CROSS LAYER PROTOCOL (APTEEN) USING WSN FOR REAL TIME APPLICATION

V. A. Dahifale[1], N. Y. Siddiqui[2]
PG Student, College of Engineering Kopargaon, Maharashtra, India[1]
Assistant Professor, College of Engineering Kopargaon, Maharashtra, India[2]

Abstract- *Over the years wireless sensor networks have been proving that they make things simpler, reliable and more importantly easy to implement and at comparatively lesser cost which have attracted many research efforts during the past few years and definitely, will keep attracting in the future years. WSNs have been extended and their designs have been advanced to support more complex applications, such as security, military, fire detection and health care related issues. In real time application (forest fire detection), data delivery and reliability must be taken as important parameters in addition to energy efficiency, because data must be collected from the sources of events and be forwarded to the sink in real time with high reliability, otherwise the application may not fulfill its purpose. By using cluster based topology where energy can be conserved by distributing energy equally between nodes in the network. Based on this capability, the life time of the entire network can be extended. The cross layer based APTEEN protocol design has been implemented for the proposed application. Simulation results show that the proposed cross layer based protocol (APTEEN) can conserve energy for nodes such as life time of the network, delay; load balancing, algorithm complexity and reliability.*

Keywords- APTEEN, Cluster based routing, FFD, military, security.

I. INTRODUCTION

Wireless Sensor network (WSN) is widely considered as one of the most important technologies for the twenty-first century. In the past decades, it has received tremendous attention from both academia and industry all over the world. Modern sensor and communication technology is subject to ongoing miniaturization. For wireless sensor networks (WSNs), this development steadily enlarges the areas of imaginable applications. Since the requirements imposed on WSNs are highly application-specific, the use of generic solutions is often rendered infeasible. One of many possible application areas of WSNs is environmental monitoring, which includes, e.g., forest fire or flood detection, volcano or habitat monitoring, precision agriculture, or pollution studies as specific applications. Cross layer protocol based on the application of forest fire detection, this paper shows that it is vision of deploying WSNs with hundreds of thousands of sensor nodes to monitor areas of tens of square kilometers [1].

In this application, data delivered and reliability must be taken as important parameters in addition to energy efficiency, because data must be collected from the sources of events and be forwarded to the sink in real time with high reliability, otherwise the application may not satisfied its aim. Routing is an essential feature in any multi-hop sensor network, in this application; a node should have the capability to deal with data transmission as required between source nodes and a sink in different situations. These capabilities may cause consumption of extra energy. Hence, efficient MAC and APTEEN [2] protocols need to be designed to enhance the lifetime of the network and reduce the delay of given network.

II. RELATED WORK

In recent years, lots of energy efficient clustering based routing algorithms have been proposed for saving energy, decreasing data delivered delay and increasing lifetime of the network. One of the traditional clustering based routing algorithms is LEACH which reduces the energy consumption of the network. In LEACH, there is a rotation of cluster head to balance the energy depletion of the network [2]. However, LEACH has many drawbacks, such as unevenness in the distribution of cluster heads and also during the selection of the cluster heads, the residual energy of nodes are not considered. Hence, a large number of improved algorithms over LEACH are proposed such as PEGASIS (Power Efficient Gathering in Sensor Information Systems), HEED and TEEN (Threshold Sensitive Energy Efficient routing Network Protocol) APTEEN. When compared with the LEACH, PEGASIS results in better network lifetime, but there is a need of dynamic topology adjustment and also end-to-end delay is significantly high, this is not suitable for large size networks. On the different side, HEED (Hybrid Energy-Efficient Distributed clustering) selects the cluster heads on the basis of the residual energy of nodes and proximity measure of the neighbor sensor nodes or node degree. Hence we can used the APTEEN protocol based on cross layer design for increase the energy efficiency, minimize the data redundancy, reduce the delay, increase the average energy consumption and increase the life time of node.

III. CLUSTER BASED ROUTING PROTOCOL

A. Routing protocols can classify based on whether they are reactive or proactive. Depending on how the source finds a route to the destination, routing protocols can be

classified into three categories, namely, proactive, reactive, and hybrid protocols. A proactive protocol sets up routing paths and states before there is a demand for routing traffic. Paths are maintained even there is no traffic flow at that time. In reactive routing protocol, routing actions are triggered when there is data to be sent and disseminated to other nodes. Here paths are setup on demand when queries are initiated. In proactive protocols, all routes are computed before they are actually needed In reactive protocols, routes are computed only when they are needed Hybrid protocols are combination of the above two ideas

B. Depending upon the network structure, routing in WSNs can be classified as (a) Flat based routing (b) Hierarchical based routing and (c) Location based routing. In flat-based routing, all the nodes in the topology are having same functionality or role. In hierarchical-based routing, nodes are assigned different roles or functionalities according to the hierarchy. In location-based routing, routing path for the data is decided according to the Sensor nodes position in the field.

