ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2015

Design & Implementation of Optimal Path Selection In Sleep Awake Cycling In Wireless Sensor Network

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ABSTRACT: This paper presents an optimal path selection algorithm under sleep awake cycling in WSN. The main issue is the energy wastage of unused nodes. So, to overcome this, it proposes an on demand asynchronous sleep awake protocol for reducing energy consumption. In this, optimal path selection is based on shortest distance between nodes which is to be calculated. In this, it covers different scenarios under sleep awake. It presents synchronous and asynchronous way of communication between nodes. The main objective is to provide energy efficiency in network & also reduce delay. We formulate the routing problem as time-dependent Bellman-Ford problem. In this, it presents a multipath routing protocol for data transmission. The projected mechanism is implemented with MATLAB.

KEYWORDS:Duty Cycle, Optimal Path Selection, Wireless Sensor Network, Sleep Cycle etc.

I. INTRODUCTION

A wireless sensor network consists of sensor nodes deployed over a geographical area for monitoring physical phenomena like temperature, humidity, vibrations, seismic events, and so on. A WSN is a collection of millimeter-scale, self-contained, micro-electro-mechanical devices. These tiny devices have sensors, computational processing ability (i.e. CPU power), wireless receiver and transmitter technology and a power supply. Wireless sensor networks have seen tremendous advances and utilization in the past two decades. Starting from petroleum exploration, mining, weather and even battle operations, all of these require sensor applications. One reason behind the growing popularity of wireless sensors is that they can work in remote areas without manual intervention. All the user needs to do is to gather the data sent by the sensors, and with certain analysis extract meaningful information from them. Usually sensor applications involve many sensors deployed together [4].

Sensor nodes are the elementary components of any WSN and provide the following basic functionalities[6] 1) signal conditioning and data acquisition for different sensors;2)temporary storage of the acquired data; 3)data processing; 4)analysis of the processed data for diagnosis and, potentially, alert generation; 5)self- monitoring (e.g., supply voltage); 6)scheduling and execution of the management task; 7)management of the sensor node configuration; 8)reception transmission of forwarding data packets; 9)coordination and management of communication and networking.

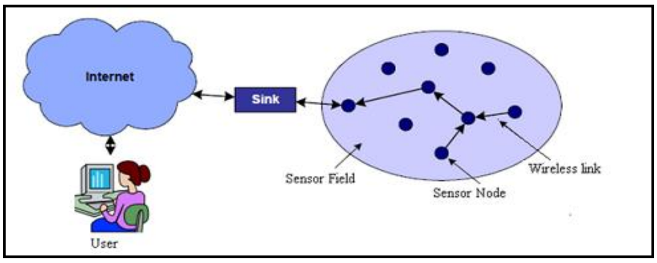

Figure 1: Wireless Sensor Architecture

Wireless Sensor Networks may consist of many different types of sensors such as seismic, low sampling rate magnetic, thermal, visual, infrared, acoustic and radar. They are able to monitor a wide variety of ambient conditions that include temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, and the current characteristics such as speed, direction and size of an object. The three application classes we have selected are: environmental data collection, security monitoring, and sensor node tracking.

The use of wireless sensor networks is increasing day by day and at the same time it faces the problem of energy constraints in terms of limited battery lifetime. As each node depends on energy for its activities, this has become a major issue in wireless sensor networks. The failure of one node can interrupt the entire system or application. Every sensing node can be in active (for receiving and transmission activities), idle and sleep modes. In active mode nodes consume energy when receiving or transmitting data. In idle mode, the nodes consume almost the same amount of energy as in active mode, while in sleep mode, the nodes shutdown the radio to save the energy. In WSNs the only source of life for the nodes is the battery. Communicating with other nodes or sensing activities consumes a lot of energy in processing the data and transmitting the collected data to the sink. In many cases (e.g. surveillance applications), it is undesirable to replace the batteries that are depleted or drained of energy. Many researchers are therefore trying to find power-aware protocols for wireless sensor networks in order to overcome such energy efficiency problems.

