Multihop Clustering based Routing SIMPLE-ATTEMPT-Energy Aware Sensor Network Sink Mobility Protocols using Aurdino - nRF 24L01+ - TI CC2420 in Wireless Body Area Networks

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Abstract : Wireless body area network is a subset of wireless sensor network. Design of routing protocols has seen remarkable advancement in the field of Wireless Body Area Networks (WBANs). These protocols work to enhance the performance of WBAN by focusing on routing, energy efficiency and end-to-end delay. In this network sensor nodes are placed in or on the human body to measure the vital signs of the human body. Various energy efficient routing protocols have been proposed for wireless body area network to increase the network lifetime. Clustering is a technique which is used to decrease the energy consumption in the sensor nodes. This research paper proposes a clustering-based routing protocol inspired by protocol for wireless sensor network. Stable Increased-throughput Multi-hop Protocol for Link Efficiency (SIMPLE) protocol is compared with the Mobility-supporting Adaptive Threshold-based Thermal-aware Energy-efficient Multi-hop Protocol (M-ATTEMPT) designed for wireless body area network. Results shows SIMPLE protocol performs better than the ATTEMPT protocol in terms of increased stability period and throughput. This research paper presents SIMPLE, ATTEMPT and Energy Aware Sensor Network Sink Mobility (EASNSM) Protocols using Arduino - Nordic Semiconductor nRF 24L01+ and Texas Instrument CC2420 in Wireless Body Area Networks recent routing protocols in the field of WBAN and presented a comparative analysis. To evaluate proposed protocols, we have conducted an extensive set of experiments using MATLAB R2017a.

***IndexTerms* - multi path routing, Sink, Routing protocol, Wireless Body Area Networks (WBAN), Wireless Sensor Network (WSN)**

I. INTRODUCTION

During the last few years, Wireless Body Area Networks (WBANs) have emerged into many application domains, such as medicine, sport, entertainments, military, and monitoring. This emerging networking technology can be used for e-health monitoring. In this research paper, we review the literature and investigate the challenges in the development architecture of WBANs. Then, we classified the challenges of WBANs that need to be addressed for their development. Moreover, investigate the various diseases and healthcare systems and current state-of the-art of applications and mainly focus on the remote monitoring for elderly and chronically diseases patients. Finally, relevant research issues and future development are discussed. Wireless Body Area Network (WBAN) is a co-field of Wireless Sensor Networks (WSN) [1-3]. The main objective of such network is establishing a communication link with the human body. These sensors can be fixed inside the body or wearable sensors depending upon the type of the application which is attached to the body [4]. These devices are used for measuring the environmental conditions, industrial environments, motion detection of the animals for non-medical applications in the forest, security, etc. Personal devices like Personal Digital Assistance (PDA) receive, collect or aggregated signals which, act as a relay node and sent them to some internet using applications or to health treatment professionals with the help of sink node. Every sensor node forward data to the sink after sensing it. The rest of the paper is organized in following order. In section 2, we review related work, while Section 3 describes motivation for this work and comparison of routing protocols. Radio model is presented in section 3, while detail of the SIMPLE protocol and Energy Aware Sensor Network with Sink Mobility (EASNSM) is presented in section 3. Performance metrics and simulation results are presented in section 4. Finally, presented the conclusion.

II. RELATED WORK

WIRELESS sensor networks (WSNs) are getting importance day by day because of their ability to work autonomously [4]. The prevailing sensor nodes may contain radio chip such as CC2420 which may provide multichannel capability to WSNs e.g., CC2420 is used in sensor nodes and therefore they can exhibit multichannel capability in the real world. The multichannel approach is superior to single channel approach because it may afford parallel transmissions by using distinct channels which may result into ensuring high throughput, reducing data gathering delay [4]. As the number of (wireless) communication technologies increases, we are witnessing a drastic increase in the number of co-located, heterogeneous wireless networks with different coverage, data rates, mobility capabilities and requirements. There is a growing need for the network solutions that would efficiently and dynamically support at run-time cooperation between devices from different subnets [5]. A multi-hop wireless routing protocol based on Software Defined Network (SDN) is proposed [6], the controller has a global view of the network and provides single-path routing or multipath routing for other nodes. WSNs consist of Sensor Nodes (SNs) which are equipped with low-power microcontrollers and transceivers to perform various operations in the network field [7]. Quality of Service (QoS) requirements of multimedia communications and energy constraints of battery-powered sensor nodes, necessitate the design of reliable and energy-efficient communication protocols for Wireless Multimedia Sensor Networks (WMSNs) [8]. Ansuman et al. proposed a new routing protocol called the *Least Common Multiple based Routing* (LCMR) for load-balanced multipath routing in *Mobile Ad hoc NETwork*s (MANETs) [10]. Congduc Pham investigated the communication performances of low-resources sensor motes that are commonly found in recent smart cities test-beds or used by the research community [12]. Nessrine identified and discussed the main future research directions related to the opportunistic routing design, optimization, and deployment [13]. Wireless ad-hoc networks are becoming popular due to the emergence of the Internet of Things and cyber-physical systems (CPSs). Due to the open wireless medium, secure routing functionality becomes important [14]. Time critical and delay sensitive multimedia applications require more spectrum and transmission resources. With the provision of cognitive radios (CRs), the underutilized spectrum resources can be exploited to gain more bandwidth for the bandwidth hungry applications (multimedia applications). Cognitive radio networks (CRNs) also have the flexibility to adjust their transmission parameters according to the needs of multimedia services or applications. For this reason, wireless multimedia cognitive radio networks (WMCRNs) have gained much attentions in today's research domain [15].

III. COMPARISION of ROUTING PROTOCOLS

1. SIMPLE

This research paper presents a protocol named Stable Increased-throughput Multi-hop Protocol for Link Efficiency (SIMPLE). Here it uses a single sink node and eight sensors in the human body where a sink was placed near the waist. All the sensors had same energy levels at the beginning but after some interval of time sensors loss their energy level. Now therefore for balancing energy level and increased the network stability, author used a cluster head in cluster formation or forwarded by using a mathematical formula. Cluster head had more residual energy which is also a node and lied in a short distance to the sink node. SIMPLE use multi-hop topology to achieve minimum energy consumption and longer network lifetime. We propose a cost function to select parent node or forwarder. Proposed cost function selects a parent node which has high residual energy and minimum distance to sink. Residual energy parameter balances the energy consumption among the sensor nodes while distance parameter ensures successful packet delivery to sink. Simulation results show that our proposed protocol maximize the network stability period and nodes stay alive for longer period. Longer stability period contributes high packet delivery to sink which is major interest for continuous patient monitoring. Multihop communication is used to improve life time of the node and minimize the energy consumption. Which is performed by with help of parent node or relay node and selection of parent is based on the cost function. Cost function is relationship between distance from their sink and residual energy of the node.

2. *M-ATTEMPT*

Mobility-supporting Adaptive Threshold-based Thermal-aware Energy-efficient Multi-hop Protocol (M-ATTEMPT), which is based on threshold routing protocol in the established links for finding the link spot. In this scheme sensors were used in descending order with respect to the sink of their data rates. Both single hope and multi hope communication is used for emergency and normal data.

Table I: Comparison of Routing Protocols of BAN

Protocol	Technique	Achievements	Disadvantages
SIMPLE	Calculate cost function using multi-hop communication	· high delivery ratio · Longer stability	Extra overhead due to finding cluster head
M-ATTEMPT	· Thermal aware protocol · Single hop Communication for emergency data · Multi hop for normal data.	· Energy Management · Mobility support	· Single sink transmission creates burden · Hence delay and decrease in data delivery

3. Energy Aware Sensor Network with Sink Mobility (EASNSM)

The problem of the work can be summarized as "simulate wireless sensor network with backup routing concept maximize the lifetime without depending on data aggregation and delayed transmission for the same." So, when a node which is part of a path start losing its energy, it informs the source. Source obtains an alternative path. Till the alternative path is formed, packets are transmitted through the previous path. As soon as the new path is formed, the previous path is dropped. When there remains no path, sink starts moving towards the source node reducing the distance between the nodes and thus maximizing data delivery (figure 16-17).

Energy Model

PL_0 is received power at reference distance d_0 and it is expressed as:

$$PL_0 = 10\log 10\frac{(4\pi \times d \times f)^2}{c} \tag{1}$$

Where f is frequency, c speed of light and d is distance between transmitter and receiver.

We use the first order radio energy model, here in Equation (2). To transmit an *l*-bit length message through a distance *d*, the energy consumption by the radio is given by:

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

$$E_{Tx}(l,d)=\begin{cases} lE_{elec}+l_{\varepsilon fs}d^{2}, d<d_{0} \\ lE_{elec}+l_{\varepsilon fs}d^{4}, d\geq d_{0} \end{cases} \tag{2}$$

where $E_{Tx-elec}$ represents transmitter electronics, E_{Tx-amp} represents receiver electronics, E_{elec} is the energy expended to transmit or receive one-bit data, ε_{fs} and ε_{mp} illustrate the amplifier model we use, and *l* is the length for data waiting to be transmitted. The electronics energy E_{elec} depends on factors like the digital coding, modulation, filtering, and spreading of the signal, whereas the amplifier energy varies according to the distance *d* between a receiver and a sender. When, $d < d_0$, a free space channel model is accepted, while multi-path channel model is used when $d \geq d_0$.