C. Routing protocols are also classified based on whether they are destination-initiated (Dst-initiated) or source initiated (Source-initiated). A source-initiated protocol sets up the routing paths upon the demand of the source node, and starting from the source node. Here source advertises the data when available and initiates the data delivery. A destination initiated protocol, on the other hand, initiates path setup from a destination node.

Traditional routing protocols for WSN are not enough optimal in terms of energy efficiency and load balancing. Clustering is introduced to balance the load and increase the lifetime of the network. Clustering is sample of layered protocols where the network is composed of several clusters of sensor nodes.

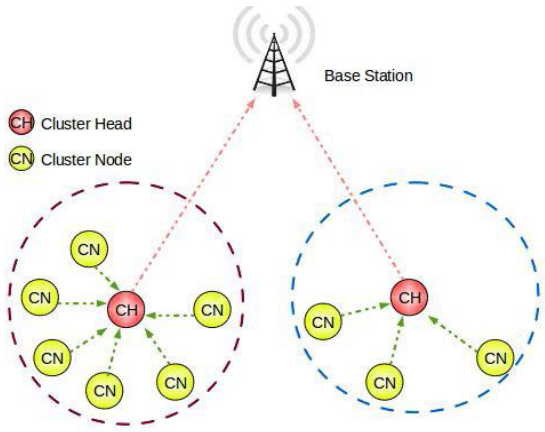

Fig.1. Cluster based Topology

As shown in fig.1, each cluster has a leader node which is also called as cluster head. CH takes data from all the nodes in its cluster. Cluster head aggregate all the data received from cluster members and then send that data to the base station. The transmission between cluster members and cluster head is said to be intra cluster communication, where as the transmission between cluster head and sink is known as inter cluster communication. The local collaboration in clusters, reduce the bandwidth demands. Clustering reduce the routing overhead and make the network more stable.

3.1 Implementation of APTEEN Protocol

APTEEN protocol implementation based on LEACH for selecting cluster heads and creating the Time Division Multiple Access (TDMA) scheme. By using this algorithm it does support mobility for multi hop cluster based topology. A new algorithm has been designed to discover routes dynamically for transmitting data toward a sink between nodes, based on the different link costs, considering multi-hops cluster based topologies. Some scenarios are simulated to validate this implementation in term of the required performance, such as energy, delay and reliability for delivered data over multi-hops WSN based applications. More details about APTEEN and its implementation in this paper are debated below.

3.1.1. An APTEEN Protocol

APTEEN [3] is a self-configuration clustering based routing protocol which has been designed for WSNs. This protocol uses a randomization related technique to distribute energy usage between nodes over time, which conserves energy and reduces collisions. Nodes are joined into a set of different groups when they turn on their radios, each group is called Cluster, where nodes belonging to each cluster are monitored by a special node which is called Cluster Head(CH). CHs are assigned to have more power and energy than other nodes, to deal with TDMA creation and data aggregation. Nodes send their data to their cluster heads and then go to sleep to save energy and reduce collisions in the network. Cluster heads receive and aggregate this data and send it back to higher cluster heads until this data is reached by a sink. Since cluster heads are selected based on their remaining energy, then the chance of nodes dying quickly is low. Data aggregation using APTEEN needs to be designed according to the requirements of the proposed applications.

APTEEN lets nodes transmit their data only when the sensed data is in the range of interest, based on the given data thresholds. This will reduce the number of unnecessary transmissions and hence allow APTEEN to be used for critical and non critical related applications using WSNs. Cluster heads are selected based on the

probability that each node has not been selected for a period of time. When cluster heads are selected, they need to advertise themselves to the rest of the nodes in the network. After the CHs advertisement, TDMA schedules are created and broadcast so that the required slots for members can be allocated. After cluster heads are selected and TDMA schedules for members are allocated, nodes can transmit their data to their cluster heads in which this data will be aggregated and send to the sink, as shown in fig. 1.

