Comparison of Routing Protocols in Wireless Sensor Network

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Abstract:We analyze the wireless sensor networks protocols and present a classification and comparison of routing protocols. Several routing protocols have been projected to maximize the sensor networks life span. Nevertheless, most of these solutions attempt to determine an energy efficient path and don't account for energy consumption balancing in sensor network. This frequently leads to network partitioning. The aim of this paper is to evaluate, analyze and compare three routing protocols (LEACH, CBR and MBC) that balance energy consumption, through a mathematical model and simulations. This paper will present a performance comparison of protocols LEACH, CBR and MBC based on parameters such as packet loss, average energy consumption, average control overhead, and better adaptivity to a mobile environment by using the NS-2 simulator.

Keywords: LEACH, CBR, MBC, WSN PROTOCOLS.

Introduction:

Wireless Sensor Networks (WSN):

A wireless sensor network (WSN) (at times called a wireless sensor and actornetwork (WSAN)) are spatially distributed autonomous sensors to monitor physical orenvironmental conditions, such as temperature, sound, pressure, etc. and tocooperatively pass their data through the network to a main location.

Components of WSN:

- Sensor: It is a transducer that converts physical phenomenon e.g. heat, light, motion,vibration, and sound into electrical signals.
- Sensor node: It is the basic unit in sensor network that contains on-board sensors,processor, memory, transceiver, and power supply.
- Sensor network: It consists of a large number of sensor nodes deployed either insideor very close to the sensed phenomenon.

A wireless sensor network (WSN) consists of a several nodes that are heavily deployed in a region of interest to collect information about an object or event, and offer a range of sensing and monitoring applications. A sensor network design is influenced by numerous factors like fault tolerance, scalability, production costs, operating environment, transmission media and power consumption.

In WSN, sensor nodes usually functions on batteries and hence Sensor nodes are constrained in energy, which has posed countless challenges on the design of a sensor network. To maintain the efficiency of network sensors, the network should be well designed to be energy efficient. Clustering is a procedure that can effectively decrease the energy utilization of sensor nodes and has been extensively used in WSNs. Among many methods, clustering the sensor nodes into groups and electing a cluster head (CH), so that these sensor nodes can send data to only the cluster heads (CH) and then the cluster head communicate to the base stations. This can be a efficient method to reduce energy consumption in WSN. It is mandatory to organized sensors in cluster form to reduce energy consumed when sending data from nodes to the base station**.**

LEACH (Low Energy Adaptive Clustering Hierarchy) Protocol:

LEACH is a TDMA-based MAC protocol which is incorporated with clustering and a simple routing protocol in wireless sensor networks (WSNs). It is a self-organizing, adaptive clustering protocolthat utilizes randomized revolving of local cluster base stations (cluster heads) to equally allocate the energy load among the sensors in the network. It is adense

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network of sensors nodes grouped into clusters. The goal of LEACH is to reduce the energy consumption required to create and maintain clusters in order to improve the life time of a wireless sensor network. In this protocol, all nodes are assumed to be homogenous plus energy-constrained. Since network partition is time variable, this protocol assumes global time synchronization. In LEACH, base station is fixed and away from sensors. Cluster members elect cluster head to avoid extreme energy consumption. This protocol incorporates data aggregation which reduces amount of information to be sent to base station, large reduction in energy dissipation as computation is much cheaper than communication.Itcan get as much as a factor of 8 in reduction in energy dissipation compared with conventional routing protocol.

LEACH is a hierarchical protocol in which the majority nodes transmit to cluster heads, and the cluster heads collect and compress the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to decide whether it will become a cluster head in this round. LEACH assumes that each node has a radio powerful enough to directly reach the base station or the nearest cluster head, but that using this radio at full power all the time would waste energy. Nodes that have been cluster heads cannot become cluster heads once again for *P* rounds, where *P* is the desired percentage of cluster heads. Thereafter, each node has a 1/*P* probability of becoming a cluster head again. At the end of each round, each node that is not a cluster head selects the nearby cluster head and joins that cluster. The cluster head then creates a schedule for each node in its cluster to send out its data. Every nodes that are not cluster heads only communicate with the cluster head in a TDMA fashion, according to the schedule created by the cluster head. They do so using the least energy needed to reach the cluster head, and simply need to keep their radios on throughout their time slot

.LEACH also uses CDMA so that each cluster uses a unlike set of CDMA codes, to reduce interference between clusters.

