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# Robust Recovery of Data in Multiple Sink Wireless Sensor Network

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**Abstract:** ***Multi-Sink Sensor network is one where the whole area is divided into subset of regions where each region has a sink and data is collected from sources of every region by the sink transmitted to base station by sink with the help of intermediate nodes. However if certain nodes in an area fails which are participated in routing, then a void region gets created and data is not transmitted to base station from that area. The unteachability problem (i.e., the so-called void problem) that exists has been studied for the wireless sensor networks. Some of the current research work cannot fully resolve the void problem, while there exist other schemes that can guarantee the delivery of packets with the excessive consumption of control overheads. Moreover, the hop count reduction (HCR) scheme is utilized as a short-cutting technique to reduce the routing hops by listening to the neighbor's traffic, while the intersection navigation (IN) mechanism is proposed to obtain the best rolling direction for boundary traversal with the adoption of shortest path criterion. This paper presents a robust recovery mechanism of nodes failure in a certain region of the network during data delivery. It dynamically finds new node to route data from source nodes to sink. We simulate the proposed system with oment and shows that the variant is better performer in void scenario***

**Keywords:** Node Failure; Area Failure; Data forwarding; Multiple Sink; WSN

## 1. Introduction

A wireless sensor network (WSN) consists of sensor nodes (SNs) with wireless communication capabilities for specific sensing tasks. Due to the limited available resources, efficient design of localized multihop routing protocols becomes a crucial subject within the WSNs. How to guarantee delivery of packets is considered an important issue for the localized routing algorithms. Several routing algorithms are proposed to either resolve or reduce the void problem, which can be classified into non-graph-based and graph-based schemes. In the nongraph- based algorithms, the intuitive schemes as proposed in construct a two-hop neighbor table for implementing the GF algorithm. The network flooding mechanism is adopted within the GRA and PSR schemes while the void problem occurs. There also exist routing protocols that adopt the backtracking method at the occurrence of the network holes (such as GEDIR, , DFS, and SPEED ). The Routing schemes as proposed by ARP and LFR memorize the routing path after the void problem takes place. Moreover, other routing protocols (such as PAGER NEAR and YAGR) propagate and update the information of the observed void node in order to reduce the probability of encountering the void problem. By exploiting these routing algorithms, however, the void problem can only be either 1) partially alleviated or 2) resolved with considerable routing overheads and significant converging time.

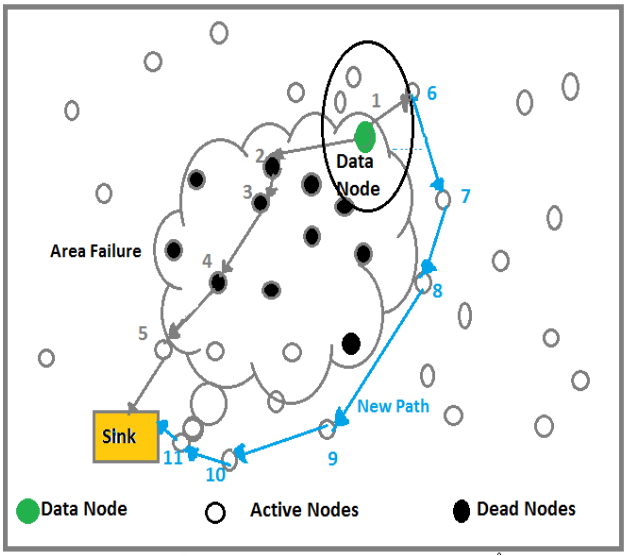



**Figure 1:** Representation of area failure and alternative route to sink

From fig.1 a fault tolerance mechanism for data forwarding using MCDR is described and situation of area failure and an alternative route to the sink is shown. The nodes with ids 1, 2, 3 4 and 5 are on the old route before the area failure occurred. A new route is used to transfer the data to the same sink (i.e. in the same partition). The new route consists of node ids 1, 6, 7, 8, 9, 10 and 11.On the other hand, a depicted in Fig. 2, where there is no way to deliver the data to the sink and hence it is sent to another sink in a different partition. It is mentioned earlier that a partitioned network with sinks placed in situation each partition is being used.

- **Module 1:** (Creation of base Wireless Sensor network topology)
  Create a simulation environment on Wireless Sensor Network implemented with Dynamic Source Routing Protocol and with more number of nodes. Source node will send the data to destination node through

intermediate nodes in the networks. Here the packets transfer using general wireless sensor network, so that we can show how the data transmission occurs in wireless sensor networks.

