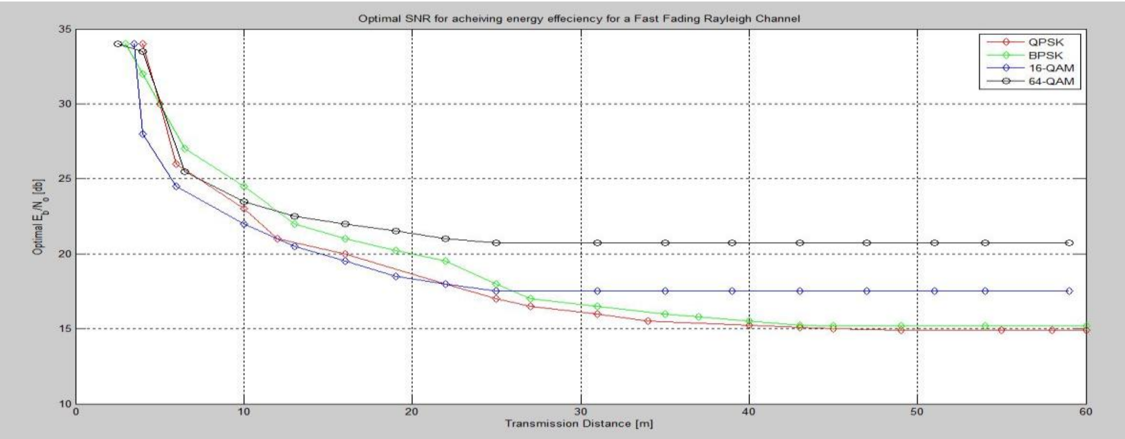

Fig. 2. Optimal SNR for achieving energy efficiency as function of link distance for a fast fading Rayleigh channel.

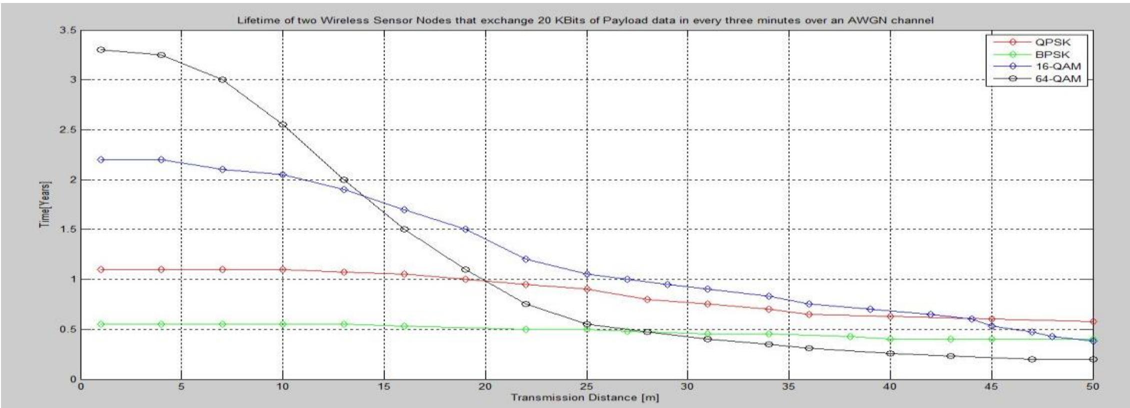

Fig.3 : Lifetime of two wireless sensor nodes that exchange 20 Kbits of Pay load data every three minutes over an AWGN Channel

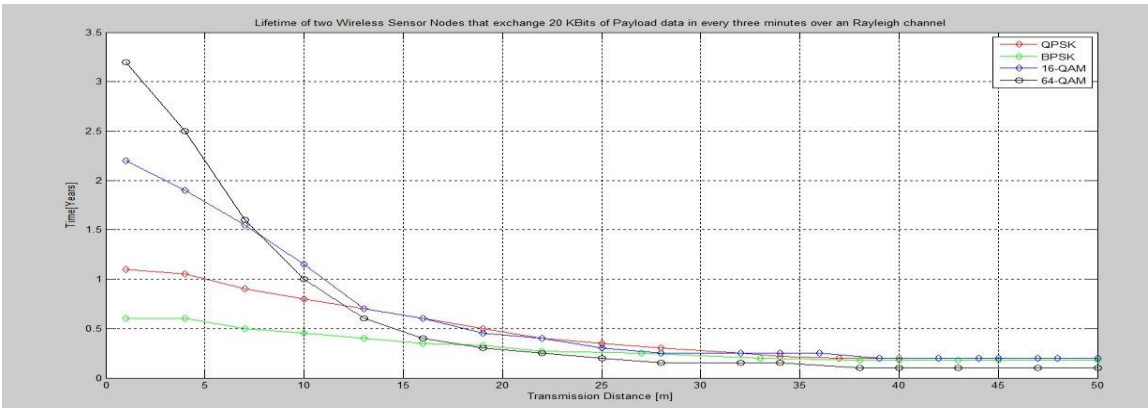

Fig.4 : : Lifetime of two wireless sensor nodes that exchange 20 Kbits of Pay load data every three minutes over an Rayleigh Channel

