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# A Cross Layer Approach Network Evaluation of IEEE 802.15.4 for Mobile WSN

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## ABSTRACT

Mobility in wireless sensor networks (WSNs), can have profound effect on the network operation.This effect is diverse according to several parameters that include: application diversity, network topography (topology), network connectivity and deployed node(s) or sensed event(s) location estimation. One major finding is that these networks suffer from control packet overhead anddelivery ratio degradation. This increases the network's energy consumption. This work introduces a cross-layer operation model that can improve the energy consumption and system throughput of IEEE 802.15.4 MWSNs. The proposed model integrates four layers in the network operation: 1) application (node location); 2) network (routing); 3) medium access control (MAC); and 4) physical layers. The model employs a mechanism tominimize the neighbor discovery broadcasts to the active routesonly. Reducing control packet broadcasts between the nodesreduces the network's consumed energy. It also decreases theoccupation period of the wireless channel. The model operationleads the network to consume less energy while maintaining thenetwork packet delivery ratio. Simulations have been carried out to check the efficacy of the proposed operation model .

## I. INTRODUCTION

A mobile wireless sensor network (MWSN) can simply be defined as a wireless sensor network (WSN) in which the sensor nodes are mobile. Sensor node mobility can be divided into two categories: limited mobility where there are specific nodes that roam around the network to perform an exclusive task (e.g., mobile sink nodes) and random mobility where the nodes (sensor nodes) roam around the area of deployment to collect the data needed for the application. Mobility as a problem has either advantageous effects or disadvantageous ones.

Advantages of introducing mobility to the network can belisted as below:

1. Applications: Introducing mobility to the network can enlarge the scope of applications to implement WSNs.Applications such as social activity monitoring, cattle monitoring, swarm bot actuated networks and more.
2. Topography and network connectivity: Since WSNs transfer their data in a multi-hop fashion, mobility can enhance the network operation by changing the location of the nodes leading to create different links to the destination required.
3. If mobility is limited to special nodes, e.g., sink node(s), the stationary nodes then can be relieved in terms of links generated to the destination node. The sink node(s) can roam around through stationary nodes and gather the information sensed by sensor nodes. Mobile sink nodes can also enhance the network connectivity by minimizing the congestion that can happen during network traffic flow.

Mobility can introduce a critical challenge to the operation of the deployed network:

1. If mobility is limited to special node(s), then those nodes can suffer from a bottleneck problem. A considerable plan and calculations are required to estimate the optimum number and paths for the special node(s) to cover the deployed network.
2. If mobility is random. i.e., sensor nodes are also mobile in the network, the effect is greater as the network topology changes become rapid and that affects the connectivity of the nodes. Topology changes have an effect on the routing operation as the links need to be rebuilt frequently; therefore, there is an increase energy consumption of the nodes. Mobility affects the MAC protocol operation because the connectivity can suffer from broken connections due to the transmission range of the wireless interface. The location of the sensor node(s) in random mobility is of importance because the sensed event is attached to the location of the sensor node. In a mobile scenario, a localization mechanism becomes a frequent operation leading to an increment in node(s) energy consumption.

The focus of this paper is the random mobility of the deployed sensor nodes and how it has effects on the networks operation in terms of the connectivity and location estimation of the nodes. The connectivity issue is dealt with by using routing protocols and MAC protocols as both layers are responsible of insuring an available connection between one hop and another. The location information is an application layer attachment; however, it requires a specific mechanism to estimate the location of the mobile node(s). This paper introduces a cross-layer operation model that can improve the energy consumption and system throughput of IEEE 802.15.4 MWSNs. The proposed model integrates four layers in the network operation: 1) application (node location); 2) network (routing); 3) medium access control (MAC); and 4) physical layers. The model employs a mechanism to minimize the neighbor discovery broadcasts to the active routes only. The model operation leads the network to consume less energy while maintaining the network packet delivery ratio

## II. LITERATURE SURVEY

DD Chaudhary in his work "A new dynamic energy efficient latency improving protocol for wireless sensor networks" has explored **the** concept of distance metric based routing protocol approach for 'high energy efficiency' and 'shortest path selection' for latency improvement. The proposed new protocol is 'Dynamic Energy Efficient Latency Improving Protocol (DEELIP). The simulation results are compared with 'AODV' routing protocol. It is observed that in proposed protocol; the overhead of the network traffic is reduced, resulting in improvement of energy efficiency and latency than existing routing protocols.

