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Congestion Control Through Mobile Agent in Wireless Sensor Network

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ABSTRACT: Mobile agent technology embedding in wireless sensor network (WSN) has a new research area for researchers. Mobile agents (MA) embedded in different applications such as commercial, civil applications, climate monitoring, vehicle tracking, military surveillance, data gathering. Congestion in a network created problem of packet losses, bandwidth degradation, time consuming and energy waste on congestion. In this paper, we have done a mobile agent base framework for congestion control and routing. Agents roamed in a network to communicate with the sensor. A mobile agent started moving from every node and went to an adjacent node at every time to collect information from sensor nodes and also maintain a routing table as well as node congestion status. When a mobile agent travels through the network, it selected a less-loaded neighbor node as its subsequent hop according to the node's congestion status and also updates the routing table of the node it is visiting. All the nodes are static and base station (BS) collected the information about network congestion from cluster heads (CH) and inform to the mobile agents (MA). Each Cluster head has a routing table that stores route information for every destination. The purpose of mobile Agent in WSN is to control link-level-congestion, which improves the network throughput, reduce the time delay.

KEYWORDS: Congestion, Cluster head (CH), Mobile Agent (MA), Sink node, Wireless sensor network.

I. INTRODUCTION

Wireless sensor network environment consist of thousand wireless sensor nodes and a single central node (called a sink node), all wireless sensor nodes collect information from the environment and send collected information to sink node for further processing. When all nodes will send sensed data directly to the sink node than congestion will surely occur. Congestion is affecting the data transmission process, increase packet loss, delay in the coming of data from the endpoint and degrade energy level of each node. Congestion in the network will happen if packets are transmitted in a many-to-one manner or from sensors-to-sink direction [1]. Congestion in the network has some negative impact on the network performance, like increase packet loss, end-to-end delay, consume energy and other fidelity degradation. The main purpose of a mobile agent in a wireless sensor network environment to congestion control so that improvement in network throughput, reduce the time of data harmful impacts on network performance such as increase packet loss, end-to-end delay consume more energy. Since the node energy, communication bandwidth, network computing capability and other resources are generally restricted, therefore the main purpose of a mobile agent in wireless sensor network environment to congestion control so that improvement in network throughput, reduce transmitted delay. It is likely to improve the network performance by protocol design, route algorithm chooses, data integration and load balancing, and so on [2]. Therefore congestion in a wireless sensor network need to be controlled in order to prolong the system lifetime, improve fairness, high energy-efficiency, and increase the quality of service.

Each sensor has limited battery power. If the sensor nodes send their data directly to the central node, it might possible that they will lose their energy in the first round of data transmission. The mobile agent concept has employed in WSN to remove the problem of energy consumption and to obtain data gathering effectively. Therefore, before migrating MA in the network, it is very important and fundamental steps to decide the route selection for mobile agent. The mobile agent (MA) is a software code that is migrating from node to node in the network and performs data processing itself. Many applications are based on mobile agent technology such as google. It has also been proved that mobile agent technology may save up to 80% of the data transmission time.

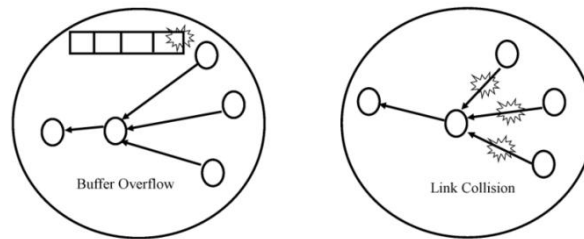
II. RELATED WORK

When a huge amount of sensor nodes are involve to send data, it must be a possibility of congestion in the network .Congestion is a major crucial problem in wireless sensor network because it has a negative impact on the performance of a network such as energy efficiency of sensor nodes. Congestion occurs in the network whenever a single link traffic becomes greater than its individual capacity. There are two types of congestion:

Node-level congestion: When the packet arrival rate is higher than packet service rate than Node-level congestion will occur [4].The result of this congestion is a high packet loss and queuing delay.

Link-level congestion: This type of congestion take place when multiple active sensor nodes start transmit packets at the same time within range of one another.Packets that leave the buffer might fail to reach the next hop as a result of the collision and bit error.Overall throughput and link utilization is decreased by this type of congestion while packet delay and energy waste will be increase[5] [6].

There are various congestion control protocols in wireless sensor networks.