B. Analysis

Numerical evaluations of (1) using the parameters presented in Table I show that BPSK, BFSK and variousM- QAM modulations attains it minimum energy consumption at a different SNR. As can be seen in Figure 1, the SNR at which these minima occur varies with transmission distance (curves areplottedagainstE_b/N_0 tocomparetheresultsagainstan equal amount of energy per bit).

From Figure 2 & 3 ,using the above mentioned model, the average lifetime of the batteries of these two nodes was calculated for BPSK, BFSK and M-QAM transmissions over different channel models as a function of link distance, with each modulation operated at its optimal SNR. It was found that as distance decreases,the longest network lifetime is achieved by more spectrally efficient modulations (Figure 2 for the AWGN channel and Figure 3 for fast fading Rayleigh channel). It is apparent that, regardless of the channel type, lifetime extensions up to 550% can be gained in short range networks by selecting modulations with larger constellations than BPSK.

III. Discussion

We have detected that for a given modulation scheme the average energy consumed per bit by transmissions over a fast fading channel as function of the SNR has a unique minimum value, which is obtained at an SNR which is optimal in the energy consumption sense. The parameters that influence this optimal SNR are the mean symbol error rate, the number of payload symbols per transmission frame and the ratio between the power consumption of electronic components versus the irradiated power.

We also found that for long transmission distances, low bandwidth efficiency modulations (small M -ary number, like BPSK) are optimal in the energy consumption sense. As the transmission distance shortens the optimal modulation size grows. In short range communications the power consumed by electronic components dominates over the irradiated power, and hence also does so over the energy consumption of the power amplifier. Under these conditions the average air time spent per data bit becomes a relevant parameter in the total energybudget.Thismakesoptimaltopackmorebitsintoeach symbol and thereby to choose a larger modulation size.

Lastly ,our results show that lifetime extensions up to 550% can be gained in short range networks by selecting modulations with larger constellations thanBPSK.

Refferences

[1] F.Akyildiz I F, Su W and Sankarsubramaniam Y 2002 Wireless sensor networks: a survey Computer Networks 38393-422

[2] J. N. Al-Karaki and A. E. Kamal, "Routing Techniques in WSNs. IEEE Communications Magazine", **(2004)**December.

[3] R. Verdone, D. Dardari, G. Mazzini, and A. Conti, Wireless Sensor and Actuator Network: technologies, analysis and design. Academic Press, 2008.

[4] B. Sklar, Digital Communications: Fundamentals and Applications.Upper Saddle River, NJ, USA: Prentice Hall, 2001.

[5] Chipcon, "CC1000 Single Chip Very Low Power RF Transceiver," datasheet,2002.

[6] "2.4 Ghz IEEE 802.15.4 Zigbee-ready RF Transceiver," SWRS041 datasheet,2006.

[7] V. Raghunathan, C. Schurgers, S. Park, and M. B. Srivastava, "Energy- aware wireless microsensor networks," IEEE Signal Processing Maga- zine, vol. 19, no. 2, pp. 40–50, Mar. 2002.

[8] S. Cui, A. J. Goldsmith, and A. Bahai, "Energy-constrained modulation optimization," Wireless Communications, IEEE Transactions on, vol. 4, no. 5, pp. 2349–2360, 2005.

[9] T. Wang, W. Heinzelman, and A. Seyedi, "Minimization of transceiver energy consumption in wireless sensor networks with AWGNchannels," in Communication, Control, and Computing, 46th Annual Allerton Conference on, 2008, pp.62–66.

[10] M. Holland, "Optimizing physical layer parameters for wireless sensor networks," Master's thesis, Rochester University,2007

[11] Fernando Rosas "Modulation Optimization for achieving energy efficient Communication"IEEE Signal Processing Magazine, vol. 12, 2012.

[12] K. Hartwell, G. G. Messier, and R. J. Davies, "Optimizing Phys- ical Layer Energy Consumption for Wireless Sensor Networks," in VTC2007-Spring, 2007, pp.76–79.