G Anastasi et al in their work "A comprehensive analysis of the MAC unreliability problem in IEEE 802.15.4 wireless sensor networks "has focused on IEEE 802.15.4 WSNs and show that they can suffer from a serious unreliability problem. They have carried out an extensive analysis based on both simulation and experiments on a real WSN to investigate the fundamental reasons of this problem, and have found that it is caused by the contention-based MAC protocol used for channel access and its default parameter values. They also concluded that, with a more appropriate MAC parameters setting, it is possible to mitigate the problem and achieve a delivery ratio up to 100%, at least in the scenarios considered in this paper. However, this improvement in communication reliability is achieved at the cost of an increased latency, which may not be acceptable for industrial applications with stringent timing requirements.

L Karim et al in their work " Reliable location-aware routing protocol for mobile wireless sensor network" have proposed a location-aware and fault tolerant clustering protocol for mobile WSN (LFCP-MWSN) that is not only energy efficient but also reliable. LFCP-MWSN also incorporates a simple range free approach to localize sensor nodes during cluster formation and every time a sensor moves into another cluster. Simulation results show that LFCP-MWSN protocol has about 25-30% less energy consumptions and slightly less end-to-end data transmission delay than the existing LEACH-Mobile and LEACH-Mobile-Enhanced protocols.

On the basis of literature survey carried out we observe that these networks suffer from control packet overhead and delivery ratio degradation. This increases the network's energy consumption. Mobility can introduce a critical challenge to the operation of the deployed network. If mobility is limited to special node(s), then those nodes can suffer from a bottleneck problem. A considerable plan and calculations are required to estimate the optimum number and paths for the special node(s) to cover the deployed network. If mobility is random. i.e., sensor nodes are also mobile in the network, the effect is greater as the network topology changes become rapid and that affects the connectivity of the nodes. Topology changes have an effect on the routing operation as the links need to be rebuilt frequently; therefore, there is an increase energy consumption of the nodes. Mobility affects the MAC protocol operation because the connectivity can suffer from broken connections due to the transmission range of the wireless interface. The location of the sensor node(s) in random mobility is of importance because the sensed event is attached to the location of the sensor node. In a mobile scenario, a localization mechanism becomes a frequent operation leading to an increment in node(s) energy consumption.

In the existing systems a self-adaptive sleep/wake-up scheduling approach used , which takes both energy saving and packet delivery delay into account. This approach is an asynchronous one and it does not use the technique of duty cycling. Thus, the trade-off between energy saving and packet delivery delay can be avoided. In most existing duty cycling based sleep/wake-up scheduling approaches, the time axis is divided into periods, each of which consists of several time slots. In each period, nodes adjust their sleep and wake up time, i.e., adjusting the duty cycle, where each node keeps awake in some time slots while sleeps in other time slots.

The existing systems suffer from Data loss , reduced network life time, premature node failure

Thus the objective of our work is to improve the energy consumption and system throughput of IEEE 802.15.4 mobile wireless sensor network while minimizing the power utilized by the network. The focus is to reduce control packet broadcasts between the nodes for reducing the network's consumed energy and simultaneously decreasing the data transmission time resulting in high speed communication

## III. PROPOSED SYSTEM AND ITS METHODOLOGY

In the proposed algorithm, nodes instead of forwarding the packets to all the encountered neighboring nodes, select only the appropriate node and the selection of appropriate node is based on the distance and energy level. Firstly, only the neighboring nodes having distance less than neighbor discovery range are considered as neighboring nodes and the neighboring nodes are filtered by calculating the distance to destination. Nodes which have distance less than average distance are selected as neighboring nodes. Thus this method presents a routing mechanism which aims at reducing energy consumption in the network which is accomplished by avoiding broadcasting of messages to all the neighboring nodes thus reducing the number of transmissions in the network. For proposed system Network life time will be high when compare with existing system with reduced energy consumption and low packet loss. At the same time the throughput is high with high packet delivery ratio and low delay .The overall system gets more secured and avoids dummy traffic.

