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Design and Implementation of Deadline Aware Multilevel Packet Priority Scheduling

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Abstract: **A wireless sensor network (WSN) consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multi-hop communication. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily-accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy. Since the sensor energy is the most precious resource in the WSN, efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN.**

Keywords: Power Controller, Packet Priority, Queue analyzer, Sensor network.

I. INTRODUCTION

The communications in the WSN has the many-to-one property in that data from a large number of sensor nodes tend to be concentrated into a few sinks. Since multi-hop routing is generally needed for distant sensor nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other nodes Sensor nodes are resource constrained in term of energy, processor and memory and low range communication and bandwidth. Limited battery power is used to operate the sensor nodes and is very difficult to replace or recharge it, when the nodes die.This will affect the network performance. Energy consumption and harvesting increase the lifetime of the network. Optimize the communication range and minimize the energy usage, we need to conserve the energy of sensor nodes .Sensor nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible. This addresses the lifetime problem in wireless sensor networks. Sensor nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the life time until the first battery expires is an important considerationDesigning energy aware algorithms increase the lifetime of sensor nodes. In some applications the network size is larger required scalable architectures. Energy conservation in wireless sensor networks has been the primary objective, but however, this constrain is not the only consideration for efficient working of wireless sensor networks. There are other objectives like scalable architecture, routing and latency. In most of the applications of wireless sensor networks are envisioned to handled critical scenarios where data retrieval time is critical, i.e., delivering information of each individual node as fast as possible to the base station become an important issue

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A. OVERVIEW OF WIRELESS SENSOR NETWORK

A Wireless sensor network is a collection of nodes organised in a network. Each node consists of one or more microcontroller ,CPU or DSP chips, a memory and a RF transceiver, a power source such as batteries, various sensors and actuators. The nodes communicates wirelessly and often self-organised after being deployed in an ad hoc fashion.

B. COMPONENTS OF WIRELESS SENSOR NETWORK

a. *Sensing unit*

Sensing unit is composed of two subunits such as sensors and analog to digital converters(ADS). The analog signals produced by the sensors are converted to digital signals by the ADC, and then fed unto the processing unit.

b. *Processing unit*

The processing unit which is generally associated with a small storage unit manages the procedures that make the sensors node collaborate with the other nodes to carry out the assigned sensing asks.

c. *Transceiver unit*

A Transceiver unit connects the nodes to the network which perform transmission and reception operation.

d. *Power unit*

One of the most important components of a sensor node is the power unit. Power units may be supported by a power scanning unit such as solar cells.

C. CHARACTERISTICS OF WIRELESS SENSOR NETWORK

There are several characteristics available in wireless sensor networks and they are summarized as follows,

- Limited power they can harvest or store
- Ability to withstand harsh environment conditions
- Ability to cope with node failure
- Mobility of nodes

- Dynamic network topology
- Communication failure

Heterogeneity of nodes
Large scale of deployment

D.APPLICATION OF WIRELESS SENSOR NETWORK

a. *Millitary application*

i. Monitoring friendly forces and equipment
ii.Battlefield surveillance
iii.Nuclear,biological and chemical attack detetion

b. *Environmental application*

i.Forest fire detection
ii.Bio-complexity mapping of the environment
iii.Flood detection

c.Health application

i.Tele-monitoring of human physiological data
ii.Tracking and monitoring doctora and patients inside a hospital
iii.Drug administration in hospital

d. *Home application*

i.Home automation.
ii.Smart environment

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E. CHALLENGES OF WIRELESS SENSOR NETWORK

a. *Network lifetime*

As sensor nodes are battery-operated, protocol must be energy-efficient to maximize system lifetime .System lifetime can be measured such as the time until half of the nodes die or by application-directed metrics ,such as when the network stops providing the application with the desired information about the phenomena.

b. Fault tolerance

Some sensor nodes may fail or b blocked due to lack of power. Have physical damage or environment interference. The failure of sensor nodes should not affect the overall task of the sensor network.This is the reliability or fault tolerance issue.Fault tolerance is the ability to sustain sensor network functunality without any interruption due to sensor nodes failure.

c.Power consumption

The wireless sensor node, being a microelectronic device, can only be equipped with a limited power source .In some application scenarios, replenishment of power resources might be impossible. Sensor node lifetime, therefore, shows a strong dependence on battery lifetime.