3.1.2. Details of the APTEEN Protocol

The operations of the APTEEN protocol are divided into rounds, where each round starts with three different phases which are set-up, routes discovery and data transmission. In the set-up phase, nodes organize themselves into different clusters, where each cluster needs to be monitored by a cluster head, followed by an advertisement phase, where cluster heads need to advertise themselves to the nodes in the network. Non cluster heads ask to join to different clusters, based on the different costs. In the route discovery phase, cluster heads are required to find different routes for relaying data from members to a sink. Based on this, a new algorithm needs to be implemented to select routes between CHs and a sink to take into account different situations. In the data transmission phase, nodes start to send data to their selected cluster heads over a single hop communication and then go to sleep to save energy. APTEEN needs to be scalable for different cluster based topologies, for instance single level and multiple levels cluster based topologies.

IV. CROSS LAYER PROTOCOL BASED ON MAC AND ROUTING PROTOCOL

At the MAC layer, as it has been debated in [6], MAC protocols only care about energy saving and cannot provide good scalability and the required routing for different applications, when the number of nodes is high. GinMAC is a suitable MAC protocol to be used in real-time applications as shown in [7], where the reliability, energy saving and delay can be guaranteed. Challenges and requirements that need to be considered before designing MAC protocols for such applications are also described in the same paper. Based on these features, GinMAC has been modified and implemented for real time applications, where a low number of nodes is considered. GinMAC cannot provide the required routing for mobile nodes in the proposed applications, when the number of nodes is high. Based on this, APTEEN [3] has been modified and new features, such as mobility modules and new algorithms for transmitting data over multi-hops WSNs have been designed.

4.1. Reliable Transmission Using MAC

A reliable data transmission between source nodes and a sink in real-time related applications with high accuracy is one of the most important requirements for designing efficient protocols using WSNs. Different applications have different requirements in term of the required reliability. A lot of Medium Access Control (MAC) protocols have been proposed to provide the required reliability for data delivered, however, there are still problems for offering the required reliability for real time and critical delivered data related applications using WSNs. In WSNs, reliability can be classified into different levels: Event reliability level and hop-by-hop reliability level.

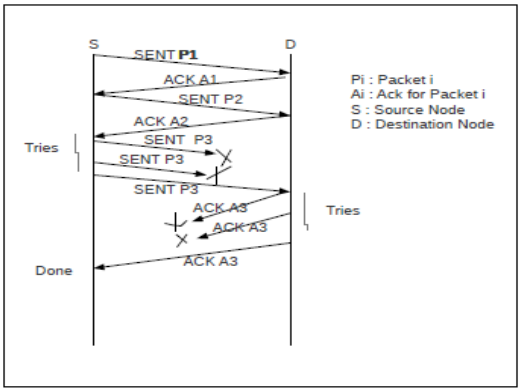

Fig.2. Reliable Transmission Algorithm Using MAC

Packet or event reliability is concerned with how much information is required to notify the sink of an occurrence of something happening in the target environment. Packet reliability re- quires all the packets carrying sensed data from all the sensor nodes in the network to be reliably transmitted to a sink. To achieve packet reliability in terms of recovering the lost packets at the hop-by-hop or end-to-end level is through the use of retransmissions and an acknowledgement. A retransmission is simply the retransmissions of the lost information in which can either be per- formed on end-to-end or hop-by-hop basis.

V. SIMULATION RESULT OF PROPOSED APTEEN PROTOCOL

Number of factors that should be taken into serious consideration is the sensors cost, size, reliability, energy efficiency, data redundancy. Even if we assume that all the above requirements are totally fulfilled and that the simulation results are accurate and realistic, still painstaking tests have to be undertaken for real time monitoring, so that the System becomes as fully reliable as possible. In general the Forest Fire Detection System proposed here is accurate, reliable but still needs to be

tested on various situations for further evaluation, which is not easy to do, provided that experimentation cannot be easily done with actual fires.

