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Abstract: Wireless Sensor Networks can be helpful for the problems where real time data sensing, data dissemination and data gathering is required to operate a system. Most of the hierarchical data operation systems require gathering the data hierarchically from the lowest point of sensing to upstream towards the highest point. The data observed at all the level of hierarchy becomes indicator of the scenario at downstream of that point. The larger geographical area presents a major challenge to WSN nodes due to their transmission distance limit. This paper proposes a protocol which can be worked out for such a problem using wireless sensor networks.

Keywords: wireless sensor networks, routing protocol, hierarchical systems, ns2, micaz motes

I. INTRODUCTION
Several problem domains require collection of data in hierarchical manner so as to operate the system in effective manner. In these problems the topmost hierarchy should checks the quantum of requirements in the downstream as per data collected and thus supplies the physical quantities so as to satisfy the requirement at various points in downstream. Wireless sensor networks can be very helpful in such problems. The WSN can sense the data in question and propagate that data to the other nodes using radio links. The WSN works on 802.15.4 IEEE standards and using ZIGBEE standard it can encapsulate the data into the communication headers and relay the data to neighbouring nodes or cluster nodes. The data then ultimately moved to the highest hierarchy called SINK. The systems like water supply system, Irrigation systems, electric power supply, real-time sales and inventory control, Flood management Systems etc are the target for the application model proposed in this paper. The problem with ZIGBEE based motes is the limit of their transmission range.

II. RELATED WORK
Data delivery has been major concern in the wireless sensor networks. Lot many algorithms (theoretical, proposed and implemented) have used by researchers in diverse conditions These routing protocols are mainly classified based on Data Centric approach, Hierarchical Approach, Location based approach, Network and QoS flow based approach. The data centric approach focuses on gathering the data from randomly deployed huge no of sensors and finally getting the data at the sink. The approach of flooding[2] and gossiping does not need any routing protocol. In flooding, each sensor receiving a data packet
broadcasts it to all of its neighbors and this process continues until the packet arrives at the destination or the maximum number of hops for the packet is reached. On the other hand, gossiping is a slightly enhanced version of flooding where the receiving node sends the packet to a randomly selected neighbor, which picks another random neighbor to forward the packet to and so on. Although flooding is very easy to implement, it has several drawbacks like implosion caused by duplicated messages sent to same node, overlap when two nodes sensing the same region send similar packets to the same neighbor and resource blindness by consuming large amount of energy without consideration for the energy constraints. Gossiping avoids the problem of implosion by just selecting a random node to send the packet rather than broadcasting. However, this cause delays in propagation of data through the nodes. The energy aware SPIN [3] (Sensor Protocol for information via negotiation) is based on the meta data attribute which is given to every node. The node negotiates with the neighboring nodes for Advertisement, negotiation and Data. The interested nodes will create a gradient toward Sink. The Directed Diffusion[4], an improvement to SPIN, was event and query based protocol where each node was told to store the data for a particular event. The query sending process established gradients from each node to the sink. When node gets the required data it will send to the sink from one of the several path selected dynamically. This saves more energy than SPIN. Destination-Sequenced Distance-Vector Routing (DSDV) [5] a table-driven routing scheme for ad hoc mobile networks based on the Bellman–Ford algorithm was developed by C. Perkins and P. Bhagwat. The main contribution of the algorithm was to solve the routing loop problem. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequently. In AODV[6], the network is silent until a connection is needed. At that point the network node that needs a connection broadcasts a request for connection. Other AODV nodes forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the needy node. When a node receives such a message and already has a route to the desired node, it sends a message backwards through a temporary route to the requesting node. The needy node then begins using the route that has the least number of hops through other nodes. Unused entries in the routing tables are recycled after a time. The TORA [7] attempts to achieve a high degree of scalability using a "flat", non-hierarchical routing algorithm. In its operation the algorithm attempts to suppress, to the greatest extent possible, the generation of far-reaching control message propagation. In order to achieve this, the TORA does not use a shortest path solution, an approach which is unusual for routing algorithms of this type. TORA builds and maintains a Directed Acyclic Graph (DAG) rooted at a destination. No two nodes may have the same height. Information may flow from nodes with higher heights to nodes with lower heights. Information can therefore be thought of as a fluid that may only flow downhill. By maintaining a set of totally ordered heights at all times, TORA achieves loop-free multipath routing, as information cannot "flow uphill" and so cross back on itself. Dynamic source routing protocol (DSR) [8] is an on-demand protocol designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. The major difference between this and the other on-demand routing protocols is that it is beacon-less and hence does not require periodic hello packet (beacon) transmissions, which are used by a node to inform its neighbors of its presence. The basic approach of this protocol (and all other on-demand routing protocols) during the route construction phase is to establish a route by flooding RouteRequest packets in the network. The destination node, on receiving a RouteRequest packet, responds by sending a RouteReply packet back to the source, which carries the route traversed by the RouteRequest packet received. One of the important protocols in this was LEACH (Low Energy adaptive clustering Hierarchy ) [9]. It is a hierarchical protocol where 20% of the nodes are the candidate for the cluster head and looking to the energy level of the nodes one of them was selected as cluster head. The cluster head changed dynamically over a period of time thus not depleting the energy of the current cluster head. PEGASIS [10] was a improvement over LEACH. Rather than forming multiple clusters, PEGASIS forms chains from sensor nodes so that each node transmits and receives from a neighbor and only one node is selected from that chain to transmit to the base station (sink). Gathered data moves from node to node, aggregated and eventually sent to the base station. The next modification were TEEN [11] and APTEEN [12] protocols. Threshold sensitive Energy Efficient sensor Network protocol (TEEN) is a hierarchical protocol designed to be responsive to sudden changes in the sensed attributes such as temperature. Responsiveness is important for time-critical application. The Adaptive Threshold sensitive Energy Efficient sensor Network protocol (APTEEN) is an extension to TEEN and aims at both capturing periodic data collections and reacting to time critical events.
The protocols mentioned above do not take care any spatial parameters like position or distance. The sole criteria of deciding the cluster head is energy. There are two reasons to go for a new protocol
1) The problem of data monitoring requires spatial distribution of the parameter
2) The area in consideration is large and sensors are located quite sparse as compared to the above protocols. As the relay limit of radio antenna in sensor networks is quite limited the distance between the node a important factor for deciding the cluster head. The cluster head must me located at the optimal distance where all the all the sensing nodes can access them. The energy consideration on nodes is also combined to decide the cluster head.

