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Design of a Reliable Wireless Sensor Network with Optimized Energy Efficiency

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Abstract: **Data gathering in wireless sensor network (WSN) is a crucial field of study and it can be optimized various algorithms like clustering, aggregation, and cryptographic technique in order to reliably transfer data between sensor and sink. But these techniques do not provide an optimized data gathering wireless sensor network because of the fact that they do not leverage the advantages of various techniques. Our problem definition is to create a reliable data gathering wireless sensor network which ensures good energy efficiency and lower delay as compared to existing techniques.**

Keywords: **Aggregation, Clustering, Data Gathering, Cryptography, Data Compression, Run Length Encoding.**

I. INTRODUCTION

Wireless sensor network is a group of sensor nodes. Each sensor node is operated on battery that has limited energy. The processing and storage capacity of sensor node is also limited. Sensor nodes in a wireless sensor network are energy constrained and efficient techniques have to be applied while collecting data to maximize network lifetime.

In a wireless sensor network, huge quantity of information pass between sensor node and sink node. When large number of sensor nodes transmits data packets simultaneously from one node to another, the load on the network increases and thus increases network traffic. This situation might causes congestion. Congestion in wireless sensor network might lead the way to issues like data-packet drop, obstruction in message sending, memory overflow, and available limited resource wastage. Thus the sensor network characteristic requires more effective method for reliable data gathering that ensures good energy efficiency and lower delay under these conditions.

II. MOTIVATION FOR STUDY

The previous work in wireless sensor network does not combine any energy efficient and data compression protocol. Due to which either the network has better energy efficiency (as given in the base paper) or lower delay as proposed by other research papers. Our motivation is to develop a hybrid protocol which ensures lower energy and less delay in reliable data gathering wireless sensor network.

III. OBJECTIVE OF THE STUDY

To ensure reliable data- gathering in wireless sensor networks.

To improve the power efficiency of a wireless sensor networks.

To achieve lower delay(obstruct) of wireless sensor network.

IV. DESIGN METHODOLOGY

In this paper, we initiated an optimal(best) approach to achieve the end-to-end reliability of the transmitting data with good energy efficiency and lower delay. We are developing a wireless sensor network in NS2 Containing various nodes, sinks and sensor nodes. Once the network is deployed we will employ reliable data gathering technique as mentioned in

the base paper which uses single source and multi source linear network. Energy efficient technique like improved leach protocol will be developed to ensure minimum energy consumption in network. After energy optimization has been done we will be implementing a compression + data collection/aggregation protocol which will lessen the delay of transmission between the sender node and receiver node.

Total six modules are required for the implementation of reliable data-gathering wireless sensor network with optimized energy efficiency and lower delay.

The First module is for the development of wireless sensor network.

The Second module is for the implementation of reliability guaranteed algorithm.

The Third module is for the development of energy efficient low power leach protocol.

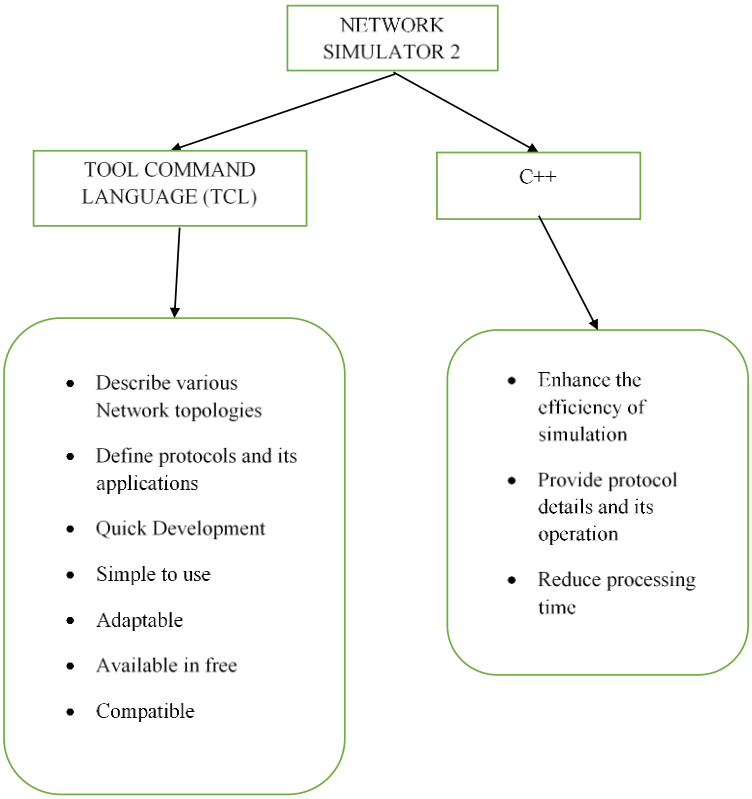
The Fourth module is for the implementation of a hybrid Compression and data aggregation algorithm in wireless sensor network.