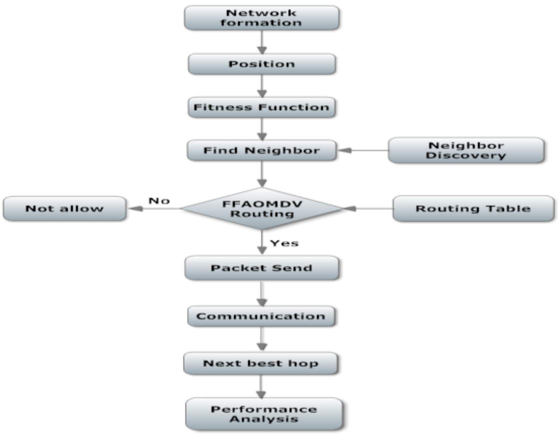



**Figure 1.** The flow diagram of the proposed system

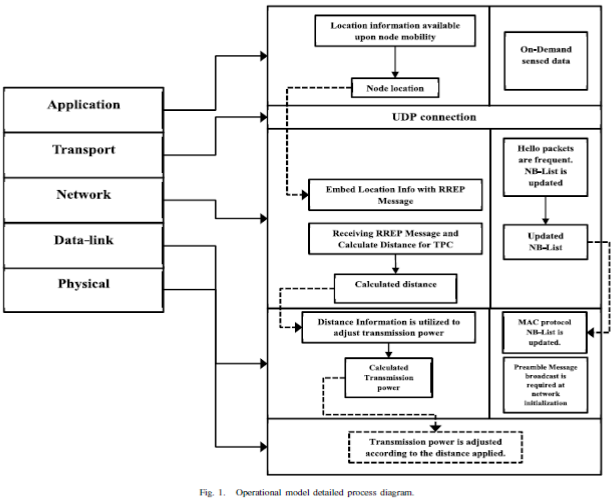



**Figure 2.** Operation model detailed process diagram

At network initialization, the mobile node started to broadcast a neighbor discovery message to initiate neighbor(s) information collection and store it in a neighbors' list (NB-List). After the initialization process, if a node in the network had data of interest to send, attached with this data was the location information of the mobile node. This node then started sending route request (RREQ) packets to establish a route to the destination node. The routing protocol utilized in the operation model utilizes a periodic neighbor maintenance message which is a hello packet. Hello packets are broadcast packets; therefore, it was possible to utilize the neighbor list from the network layer in the data-link layer. This eliminated the need for neighbor discovery messages to be sent by the MAC protocol.

After the destination node received the RREQ packets, it replied by sending a unicast route reply (RREP) packet. The destination node embedded its own location information in the RREP message and sent it back to the next hop node in the reverse route. The next hop node in the reverse route calculated the distance between it and the destination node and exported this information to the data-link layer. The MAC protocol utilized the transmission power control-based on the distance information and calculated the required power to use when sending data packets back to the destination node. The transmission power and range is calculated by implementing the radio propagation model according to the distance calculated by the nodes. The distance between two nodes is calculated as the Euclidian distance between two points. This operation was repeated through all nodes until the source node.

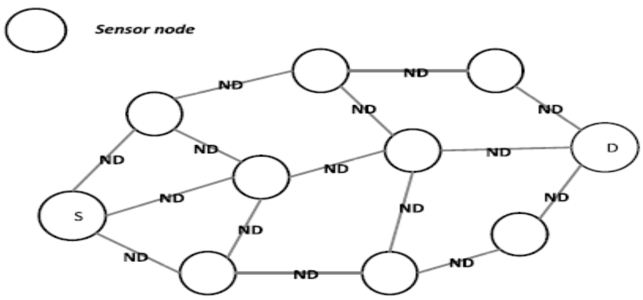



**Figure 3.** Network activity state at time stamp ts

## IV. RESULT AND DISCUSSION

- The simulation work has been done with the Network Simulator ns-2, Version 2.34.