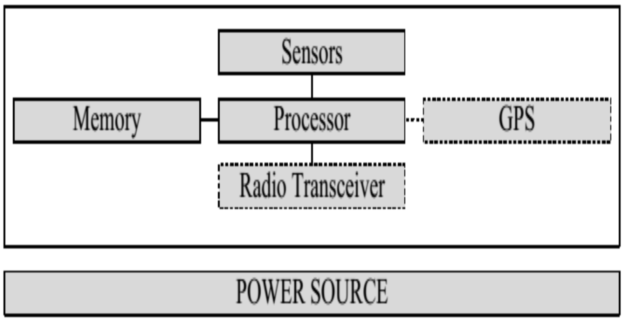

Figure 2: Wireless Sensor Network Schematic [1]

One reason behind the growing popularity of wireless sensors is that they can work in remote areas without manual intervention. All user needs to do is to fold the data sent by sensors, and with certain examination extract meaningful information from them. Usually sensor applications involve many sensors organized together. These sensors form a network and collaborate with each other to gather data and send it to the base station. The base station acts as the control centre where the data from the sensors are gathered for further analysis and treating. In a husk, a wireless sensor network is a system consisting of spatially dispersed nodes which use sensors to monitor physical or environmental circumstances. These nodes combine with routers and gateways to generate a WSN system [4].

The development of sensor networks requires technologies from three different research zones: sensing, communication, and computing (as well as hardware, software, and procedures). Thus, combined and separate progressions in each of these areas have driven investigation in sensor networks. Examples of early sensor networks comprise the radar networks used in air traffic regulator. The national power grid, with its numerous sensors, can be viewed as one large sensor system. These systems were recognized with specialized computers and communication capabilities, and before the term “sensor networks” came into vogue [5].

The paper is ordered as follows. In section II, It defines Sleep scheduling techniques. In Section III, it describes proposed work of system. In section IV, it describes the proposed results of system. Finally, conclusion is explained In Section V.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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II. SLEEP SCHEDULING IN WSN

The major design objective for wireless sensor network applications is to minimize the energy consumption in order to maximize network lifetime. To improve a sensor network's reliability and extend its longevity, sensor networks are deployed with high densities. However, if all sensor nodes in such a dense deployment scenario operate at the same time, energy will be consumed excessively. Also, packet collisions will increase as a result of the large number of packets being forwarded in the network. In addition, most of the data forwarded in the network will be redundant since when node density is high, sensing regions of the nodes will overlap and the data of adjacent sensor nodes will be highly correlated.

A practical sleep scheduling algorithm should both choose the minimum number of active nodes and satisfy user defined constraints. The non-sleeping nodes must be chosen so that they are connected to the sink and they provide some minimum coverage of the network field. User defined constraints may vary depending on the application type. F or instance, the user may want the network to be connected and provide some minimum coverage for as long as possible or the user may want the network to be connected and provide full coverage of the network field while ensuring some minimum delay in gathering data. The purpose of sleep scheduling techniques is to save energy and prolong network lifetime. Several protocols have been proposed to reduce the energy consumption using sleep scheduling methods. This section describes the fundamental asynchronous and scheduled sleep techniques.

Asynchronous sleep techniques

Asynchronous sleep techniques aim to keep the radio in default sleep mode and wake-up briefly to check for traffic or send/receive messages. The various asynchronous sleeping techniques are discussed:
The secondary wake-up radio concept uses a hardware solution to enable nodes to sleep by default and only awake when needed [4]. In the design, each sensor node is equipped with two radio transceivers. The primary (data) radio remains asleep by default. The secondary radio is a low-power wake-up radio that remains on at all times. When the secondary radio receives a wake-up signal from another node, it instructs the primary radio to wake up for data transmission. This method assumes that an extremely low power radio can be used as a secondary radio.