The Fifth module is for the integration of third and fourth module to form a low power low delay reliable information-gathering in wireless sensor network.

The Sixth module is used for the result and analysis

A Development of Wireless Sensor Network:

Wireless sensor Network made up of a various sensor nodes , individual sensor node has a insufficient energy and processing capacity. So utilizing the limited available resources in an efficient manner is the biggest challenge. This module is mainly used for showing the communication/transmission between the source node and sink. To simulate the existing or contributed models of WSN in NS2 , we have to write a script in TCL or C++ respectively. The advantage of NS2 over NS3 is that it has more contributed models.



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NS2 has two language concepts:

- C++
- Tool Command Language (TCL).

The C++ language specify the Inner mechanism i.e., Back end scenario. Front end scenario is used in TCL. C++ is the core part of NS-2 and shows the informative part of NS-2. TCL shows the control part of NS-2 and specify the network topologies.

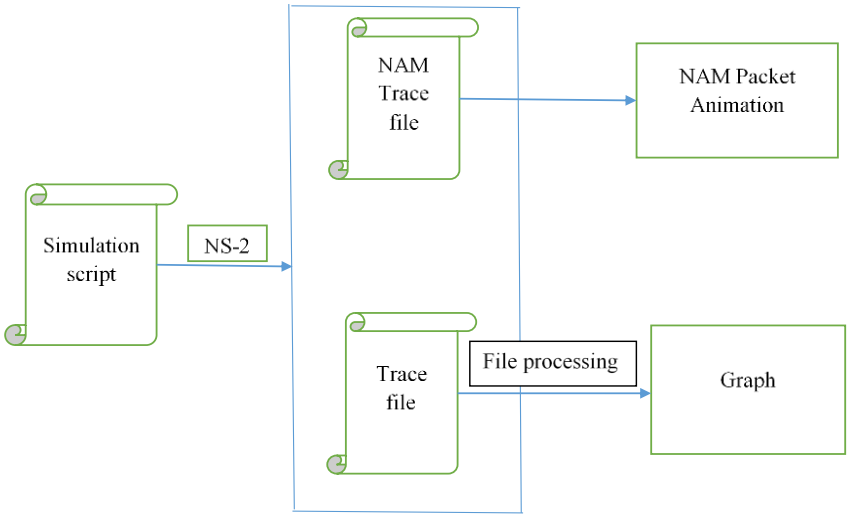
TCL (Tool Command Language) - It is used for creating a network.

For executing TCL script in NS-2, we can use the following syntax:

>ns Filename.tcl

When we successfully executed the TCL script, we get two files

- NAM (Network Animator) – It is used to display the animation area of the network
- Trace file- It is used for analysing the functioning of protocols i.e., packet-loss, packet-delay, throughput, etc.



TRACE FILE FORMAT:

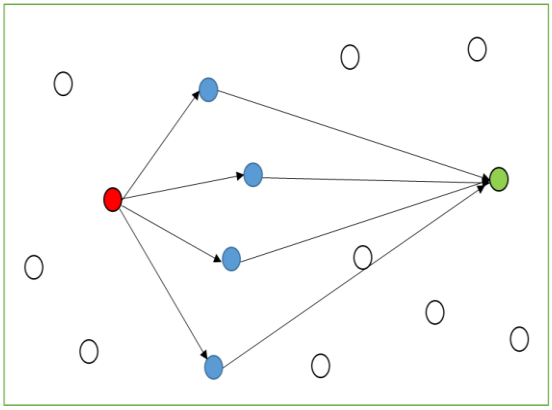
1) Network Option Define
2) Define NAM file and Trace file
3) Nodes Configuration
4) Nodes Created and Placed (randomly)
5) Nodes Communication
6) Communication Start/ Stop
7) Graph Plot
8) NAM Run

B. Implementation of Reliability Guaranteed Algorithm:

Securing Reliable transmission of data/information in a wireless sensor network is one of the main concern to attain maximum efficiency.

