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EX-APTEEN: A Hybrid Protocol for Information Retrieval Using Backup Cluster Head Election and Queuing Mechanism for Overloading Condition.

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***Abstract* — In Wireless Sensor Network, dynamic cluster based routing protocol is mostly used. It is a network of battery operated, tiny, mostly homogeneous sensor nodes having limited memory, processing power with wide applicability in the area of military, weather forecasting etc. As it is battery operated, it requires energy awareness in all layers of the networking protocol stack to prolong the life time of the network. Protocol designed for such sensor network must efficiently use limited bandwidth and energy of the sensor node. In this paper energy is saved by minimizing no of Communication by lowering the cluster re-election using a Backup node concept and EX-APTEEN is a hybrid protocol like APTEEN (Adaptive Periodic Threshold Energy Efficient Sensor Network Protocol).Our Protocol uses a Enhanced TDMA Schedule to efficiently handle query handling with a queuing mechanism for heavy load. It has the capability of querying the network through base station and through a network node also.**

Index Terms—Wireless Sensor Network, cluster-reelection, Back up node, Hybrid protocol, Queueing mechanism.

I. INTRODUCTION

A Wireless sensor network is a network of 100's or 1000's nodes having low cost, low powered, extremely small sensor nodes with processing capability. It has the capability of sensing very dynamic, fast changing physical parameter .Parameters change dynamically .They are used in target field imaging, intrusion detection, weather monitoring, security and tactical surveillance and measuring ambient conditions. They are deployed in random fashion manually or dropped from aeroplane .Network protocols must be designed to achieve fault tolerance in the presence of individual node failure while minimizing energy consumption. The assumption is the Base station is fixed and located far from the sensors. Data fusion is the method of data aggregation, which combines several unreliable data measurements to produce a more accurate signal by enhancing the common signal and reducing the uncorrelated noise. Large energy gains can be achieved by performing the data fusion or classification algorithm locally, there by requiring much less data to be transmitted to the base station.

II. HIERARCHICAL CLUSTER BASED MODEL FOR SENSOR NETWORK

A typical sensor node consists of transmission circuit and receiver circuit. Any ambient condition is sensed by analog signal and it is converted into digital form by analog to digital converter. Same amount of energy is required in transmission and receiving of a k bit packet .But the Energy differ in amplifying the signal to send it to a greater distance, so that it can reach to the destination uninterrupted. The sensor nodes have limited sensing area and if transmission is for larger distance, then the nodes quickly lose their energy and become dead. That, s why hierarchical cluster based structure is necessary.

In this model all the nodes form cluster among themselves .Each cluster has an Actor node called cluster Head (CH) and the cluster members .The cluster members sense the attributes and send the data to the cluster head where it is aggregated and send to the second level cluster head. It is the cluster head formed by 1st level cluster head as its members. Likewise data transmits to the upper level and subsequently to the base station .BS is a location which has no energy constraint .It can directly send the query and answers to the requesting node or the user through the network.

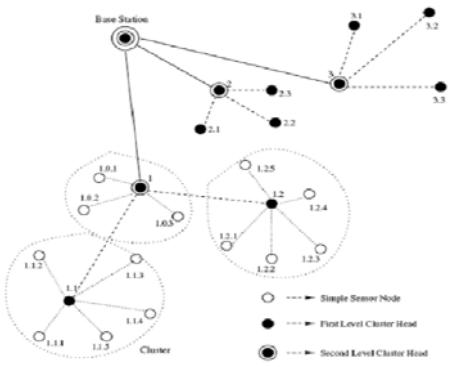

Fig.1 Hierarchical structure of sensor nodes

III. SENSOR NETWORK PROTOCOLS

Depending upon the reporting time of the data and its time criticality, the network protocols can be classified into proactive, reactive and hybrid protocols.

A. Proactive Protocol

It has a report time (TR) and attributes to be sensed (A) .Each cluster member has a time slot to send the data to cluster head. Each node in this network periodically switch on their sensor and transmitter to sense the environment and transmit the data of interest.