Sleep Scheduled Techniques

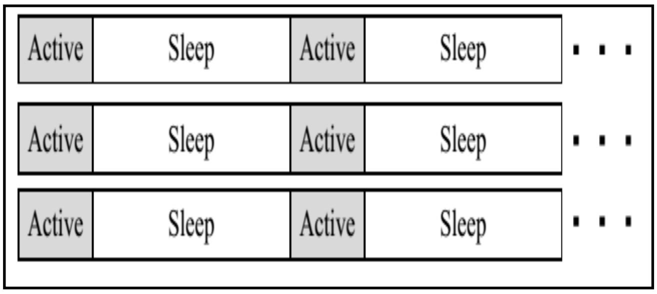

Figure 3: Sleep Scheduling in WSN

Sleep scheduling techniques aim to reduce energy consumption by synchronizing sleep schedules and enable lower duty cycles. S-MAC, T-MAC, and D-MAC are the most well-known WSN sleep scheduling techniques. Sensor MAC (S-MAC) provides a tunable, non-adaptive, periodic active/sleep cycle for sensor nodes (see Figure 3.5). During sleep periods nodes turn off their radios to conserve energy. During active periods nodes turn on their radios to exchange data. During the initialization phase nodes remain awake and listen for sleep schedules from neighbours. If they do not receive a sleep schedule, they create their own schedule and start broadcasting it. A protocol is said to be real-time support if and only if it is fast and reliable in its reactions to the changes prevailing in the network. It provides redundant data to the base station and or sinks using the data that is collocated among all the sensing nodes in the network.

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III. PROPOSED OPTIMAL PATH SELECTION UNDER SLEEP AWAKE IN WSN

The network layer is accountable for routing information through the sensor network, which finds the most efficient lane for the packet to travel on its way to a specific destination. This deals with energy-saving methods at network level, the choice of data routing in the network and different protocols which will results in less energy consumption in the network. In minimizing the overall power consumption of the network, the data routing algorithm plays an important role.

Sensor nodes are assumed to be stationary in most of the network architecture. If not it is more challenging to route messages between moving nodes depending on the application: the sense event can be dynamic or static. Traffic is generated only when reporting has to be done in static events; on the other hand most application periodic reporting is required in dynamic events, resulting in the generation of significant traffic that has to be routed to the base station. One of the factors that affect the performance of routing protocols is the deployment of sensor nodes, which is either deterministic or self-organizing.

A. Power Management Protocol

The power management protocol for WSNs is one of the main energy conservation techniques available for a WSN. The power management protocol can be classified into two categories depending on the location of the power saving within the network layering. Each category of these power management protocols is best suited for a certain type of network topology .The two power management protocols are independent sleep-/wakeup protocols running at the network or application layer and integrated with the MAC protocol itself. Based on the specific sleep scheduling, the MAC protocol then optimizes the medium access functions which are used for power management. Independent sleep/wakeup protocols can be used in combination with any MAC protocol in order to reduce the energy consumption. Within these kinds of sleep/wakeup protocols a classification can be made into three main categories: on demand, scheduled rendezvous and asynchronous protocols.

1. The On-demand Protocol

First of the power management protocol that is introduced is the on-demand protocol. This procedure is based on the plan that a sensor node should be in the sleep mode or off when there is no data packet to broadcast and/or receive. As soon as there is a data packet that needs to be transmitted and/or received the sensor node shall become active. In this way sensor nodes alternate between active and sleep periods depending on network activity. The consequence is that the energy consumption is minimized since sensor do not waste energy by unnecessary transmissions and unnecessary sensing. But the main disadvantage of this protocol is that it is difficult to inform the sleeping sensor nodes if another sensor node wants to communicate with them.In order to combat this disadvantage the use of multiple radios is required. This requires two channels to work corporately, namely a data channel and a wakeup channel, the former one is used for normal data communication and the other one is for awaking neighbouring sensor nodes when needed.

2. The Scheduled Rendezvous Protocol

The second power management protocol is called scheduled rendezvous protocol which belongs to the synchronous protocols since it requires all neighbouring sensor nodes to wake up at the same time. In this approach sensor nodes wake up according to a wakeup schedule and remain active for a short time interval to communicate with their neighbours. After the transmission of the data the senor nodes will go to sleep until the next rendezvous time. The main advantage of this protocol is that it is guaranteed that if a sensor node is awake that all its neighbouring sensor nodes are awake as well. It is very convenient for data aggregation and allows sending broadcast messages to all neighbours. The disadvantage is that this protocol is a synchronized protocol which requires all the neighbouring nodes exchange the synchronization information so that their clocks are synchronized.