- Network formation is an aspect of creating nodes of network and transmit data.
- Network of 100 nodes is created using network simulator for wireless sensor network.

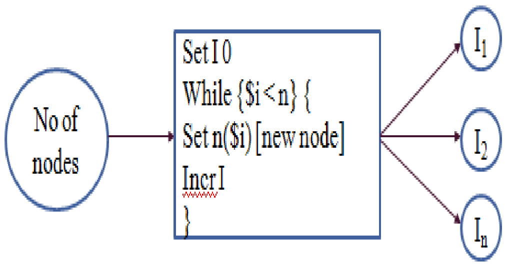



**Figure 4.** Method of Node formation

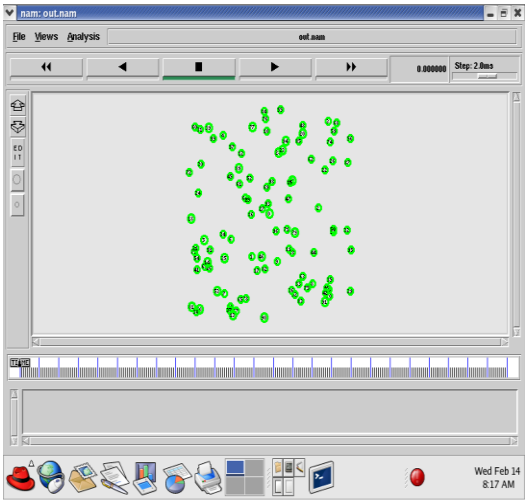
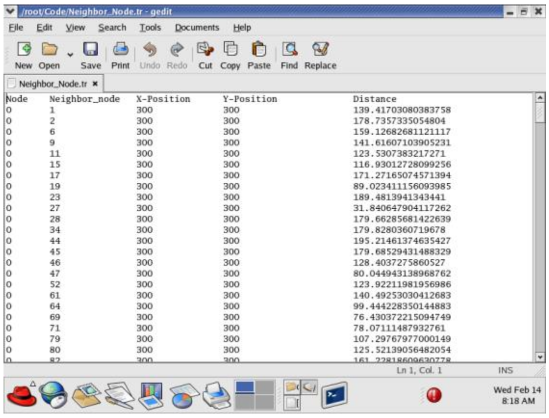



**Figure 5.** showing the created nodes

## NEIGHBOR DISCOVERY

- On-demand reactive routing protocol that uses routing tables with one entry per destination.
- When a source node needs to find a route to a destination, it starts a route discovery process, based on flooding, to locate the destination node.
- Upon receiving a route request (RREQ) packet, intermediate nodes update their routing tables for a reverse route to the source.
- Similarly, the forward route to the destination is updated upon reception of a route reply (RREP) packet originated either by the destination itself or any other intermediate node that has a current route to the destination.




| Node | Neighbor_node | X-Position | Y-Position | Distance |
|---|---|---|---|---|
| 0 | 1 | 300 | 300 | 139.41703080383758 |
| 0 | 2 | 300 | 300 | 178.7357335054804 |
| 0 | 6 | 300 | 300 | 159.12682681121117 |
| 0 | 9 | 300 | 300 | 141.61607103905231 |
| 0 | 11 | 300 | 300 | 123.5307383217271 |
| 0 | 15 | 300 | 300 | 116.93012728099256 |
| 0 | 17 | 300 | 300 | 171.27165074571394 |
| 0 | 19 | 300 | 300 | 89.023411156093985 |
| 0 | 23 | 300 | 300 | 189.4813941343441 |
| 0 | 27 | 300 | 300 | 31.840647904117262 |
| 0 | 28 | 300 | 300 | 179.66285681422639 |
| 0 | 34 | 300 | 300 | 179.8280360719678 |
| 0 | 44 | 300 | 300 | 195.21461374635427 |
| 0 | 45 | 300 | 300 | 179.68529431488329 |
| 0 | 46 | 300 | 300 | 128.4037275860527 |
| 0 | 47 | 300 | 300 | 80.044943138968762 |
| 0 | 52 | 300 | 300 | 123.92211981956986 |
| 0 | 61 | 300 | 300 | 140.49253030412683 |
| 0 | 64 | 300 | 300 | 99.444228350144883 |
| 0 | 69 | 300 | 300 | 76.430372215094749 |
| 0 | 71 | 300 | 300 | 78.07111487932761 |
| 0 | 79 | 300 | 300 | 107.29767977000149 |
| 0 | 80 | 300 | 300 | 125.52139056482054 |