We have $d_0=\sqrt{\varepsilon_{fs}/\varepsilon_{mp}}$ by equaling $\varepsilon_{fs}d^2$ and $\varepsilon_{mp}d^4$, ε_{fs} where represents free space fading and ε_{mp} represents multipath fading. To receive the message, the radio consumes:

$$E_{Rx}(l)=E_{Rx-elec}(l)=lE_{elec} \tag{3}$$

The total energy consumption in the network is calculated in Equation (4), where E_{DA} represents the energy for data aggregation and *N* is the number of nodes distributed uniformly in the network:

$$E_{tot}=L.(2NE_{elec}+NE_{DA}+\varepsilon_{mp}k.d^{4}_{t_0BS}+N\varepsilon_{fs}\frac{M^{2}}{2\pi k}) \tag{4}$$

The optimum number of clusters can be found by setting the derivative of E_{tot} with respect to k to zero, which is shown in Equation (5) as follows:

$$K_{opt}=\sqrt{\frac{N}{2\pi}}\sqrt{\frac{\varepsilon_{fs}}{\varepsilon_{mp}}}\frac{M}{d^{2}_{t_0BS}} \tag{5}$$

$$p_{opt}=\frac{K_{opt}}{N} \tag{6}$$

Cluster Heads Selection

the threshold of cluster heads is set in Equation (7) as follows:

$$T(n)=\begin{cases} \dfrac{p}{1-P[r \bmod (1/P)]} \\ 0 \end{cases} \text{ if } n \in G, \text{ other wise } 0, \tag{7}$$

where *P* is a ratio of cluster heads among all sensors, 1/*P* is the expected number of nodes in one cluster, *r* is the index of the current round and *G* is the set of nodes that have not been cluster heads in the last *r* mod(*1*/*P*) rounds.

The total energy of new heterogeneous network is calculated in Equation (8):

$$N \cdot (1-m)\, E_0 + N \cdot m \cdot E_0\,(1+\alpha) = N \cdot E_0 \cdot (1+\alpha m) \tag{8}$$

Hence, the total energy increases by $(1+\alpha\cdot m)$ times. Virtually there are $n\cdot(1+\alpha\cdot m)$ nodes with energy equal to the initial energy of a normal node.

The weighed probability for normal nodes is:

$$P_{nrm}=\frac{P_{opt}}{1+\alpha.m}.\frac{E_{residual}}{E_{0}} \tag{9}$$

where P_{opt} is the optical percentage of cluster head, α is the factor of additional energy, *m* is the percentage of advanced nodes, $E_{residual}$ is the energy left in sensor nodes after certain rounds, and E_0 is the initial energy of any nodes. Similarly, in Equation (10), weighed probability for advanced nodes is:

$$P_{adv}=\frac{P_{opt}}{1+\alpha.m}\times(1+\alpha)\frac{E_{residual}}{E_{0}} \tag{10}$$

SEP replaces P_{opt} by the weighted probabilities discussed above. Define $T(s_{nrm})$ as threshold for normal nodes and $T(s_{adv})$ as threshold for advanced nodes. As is illustrated in Equation (11), for normal nodes:

$$T(S_{nrm}) = \left\{ \begin{array}{l} \dfrac{p_{nrm}}{1 - P_{nrm}[r \bmod(1/P_{nrm})]} \\ 0 \end{array} \right\}$$

if n ∈ G', other wise 0, (11)

where r is the current round, G′ is the set of nodes which have not become cluster heads within the last $1/P_{nrm}$ rounds, and $T(s_{nrm})$ is the threshold applied to a population of normal nodes. Similarly, in Equation (12), for advanced nodes, we define:

$$T(S_{adv}) = \left\{ \begin{array}{l} \dfrac{p_{adv}}{1 - P_{adv}[r \bmod(1/P_{adv})]} \\ 0 \end{array} \right\}$$

if n ∈ G'', other wise 0, (12)

where r is the current round, G'' is the set of nodes that have not become cluster heads within the last $1/P_{adv}$ rounds, and $T(s_{adv})$ is the threshold applied to a population of normal nodes

Table II: Simulation parameters.

Simulation Parameters	**Representation**	**Unit**
N	Number of sensor nodes	100
E_0	Initial energy of sensor nodes	0.2 J
E_{DA}	Data aggregation	5 nJ/bit/signal
E_{elec}	Energy dissipation to run the radio device	50 nJ/bit
ε_{fs}	Free space model of transmitter amplifier	10 pJ/bit/m^2
ε_{mp}	Multi-path model of transmitter amplifier	0.0013 pJ/bit/m^2
l	Packet length	4,000 bits
d_0	Distance threshold	$\sqrt{\dfrac{\varepsilon_{fs}}{\varepsilon_{mp}}}$

Node Variation (figure 16-17)

1) a) Node v/s Energy (consumption and spent)
b) Node v/s BER
c) Node v/s Delay

Round Variation

d) Round v/s Energy
e) Round v/s BER
f) Round v/s Delay

SNR Variation

g) SNR v/s Energy
h) SNR v/s BER
i) SNR v/s Delay

Packet Length Variation

j) Packet length v/s Energy
k) PL v/s Delay
l) PL vs BER

2) To start a new comparison, click on new simulation (figure 16), then vary the input parameter (node/rounds/snr/packet length) serially. Say N=40, SNR=10, PL=50, Rounds=20 in Node vs all comparison.

3) Now generate network and simulate for first network (figure 16). Then again generate network and simulate for second parameter.

4) Now change nodes to 50 and re do the experiment

5) In the graph, x-axis is whatever you are varying, and Y axis is output parameter mentioned above.

Block Diagram

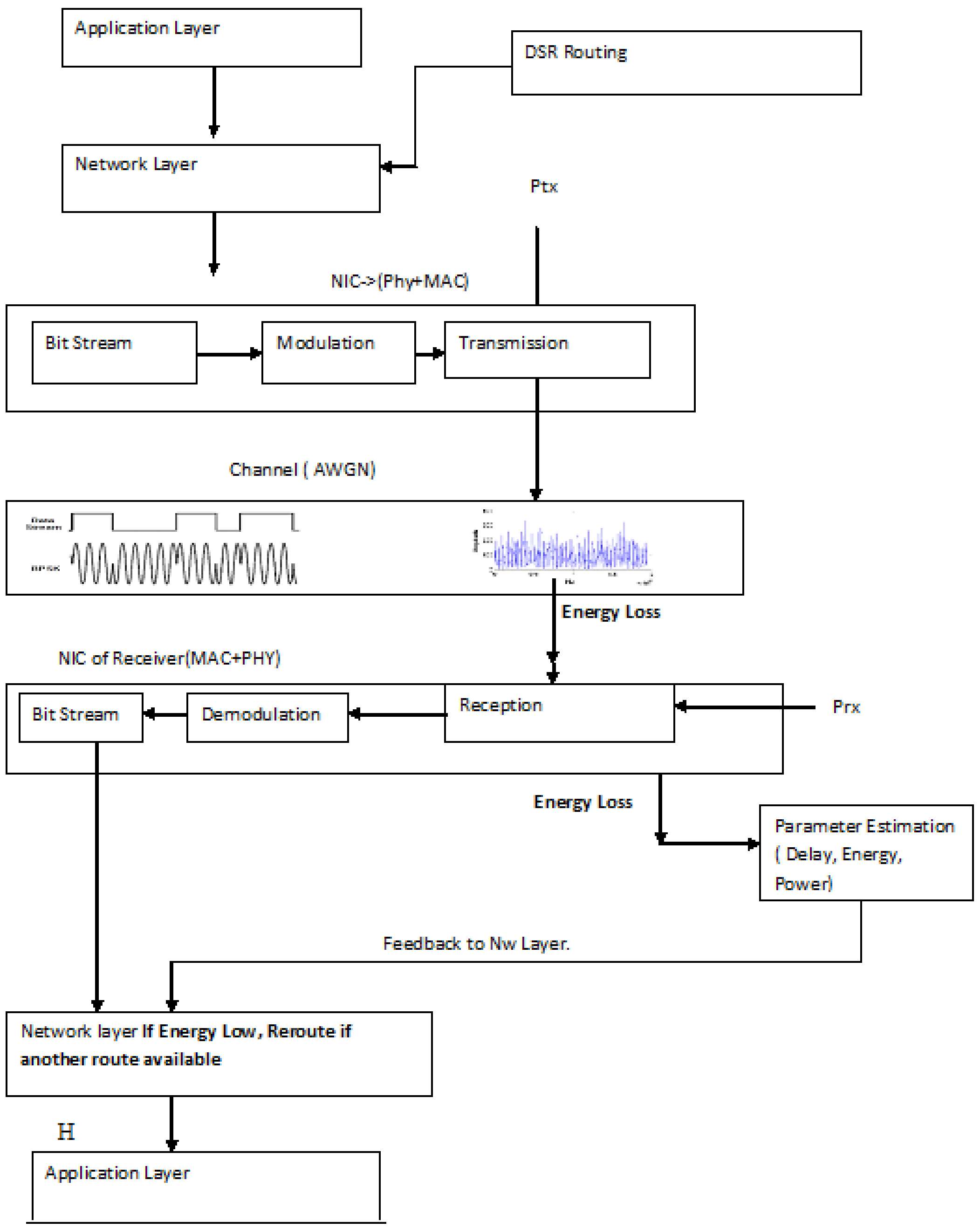


Figure 1: Block Diagram Energy Aware Sensor Network with Sink Mobility (EASNSM)

IV. IMPLEMENTATION

APPLICATIONS OF ROUTING PROTOCOLS FOR WSNS

In this scheme, we deploy eight sensor nodes (figure 2) on human body (figure 3). All sensor nodes have equal power and computation capabilities. Sink node is placed at waist. Node 1 is ECG sensor and node 2 is Glucose sensor node. These two nodes transmit data direct to sink. Figure 3 shows the placement of nodes and sink on the human body.