B. Reactive Protocol

In this scheme the nodes react immediately to sudden changes in the value of a sensed attribute beyond a pre-determined threshold value and are well suited for time critical applications as used in T*EEN*

C. Hybrid Protocol

It uses the best feature of proactive and reactive network. It can act as proactive or reactive protocol depending upon value set for some parameter. It has the following parameters:-

1) *Hard Threshold (Ht):* It is the minimum value of a parameter to be reached for any communication. There will be no communication if the sensed value will not reach this point.
2) *Soft Threshold (St):*This is the minimum small change in the previously sent value after which there will be a transmission.
3) Count time (Tc):- It is the maximum period up to which there can be no transmission of an attribute for not reaching the hard threshold or not exceeding the soft threshold. It is generally set the multiple of the frame time Tf. The frame time is the sum of the Time period of all the cluster member nodes in the TDMA schedule.

IV. QUERY CLASSIFICATION

The queries in a sensor network can be categorized into three types depending on the type of data (past, present, or future) they request:

A. Historical Queries

This type of query is mainly used for analysis of historical data stored at the BS.For example, “What was the temperature two hours back in the northwest quadrant?”

B. One-time query

This type of query gives a snapshot view of the network. For example, “What is the temperature in the northwest quadrant?”

C. Persistent:

This type of query is mainly used to monitor a network over a time interval with respect to some parameters. For example, “Report the temperature in the northwest quadrant for the next two hours.”

All the above type of queries can either be Time-critical queries or Non time-critical queries depending upon the state set by base station .Base station sets the situation depending upon the requirement from the user .A user can query the network through a wireless device either through a node of the network or base station. Our assumption is all query will route through the base station .The base station broadcasts the queries to all the nodes of the network. Some nodes of the requesting region accept the query and send the data according to the routing protocol.

V. EX-APTEEN :- EXTENDED APTEEN

It has two phases, cluster setup phase and data transfer phase. In cluster set up, phase cluster formation and cluster member selection is done .In the data transfer phase data is aggregated and send to the base station.

A. Cluster Setup Phase

It consists of 2 phases:-

1) *Cluster Head Selection:* All the nodes of the network is divided into clusters. Each cluster has a cluster head nodes and cluster members. It uses the cluster formation algorithm like LEACH.

It uses the randomised function

$T(n) = P/(1-P * [r \bmod (1/P)])$ if $n \in G$,

$T(n) = 0$ if n not belongs to G.

Where P=percentage of nodes to be cluster head selected a priori.value=a random number generated between 0 and 1 for a node.r= round of cluster formation.1/P=total no of rounds of a cycle in which a node will become a cluster head at least once.

G=number of nodes which are not elected as cluster head in last 1/P rounds.

In a round if value < T (n), the nodes become a cluster Head.

Then each cluster head broadcasts the advertisement message to the entire network declaring that they are the cluster heads. The advertisement message includes all the attribute set A , its hard threshold (Ht) ,Soft threshold (St)and Count time. Depending upon the received signal strength from different cluster heads, the nodes join in a particular cluster.

2) Back up node determination and shortest path establishment:

The disadvantage of leach algorithm is uneven distribution of nodes in a cluster. Each cluster head executes the single source shortest path graph algorithm and finds the shortest route from cluster head to all its members .By reversing the direction of each shortest path all the member sensor nodes sends the data to the cluster head. All the edge length is assumed to be 1 depending upon the sensing area of a sensor node. All the member nodes which is inside the sensing area of the cluster head nodes ie the nodes which gets the broadcasts massage in 1 hop by single flooding are eligible for backup nodes. Each cluster member nodes after getting the 1 hop massage ,sends the reply to be registered as the backup clusterhead.The nodes are listed in a queue and in the next

round the cluster head nodes sends the responsibility to the first node in the back up node list depending upon the energy of the node .Any node can be a cluster head if it has the energy to be available for entire round. By electing the backup node, we reduce the frequent clustering, there by saving energy. The shortest route establishment accounts for the uneven distribution of cluster member nodes inside a cluster.

All the first level cluster heads will be the member for the second level cluster heads and likewise a hierarchical structure is formed ,having Base Station as the root.

B. Data transfer phase

TDMA Schedule is built depending upon the cluster with maximum no of members. If an event occur in an area, that will be sensed by different nodes in the close proximity. The pairing is done between closely placed nodes as they are sensing same data .One node will be in sleep state and other will be in idle state to sense the data. Nodes alternate their role between themselves in alternate cluster change time, so that energy of both nodes will be used properly.

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All sleeping, idle nodes are grouped together. It gives the flexibility of querying network through a nearby node as well as through Base station. Assumption is all the queries must be routed through Base station. Since the nodes are sending data to the base station, we can combine answers to the previous query and the next query in the same data and transmit to the Base station. There is a slot for CH-> BS and BS-> nodes in the TDMA schedule .CH->BS (Uplink), BS->nodes, all the different clusters use same CDMA schedule, so that inter cluster collision will not be there.