**Figure 6.** showing created nodes the distances between them.

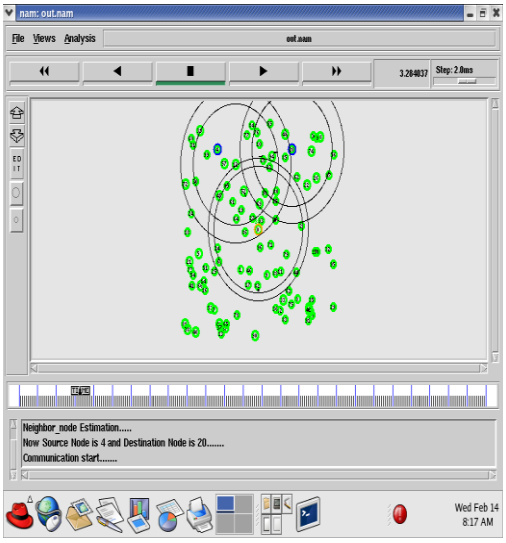
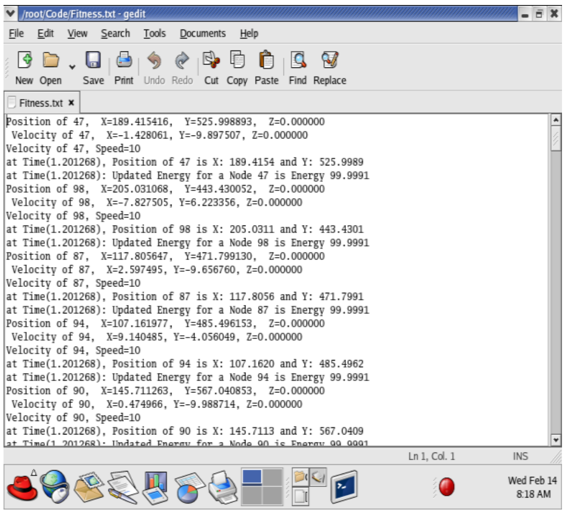



**Figure 7.** showing the neighbour discovery




```
Position of 47,  X=189.415416,  Y=525.998893,  Z=0.000000
 Velocity of 47,  X=-1.428061, Y=-9.897507, Z=0.000000
Velocity of 47, Speed=10
at Time(1.201268), Position of 47 is X: 189.4154 and Y: 525.9989
at Time(1.201268): Updated Energy for a Node 47 is Energy 99.9991
Position of 98,  X=205.031068,  Y=443.430052,  Z=0.000000
 Velocity of 98,  X=-7.827505, Y=6.223356, Z=0.000000
Velocity of 98, Speed=10
at Time(1.201268), Position of 98 is X: 205.0311 and Y: 443.4301
at Time(1.201268): Updated Energy for a Node 98 is Energy 99.9991
Position of 87,  X=117.805647,  Y=471.799130,  Z=0.000000
 Velocity of 87,  X=2.597495, Y=-9.656760, Z=0.000000
Velocity of 87, Speed=10
at Time(1.201268), Position of 87 is X: 117.8056 and Y: 471.7991
at Time(1.201268): Updated Energy for a Node 87 is Energy 99.9991
Position of 94,  X=107.161977,  Y=485.496153,  Z=0.000000
 Velocity of 94,  X=9.140485, Y=-4.056049, Z=0.000000
Velocity of 94, Speed=10
at Time(1.201268), Position of 94 is X: 107.1620 and Y: 485.4962
at Time(1.201268): Updated Energy for a Node 94 is Energy 99.9991
Position of 90,  X=145.711263,  Y=567.040853,  Z=0.000000
 Velocity of 90,  X=0.474966, Y=-9.988714, Z=0.000000
Velocity of 90, Speed=10
at Time(1.201268), Position of 90 is X: 145.7113 and Y: 567.0409
```