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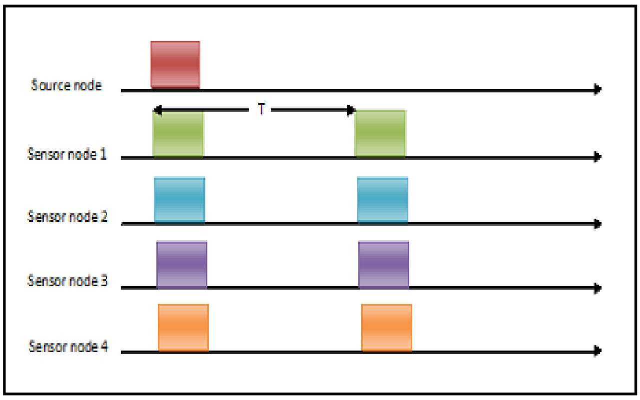

Figure 4: The Sleep Scheduling for a Synchronous Protocol

3. The Asynchronous Protocol

The last algorithm that can be used is the asynchronous protocol. The basic idea is that each node is allowed to wake up independently of the others by guaranteeing that neighbouring sensor nodes always have overlapped active periods of time within a specified number of cycles. According to this only sensor node 1 and sensor node 3 can receive the transmitted packet. Since the active period of the sensor nodes partially overlap with the active period of the source node. One of the advantages of this protocol is that a sensor node can wake up at anytime when it wants to communicate with its neighbouring sensor nodes.

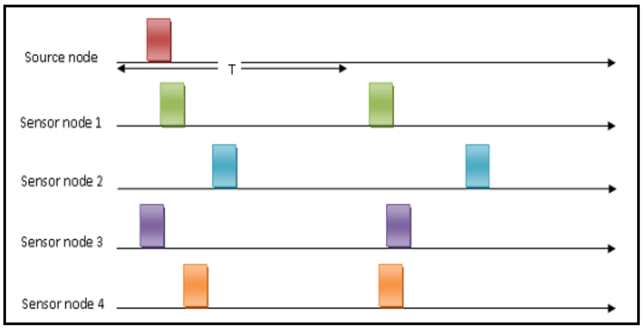

Figure 5: The Sleep Scheduling for a Asynchronous Protocol

IV. SIMULATION RESULTS

In order to reduce the end-to-end latency with energy efficient data transmission proposed an Asynchronous Wakeup Schedule(AWS) in WSNs. Each node was assigneda particular color. Data transmission is an important topic of WSNs, as the distance between each sensornodes is different; the energy consumed by each sensor node is different. When thedistance between a sensor node and the base station is large the data transmissionfrom sensor node to base stations consumes more energy than in the case when thedistance is small. Hence the distance between sensor nodes among another and thedistance from sensor nodes to the base station impacts the lifetime of the WSNs.Datatransmissions can be classified into two categories, namely direct transmissions andindirect transmissions.

In a direct data transmission, each sensor node collects and transmits the data to the base station directly, there do not exist any intermediate nodes for transmission, the path which from sensor node to the BS can also be called single-hop path. The advantage of direct transmissions is that the data rate is higher and the implementationis easier.Indirect transmission means that sensor nodes send their collected data to intermediatenodes also called relay nodes that are in the proximity of themselves. This relay nodewill then forward the aggregated data to the BS, the path from the sensor

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International Journal of Innovative Research in Computer and Communication Engineering

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node to theBS is also called multi-hop path. The advantage of this kind of transmission is thatthe high energy consumption problem in long distance transmission has been solved.

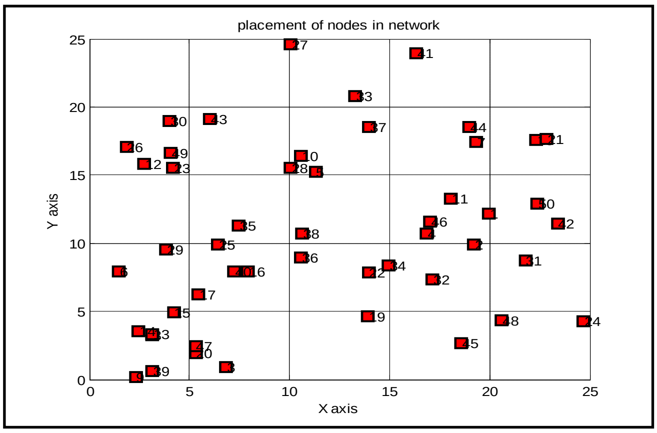

Figure 6: Placement of Nodes in Network

Broadcasting works that if a sensor node wants to transmit data it will broadcast the data to all its neighbouring nodes. The sensor nodes that received the packet from the source node shall further rebroadcast the packet to their respective neighbouring sensor nodes which the source node could not reach. In this way in a short time the entire network is reached. Although broadcasting has many advantages such as it is simple to implement, fast and robust, it also has some disadvantage.