So this paper presents a protocol suitable for wireless sensor network especially to be deployed for the systems which collect data in hierarchical manner

III. REPRESENTATION OF SYSTEMS IN CONSIDERATION AND DEPLOYMENT OF SENSORS
To understand the purpose of paper one has to understand the nature of problem being considered. The system here moreover a hierarchical network for collection of data towards upstream and supply of data in the downstream as given in fig 1 and Fig 2.

Fig.1 The Hierarchical Accumulative Data Collection System
Fig.2 The Hierarchical Deductive Data Supply System
Fig. 3 shows a macroscopic view of the effective command under data accumulation point. For a smaller area WSN nodes can be deployed in the command randomly to sense the local data and all the sensors report their data to the cluster head. The cluster head finally supply the data to sink (data accumulation node). In fig.4 the size of the command may be very large, so it requires more no of cluster heads. (An area of 300 m by 300m is shown). This is because of limiting distance of the ZIGBEE based motes. Two operations are generally expected from the system:

1) Getting the real-time data from the extreme downstream to upstream in accumulated manner. Each node on fig.1 will have the aggregate function of all the requirements in the downstream.
2) Querying the entire system using the relational operator for the data concerned. In this the query travels from the topmost point to the last point as shown in Fig.2.
3) Proactive supply of data to the system if critical condition of the observed parameter is encountered.
4) Relay of action from the control point, which are to be taken to mitigate the critical condition.

All the above actions require a different kind of routing protocol to be a part of application in the WSN mote nodes and the cluster heads. The data from the accumulation points can be relayed using long distance propagation mechanism like microwave or radio transmissions. The data propagation is done in two phases.

a) Inter-command routing using cluster based topology for Wireless sensor Network.
b) Inter-Node routing for data accumulation node

IV. CLUSTER BASED LOCATION AWARE ROUTING PROTOCOL – INTER-COMMAND ROUTING

Looking to all the popular protocols like AODV, DSR, DSDV, TORA, LEACH as given above in the related work, they seem to have been developed for the random sensor placements and the sensed data is of continuous nature. While AODV, DSR, DSDV and TORA have a non clustered LEACH provide the solutions for the cluster based sensors but taking 20 % of sensors on adhoc basic does not satisfy the nature of the problem in considerations. As the distances are comparatively larger among the sensors the distance should also be a deciding factor. The dissemination interval is the another important factor. As the moisture data varies slowly keeping low dissemination does not give any change in the result. So the scheme of event based threshold model is combined with CALAR to decrease the no of packet transmission and thus conserve the energy. CALAR follows the following algorithm.
ALGORITHM FOR INTER – COMMAND ROUTING (CALAR):

1. ALGORITHM TO DETERMINE CLUSTER HEAD

var i as int
var n → No of Nodes
var c → node no of cluster head
var N[i](xi,yi) → Node no. i at coordinates xi and yi
var N[0] → Access Point
var NBUFFER[128] → buffer memory on cluster head to store xi an yi of different nodes
var SUM_NCH → Sum of distances of Nodes and the cluster head
var SUM_NA → sum of distances from nodes to Access Point
var EDR → effective distance ratio
var MIN → find minimum
Function ADV → Network Advertisement
Function JOIN-REQ → Request for joining the cluster head
Function FRIIS → Friis equation to find distances based on signal strength
Function DIST → find distance between nodes
Function RND → Randomizer