Data can only be transmitted either in CH->Bs or BS->nodes in downlink direction. That's why separate time slot is included in the TDMA schedule. Each sensor nodes contains a queue ,which will be helpful for overloading condition .If a query arrive at a node before the previous query is not answered ,then it is queued .It is answered in the next slot after the current query is answered

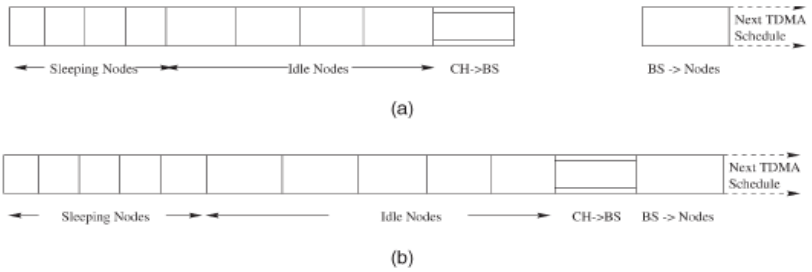
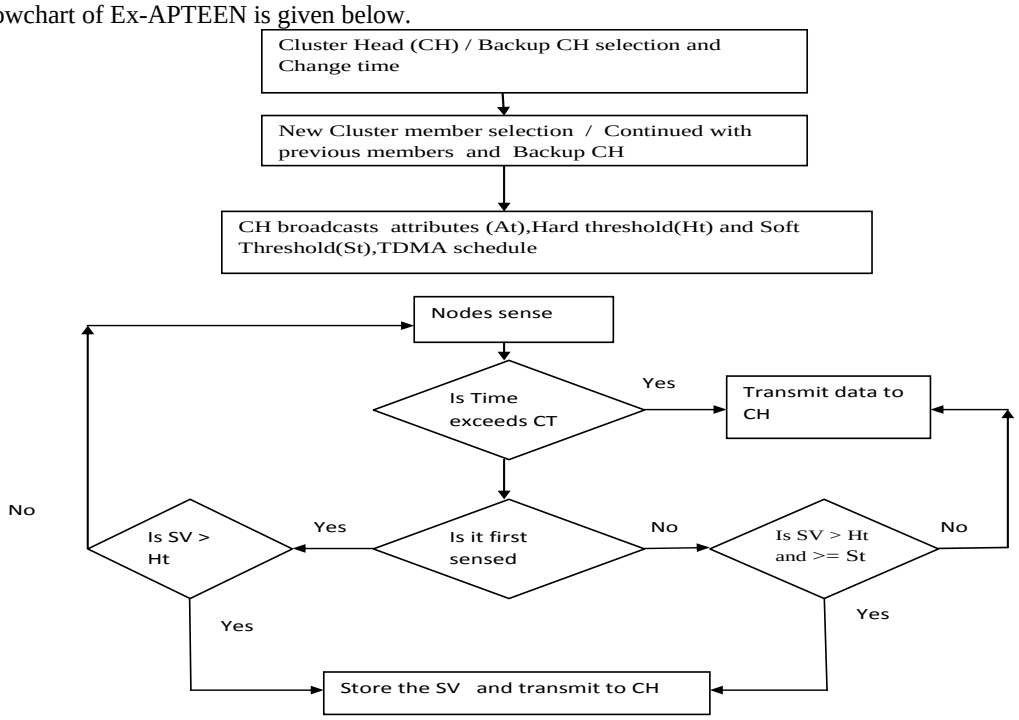


Fig2.Different Frame length in a network (a) Frame time less than the longest frame time (b) Longest frame time

The Operation flowchart of Ex-APTEEN is given below.



VI. CONCLUSION

Wireless sensor networks are used in a variety of applications which require continuous monitoring and detection of distributed events. They can be used in industrial, medical, consumer and military applications. Sensor nodes are operated and constrained by battery lifetime which cannot be recharged or replaced. Therefore, energy efficiency is the most important design factor in wireless sensor networks.Ex-APTEEN saves energy by reducing repeated cluster formation .Overloading condition of queries is avoided by using the queue in every node. The concept will be evaluated by implementing the idea with the help of ns-2 simulator in our future work.

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