The malfunctung of few nodes can cause significant topology change and might require rerouting of packets and re-organization of the network. Hence, power conservation and power management take on additional importance. It is for these reasons that researches are currently focusing on the desing of power aware protocols and algorithm for sensor networks

.In sensor networks, power efficiency is an important performance metric, directly influencing the network lifetime. Application specific protocols can be designed by appropriate tradind off other performance metric such as delay and throughput with power efficiency. The main task of a sensor node in a sensor field is to detect event, perform quick local data processing and transmit the data. Power consumption can hence be divided into three domain such as sensing, communication, and radio.

II. SYSTEM ANALYSIS

A. Existing system:

The existing packet-scheduling mechanisms of WSN use First Come First Served (FCFS), non-pre-emptive priority and pre-emptive priority scheduling algorithms. These algorithms incur a high processing overhead and long end-to-end data transmission delay due to the FCFS concept**.** Indeed, most existing Wireless Sensor Network operating systems use First Come First Serve schedulers that process data packets in the order of their arrival time and, thus, require a lot of time to be delivered to a relevant base station (BS).

a. *Problem statement:*

However, to be meaningful, sensed data have to reach the BS within a specific time period or before the expiration of a deadline.

Additionally, real-time emergency data should be delivered to BS with the shortest possible end-to-end delay. Hence, intermediate nodes require changing the delivery order of data packets in their ready queue based on their importance and delivery deadline.

Furthermore, most existing packet scheduling algorithms of WSN are neither dynamic nor suitable for large scale applications.

B. Proposed system

In the proposed scheme data packets that are sensed at a node are scheduled among a number of levels in the ready queue, each node, except those at the last level of the virtual hierarchy in the zone- based topology of WSN, has three levels of priority queues. Real-time packets are placed into the highest-priority queue and can pre-empt data packets in other queues. Non-real-time packets are placed into two other queues based on a certain threshold of their estimated processing time. Leaf nodes have two queues for real-time and non-real-time data packets since they do not receive data from other nodes and thus, reduce end- to-end delay. We evaluate the performance of the proposed DMP packet scheduling scheme through simulations for real-time and non-real-time data. Simulation results illustrate that the DMP packet scheduling scheme outperforms conventional schemes in terms of average data waiting time and end-to-end delay. According to the priority of the packet and availability of the queue, node will schedule the packet for transmission.

a. Advantages:

Due to separated queue availability packet transmission delay is reduced. Due to reduction in packet transmission delay, node can goes to sleep mode as soon as possible. So we can improve the energy saving also

b. *Architecture:*

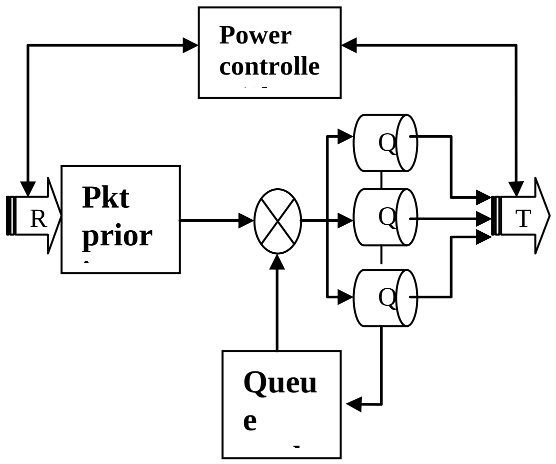


Fig 2.1 architecture

C. Routing Layer

Despite the availability of many routing protocols for ad hoc networks, the design of routing protocols for WMNs is still an active research area. We believe that an optimal routing protocol for WMNs must capture the following features:

a. Multiple Performance Metrics:

Many existing routing protocols use minimum hop-count as a performance metric to select the routing path. This has been demonstrated to be ineffective in many situations.

b. Scalability:

Setting up or maintaining a routing path in a very large wireless network may take a long time. Thus, it is critical to have a scalable routing protocol in WMNs.

c. Robustness :

To avoid service disruption, WMNs must be robust to link failures or congestion. Routing protocols also need to perform load balancing.

D. Efficient Routing with Mesh Infrastructure:

Considering the minimal mobility and no constraints on power consumption in mesh routers, the routing protocol in mesh routers is expected to be much simpler than ad hoc network routing protocols. With the mesh infrastructure provided by mesh routers, the routing protocol for mesh clients can also be made simple. Existing routing protocols for ad hoc networks have already considered some of these features. However, none of them has captured all of these features, as explained in the following routing protocols.