1- Congestion at Node-level

2 - Congestion Link-level

Fig.1. Congestion types in WSNs

Congestion Avoidance and Detection (CODA) [7]: it detects the congestion by detecting the buffer size of sensor nodes and the load of the wireless channel. If channel load exceeds from a pre-defined threshold value, a sensor node informs its neighbors to decrease the transmission rate.

Congestion Control and Fairness (CCF): It [8] detects congestion at the packet service time at the medium access control MAC layer CCF uses packet service time to decrease the rate of service and congestion at every node.

Adaptive Rate Control (ARC) [8]: These protocols monitor the traffic route and how many packets are injected into the traffic stream. Every node estimates the amount of upstream nodes therefore the bandwidth is divided proportionally between route-through and locally generated traffic, with preference given to the former node. The resulting bandwidth allotted to every node is thus almost fair.

III. MOBILE AGENT BASED CONGESTION CONTROL

The attention of users in wireless sensor technology is increasing exponentially. Researchers work on the design an information retrieval system and tools that can efficiently find, collect and process the information .To achieve this goal, A mobile agent model is widely used in distributed applications. A mobile agent is a software entity that can migrate in the network with its execution code and current state to finish its works intelligently on behalf of the users. Whenever user requires information, it sends query to the base station and the base station dispatches a mobile agent to fulfil the requirement of users. As it migrates from one node to another node it saves its current state to the new host and resumes its state from the saved state. This process will save the bandwidth of wireless networks and improve the efficiency of network. Figure 2 shows the functional component of the mobile agent system, the agent manager has concern about sending and receiving mobile agents back and forth remote hosts so that the mobile agents may organize their work nearby. An agent manager is also responsible for agent creation; cloning, dispatching and destroying. The communication manager provides the facility to establish communication between two or more mobile agents. The reliability manager will also be a part of the relocation process when is necessary to prove that the agent manager has certainly received a mobile agent at the remote gateway. The directory manager is used to identify the position of an application server that the mobile agent can migrate to gateway . The security manager will to approve the process use of the gateway, and agent to the application server.

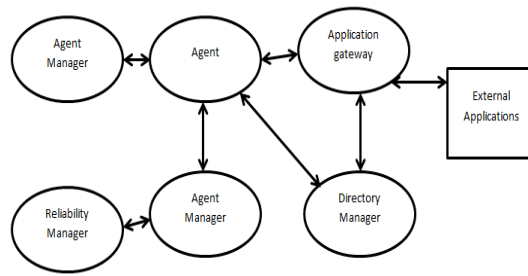


Fig.2. Mobile Agent System

Figure 3 shows mobile agent based WSN architecture .here three clusters of sensor nodes is given they have unlike sensor nodes, source node and destination node.

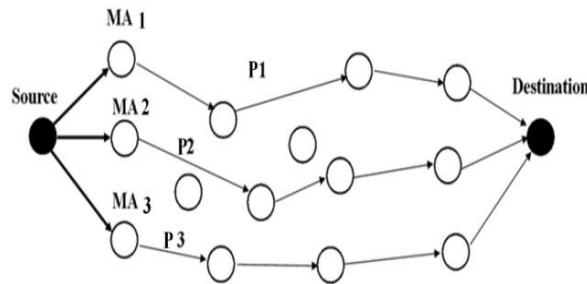


Fig.3. Congestion control routing by Mobile agent

The following steps are followed by mobile agent:-

- i. The source node verified the number of available clusters and communication mobile agents in each cluster.
- ii. Mobile Agents select the shortest path to move from one sensor to another sensor in order to collect information.
- iii. MA1, MA2 and MA3 will check the routing table and move toward destination according to P1,P2 and P3 path respectively.
- iv. Mobile Agents will also calculate Total Congestion Metric (TCM) of their respective paths on the basis of congestion status stored at destination node.
- v. Destination node will send the total congestion metrics of path P1, P2 and P3 in the form of TCM1,TCM2 and TCM3.
- vi. A source node will select a path having minimum congestion and transmit data to that route which has minimum congestion.