- **Module 2:** (Implementation of Area failure)
  Create a Mobile Adhoc network topology with more number of nodes and implement Area Failure, and transmit the packets from source to destination.
- **Module 3:** (Performance Analysis of Area failure).
  Packet Delivery Ratio, End to end delay, Energy Consumption are measured for Area failure, and output is Shown using graphs.
- Module 4: (Implementation of proposed system)
  Create a Wireless Sensor Network topology with more number of nodes and implement proposed Fault Tolerance in Case Of Area Failure and transmit the packets from source to destination.
- **Module 5:** ( Performance analysis of proposed System )
  Packet Delivery Ratio, End to end delay, Energy Consumption are measured for proposed Fault Tolerance in Case Of Area Failure , and output is Shown using graphs.
- **Module 6:**(Comparison)
  compared Area failure with proposed Fault Tolerance in Case Of Area Failure regarding measured factors( Packet Delivery Ratio, End to end delay, Energy Consumption ) and output is shown using graphs. Implementation: Graph Analysis

## 2. Statement of the Problem

In sensor networks, due to energy losses and node movement, void regions are created from source to destination such that source can't find the destination in its forward direction. Hence normally transmission is halted. But instead of stopping the transmission we propose a mechanism whereby nodes forms a unit disk graph around it and look for another node in this which might find the destination in its forward direction( Even though it has more distance than the source). Thus by pre-emptively replacing current node with another node in the route ensures consistent data transmission.

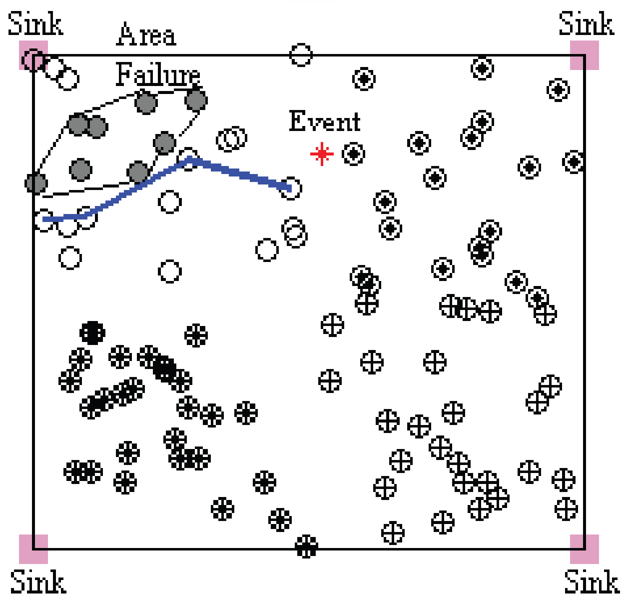



**Figure 2:** No possibility to reach sink

## 3. Objective

Void regions are of severe concern in any networks, especially in sensor networks. Sensors are limited capability hardware. Hence deploying complicated protection routing is difficult for such a network. In case of void regions, many authors have earlier proposed backup routing. But such schemes consume energy and memory. Hence the objective is to derive an algorithm that develops anti void traversal and align the nodes transmission is such a way to avoid the void regions.

## 4. Future Scope

The system can be used in scenarios where the sensor nodes have high energy dissipation and movement. A movable sensor is basically deployed on large fields like battlefield and agricultural areas with Hilbert curve and line following sensors. In such networks due to mobility, regions are created where a source can't find sink in its forward direction. The system can be used even for other wireless networks like MANET. The system uses minimum energy for repairing the path loss and no extra control packet is generated. The greedy forwarding improves the packet delivery of the network significantly.

## 5. Limitation

Major limitation of the work is that the system uses a technique to increase signal power of REQUEST packet once it detects that there is no neighbor in its ENS table so that packet reaches to nodes at a far away distance. Increasing power of transmission and reception threshold needs more energy. Hence nodes runs a risk of losing its energy faster.

## 6. Existing System

As mobile computing requires more computation as well as communication activities, energy efficiency becomes the most critical issue for battery-operated mobile devices. Specifically, in Sensor networks where each node is responsible for forwarding neighbor nodes' data packets, care has to be taken not only to reduce the overall energy consumption of all relevant nodes but also to balance individual battery levels.

Void regions are generally created when nodes in an area looses out their energy. In most widely used Anti-Void routing Nodes either stores 2 hop neighbor list or a backup path so that when primary path fails, it can immediately switch back to secondary path.