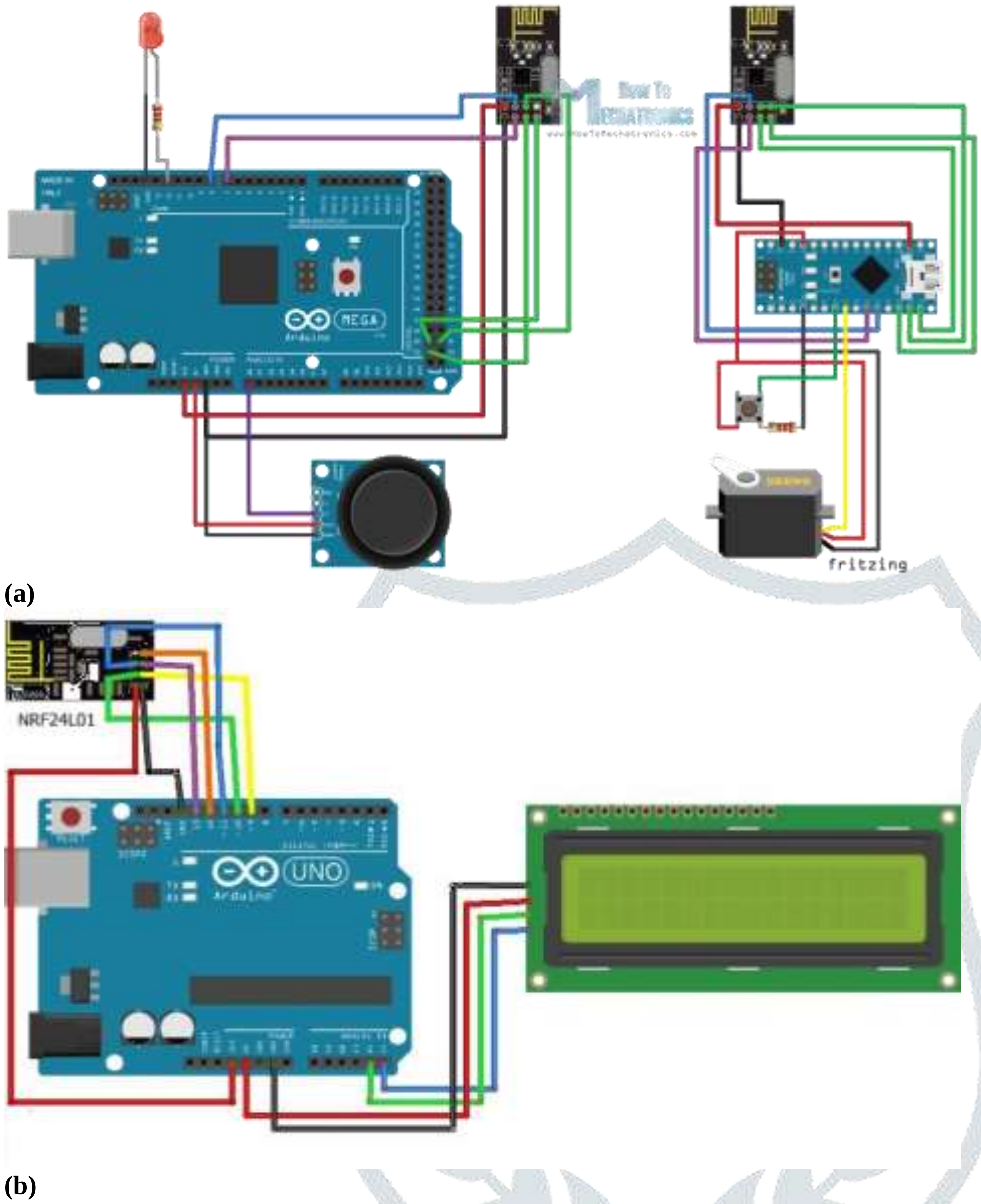


Figure 2: (a) Wireless Sensor Tx & Rx (b) Arduino and NRF24L01 with LCD Display [13]

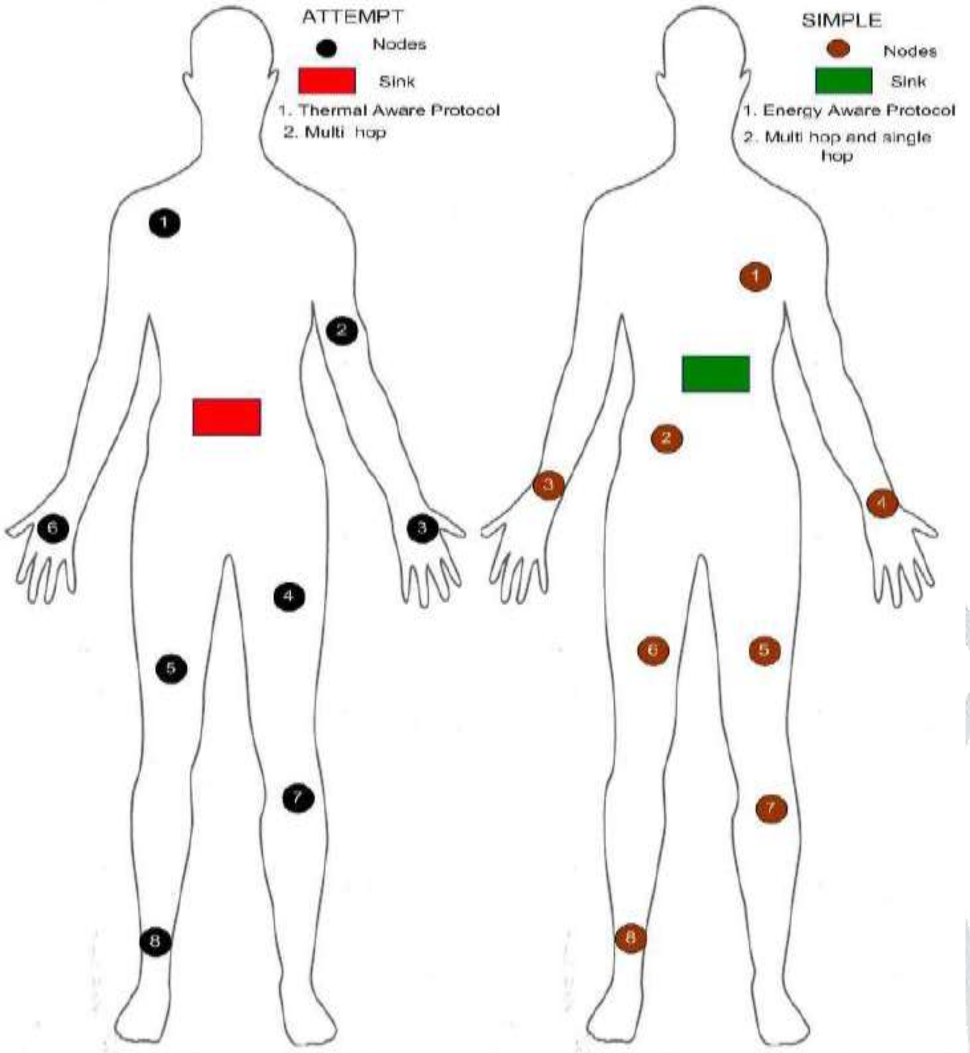


Figure 3: Sensor Node Deployment

Node Deployment

```
S(1).xd=0.3;  % calf
S(1).yd=0.1;
S(1).P = 1;

S(2).xd=0.5;     % knee
S(2).yd=0.3;
S(2).P = 1;

S(3).xd=0.3;    % lactic acid(thigh) 2.5
S(3).yd=0.55;
S(3).P = 1;

S(4).xd= .5; % temp(thigh)  2.5
S(4).yd= .55;
S(4).P = 1;

S(7).xd= .37; % glucose
S(7).yd= .75;
S(7).P = 2;

S(8).xd= .45; % ECG
S(8).yd= .9;
S(8).P = 2;

S(5).xd= .7; % left PALM 4.3 feet
```

```
  S(5).yd= .8;
  S(5).P = 1;

  S(6).xd= .1; %  rite palm   5.4
  S(6).yd= .8;
  S(6).P = 1;
```

Energy Parameters:

```
ETX=16.7*0.000000001;
ERX=36.1*0.000000001;
Emp=1.97*0.000000001;
EDA=5*0.000000001;
do = 0.1;

lambda = .125; f = 2.4 GHz
speed = 299792458;
```

where ETx is the energy consumed in transmission, ERx is the energy consumed by receiver, ETx−elec and ERx−elec are the energies required to run the electronic circuit of transmitter and receiver, respectively. Eamp is the energy required for amplifier circuit, while k is the packet size.

Test set-up:

In all the tests described in this article, the transmission power is set to the maximum radio module power. Figure 2 illustrates the platforms used in the tests. Practical set up comprises Arduino & nRF 24L01+ & CC2420.