As in Wireless Sensor Network, Packet loss is a major issue . So this module is mainly for improving the packet delivery ratio of the network. Reliable transmission of data-packets is assured in terms of recovering the drop packets by performing retransmission task.

Data-packet reliability requires all the data-packets from all relevant sensor-nodes reaches effectively to the sink-node. Reliability events assure that the sink-node(receiver node) only get relevant and non-repeated information.



SOURCE NODE

DESTINATION NODE(SINK)

K-RELIABILITY NODES

SENSOR NODES

For ensuring reliability in Wireless Sensor Network we are using K-COPY SCHEME.

In this K-COPY SCHEME , instead of sending data packets directly to the sink , sender from source-node first transmits the data packet to all (available)its closest nodes (called K reliability nodes). Then the sink-node will receive the data-packet from all the K reliability node in a sequential order. Some packets may get drop before reaching to the sink.

If the first reliability node k1 drops some packets, sink node will recover the dropped packet by receiving packets from next node i.e K2 reliability node and discarded the duplicate (redundant data) packets. This process continues until all the data packets reaches to the sink node.

C. Development of Energy Efficient Low Power LEACH Protocol:

In a wireless sensor networks, every individual sensor node has a restricted power resource. So minimizing energy consumption and improving network lifetime are major issues in Wireless Sensor network. The main purpose of this module is to propose a newly improved (upgraded) algorithm of LEACH protocol which is targeted to improve the lifespan of Wireless Sensor Networks by balancing the energy consumption required to create and maintain cluster heads. For this module we are using M-LEACH algorithm.

The LEACH (Low-Energy Adaptive Clustering Hierarchy) network divides the sensor network into a various number of clusters. The number of clusters rely on the size of the network. Each cluster has a equal size sensor nodes. Each cluster has a unique Cluster-head (CH) which is selected from the available sensor nodes within the cluster. Cluster-head has the responsibility to manage the sensor nodes within the clusters for data transmission.

Normal LEACH protocol selects the Cluster Head randomly while M-LEACH protocol selects the Cluster-Head based on maximum energy(resource) node. Suppose one wants to transmit data packet from source node of Cluster Head 1 to sink node of Cluster Head 2, one cannot send directly from source sensor-node to sink-node. Source node first send the packet to its cluster head (CH1) . This CH1 then send packet to the sink-node (Destination node) Cluster-Head (CH2). Then CH2 will transmit the data-packet to the intended sink (Destination)node. The Cluster Head should have maximum energy capacity because all the transmission within the clusters depend on the lifetime of Cluster Head.

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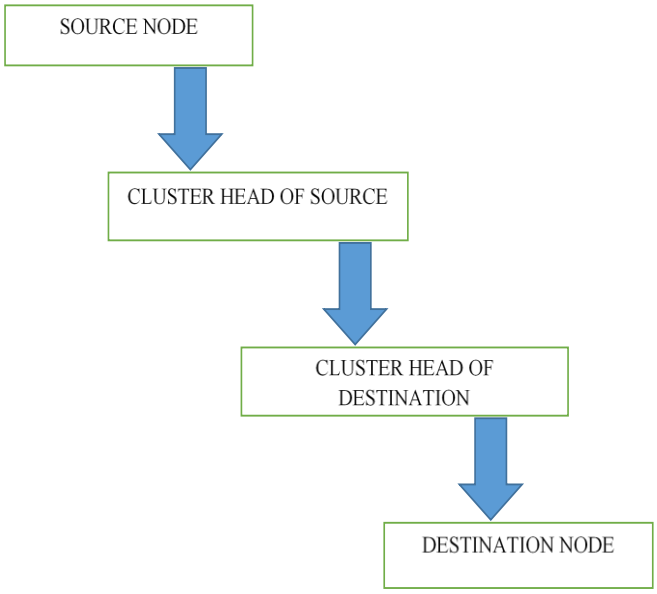
Sequence of communication using M-LEACH protocol:



D. Implementation of a Hybrid Compression + Data Aggregation Algorithm to Reduce the Delay of Wireless Sensor Network:

In this module we are developing a hybrid protocol which is the combination of Compression and Data Aggregation Algorithm.