IV. MOBILE AGENT EMBEDDED IN WSN ENVIRONMENT

In our work , mobile agent technology will use in a cluster based wireless sensor network.These are the following steps:

- Step 1: Node Deployment
- Step 2: Clustering Algorithm in WSN
- Step 3: Embedding Mobile agent in clustered WSN
- Step 4: Define Itinerary planning of MA
- Step 5: Defining a simulation environment
- Step 6: Simulation and Performance evaluation

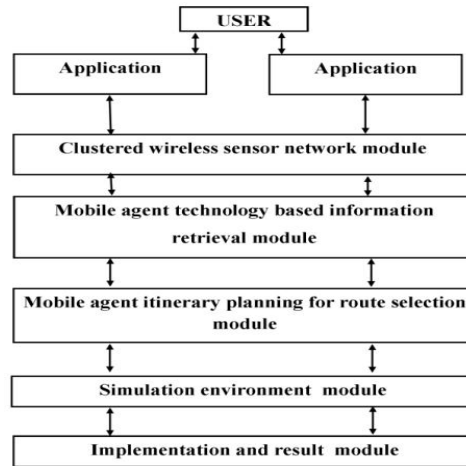


Fig.4. Mobile agent embedding in cluster based WSN

A. Clustering Algorithm for Wireless Sensor N/W

Clustering is a mechanism that divides the network into a number of groups. Each group assigned to the co-ordinator node called cluster head (CH).The coordinator node of the cluster is responsible for collecting, processing and transmitting of the detected data to the sink node. Other nodes in the cluster are member nodes, which sense and transmit detected data to the CH. Cluster head will selected using threshold value T (n) in Low Energy Adaptive Clustering Hierarchy (LEACH) [9].

revise the function of threshold value of T (n) using projected progressive approach to extend the probability of cluster head selection for other nodes. The revised function T (n) is:

$$T(n) = \begin{cases} \frac{P}{1 - P(r \bmod (1/p)) - Pk} & n \in G \\ 0 & \text{others} \end{cases} \quad (1)$$

P means the probability of cluster head selection, r means the number of rounds, k means the number of nodes that are not included in the cluster head selection.

It has become important to retrieve information efficiently and rapidly from distributed network. A mobile agent is software code capable of moving across the entire network. Mobile agents move into a network either on a predetermined path from sink node, or the agents itself determine the path dynamically. In A mobile agent-based wireless sensor network sink node sends a query to mobile agent for data collection in the target node, then mobile agent travel in the network, move to each cluster head one by one. In traditional client server model all data stored on server, clients can access data from server only. So one client cannot transmit data to another client directly without a server. This will create a significant problem if we increase client server model. But using mobile agent data are often shared between client machines. The mobile agent approach reduces the traffic load over the network as well as use low bandwidth.

B. Itinerary Planning by Mobile Agent for route selection in WSN

A mobile agent based applications for data gathering, it is very important steps to find out the route planning for mobile agent. An itinerary means information about routes which the agent will follow to urge information from the network with low resource usage. According to topology itineraries would be either static or dynamic and according to uses in network mobile agent is a single agent or multiple agents [10].Stationary itineraries calculated at the sink node before the MA is transmitted while in the dynamic itineraries mobile agent it defines the source nodes to be visited and the route of migration. In an approach [11] two SIP approaches, namely: Local Nearest First (LNF) and Global Nearest First (GNF) used. In LNF mobile agent visit the next node having the least distance from the current node and Global Nearest First (GNF), where mobile agent search for the next node having the smallest distance from the processing node.

V. PERFORMANCE EVALUATION

There are various types of simulators which are used in a wireless sensor network, the simulator provides result analyses of our work. We simulate our work using NS-2. It is composition of two languages: Object-oriented Tool Command Language (OTcl) & C++ Library for the simulator. To setup and run a simulation, the source code is written in the article then the article - interpreter will interpret the program using C++ library. When the simulation is complete, the simulation results will store in the form of text-based on specified output files that contain detailed simulation data, which can be used to analyze directly in the term of X graph or can be visualized in graphical user interface using Network Animator (NAM) [12].

The proposed work is simulated using 2000*2000 m² areas, with 20 nodes and the base station are located at “550,140”. The initial energy of each of the normal node is 100 J.

A. Simulation Environment

Step1: Random Node Deployment

Sensors are randomly deployed in a wireless sensor network. All sensor nodes have assigned with equal energy and the location of the base station is far from wireless sensor area. Next step shows that the network of sensor is divided into clusters using a clustering algorithm.

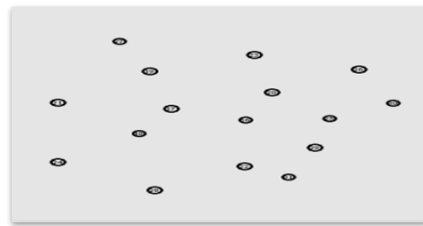


Fig.6. Random node deployment of sensor nodes.

Step 2: Revised LEACH clustering algorithm in WSN.

Here a modified LEACH clustering algorithm is applied to create different clusters in the network. This algorithm is location based algorithm and divides region, according to the X-axis.