E. Routing Protocols with Various Performance Metrics:

The impact of performance metrics on a routing protocol is studied where link quality source routing (LQSR) selects a routing path according to link quality metrics. Three performance metrics, i.e., expected transmission count (ETX), per-hop RTT, and per-hop packet pair, are implemented separately. The performance of the routing protocol with these three performance metrics is compared with the method using the minimum hop-count. For stationary nodes in WMNs, ETX achieves the best performance, while the minimum hop count method outperforms the three link quality metrics when nodes are mobile. This result illustrates that the link quality metrics are used still not enough for WMNs when mobility is concerned.

a. Multi-Radio Routing:

A multi-radio LQSR (MR-LQSR) is proposed , where a new performance metric, called weighted cumulative expected transmission time (WCETT), is incorporated. WCETT takes into account both link quality metric and the minimum hop-count and achieves good trade off between delay and throughput. MR-LQSR assumes that all radios on each node are tuned to non-interfering channels with the assignment changing infrequently.

b. Multi-Path Routing :

The main objectives of using multi-path routing are to perform better load balancing and to provide high fault tolerance. Multiple paths are selected between source and destination. When a link is broken on a path due to a bad channel quality or mobility, another path in the set of existing paths can be chosen. Thus, without waiting to set up a new routing path, the end-to-end delay, throughput, and fault tolerance can be improved. However, given a performance metric, the improvement depends on the availability of node disjoint routes between source and destination. Another drawback of multi-path routing is its complexity.

c. Hierarchical Routing:

In hierarchical routing, a certain self-organization scheme is employed to group network nodes into clusters. Each cluster has one or more cluster heads. Nodes in a cluster can be one or more hops away from the cluster head. Since connectivity between clusters is needed, some nodes can communicate with more than one cluster and work as a gateway. When the node density is high, hierarchical routing protocols tend to achieve much better performance because of less overhead, shorter average routing path, and quicker set-up procedure of routing path. However, the complexity of maintaining the hierarchy may compromise the performance of the routing protocol. Moreover, in WMNs, a mesh client must avoid being a cluster head because it can become a bottleneck due to its limited capability.

d. Geographic Routing:

Compared to topology-based routing schemes, geographic routing schemes forward packets by only using the position information of nodes in the vicinity and the destination node . Thus, topology change has less impact on the geographic routing than the other routing protocols.Early geographic routing algorithms are a type of single-path greedy routing schemes in which the packet forwarding decision is made based on the location information of the current forwarding node, its neighbors, and the destination node. However, all greedy routing algorithms have a common problem, i.e., delivery is not guaranteed even if a path exists between source and destination. In order to guarantee delivery, planar-graph-based geographic routing algorithms have been proposed recently. However, these algorithms usually have much higher communication overhead than the single- path greedy routing algorithms.

F. Working of Address Resolution Protocol (ARP)

ARP is a layer 2 protocol, used for obtaining MAC address of any devices within a network. Not only switch but also host machines use ARP protocol to obtain MAC Address. ARP protocol in conjunction with Layer 3 IP

Protocol addressing (IP Address). Host machine uses ARP because when machine needs to send packet to another device, destination MAC address is needed to be written in packet sent, so host machine should know the MAC Address of destination machine. Operating Systems also maintain ARP Table (MAC Address Table). To obtain MAC address, ARP performs following process: (ARP request by host machine)

Source machine generate ARP REQUEST packet with source MAC address (of this machine), source IP address (of this machine) and destination IP address and forwards this packet to switch.

- Switch receives the incoming packet and reads the source MAC address and checks its MAC address table, if entry for packet at incoming port is found then it checks its MAC address with the source MAC address and updates it, if entry not found then switch add and entry for incoming port with MAC address.
- (Broadcast are those packets which are sent to everyone in network except the sender, only in network to which it belongs, it cannot span multiple networks)
- All devices in network receives ARP packet and compare their own IP address with the destination IP address in that packet.
- Only the machine which matches the both will reply with ARP reply packet. This packet will have source IP of this machine (which was destination machine in previous packet, as now its replying this machine will be the source machine) , source MAC address, destination MAC address (same as source MAC address in REQUEST packet) and destination IP address (same as source IP address in REQUEST packet).