Data Compression:

Data Compression is a method used to reduce the energy consumption of a sensor network by minimizing the size(area) of data-packet/information transmitted and decreases the number of re-transmissions. The Compression algorithm is mainly used to compress the unwanted redundant data, so that the energy consumption required for transmitting data will reduced. It also reduces the Delay which occurs due to retransmission of unwanted redundant data. In this module we have presented a new improved compression algorithm which is motivated from Run Length Encoding(RLE).Run Length Encoding is the simplest method of compression. It is a data/message compression technique which is used to compress the sequence of data occurred repeatedly and stored it as a single data value.

The main objective behind this method is to replace consecutive repeating event of a symbol by one event of the symbol followed by the number of events. The method can be even more effective if the data/message uses only two symbols(for example 0 and 1) in its bit pattern and one symbol is more frequent than the other.

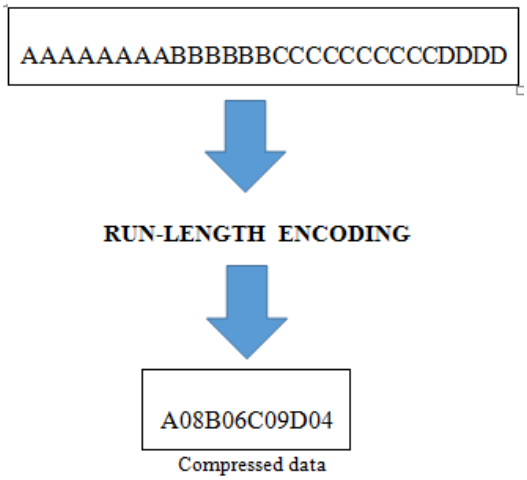


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Fig.1. Run Length Encoding example

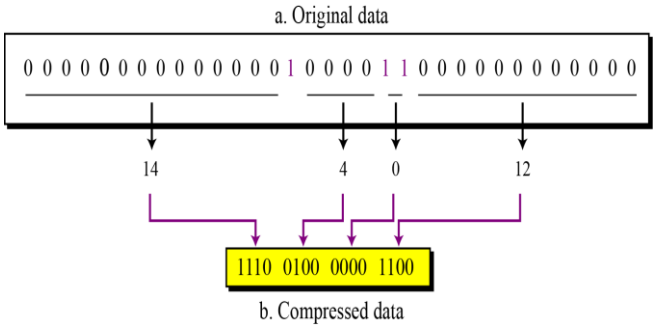

Fig.2: Run Length Encoding for two symbols

Data Aggregation:

The primary purpose of data aggregation/collection algorithm is to combine and aggregate data in a power-efficient manner so that the network life-duration will enhance and packet delay will reduced. By using Data Aggregation technique we can reduce the data packet size by aggregating data on route. Parallel process leads to large aggregations of data in the network. In this paper we are using Repeat Value Removal algorithm for achieving power-effective Data gathering in wireless sensor network. Repeat information are identified in each cluster to know the exact and inexact duplicate information/data. Repeat data removal rule will determine the quality/standard of the each duplicate-data to reject poor(resource-less) quality duplicate data/ records. A Repeat value removal algorithm is developed to handle any repeat data in the network. Repeat value removal is very essential to determine which repeat data to retain and which duplicate data is to be removed. This approach is mainly used to enhance the efficiency of the data.