Table 3: Radio Parameters

Parameters	**nRF 24L01+** [2]	**CC2420** [1]	**Units**
DC Current(Tx)	10.5	17.4	mA
DC Current(Rx)	18	19.7	mA
Supply Voltage(min)	1.9	2.1	V
Etx−elec	16.7	96.9	nJ/bit
Erx−elec	36.1	172.8	nJ/bit
Eamp	1.97e-9	2.71e-7	j/b

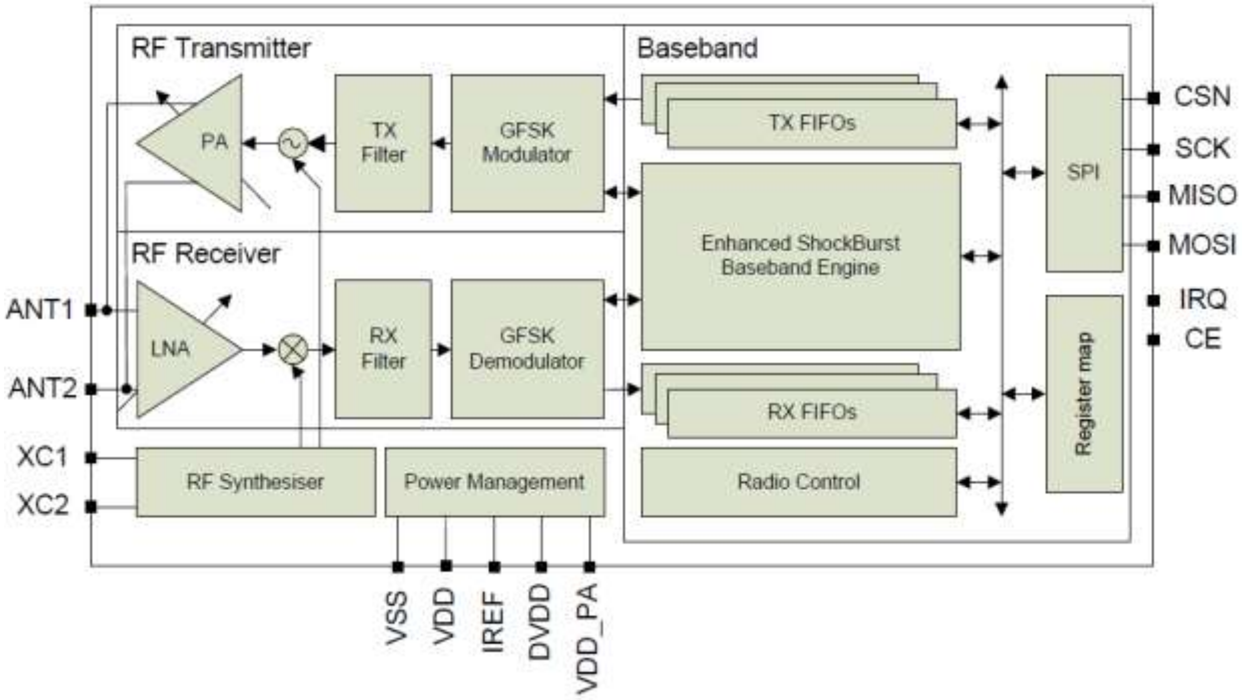


Figure 4: nRF 24L01+ Block Diagram [2]

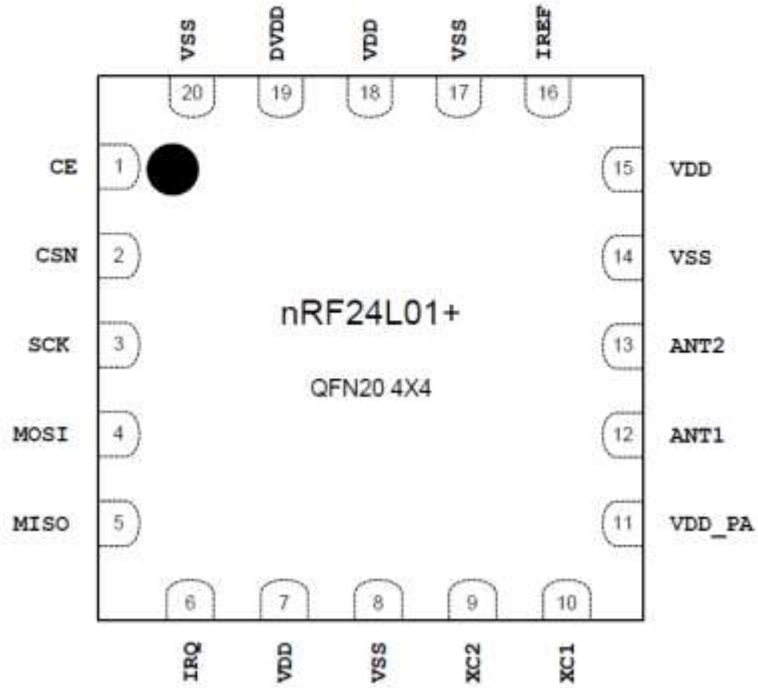
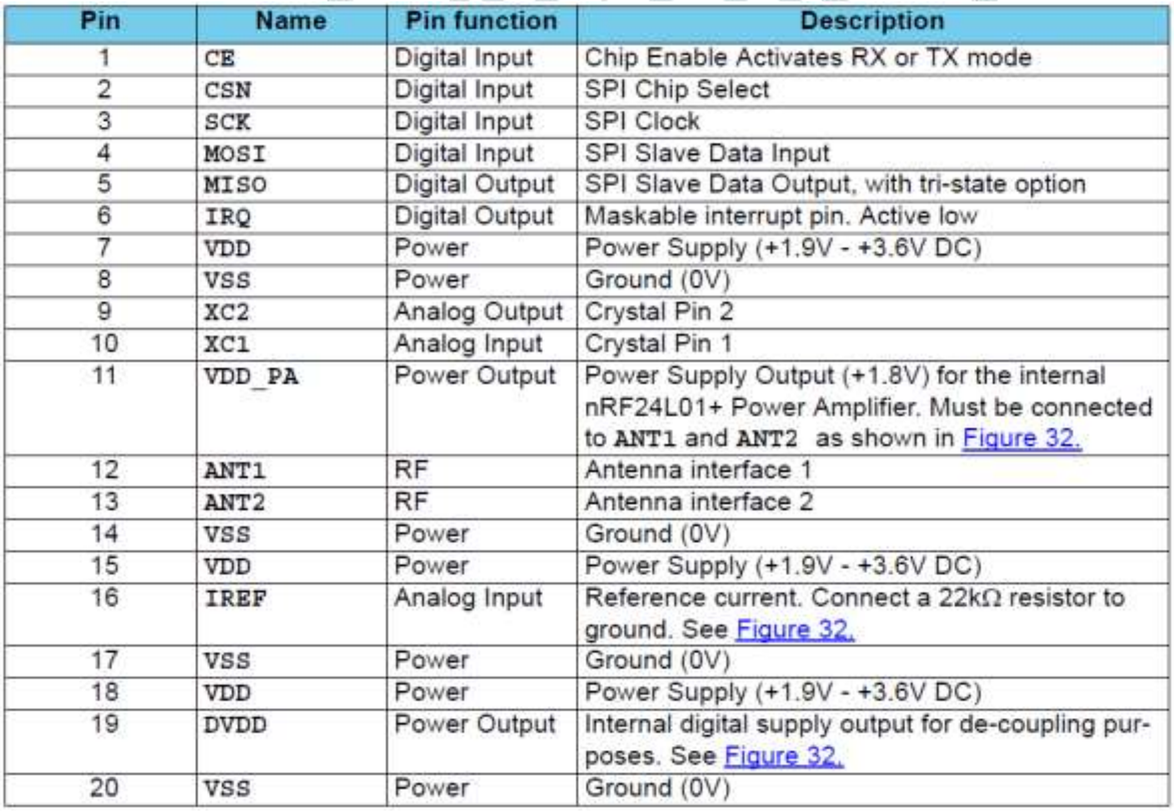


Figure 5: nRF 24L01+ Pin Assignment [2]



Pin	Name	Pin function	Description
1	CE	Digital Input	Chip Enable Activates RX or TX mode
2	CSN	Digital Input	SPI Chip Select
3	SCK	Digital Input	SPI Clock
4	MOSI	Digital Input	SPI Slave Data Input
5	MISO	Digital Output	SPI Slave Data Output, with tri-state option
6	IRQ	Digital Output	Maskable interrupt pin. Active low
7	VDD	Power	Power Supply (+1.9V - +3.6V DC)
8	VSS	Power	Ground (0V)
9	XC2	Analog Output	Crystal Pin 2
10	XC1	Analog Input	Crystal Pin 1
11	VDD_PA	Power Output	Power Supply Output (+1.8V) for the internal nRF24L01+ Power Amplifier. Must be connected to ANT1 and ANT2 as shown in Figure 32.
12	ANT1	RF	Antenna interface 1
13	ANT2	RF	Antenna interface 2
14	VSS	Power	Ground (0V)
15	VDD	Power	Power Supply (+1.9V - +3.6V DC)
16	IREF	Analog Input	Reference current. Connect a 22kΩ resistor to ground. See Figure 32.
17	VSS	Power	Ground (0V)
18	VDD	Power	Power Supply (+1.9V - +3.6V DC)
19	DVDD	Power Output	Internal digital supply output for de-coupling purposes. See Figure 32.
20	VSS	Power	Ground (0V)

Figure 6: nRF 24L01+ Pin Function [2]

Real-time data flow model:

Fig. 7 depicts real-time data flow of the proposed protocol in a wireless multimedia sensor node.