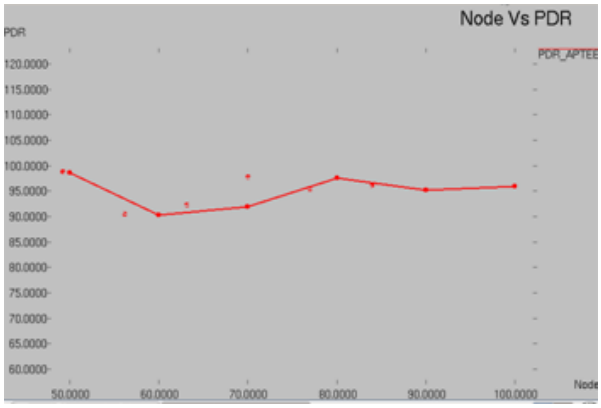

Fig.5.4 Node Vs PDR

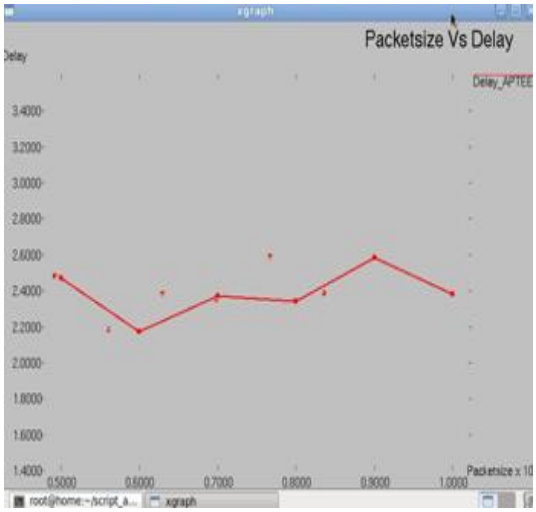

Fig.5.5 Packet size Vs Delay

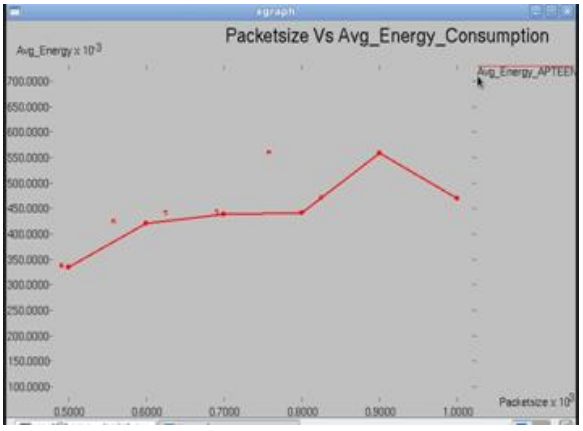

Fig.5.6 Packet size Vs Avg. Energy Consumption

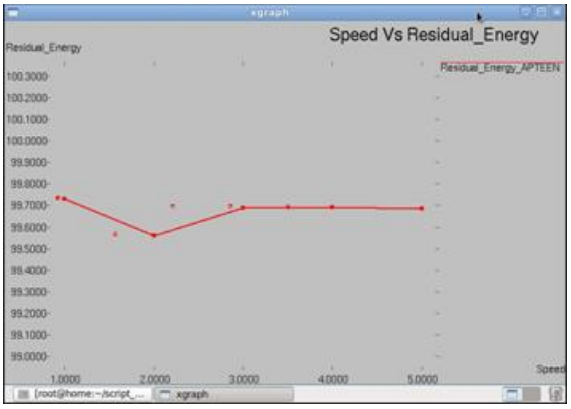

Fig.5.9 Speed Vs Residual Energy

The point here is that the reliability of such a system except from the characteristics of the systems itself, also depends on external factors such as the reliability of the WAN used to convey alarms from sensors to the operations center. Redundancy, alternative networks, new protocols are to be design such as APTEEN to be considered. In this thesis, we presented the design and implementation of a wireless sensor network system for detecting forest fires based on cross layer protocol.

CONCLUSION

The design and implementation of cross layer based protocol (APTEEN) is used for various applications, where energy efficiency, critical data delivery, reliability, execution speed, average energy consumption and delay time are required. The APTEEN protocol implentation performs better performance than other hierarchical protocol in the case of energy efficiency as well as reliability. But the some protocols will give appropriate output in terms energy related issues depending on the input conditions but it does not handled critical data. Developed protocol increase the life time of the node by using energy efficient clustering technique. In this implementation we can used APTEEN protocol based on cross layer so it gives better efficiency, speed, residual energy, average power consumption, execution speed, time delay and reliability for real time application (forest fire detection) to save the forest easily.

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Authors

Mr. V. A. Dahifale born in India on 10th October 1982. He received his BE degree in Electronics engineering from Pune University, Maharashtra, India in 2009 and currently is a ME Electronics (Digital Systems) student in college of engineering, Kopargaon, Maharashtra, India. His interest in automation, robotics and WSN.

Prof. N.Y. Siddiqui born in India 5th May 1974, He received BE degree in Electronics engineering from BAMU, Aurangabad, Maharashtra, India in 1997, completed his ME in Electronics from BAMU, Aurangabad, Maharashtra in 2004 and Persuing PhD from SPPU Pune Rsearch topic is "Development of Routing Algorithm for WSN". Now he is working as an Assistant professor in college of engineering Kopargaon. His interest of research in robotics, carbon nanotube, automation and WSN.