III. PROJECT DESCRIPTION MODULES:

1. Topology formation
2. Priorities
3. TDMA
4 .Pre-emption and Non – pre-emption

A. Topology formation:

- Scheme assumes that nodes are virtually organized as hierarchical structure.
- Nodes that are at the same hop distance from the base station (BS)
  are considered to be located at the same level.
- Nodes in zones that are one hop and two hops away from the BS are considered to be at level 1 and level 2, respectively.
- Whole structure divides in zone. Zone also divides in Small Square
- Data are transmitted from the lowest level nodes to BS through the nodes of intermediate levels

B. Priorities and Queues :

- Real-time and emergency data should have the highest priority the priority of non-real-time data packets is assigned based on the sensed location (i.e., remote or local) and the size of the data.
- The data packets that are received by node *x* from the lower level nodes are given higher priority than the data packets sensed at the node *x* itself

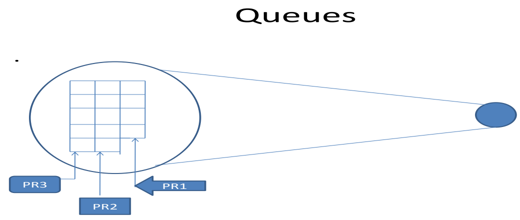


Fig 3.1 queue formation

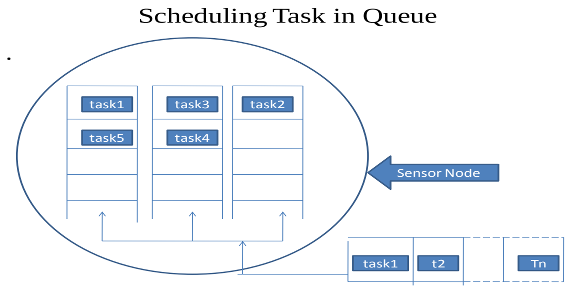
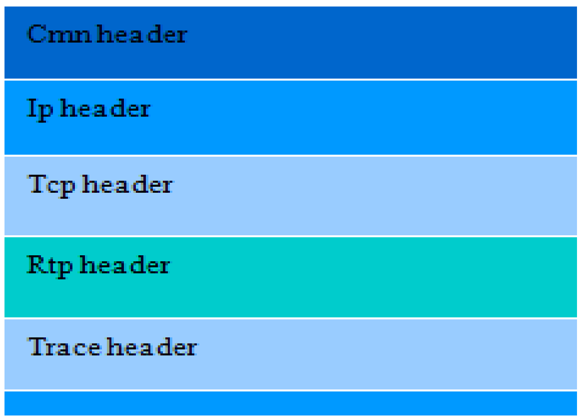


Fig 3.2 Task scheduling



In case of two same priority data packets the smaller sized data packets are given the higher priority.Data packets that are sensed at a node are scheduled among a number of levels in the ready queue.

C. TDMA:

- Every level has fixed time slot

- f that time greater than the time calculated for pr1 queue then all pr1 packet proceed as FCFS
- Whatever time remains that use for pr2 and pr3 in between this.
- If any higher priority calculated time is greater than total remain time the higher priority queue task send as FCFS no priority task send.

D. Pre-emption and Non – pre-emption:

- If pr1 queue is empty then it will send pr2 queue packet unless until remaining time less than total pr2 proc time.
- If pr3 packet comes means it pre-empted pr2
- At the time execution of pr3 if highest priority packet comes it save the context of pr3 and given priority to that packet. again process pr3.

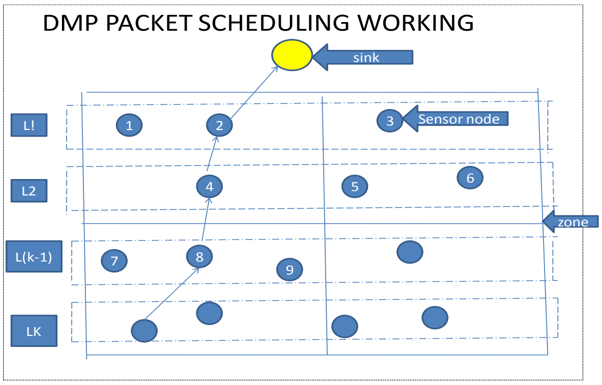


Fig: 3.3 Working of DMP

IV. SOFTWARE FEATURES

A. Software Requirements:

- Linux OS (Ubuntu 10.04)
- NS2.34

B. NS features:

- NS is an object oriented discrete event simulator
- Simulator maintains list of events and executes one event after another
- Single thread of control: no locking or race conditions
- Back end is C++ event scheduler
- Protocols mostly
- Fast to run, more control
- Front end is OTCL
- Creating scenarios, extensions to C++ protocols
- fast to write and change