However in Both Backyp/Multipath routing, more packet flooding are needed in the route discovery stage. Hence more energy is wasted in routing than data transmission. Hence such techniques can protect against void areas but at the same time are also responsible for creation of such area.

## 7. Proposed System

In the proposed system, nodes first send a request with low energy before transmission. Immediate neighbors receive the packets and replies. The source node updates it's primary neighbor table called ENS. It transmits data through nodes in ENS. Once it does not receive any REPLY from any neighbor for a certain time period, it assumes that a void region is created. Now it transmits REQUEST by increasing its energy. Packets reach to nodes at a longer distance. At this time Source creates a secondary table called SENS. It assumes all responding nodes are at 2 hop distance. If it does not get any response for this REQUEST too, it increases energy to another level.

However interestingly if a node needs more energy to transmit packet to second hop level, it needs more energy to receive also. Base paper does assume that while receiving, this node will receive REPLY from second hop neighbor which is not true. Further if the sensors in the intermediate void region regain energy (through battery replacement or recharging) they respond to enhanced energy packets with reply, so source never knows that void region is filled.

So we update the base paper and introduce a field called ONE_HOP in the Response packet. Nodes check reception power. If a node is in one hop distance, it receives REQUEST packet with enhanced power, it sets ONE_HOP filed with 1 in response packet. When source receives such reply, it knows void region is recovered and again brings down Transmission and reception power level and shifts back to ENS table.

## 8. System Requirement

### 8.1 Software Requirement:

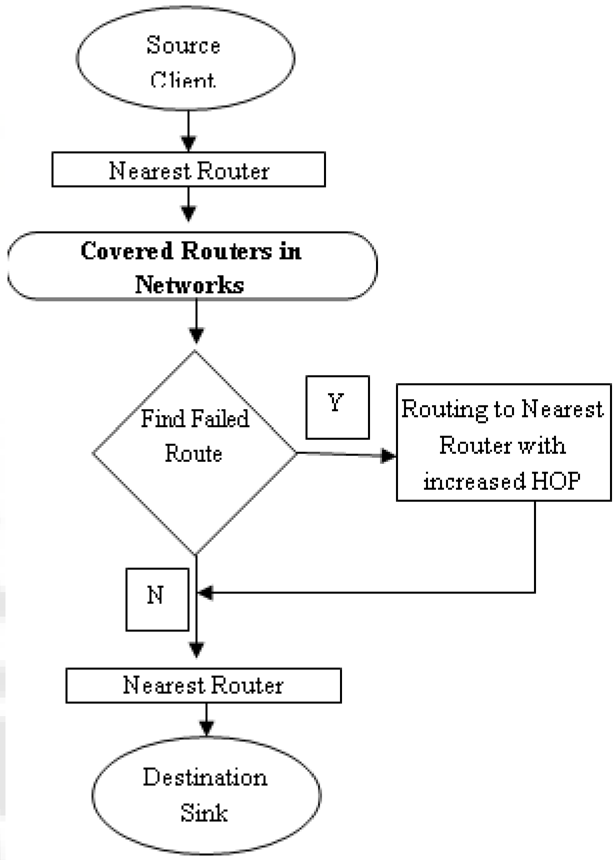
Omnet++ 3.3p1, Visual Studio.Net 2005/2008, Ms Excell 2007

### 8.2 Hardware Requirement:

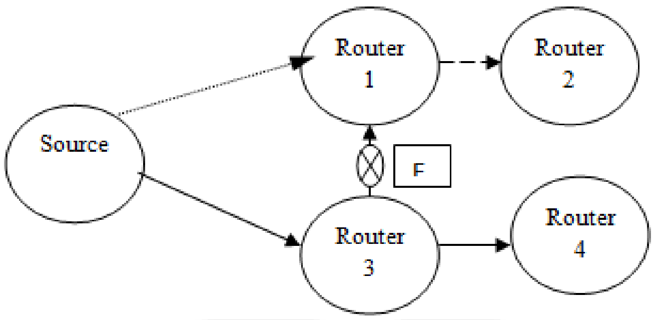
Processor: Intel Core i5-2410M CPU @ 2.30 GHz
Installed Memory (RAM): 4.00 Gb
Operating System Type: 64 Bit Windows 7 Home Premium