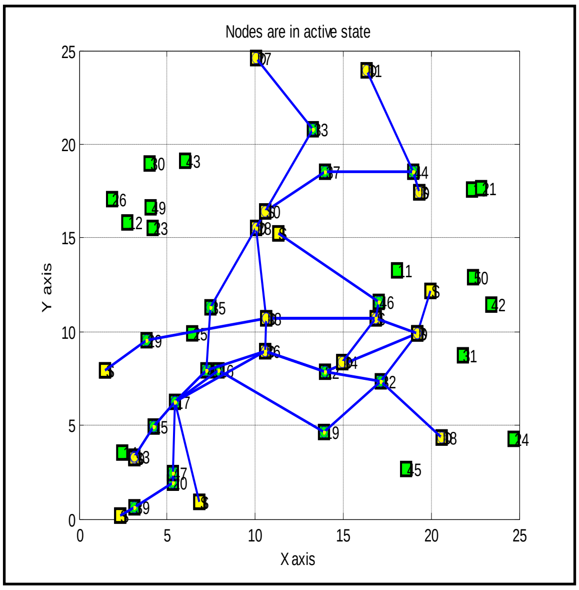

Figure 7: Communication of Nodes in Network

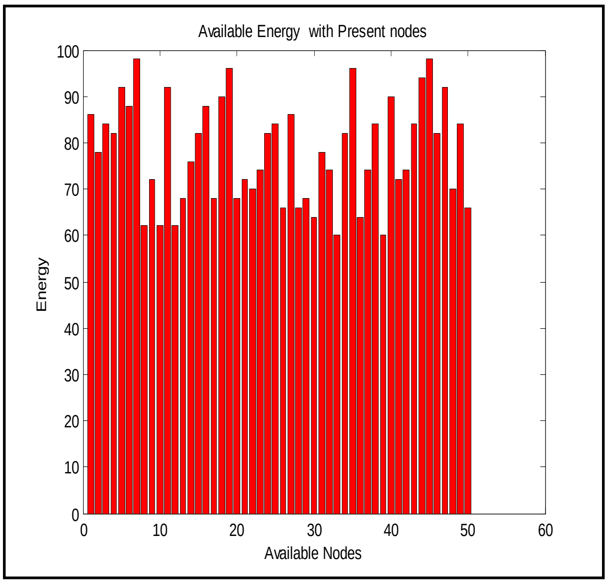

Figure 8: Energy Used by All Nodes

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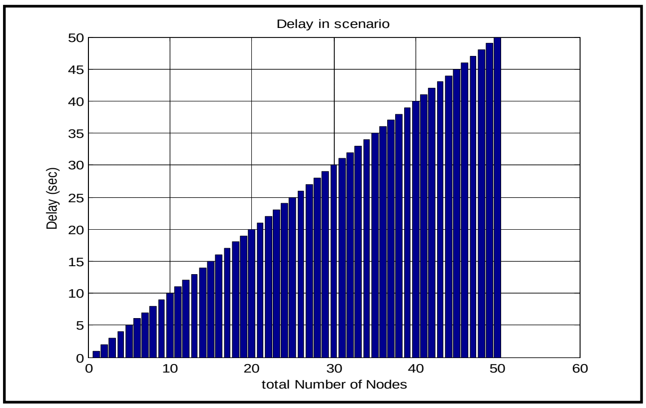