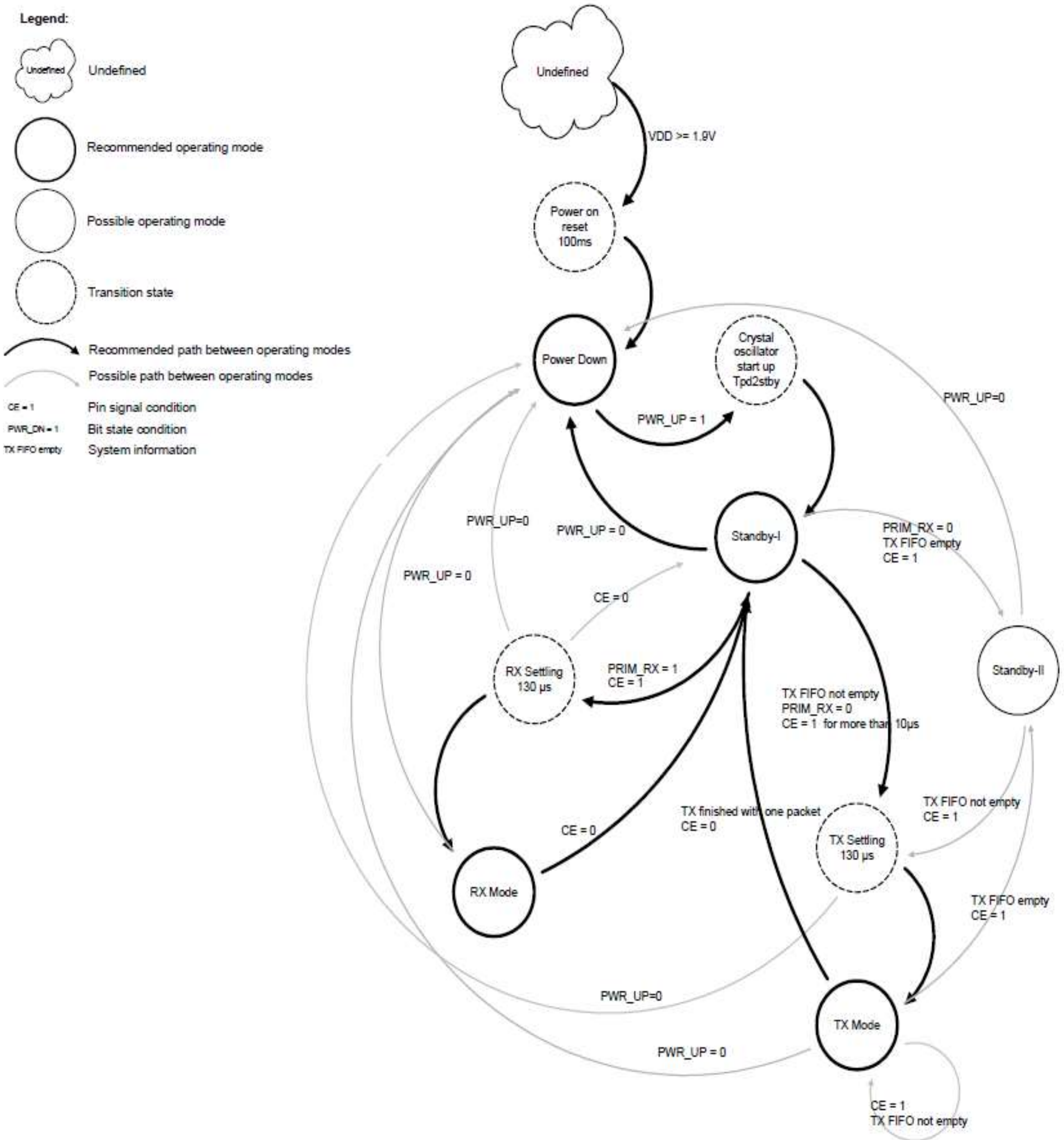


Figure 7: nRF 24L01+ Radio Control State Diagram [2]

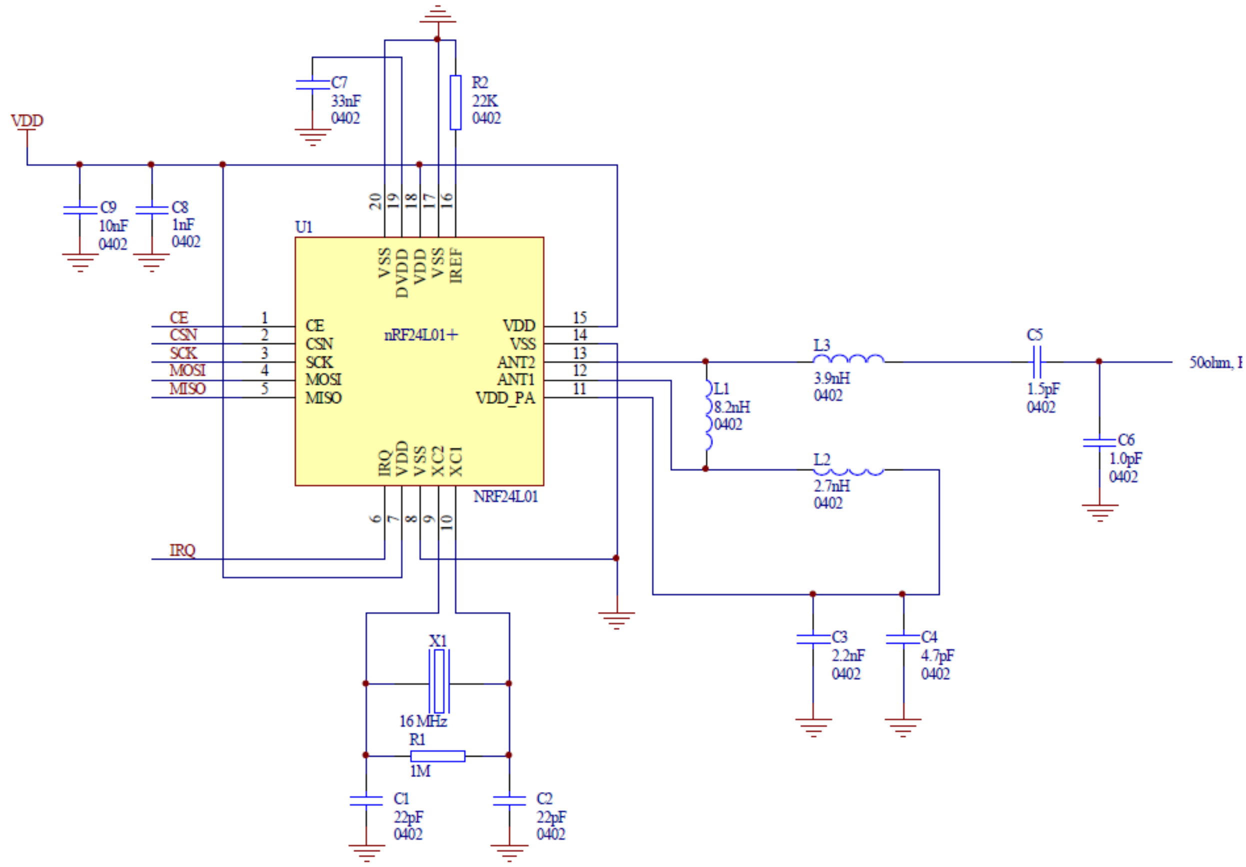


Figure 8: nRF 24L01+ Schematic for RF layouts with single ended 50 Ω RF output [2]

The Nordic nRF24L01+ is a highly integrated, ultra-low power (ULP) 1Mbps RF transceiver IC for the 2.4GHz ISM (Industrial, Scientific and Medical) band. With peak RX/TX currents lower than 20mA, a sub µA power down mode, advanced power management, and a 1.9 to 3.6V supply range, the nRF2401A provides a true ULP solution enabling months to years of battery lifetime when running from coin cells or AA/AAA batteries. The nRF24L01+ is a single chip 2.4GHz transceiver with an embedded baseband protocol engine (Enhanced Shock Burst™), suitable for ultra-low power wireless applications. The nRF24L01+ is designed for operation in the world-wide ISM frequency band at 2.400 - 2.4835GHz.

RX mode: The RX mode is an active mode where the nRF24L01+ radio is used as a receiver. To enter this mode, the nRF24L01+ must have the PWR_UP bit, PRIM_RX bit and the CE pin set high. In RX mode the receiver demodulates the signals from the RF channel, constantly presenting the demodulated data to the baseband protocol engine. The baseband protocol engine constantly searches for a valid packet. If a valid packet is found (by a matching address and a valid CRC) the payload of the packet is presented in a vacant slot in the RX FIFOs. If the RX FIFOs are full, the received packet is discarded.

TX mode: The TX mode is an active mode for transmitting packets. To enter this mode, the nRF24L01+ must have the PWR_UP bit set high, PRIM_RX bit set low, a payload in the TX FIFO and a high pulse on the CE for more than 10µs.