## 9. System Design

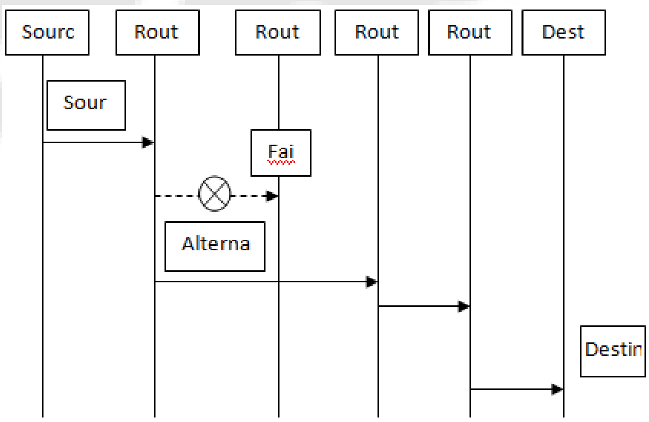
Flow Chart




## 10. Design Flow Diagram




## 11. Sequence Diagram



## 12. Algorithm

**Steps**

1) Nodes form a sensor network with Random MESH Topology having multiple sink and one base station.
2) Nodes generate REQUEST packet before transmission. Neighbours responds with REPLY. Thus neighbor table is generated.
3) Nodes forms a path in the forward direction and starts transmitting
4) If Route error is generated and nodes do not get any signals from the node in its forward direction, void region alarm is generated.
5) Upon generating the alarm, Node increases power of REQUEST packet and Reception threshold. When they receive reply from neighbors, updates its secondary table.
6) The other node looks if it has a node in its forward direction which has the destination or sinks in the forward direction. If so forward to that node.
7) Route with void region is repaired through nodes located at next region till void region's nodes are not recovered and transmission is continued.

## 13. Implementation

### A. Fault Detection

Any node it has data to send, first it broadcasts REQUEST packet to all its 1-hop neighbor nodes. Then id of the nodes which send REPLY packets back to the sender node are stored in the ENS of the sender node. Nodes in the ENS are termed as FORWARDING nodes. When none of the receiving nodes send REPLY packets back to the sender, the ENS of the sender is found to be empty. In such situation, the sender node assumes failure of the neighboring nodes and starts the recovery mechanism. The structures of the REQUEST and REPLY packets are shown in Fig. 3 and in Fig. 4 respectively.

| sender id | destination id | distance |
|---|---|---|

Fig. 3. REQUEST packet structure

| sender id | new distance | remaining energy |
|---|---|---|

Fig. 4. REPLY packet structure

### B. Recovery Mechanism

For recovering from the failure situation described above, a status field is associated with every node listed in the 1-hop neighbor list (mentioned in Section 3) of a node. Thus the list not only contains the id of the neighbor nodes; it also maintains a status field for every neighboring sensor node. The status field can be ACTIVE, DEAD or BLOCKED. Initially, it is assumed that all nodes are ACTIVE. In case of a area failure, after waiting for a predefined time period t, when the source node sees that its ENS is empty, it again rebroadcasts the REQUEST packet to all the neighbor nodes with an additional field ENS_EMPTY set as true. When a neighbor node receives this REQUEST packet, it immediately replies back to the source node irrespective of its distance from the sink, i.e., in such situation even a node which is away from the sink compared to the source node replies back. When a REPLY packet I received from any node, the source node adds the responding node to an additional set called Secondary Eligible Neighbor Set (SENS). The nodes in the SENS are called ALTERNATE nodes. After generating the SENS, the source node sets status of the remaining nodes (from which no REPLY packet was received) in its neighbor list as DEAD. The ALTERNATE nodes, which receive a REQUEST packet from a node with an ENS_EMPTY field set as true, set the status of the sender node as BLOCKED in their respective neighbor lists. The reason is that the FORWARDING nodes of the sender node are considered as dead and there may not be any route to sink through the sender node. Fig. 5 shows a situation where the node s1 finds an empty ENS after its first broadcast of the REQUEST message (because nodes are dead). Following the second broadcast, nodes 1, 2 and 3 send REPLY packets to node s1. Therefore, node 1, 2, and 3 are stored in the SENS of the node s1. In this example nodes 1, 2, and 3 are ALTERNATE nodes of node s1. Following the construction of SENS, the source node selects a suitable node from these ALTERNATE nodes as the NextNode and data is forwarded through the NextNode. In NextNode the same algorithm is applied until the sink is reached (Fig. 1). In certain cases a source node (with sensed data) may obtain an empty ENS and an empty SENS, i.e. there is no possible route from the source node to forward packets to the corresponding sink. However, as our research work is based on a multiple-sink topology, it is possible that a route from the source node to another sink can be established. In such situations the recovery mechanism tries to attach the nodes of that partition to other partitions so that the data can be forwarded to alternative sinks (Fig. 2).