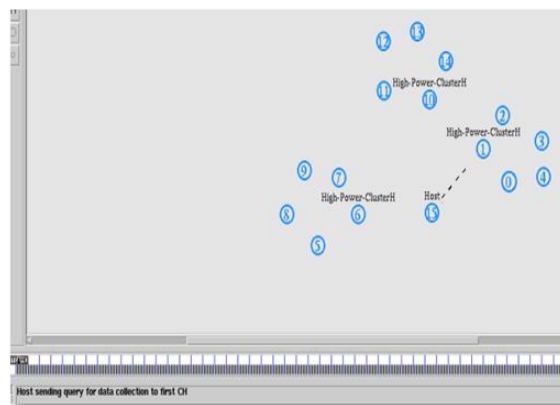


Fig. 7. Clustered WSN without MA

First of all base station (sink) will find total clusters in the network and then broadcast a TCM (Total Congestion Metric) message to each cluster head in order to find the congestion status.

Step 3: Embedding Mobile agent in a clustered WSN

Base Station will find congestion status and then dispatch mobile agent to that particular path which have less congestion. Mobile agent starts moving toward the cluster head (CH).

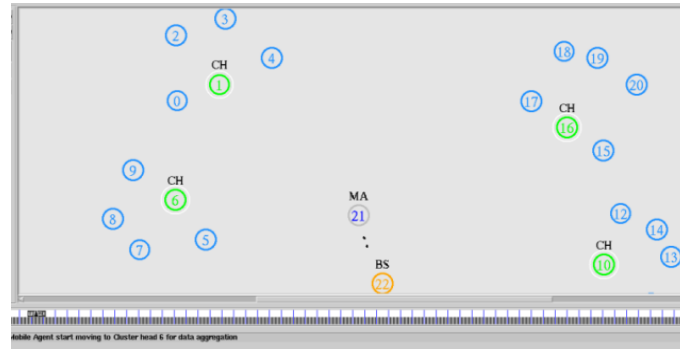


Fig.8.Embedding a mobile agent in WSN

Step 4: Migration of a mobile agent in clustered WSN

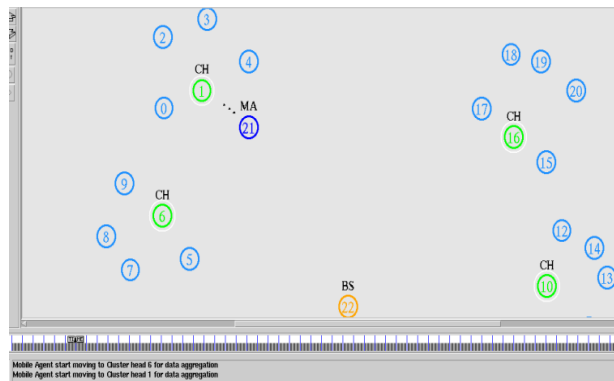


Fig.9.A mobile agent is moving to cluster head 1

A mobile agent uses two types of migrations weak and strong. In the weak migration mobile agent will move with its executable code and in strong it also execution state.before migration route for the mobile agent must be decided by base station .

VI. SIMULATION RESULTS

A mobile agent moves across the whole network and it can select the next node in routing table according their fewer loads which are near to present node to remove congestion control. By simulation of result shows to attain high throughput with reduced delay.

- **Throughput/Bandwidth**

Mobile agent migrates according to the itinerary planning to each CH to collect data, refine it and return back to the sink node with efficient data. It defines the throughput on which the communication is performed. The throughput is defined in terms of a bit rate.This rate is also defined with delay parameters also. The throughput will vary over the communication over the network.

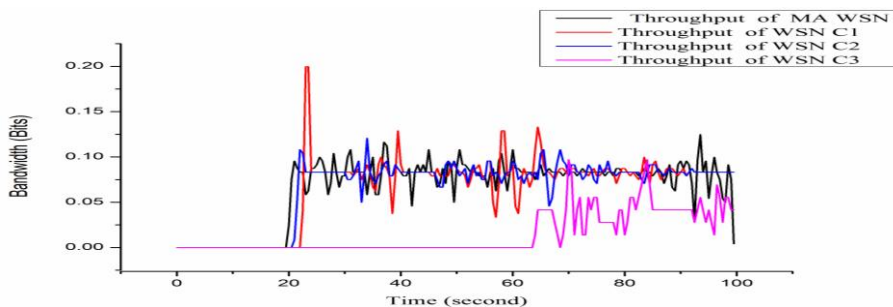


Fig.10. Compare Throughputs of network using mobile agent enabled WSN and Traditional WSN



Figure 10 shows the throughput of Mobile Agent while it communicates with Sink node. In above graph x-axis denotes time and Y axis denote the number of packets over the network. The throughput of the network is being increased after using mobile agent technology and the redundant data is also removed by a mobile agent. So mobile agent increases the efficiency up to 30% of the network.