**Figure 8.** showing the fitness function

## OPTIMAL PATH FINDING

- Optimal Path Finder Algorithm is an optimization algorithm used in the proposed method for constructing an optimal path for transmitting the sensed data to the Destination.
- The node which has the data to transmit is called source node.
- Such node checks for the next best hop to transmit the sensed data towards the destination.
- For finding the next best hop, a *route_request message* is sent to all the neighbors.
- Route request send to all intermediate nodes between source S and destination D.

## SCREENSHOT FOR OPTIMAL PATH FINDING

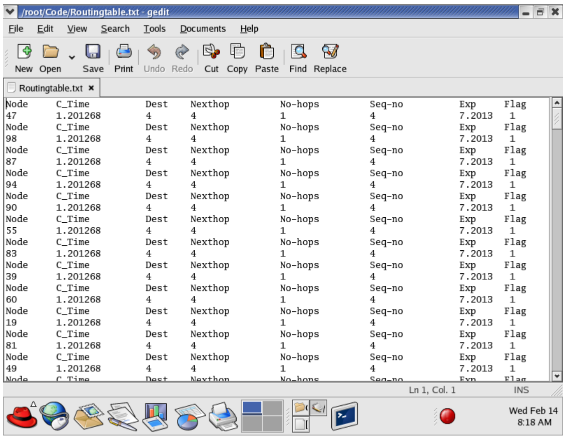



**Figure 9.** showing the optimal path finder in FFAOMDV Protocol in MANET.

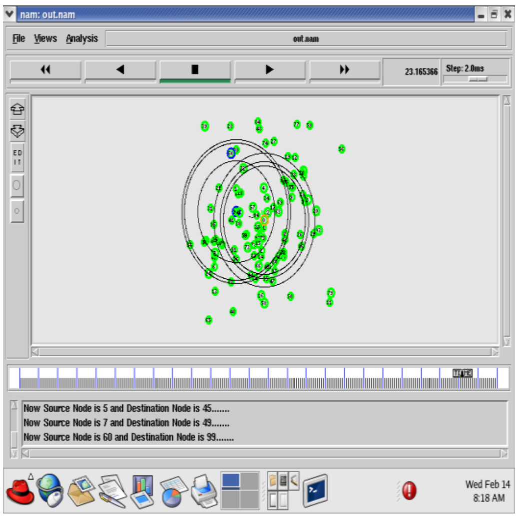



**Figure 10.** showing the communication in the FFAOMDV Protocol in MANET

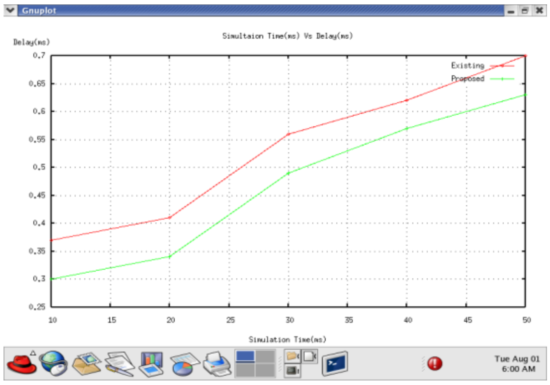



**Figure 11.** showing Delay by the nodes

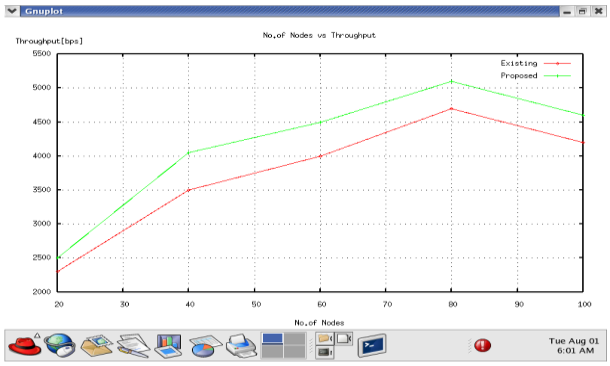



**Figure 12.** showing the Throughput carried in the network out by the nodes in network.

From figure 12 we can make an observation that the delay exhibited by the proposed system is around 0.62 ns as compared to the delay exhibited by the existing system which is around 7 ns .Thus the proposed system scores over the existing system. Similarly for figure 4.8 we observe that the throughput of the proposed system is around 4600 bps as compared to the throughput of the existing system which is around 4300.

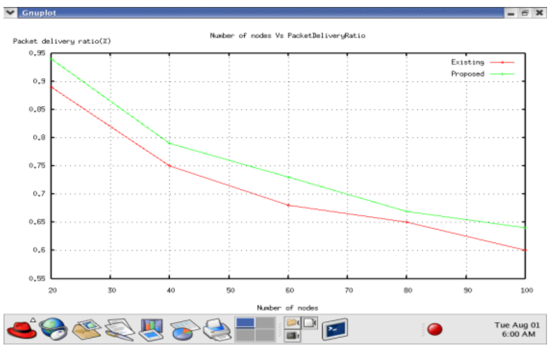