C. NS PROGRAMMING STRUCTURE

- Create the event scheduler
- Turn on tracing
- Create network topology
- Create transport connections
- Generate traffic
- Insert errors

a) Event scheduler

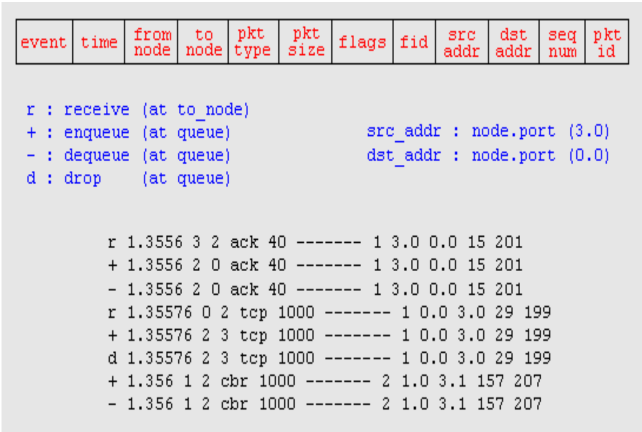
In this Event scheduler while we processing many datas at a time it will process one by one (i.e) FIFO concept , so there is no congestion while transferring the packets.

b) Packets

It is the collection of data, whether header is called or not all header files where present in the stack registers.

c) Turn on Tracing

Trace packets on individual link Trace file format



event	time	from node	to node	pkt type	pkt size	flags	fid	src addr	dst addr	seq num	pkt id

```
r : receive (at to_node)
+ : enqueue (at queue)           src_addr : node.port (3.0)
- : dequeue (at queue)           dst_addr : node.port (0.0)
d : drop    (at queue)

r 1.3556 3 2 ack 40 ------- 1 3.0 0.0 15 201
+ 1.3556 2 0 ack 40 ------- 1 3.0 0.0 15 201
- 1.3556 2 0 ack 40 ------- 1 3.0 0.0 15 201
r 1.35576 0 2 tcp 1000 ------- 1 0.0 3.0 29 199
+ 1.35576 2 3 tcp 1000 ------- 1 0.0 3.0 29 199
d 1.35576 2 3 tcp 1000 ------- 1 0.0 3.0 29 199
+ 1.356 1 2 cbr 1000 ------- 2 1.0 3.1 157 207
- 1.356 1 2 cbr 1000 ------- 2 1.0 3.1 157 207
```

Fig 4.2 Turn on tracing

d) Create Network Topology(PHYSICAL LAYER)

The Physical Layer is the first and lowest layer in the seven-layer OSI model of computer networking. The implementation of this layer is often termed PHY.

The Physical Layer consists of the basic hardware transmission technologies of a network. It is a fundamental layer underlying the logical data structures of the higher level functions in a network. Due to the plethora of available hardware technologies with widely varying characteristics, this is perhaps the most complex layer in the OSI architecture.

The Physical Layer defines the means of transmitting raw bits rather than logical data packets over a physical link connecting networking nodes. The bit stream may be grouped into code words or symbols and converted to a physical that is transmitted over a hardware.

e) Transport Connection (TRANSPORT LAYER)

Transport layers are contained in both the TCP/IP. which is the foundation of the INTERNET. and the OSI model of general networking. The definitions of the Transport Layer are slightly different in these two models. This article primarily refers to the TCP/IP model, in which TCP is largely for a convenient application programming interface to internet hosts, as opposed to the osi model of definition interface.The most well-known transport protocol is the (TCP). It lent its name to the title of the entire internet protocol suite TCP/IP. It is used for connection-oriented transmissions, whereas the connectionless user datagram suite(UDP) is used for simpler messaging transmissions. TCP is the more complex protocol, due to its stateful design incorporating reliable transmission and data stream services.

f) Generate Traffic (APPLICATION LAYER)

In TCP/IP, the Application Layer contains all protocols and methods that fall into the realm of process-to-process communications via an Internet Protocol (IP) network using the Transport layer protocols to establish underlying host-to-host connections.