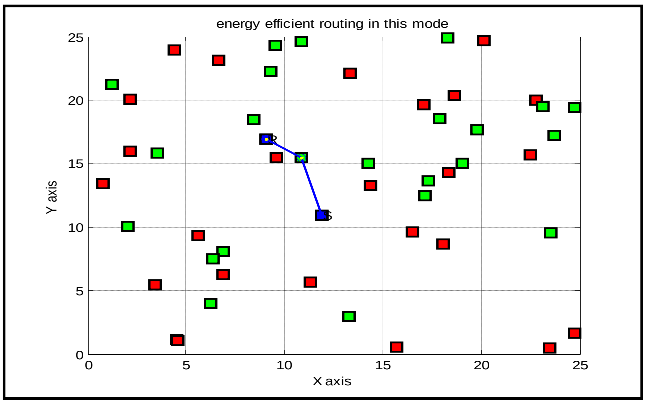
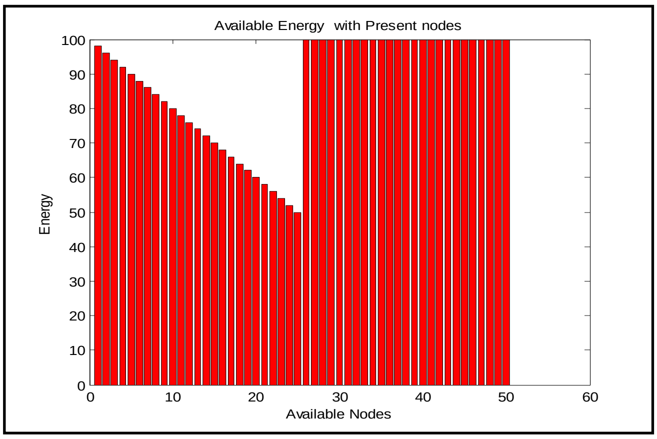


Figure 9: Delay Provided by All Nodes **Figure 10:** Energy Efficient Routing in Asynchronous Mode



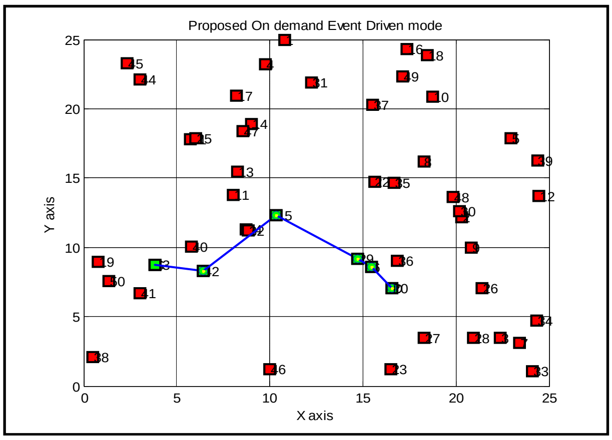


Figure 11: Energy Output in Asynchronous Mode **Figure 12:**Proposed Routing in Network

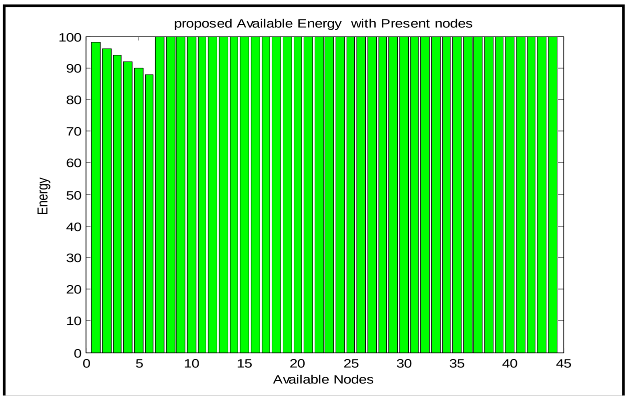


Figure 13: Energy Efficiency in Network

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International Journal of Innovative Research in Computer and Communication Engineering

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V. CONCLUSION

In this work, it presents the sleep scheduling of nodes in WSN.In this, optimal path selection is based on shortest distance between nodes which is to be calculated. In this, it covers different scenarios under sleep awake. It presents synchronous and asynchronous way of communication between nodes. The main objective is to provide energy efficiency in network & also reduce delay. We formulate the routing problem as time-dependent Bellman-Ford problem. In this, it presents a multipath routing protocol for data transmission. The projected mechanism is implemented with MATLAB. All these are useful for reducing the energy consumption and improve the accuracy. In this, optimal path selection is based on shortest distance between nodes which is to be calculated.

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