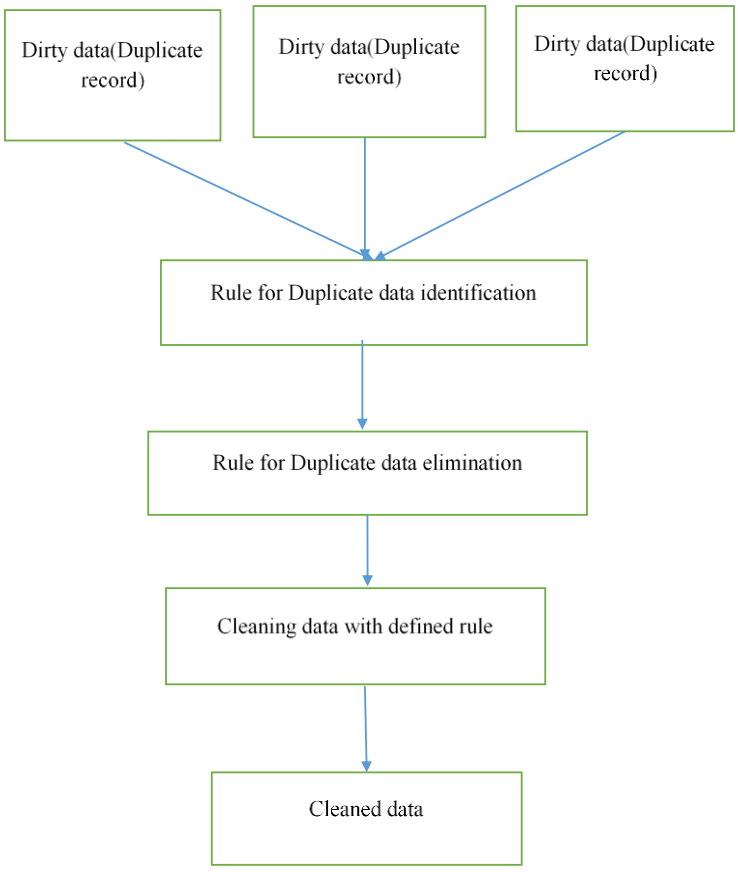

Fig.3: Framework for duplicate data identification and elimination

E. Integration of 3rd and 4th Module to form a low power low delay reliable data-gathering in wireless sensor network:

The 5th module is used for integrating the 3rd and 4th module to form a low power low delay reliable data gathering Wireless Sensor Network. This integration of modules are required to develop a single hybrid protocol for wireless sensor network which ensures the reliable data gathering and optimize energy efficiency with lower delay

V. RESULT AND ANALYSIS

In this paper, we are recommending an optimal approach to gain the end-to-end reliability of the transmitting data with good energy efficiency and lower delay. This module is used for analyzing and observing the result of our proposed protocols.

With these steps, we obtain a reliable data gathering wireless sensor network with optimized energy efficiency and lower delay

In this module an improved hybrid reliable protocol with optimized energy efficiency and lower delay will be implemented.

Parameters used for comparative analysis are:

- Delay: It is the amount of time taken by data packets to travel across network from one node to another.
- Energy consumption: It is the difference between energy value of node at particular time and energy value of node at initial time.
- Packet delivery ratio: It is the ratio of number of packets received at destination node to the number of packets send by source node.
- Jitter: It is a variation in the delay of received packets.
- Throughput: It is the total number of packets received at destination over a period of time.

POSSIBLE CONTRIBUTION OF RESEARCH:

A hybrid algorithm for data gathering will be built using clustering and low delay protocol which will combine compression and data aggregation.

VI. CONCLUSION & DISCUSSIONS

In this paper, we propose an optimal approach to achieve the end to end reliability of the transmitting data with good energy efficiency and lower delay. We will be developing a wireless sensor network in Network Simulator 2 (NS-2) Containing various nodes, sinks and sensor nodes. Once the network is deployed we will employ reliable data gathering technique as mentioned in the base paper which uses single source and multi-source linear network. Energy efficient technique like improved leach protocol will be developed to ensure minimum energy consumption in network. After energy optimization has been done we will be implementing a compression + data aggregation protocol which will reduce the delay of communication between sensor and sink. With these steps, we obtain a reliable data gathering wireless sensor network with optimized energy efficiency and lower delay. As the wireless sensor network has many challenges so there is a huge scope in the field of research.

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