Properties

- Cluster based
- Random cluster head selection each round with rotation. Or cluster head selection based on sensor having highest energy
- Cluster membership adaptive
- Data aggregation at cluster head
- Cluster head communicate directly with sink or user
- Communication done with cluster head via TDMA
- Threshold value

CBR (Cluster Based Routing) Protocol

Cluster Based Routing (CBR) Protocol is a routing protocol in mobile ad hoc networks. The protocol separates the nodes ofthe ad hoc network into a number of overlapping 2-hop-diameter clusters in a disseminated manner. A cluster head is designatedfor each cluster to preserve cluster membership information. Inter-cluster routes are revealed dynamically using the cluster membership information kept at each cluster head. By clustering nodes into groups, the protocol efficiently reduces the floodingtraffic during route discovery and increases this process as well.Furthermore, the protocol takes into account the existence of unidirectional links and applies these links for both intra-cluster andinter-cluster routing.

Features

- Completely distributed operation.
- Minimizes flooding traffic during the dynamic route discovery process.
- Explicit utilization of unidirectional links that would or else be unused.
- Broken routes are repaired locally without rediscovery.
- Sub-optimal routes are reduced as they are utilized.

Advantages

- On-demand route discovery traffic and routing overhead is reduced due to clustering approach.
- To minimize route acquisition delay and new route re-discovery traffic, “local repair” mechanism is utilized.
- Speeds up the packet delivery ratio to a high extent.

Disadvantages

- The overhead per packet increases due to source routing, with increase in cluster size.
- In routed packet every node of the route is stored. So the packet size increases proportional to the path length of the route.
- With increase in cluster size and path length of the route transmission time increases.

MBC (Mobility Based Clustering) Protocol

In MBC protocol,a cluster-head based on its residual energy and mobility is elected by a sensor node itself. A non-cluster-head node aims at its link durability with a cluster head during clustering according to the anticipated connection time. A timeslot is allocated for data transmission in ascending order in a time division multiple address (TDMA) schedule based on the estimated connection time for each non-cluster-head node. In the steady-state period, a sensor node transmits its sensed data in its timeslot and broadcasts a joint request message to link in a new cluster and evade more packet loss when the connection is lost with its cluster head. Simulation outcome illustrate that the MBC protocol can minimize the packet loss by 25% compared with the cluster-based routing (CBR)

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protocol and 50% compared with the low-energy adaptive clustering hierarchy-mobile (LEACH-mobile) protocol. In terms of average energy consumption and average control overhead,it outperforms both the CBR protocol and the LEACH-mobile protocol, and can better acclimatize to a highly mobile environment.

MBC Protocol is appropriate when senor nodes are mobile. In MBC protocol, selection norm of CH is unusual from the classical LEACH protocol, here CH is selected based upon the residual energy and mobility. MBC has few key parameters as packet delivery rate, stable link connection, energy efficiency and lifetime of the network.

Assumptions made for MBC protocol are:

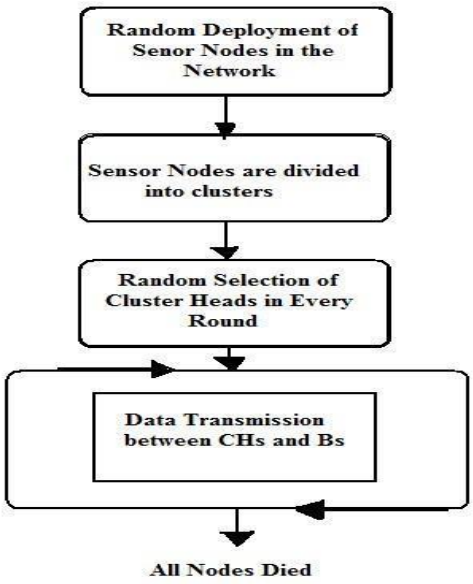
- Symmetric radio model.
- All SNs in the network are homogenous.
- Location and velocity for each SN in the network is known.
- Fixed BS.
- All SNs in the network are matched with time.
- Each SN can guess the time for transmitting a packet

Characteristics of Mobility Based Clustering Protocol are:

- Energy efficient compared to other protocols in terms of energy consumption.
- Minimized control overhead due to less persistent membership change.
- Successful packet delivery rate increases.
- Protocol is proactive.
- Fault tolerance is not provided.

EXISTING SYSTEM:

LEACH (LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY)PROTOCOL :



The above figure illustrates the basic block diagram of LEACH algorithm. It provides a representation of step by step operation of LEACH. The working initiates by deployment of sensor nodes in a haphazard manner in network. To separate the sensor network into clusters a traditional clustering scheme is applied.Then cluster heads are chosen erratically and transmit the data to Base station. This method continues in every round until the entire sensor nodes expire or Base station commands for stopping the process.