In the OSI model, the definition of its Application Layer is narrower in scope, explicitly distinguishing additional functionality above the Transport Layer at two additional levels: session layer and presentation layer OSI specifies strict modular separation of functionality at these layers and provides protocol for each layer.

g) Insert Errors

The error is inserted in the network and checked whether the error occur in the real time. In the insert errors perform the operation of Start debugging of errors in the network.

D. Implementation

a) Topology:

The topology formation has seven nodes are created and each sensor nodes are sending the packets to the base station .The nodes are fixed in the network. In a zone- based routing protocol, each zone is identified by a zone head (ZH) and nodes follow a hierarchical structure, based on the number of hops they are distant from the base station (BS)

b) FIFO :

First come first server algorithm those packet coming first that packet goes first. In this user has given choice to change starting time of node to change source node .According to the priority the first packed will send first to the base station.

c) Priority:

If user interested then he can give priority to node. so packet of that node will goes to sink first. In this choice also we can generate simulation time for all source node . and we can change source node also.

d) MAC:

The scheduler is implemented as part of the MAC layer and can thus, use only the MAC-layer queue lengths. Upon arrival of a file, a TCP connection is established which regulates the injection of packets to MAC layer. Upon arrival of a file, a TCP connection is established which regulates the injection of packets to MAC layer. The scheduling algorithm must determine which links can transmit packets at each time instant. When the transmission of a file ends, its corresponding TCP connection is closed and the file departs the system. If the scheduler has access to the total queue length at Transport and MAC layers, then it can use Max Weight algorithm to achieve throughput optimal.

V.RESULTS OBTAINED

A. Sensor performance measurements

Although the special characteristics of wireless sensor networks (WSNs) help in reducing the cost of sensor nodes manufacturing and deployment, they added new challenges that directly affect the network functionality. This is increases the probability of network functionality deviation from its norm operation and affects its' collected data accuracy. Moreover, these challenges reduce the network lifetime. To insure the stability of WSN functionality at acceptable level during its operation, this paper proposes a new performance-monitoring algorithm. The proposed algorithm tracks network operation and isolate deviated network nodes before they have a high impact on network collected data accuracy or network lifetime. The experiment results show that the algorithm achieved a high-level of detection reliability with resilience to both high packet loss and environmental changes.

B. Lifetime of Wireless Sensor Networks

The extension of the network lifetime of Wireless Sensor Networks (WSN) is an important issue that has not been appropriately solved yet. This paper addresses this concern and proposes some techniques to plan an arbitrary WSN. To this end, we suggest a hierarchical network architecture, similar to realistic scenarios, where nodes with renewable energy sources (denoted as primary nodes) carry out most message delivery tasks, and nodes equipped with conventional chemical batteries (denoted as secondary nodes) are those with less communication demands. The key design issue of this network architecture is the development of a new optimization framework to calculate the optimal assignment of renewable energy supplies (primary node assignment) to maximize network lifetime, obtaining the minimum number of energy supplies and their node assignment. We also conduct a second optimization step to additionally minimize the number of packet hops between the source and the sink.