**Figure 13.** showing the ratio of Packet Delivery between nodes in the network.

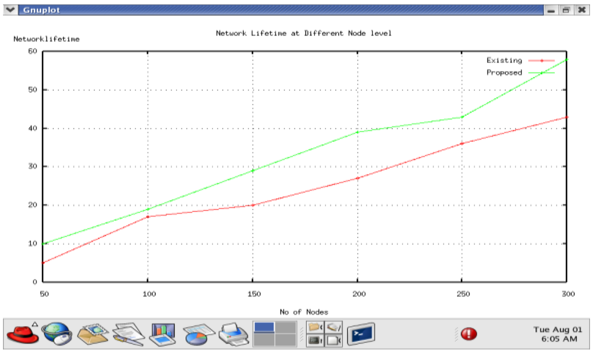



**Figure 14.** indicating Network Lifetime in the FFAOMDV protocol

From figure 4.9 we can make an observation that the packet delivery ratio for 100 nodes of the proposed system is around 95 % as compared to the packet delivery ratio for 100 nodes of the existing system which is around 87 %. Similarly for figure 4.10 we observe that the network lifetime at different node level for the proposed system is around 58 which is comparatively higher to the network lifetime at different node level of the existing system which is around 43.

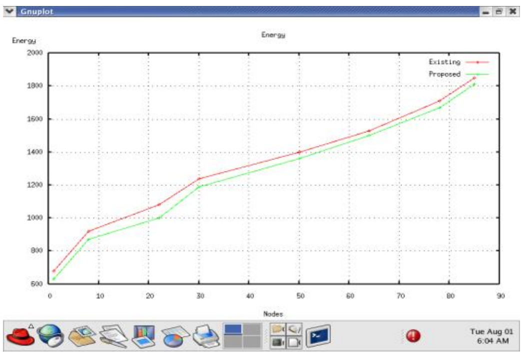



**Figure 15.** showing Energy consumption in the FFAOMDV protocol

From figure 15 we observe that the energy consumed by the existing system is higher as compared to the energy consumed by the proposed system.

## V. CONCLUSION

Thus we conclude that in this work we have been able to present a new energy efficient multipath routing algorithm called FF-AOMDV simulated using NS-2 under three different scenarios, varying node speed, and packet size and simulation time.These performance metrics (Packet delivery ratio, Throughput, End-to-end-delay, Energy consumption and Network lifetime) and the Simulation results shows that the proposed FF-AOMDV algorithm has performed much better than both AOMR-LM and AOMDV in throughput, packet delivery ratio and end-to-end delay and It also performed well against AOMDV for conserving more energy and better network lifetime.

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