The CC2420 is a transceiver designed specifically for low-power, low voltage RF applications in the 2.4 GHz. True single-chip 2.4 GHz IEEE 802.15.4 /ZigBee™ RF transceiver with MAC support • Suitable for FFDs (Full Function Devices) and RFDs (Reduced Function Devices) defined by IEEE 802.15.4 and as well as end devices, routers and coordinators according to ZigBee.

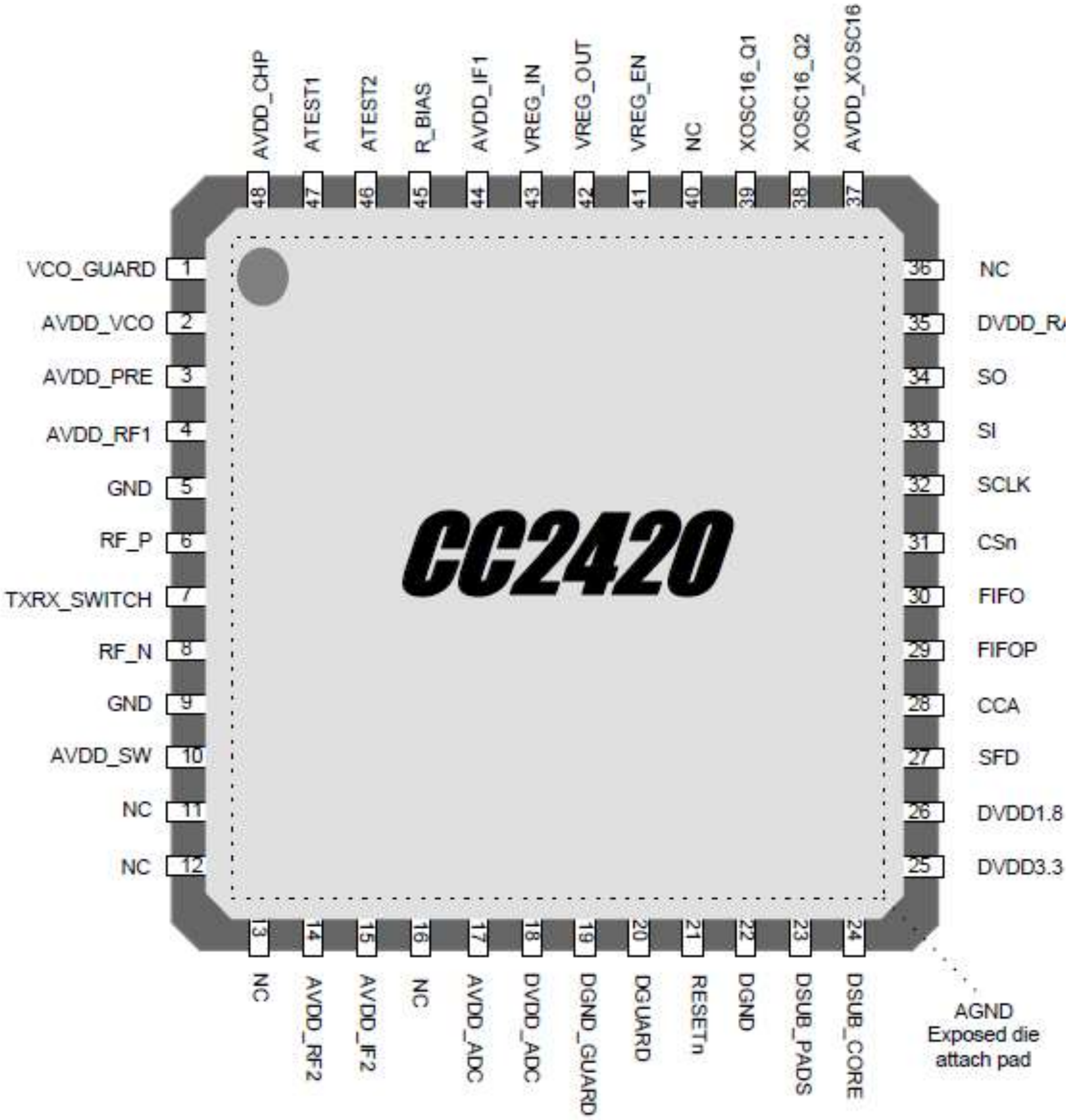


Figure 9: CC2420Pin Assignment [1]

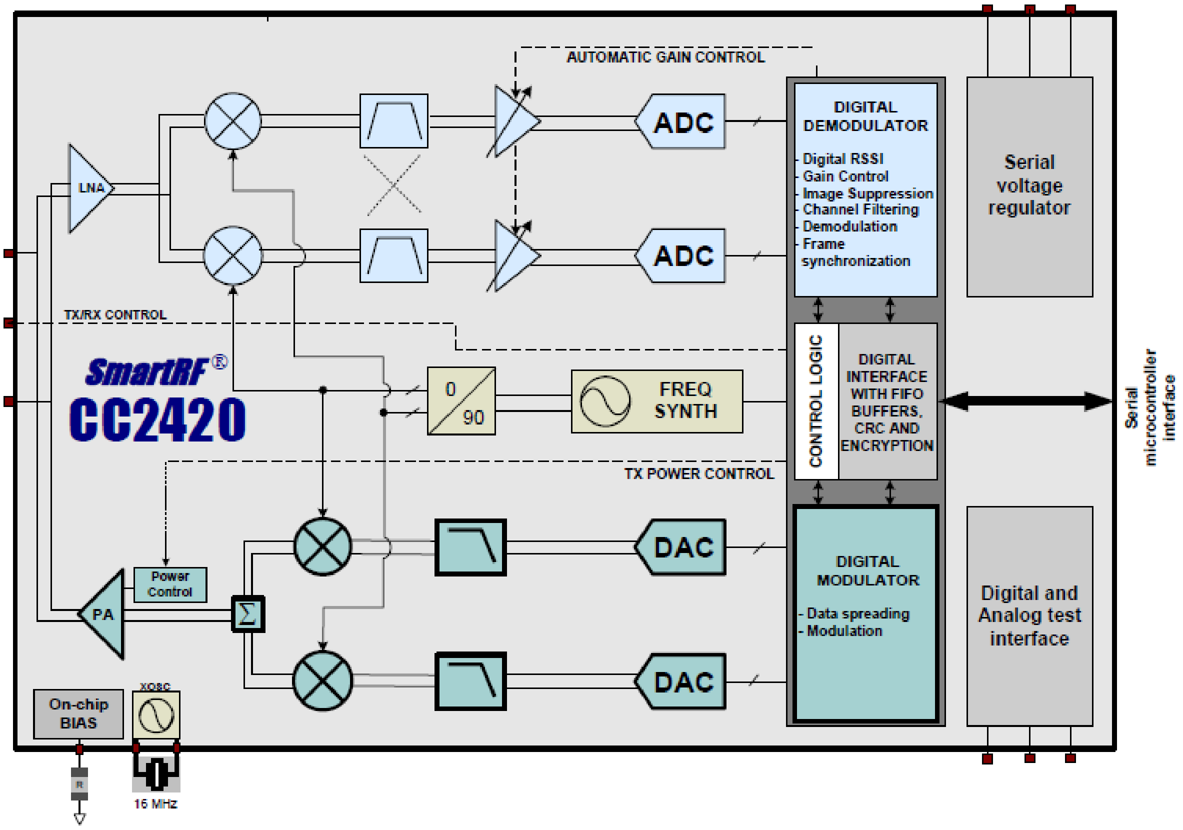


Figure 10: CC2420 Block Diagram [1]

PERFORMANCE EVALUATION

PERFORMANCE METRICS

We evaluated key performance metrics for proposed protocols. Definition of performance metrics are as below.

1. **Network lifetime:** It represents the total network operation time till the last node die. Time until the first sensor node depletes its energy [11].
2. **Stability period:** Stability period is the time span of network operation till the first node die. The time after the death of first node is termed as unstable period [12].
3. **Throughput:** Throughput is the total number of packets successfully received at sink [9].
4. **Residual Energy:** To investigate the energy consumption of nodes per round, we consider residual energy parameter to analyze energy consumption of network [11].
5. **Path Loss:** Path loss is the difference between the transmitted power of transmitting node and received power at receiving node. It is measured in decibels(dB) [10].
6. **Latency:** average hop count that a packet travels until it reaches the mobile sink node. We model latency as the number of hops traveled.