C. RESULT OBTAINED

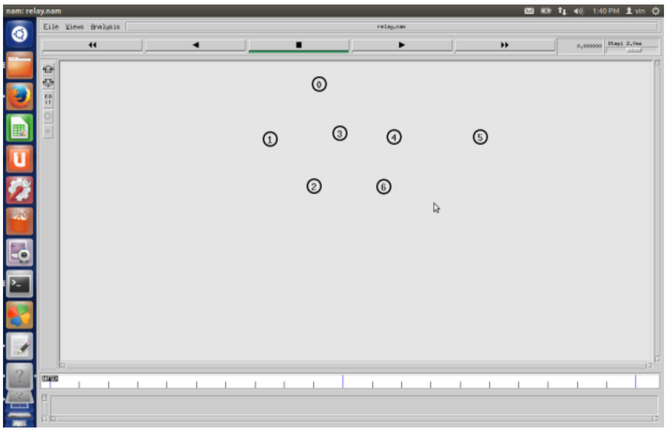


Fig 5.1 Topology formation

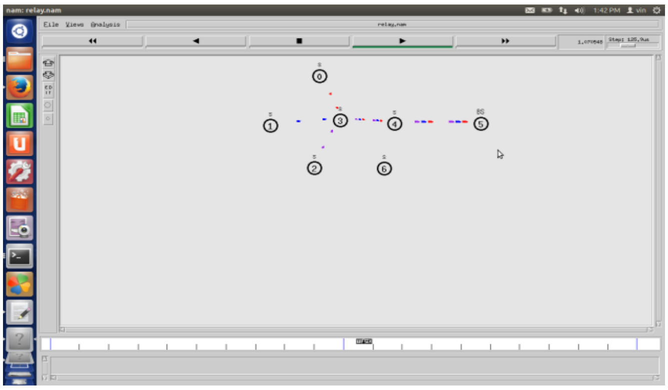


Fig 5.2 FIFO formation

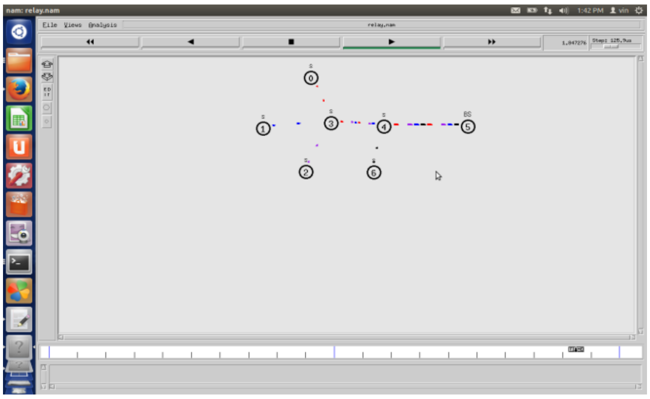


Fig 5.3 FIFO based packet send first

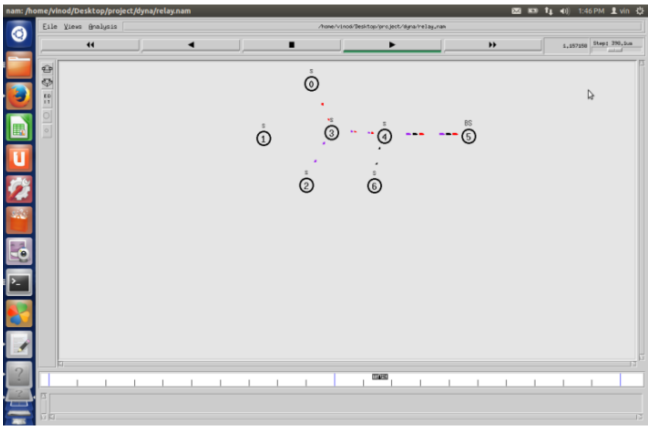


Fig 5.4 With starting time formation

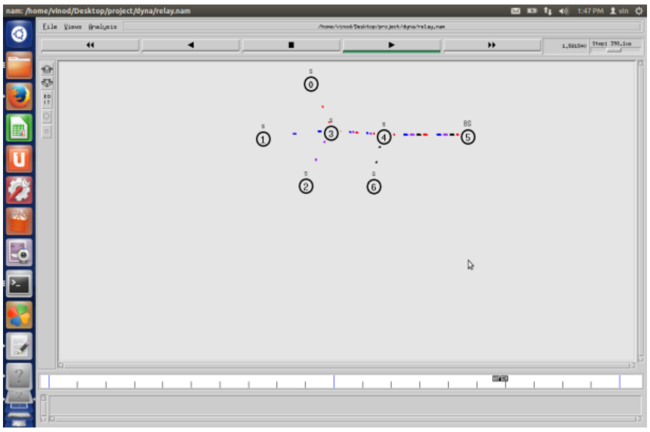


Fig 5.5 packet send at the starting time process

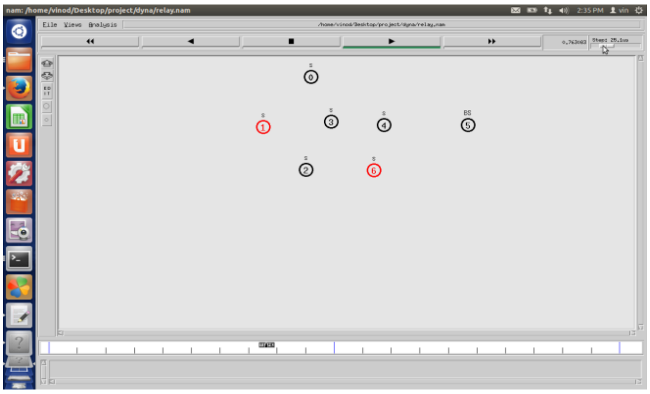


Fig 5.6 priority given to the nodes

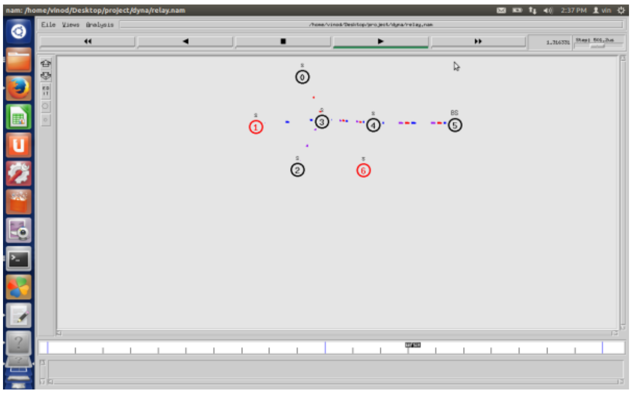


Fig 5.7 priority nodes sending the packet

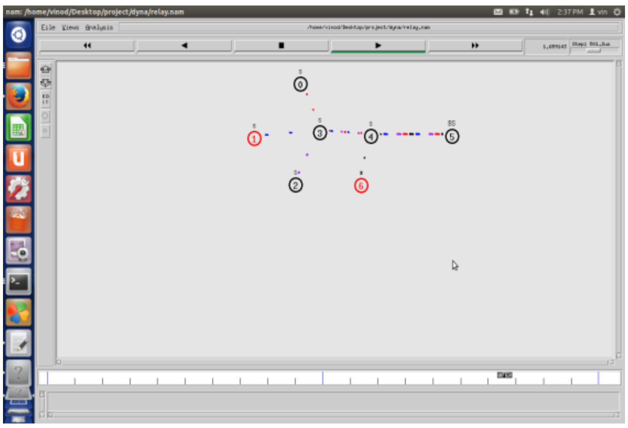


Fig 5.8. Priority packets goes first to the base station

VI. CONCLUSION AND FUTURE ENHANCEMENT

A. CONCLUSION

A Dynamic Multilevel Priority (DMP) packet scheduling scheme for Wireless Sensor Networks (WSNs). The scheme uses three-level of priority Queues to schedule data packets based on their types and priorities. It ensures minimum end-to-end data transmission End-to-End Delay of all Tasks (microSec) for the highest priority data while exhibiting acceptable fairness towards lowest-priority data. Experimental results show that the proposed DMP packet scheduling scheme has better performance than the existing FCFS and Multilevel Queue Scheduler in terms of the average task waiting time and end to-end. As enhancements to the proposed DMP scheme, we envision Assigning task priority based on task deadline instead of the shortest task processing time. To reduce processing overhead and save bandwidth, we could also consider removing tasks with expired deadlines from the medium. Furthermore, if a real-time task holds the resources for a longer period of time, other tasks need to wait for an undefined period time, causing the occurrence of a deadlock. This deadlock situation degrades the performance of task scheduling schemes in terms of end to- end delay. Hence, we would deal with the circular wait and pre-emptive conditions to prevent deadlock from occurring. We would also validate the simulation result using a real test-bed.

B. FUTURE ENHANCEMENT

a) Proposed design:

Proposed DMP packet-scheduling algorithm for different types of traffic in terms of average task waiting time and end-to-end data transmission delay. It evaluates the performance of the DMP packet scheduling scheme through simulations and compares it against that of the existing FCFS and Multilevel Queue Scheduler algorithms, we propose a Dynamic Multilevel Priority (DMP) packet scheduling scheme for WSNs in which sensor Nodes are virtually organized into a hierarchical structure. Nodes that have the same hop distance from the BS are considered to be located at the same hierarchical level. Data packets sensed by nodes at different levels are processed using a TDMA scheme

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