Redistribution of nodes of a partition when the sink is unreachable is done in the following steps. The node first broadcasts a FIND_SINK message. The FIND_SINK message contains two fields, Route_Status and Partition_id. Route_Status indicates status of the route to destination, i.e. “Sink Reachable” or “Sink Unreachable” and Partition_id contains the sink id with which the node was attached. If nodes which are recipients of the FIND_SINK message find that they are from the same partition then they rebroadcast the message. On the other hand, if the nodes find that they are from a different partition and they have ACTIVE neighbor nodes then they reply back with a SINK_FOUND message. The SINK_FOUND message contains the sink id in that partition as the Partition_id. After receiving the SINK_FOUND message, every node which is a sender of the FIND_SINK message changes its Partition_id to the new value received as Partition_id in the SINK_FOUND message and broadcasts the message until all nodes of the failed partition (partition at which source node belongs) receive SINK_FOUND message at least once.

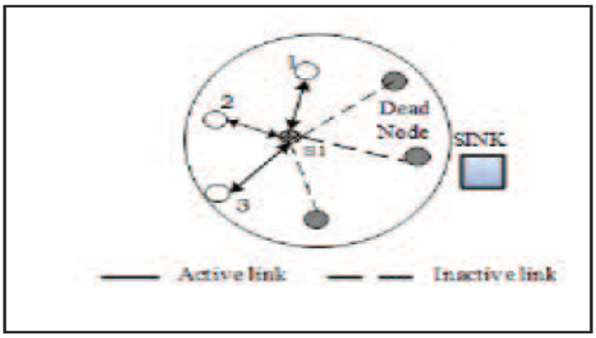



Fig. 5. Creation of SENS

### C. Area Failure Scenarios

In case of an area failure, all nodes within a certain geographical area fail. This mostly happens due to an external event, such as fire, flood, etc. The following two scenarios may occur and our proposed techniques are applied to handle the area failure in both scenarios.

Case1: ENS is empty because there are no forwarding nodes (route hole) at the time of deployment. It is shown in Fig. 6(a).

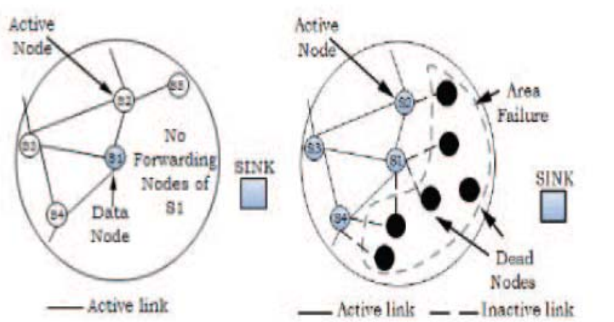



Fig. 6. Example of ENS

• Case2: ENS is empty due to depletion of battery power of all forwarding nodes (energy hole) or all nodes in a certain area are already dead due to an external event (any kind of disaster like fire).

## 14. Simulation Environment and Results

The recovery mechanism presented in the previous section is incorporated in the MCDR data forwarding algorithm and simulated in OMNET 3.3 environment. A square region deployed with a wireless sensor network is considered for simulation purpose. The WSN is created by randomly placing 100 nodes and 150 nodes in a 200 m x 200 m area. The network is partitioned into four sub-parts and four sinks are placed at each corner of the square region. We assume that the area contains homogeneous sensor nodes with a communication range of 45m.