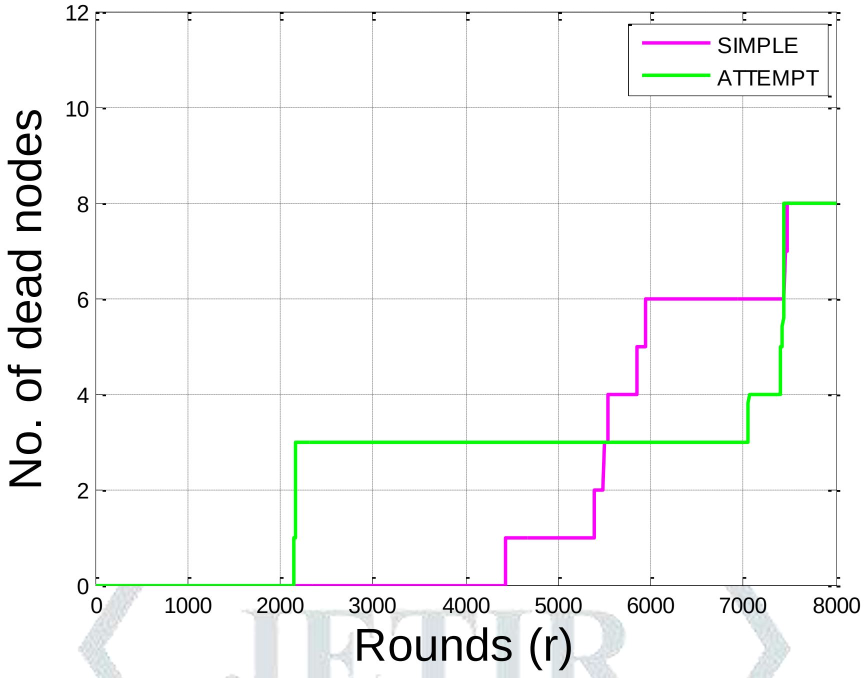


Figure 11: Analysis of Network Life Time

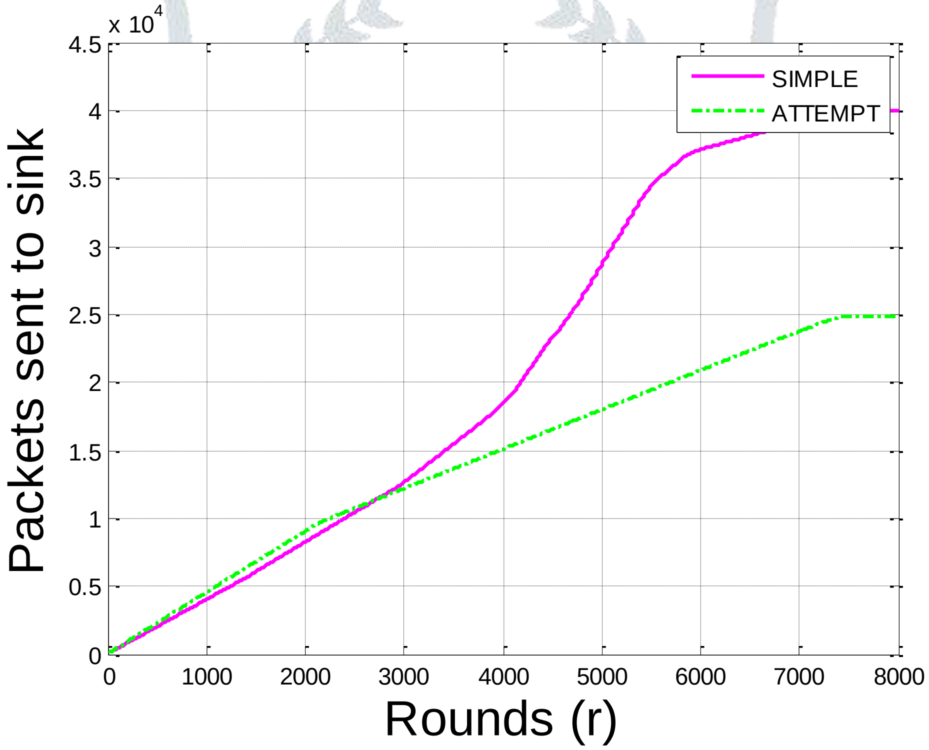


Figure 12: Analysis of Throughput

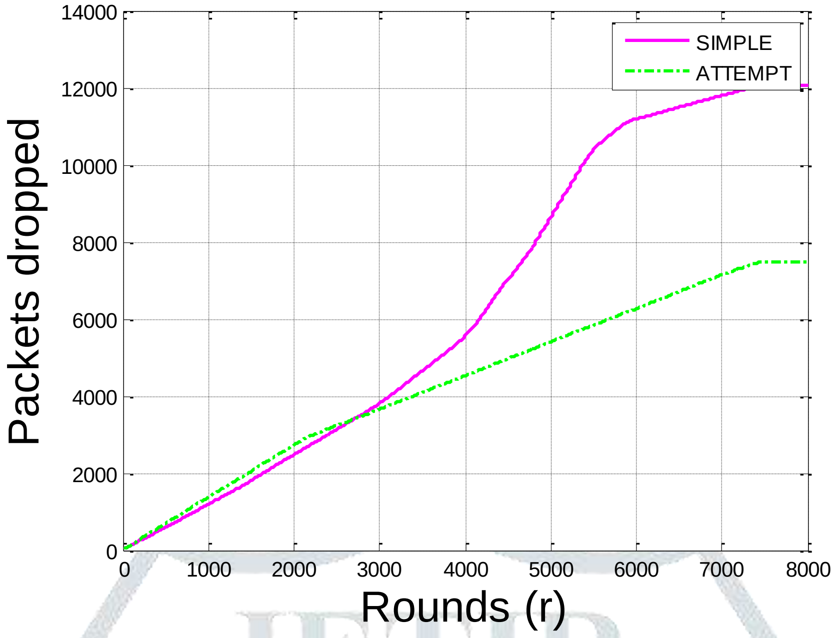


Figure 13: Analysis of Packets dropped

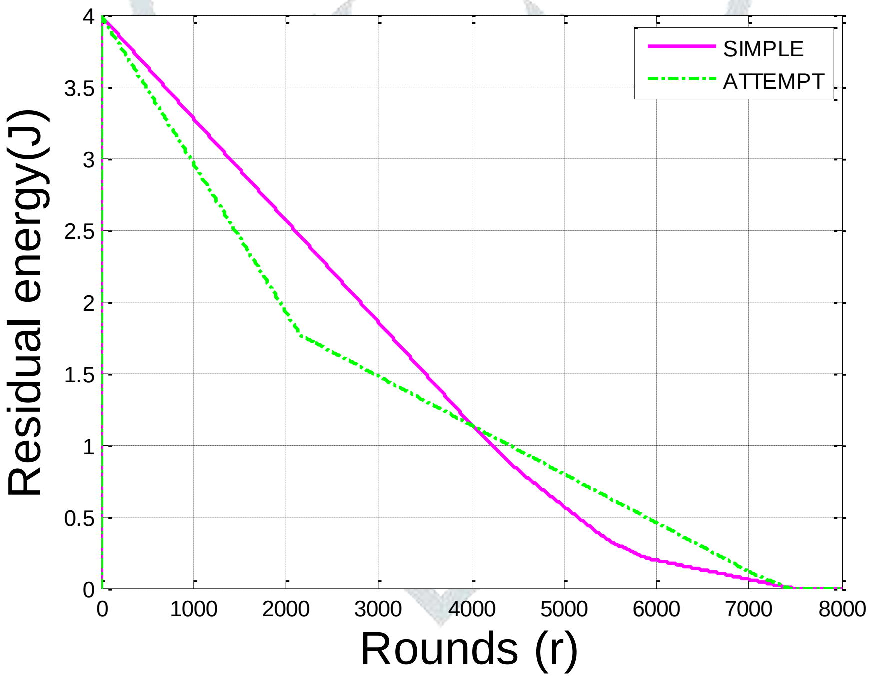


Figure 14: Analysis of Residual Energy

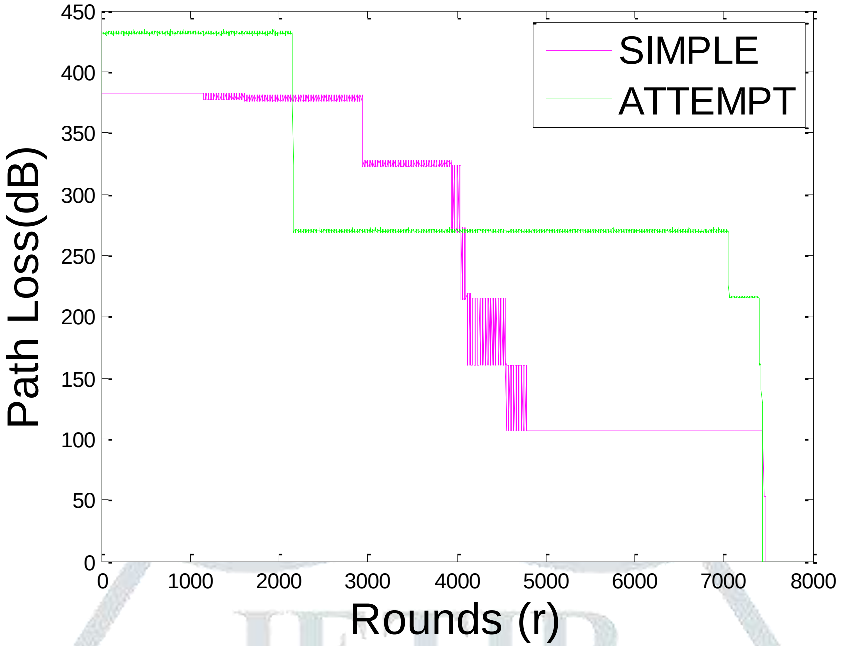
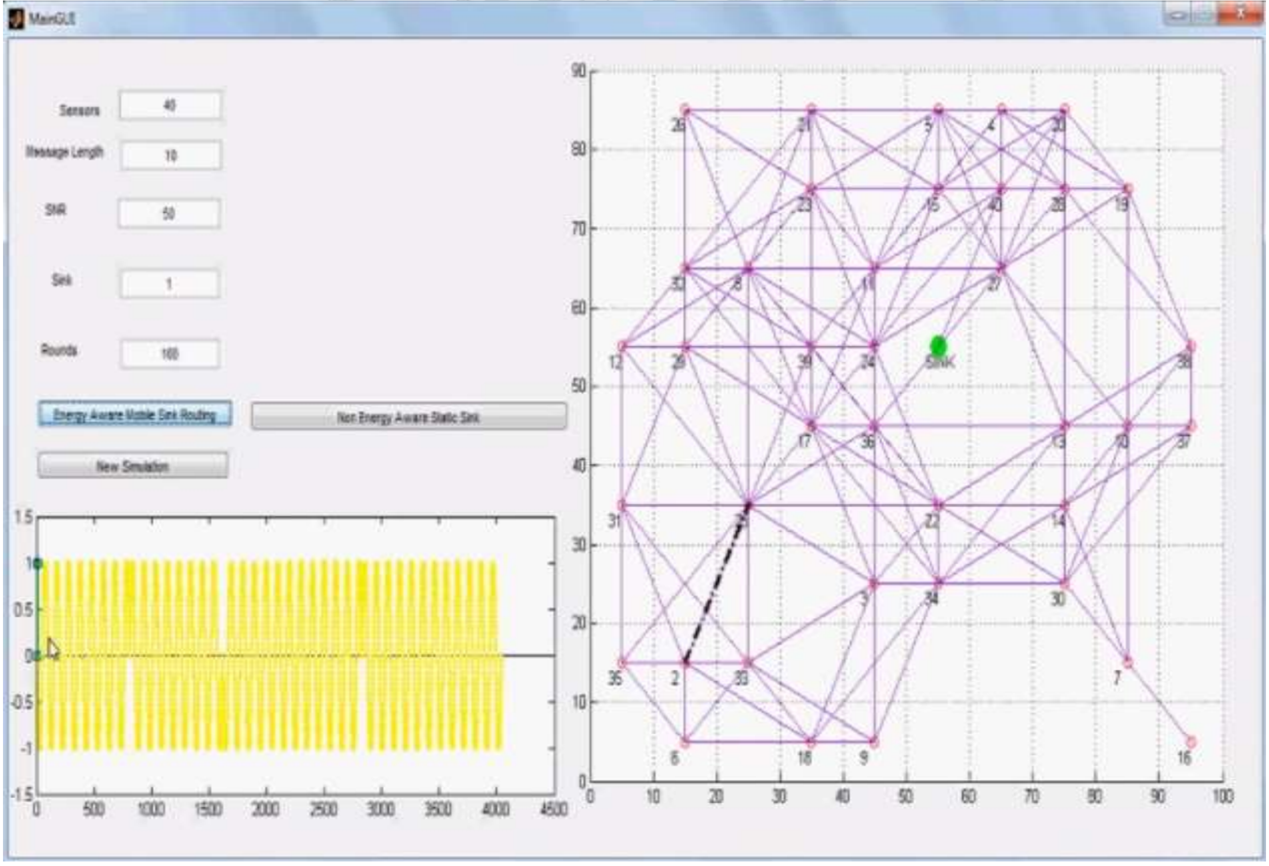


Figure 15: Analysis of Network path loss (dB)



Sensors 40

Message Length 10

SNR 50

Sink 1

Rounds 100

Figure 16: Network of Energy Aware Sensor Network with Sink Mobility (EASNSM) protocol

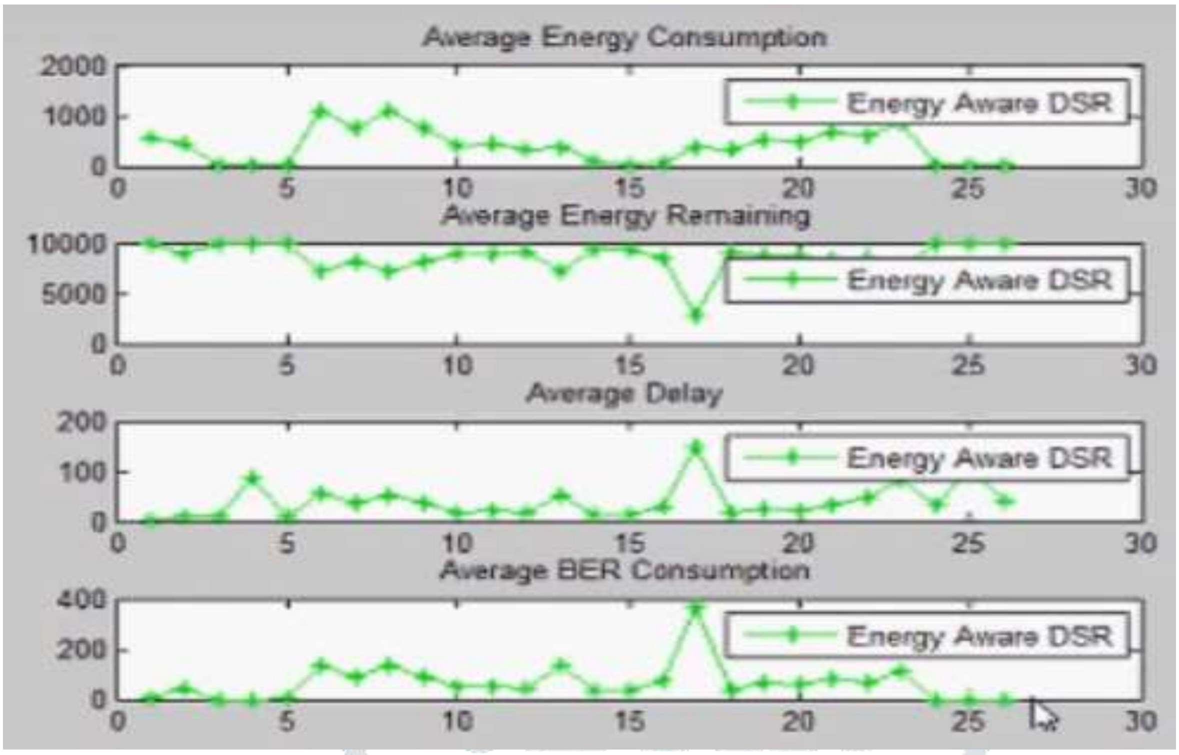


Figure 17: Results of Energy Aware Sensor Network with Sink Mobility (EASNSM) protocol

SIMULATION RESULTS AND ANALYSIS

To evaluate proposed protocols, we have conducted an extensive set of experiments using MATLAB R2017a. Compare the performance of the SIMPLE protocol with the M-ATTEMPT protocol.

We compare the performance of two protocols (ATTEMPT and proposed SIMPLE) with the help of MATLAB simulations. We compare these protocols based on performance metrics. Performance matrices are given below. 1. No of Alive nodes Alive nodes are very important parameter. By analyzing no of alive node, we decide the network life time of the network. It is the time for which the last node dies in the network. In WBAN high network life is required. It is total time in which the network operates. 2. No of dead nodes Node in the network which has o energy remaining is called dead node. It is very important parameter. First dead node decides the stability of the network. Network before the first node dead is called stable. 3. No of packets sent to sink Throughput is the number of packets successfully received at sink. 4. Path Loss It is measure signal attenuation between the transmitter and receiver. It is the difference between the transmitted power and received power. It is measured in dB. Figure (11-15) shows the results of proposed and ATTEMPT protocol. It shows that the proposed protocol is more stable than the ATTEMPT. Stability period is the time gap from the beginning to the first node dead. In ATTEMPT protocol first node is dead at 2200 rounds and in proposed protocol first node dead at 3200 rounds this happen because in ATTEMPT protocol nodes use same amplification energy to transmit data from transmitter to receiver whether the distance is more or less between them. If we use same amplification energy for the nodes