• **Packet Loss**

The performance of a wireless sensor network can be calculated using packet loss rate. It defines how many numbers of data packets are lost during network communication. Here we can see that mobile agent technology reduce the possibility of packet lost in the communication of mobile agent and Base station. In figure 11 shows the packet loss between mobile agent and Sink node communication over the network. Graph shows x-axis represents time and y-axis represents the number of packet loss.

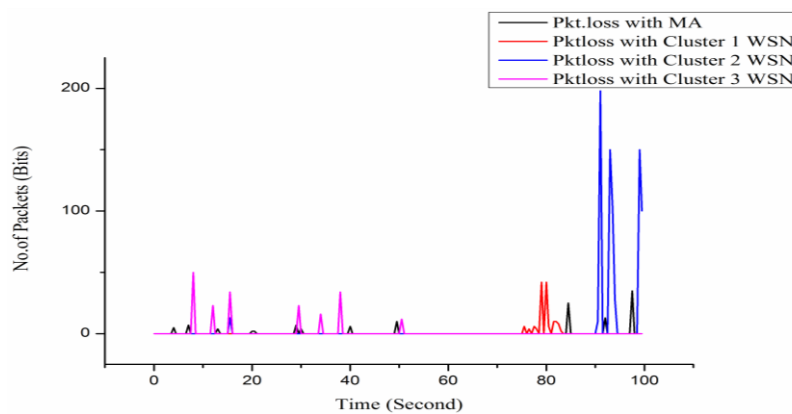


Fig.11. Compare Packet loss of network using mobile agent enabled WSN and Traditional WSN

• **End to End Delay**

Delay rate will be different according to the topologies of the network. If the delay rate increases, it affects the overall performance of the network such as slow network communication, packet loss. Here the work is presented in sort of delay analysis over the network.

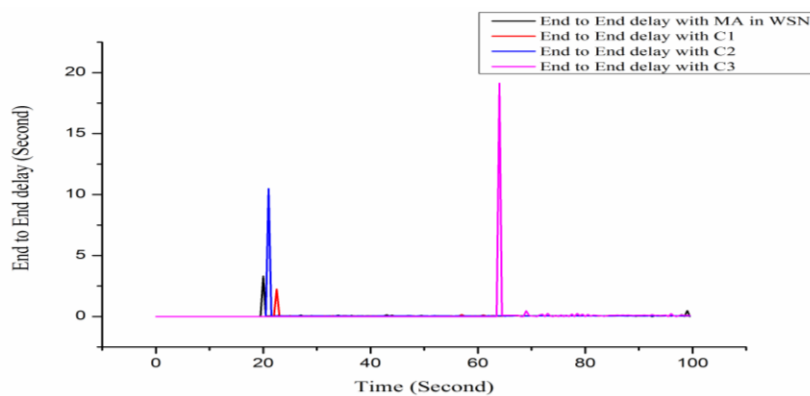


Fig.12. Compare end to end delay of network using mobile agent enabled WSN and Traditional WSN

VII. CONCLUSION

There are some problems in the traditional wireless sensor network such as bandwidth constraints, energy constraints, packet loss, data redundancy, lifetime of network, data security etc. MA technology improves the performance of WSN. Instead of collecting data from CHs, Host sent mobile agent in the network to collect data from each CHs. Mobile agent is a software code which has migrated within the network from node to node constant with to predefined static itinerary planning . Static itinerary planning decided by sink node, before transmitting data to sink node. It is pre-

processed by Mobile Agent, it removed unnecessary or duplicate data and then transmits it to Host. A mobile agent deployed in such a way that the impact on the energy of the wireless sensor network minimized and it provides a high degree of flexibility, robustness, and load balancing. The performance of a mobile agent based wireless sensor network depend on various network parameters like network coverage, bandwidth, network security, energy utilization, as well as agent parameters like agent's code size and data size, execution environment etc.

The analysis of proposed work shows that A mobile Agent based Wireless Sensor Network improve network performance over without Mobile Agent Wireless Sensor Networks in the term of throughput, packet loss, end to end delay. Simulation result shows that Mobile Agent technology improves up to 30% bandwidth utilization, decreases the chance of packet loss and reduces end to end time delay and also helps in congestion control by increasing throughput of wireless sensor network.

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