PROCEDURE
// Initialisation for x,y at Access Point
1. N[0](xi) = 0, N[0](yi) = 0
2. ADV N[0] with xi, yi
3. For I = 1 To N JOIN-REQ N[i]
4. FRIIS N[0] → N[i]
5. ADV N[0] with xi,yi to N[i] I = 1 to n
6. FOR k = 1 to n
c = RND (1 to n)
7. ADV N[c]
8. JOIN-REQ N[i] for 1 to n
9. FOR I = 1 to N
   SUM_NCH = SUM_NCH + DIST(N[i], N[c])
   SUM_NA = SUM_NA + DIST(N[i], N[0])
   NEXT
10. EDR[c] = SUM_NCH / SUM_NA
    NEXT k
11 Find c with MIN (EDR[])
12 Node c is Cluster Head

2. ALGORITHM TO SENSE AND DISSEMINATE

var n → no of nodes
var c → cluster head node no

var si → sensing interval
var di → disseminating interval
var N[i] → node no I
var N[c] → cluster head node
var N[0] → Access Point
var Threshold → Threshold value of moisture
var limit → no of nodes reporting the threshold value
Function SENSE → sense the data
Function DISSEMINATE → disseminate to access point
Function COUNTN → no of nodes reported threshold value

**PROCEDURE**
1. FOR I = I to n
2. IF (SENSE N[i] at si) <= Threshold THEN
   DISSEMINATE(N[i], N[c])
   COUNTN = COUNTN+1
   if COUNTN>= limit * n THEN
   DISSEMINATE (N[c], N[0])
END IF
NEXT I

**V. DATA ROUTING FOR INTER-ACCUMULATION POINTS**
The data disseminated from cluster head to routing point will be carried for over the nodes in the upstream using GSM or Any Radio Based Networks. The data accumulation node (DAN) consists of TxRx combination of ZIGBEE and GSM The Proposed algorithm is as under

<table>
<thead>
<tr>
<th>ZIGBEE TxRx</th>
<th>CONVERTER (Zigbee-Gsm)</th>
<th>GSM (TxRx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Data Accumulator</td>
<td></td>
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</tr>
</tbody>
</table>

Fig 5. A schematic diagram of Data Accumulation Node (DAN)

**ALGORITHM For ACCUMULATION**
1. Data(DAN)current = Data(DN)current + Data (DAN) child
2. Search Parent of (DAN)current
3. Go to 1

**ALGORITHM For QUERY EXECUTION**
1. If Data(DAN) (RELATIONAL OPERATOR) Value
2. Data(DAN)current = Data(DN)current + Data (DAN) child
3. Search Parent of (DAN)current
4. Go to 1
5. End IF

**5.0 SIMULATION SCENARIO**
The simulation parameter are given as under

- Channel Type: Wireless Channel
- Radio-Propagation Model: TwoRayGround
- Network Interface Type: WirelessPhy/802_15_4
- MAC type: Mac/802_15_4
- Interface Queue Type: DropTail/PriQueue
- Link Layer Type: LL
- Antenna Model: Omni Antenna
- Queue Length: 50
- Network Layer Protocol: AODV/DSDV/ DSR/ TORA/ LEACH/ CALAR
- Size of the Topography: 500 X 500
- The Constant Simulation Parameters are,
- Active Data Senders: 75% Sensor Nodes
Sensor Data Size: 64 Bytes
Fused Data Size: 512
Sensor Data Interval: 1 Data Packet per 15 min
Channel Error Rate: 0.15
Total Simulation Time: 10 sec to 100 sec
The Variable Simulation Parameter has Total Sensor Instructions Per Second_ 8000000
Nodes : 10,20,30,40,50,60,70,80,90,100

The simulation is performed in ns2 simulator using the TCL script. The trace files obtained from all the protocols in consideration were analyzed for various performance parameter. Some of them are given in the result. The behavior of these parameter on single node as well as the entire network was observed.

VI. RESULTS

1) Simulation Result at the cluster node

Table 1 and Graph1 : Packet delivery ratio vs time

<table>
<thead>
<tr>
<th>Time in sec</th>
<th>AODV</th>
<th>DSDV</th>
<th>DSR</th>
<th>TORA</th>
<th>LEACH</th>
<th>CALAR</th>
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Table 2 and Graph2 : Throughput (TIL) vs time

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Table 3 and Graph3 : Energy Remaining(%) vs time

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Simulation Results for different no of nodes in layout
VII. CONCLUSION

The Routing strategy of inter command cluster based protocol CALAR is tested and is found most suitable for the criteria of Packet delivery ratio, throughput and remaining energy. These simulations were run on ns2 network simulator. The simulation was done for the single node with varying time and collection of nodes in the cluster with time. It was found that CALAR protocol gives 15-20% better performance in the testing criteria. The algorithm of Data Accumulation node is presented for forwarding the data from leaf node to the root node of the system domain tree.

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