### A. Simulation Results

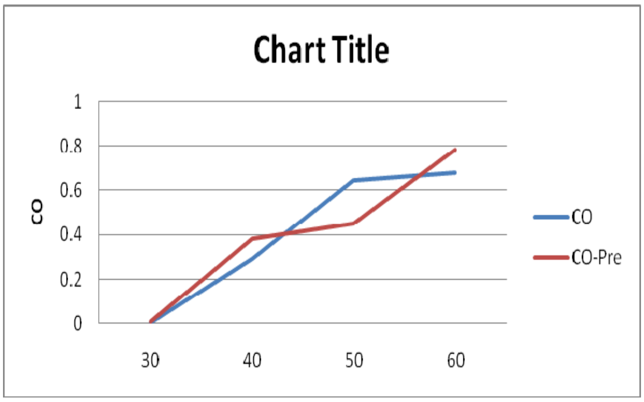



**Figure 7:** Simulation Result of Control Overhead

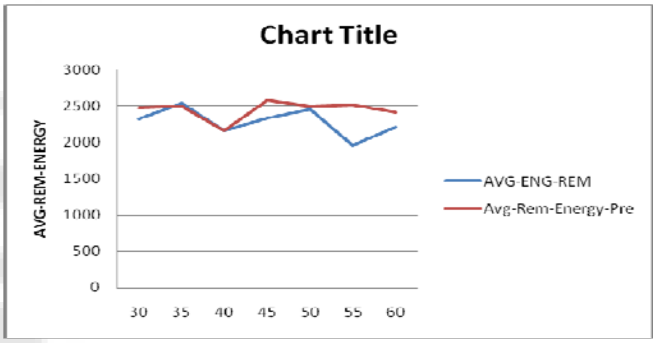



**Figure 8:** Simulation Result of Average Energy Remaining

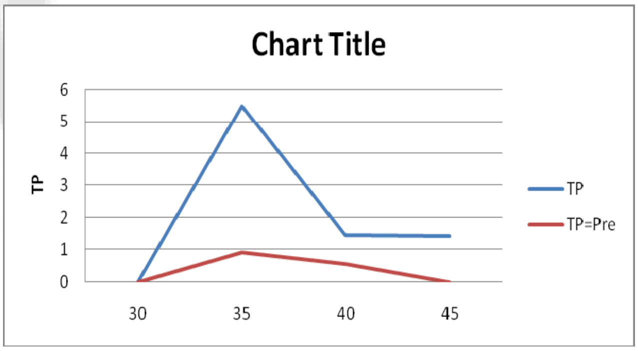



**Figure 9:** Simulation Result of Throughput

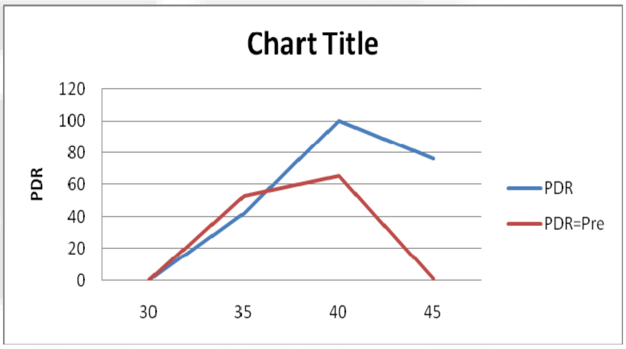



**Figure 1:**0 Simulation Result of Packet Delivery Ratio

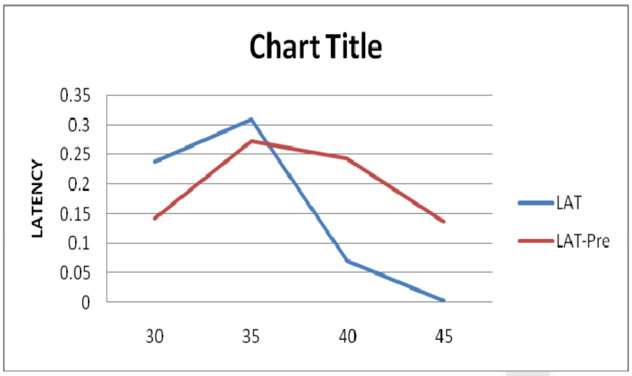



**Figure 11:** Simulation Result of Latency

From Simulation Resuts we can see that the Proposed (Blue Line) System is much better than the Present System (Red Line)

TABLE I. PERFORMANCE ANALYSIS

| Algorithms | Single Sink | Multiple Sink | Packet Block | Energy Efficient | Area Failure (all cases) |
|---|---|---|---|---|---|
| AR1 | Yes | No | Yes | No | No |
| AR2 | Yes | Yes | No | Yes | Yes |

## 15. Conclusion

The simulations results show that data delivery to sink is still possible in spite of all nodes in a certain geographical area are dead. This mechanism is also considered in the situation where the active nodes in a particular region are unable to transfer the data to the sink node within that region. For such cases the active nodes try to be attached with other region. Simulation results show that the proposed technique has better tolerability and energy efficiency for area failure.

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