which transmitting the packet to cluster head and the nodes which transmitting the packet the base station it results in wastage of energy. Due to this In ATTEMPT protocol first node die early. In Proposed Protocol two power levels are used that increases the stability period. Figure (11) shows the network lifetime analysis of ATTEMPT and Proposed Protocol. Network lifetime of the Proposed Protocol is more than the ATTEMPT Protocol. In Proposed protocol cluster head is selected based on threshold. If the previous cluster has not pent much energy and still has energy which is larger than the threshold level, it will remain cluster head for the next round. In this way the energy is saved which is wasted to select the new cluster head and route the packet through the new cluster in ATTEMPT Protocol. Figure (12) shows the throughput analysis. Throughput is the no of packets received at the receiver. Nodes alive in the proposed protocol for longer duration than the ATTEMPT that increases the no of packets received by proposed protocol increases.

CONCLUSION

In this research paper, various schemes are presented for energy efficiency, stability of network to maximize throughput and to minimize delay in WBANs. Proposed protocol is based on clustering. At the center of the human body sink is placed. For transmission of normal data multi hop communication is used and transmission of emergency data transmission single hop communication is used. The technique which is used to select the cluster head is threshold based. If the previous cluster has not pent much energy and still has energy which is larger than the threshold level, it will remain cluster head for the next round. In this way the energy is saved which is wasted to select the new cluster head and route the packet through the new cluster. If the cluster head has the energy less than the threshold level, it will be replaced by the new cluster head which has larger energy than the threshold level. Minimum amplification energy required for the communication between base station to node and node to cluster is not same. Considering this point different power levels are used for the two types of communication. Simulation results shows that proposed protocol increases the stability period and number of packets delivered to sink than ATTEMPT protocol. Results of Energy Aware Sensor Network with Sink Mobility (EASNSM) protocol are shown in figure 16-17.

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