Phases

1) **Set-up phase** :

Cluster-heads can be selectederraticallybased on this algorithm:

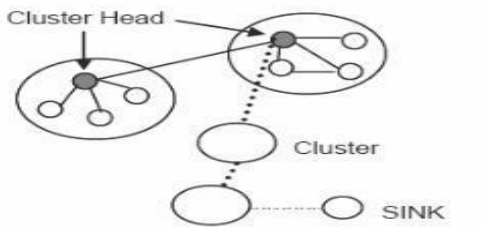
T(n) =P/1-P*(r mod/p) if n € G, where n is a random no. between 0 and 1 and P is cluster head probability and G is the set of nodes that were not cluster head in the last round. If n <T(n), then that node becomes a cluster head.

Each node becomes a cluster-head minimum once as per the algorithm. Each node that elected itself a cluster-head for existing round broadcasts advertisement message to rest of nodes. They use a CSMA MAC protocol. Using same transmit energy all cluster-heads transmit advertisement. To hear advertisements non-cluster-head nodes must keepreceivers on during this phase. After phase, they fix on which cluster to belong to for this round by selecting cluster-head that requires least communication energy. In case of ties, arbitrarily cluster heads are chosen.

2) **Steady-Set phase**:

After node elects cluster, must notify cluster-head. Cluster head now knows number of members. Cluster head then creates a TDMA schedule informing each node when it can transmit. During its transmit time, it allows radio components of each non-cluster-head node to be turned off, thus reducing energy debauched in individual sensors. Cluster head now has the entire data from the nodes in its cluster, aggregates data & transmits to base station.

CBR (Cluster Based Routing) Protocol:



The operations of CBR Protocol takes place in three steps which are as follow:

1) Cluster Formation

The objective of Cluster Formation is to carry out certain kind of hierarchy or structure in the otherwise entirely disordered ad hoc network. The procedure is a variation of the simple "lowest ID" clustering algorithm where the node with the lowest ID among its neighbors is selected as the Cluster Head. Apart from the states of C_MEMBER and C_HEAD, we describe a temporary state called C_UNDECIDED for smoother set-up of cluster formation. "Undecided" means that

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the node is still in looking for a cluster head. All nodes start in the Undecided state.

A node uses the data obtained from the HELLO messages for Cluster Formation. An Undecided node plans an timer to go off in UNDECIDED_PD seconds and broadcast a HELLO message every time it move in the C_UNDECIDED state. When a cluster head obtains a HELLO message from an Undecided Node, it will emit a triggered HELLO message immediately. If an undecided node gets a HELLO message from a Cluster Head showing a bi-directional linkage in between, it stops its timer and sets its own status to C_MEMBER. When the timer times out, if the node's Neighbor Table contains no bi-directional neighbors, then it returns back to the Undecided state; or else it elects itself as a Cluster Head. This new Cluster Head will now change the first field in its next broadcast HELLO messages from C_UNDECIDED to C_HEAD.

2) Neighboring Cluster Discovery

The guidelines for Neighboring Cluster Discovery is as follows:

- If there is at least one gateway with whom the node has a bi-directional link, it announces the neighboring cluster as bi-directionally accessible.
- If there are only unidirectional links (LINK_FROM), the neighboring cluster will be announced as LINK_FROM.

3) Routing

CBR Protocol practices two data structures to support the routing procedure:

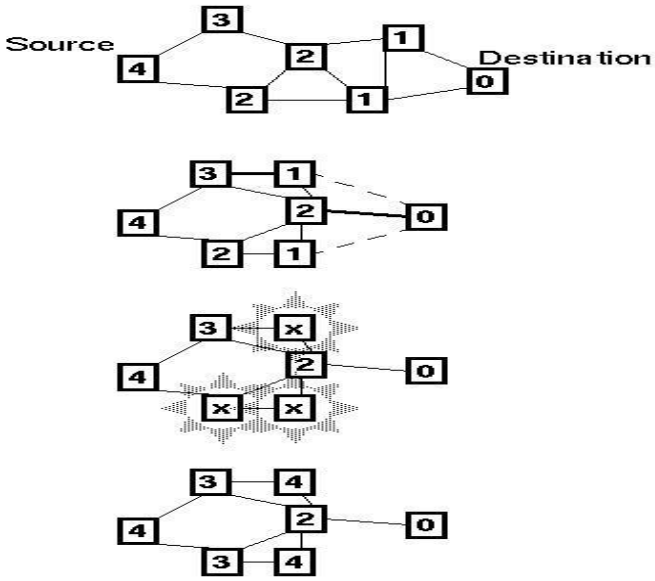
- **The Cluster Adjacency Table (CAT)**: The CAT is used to storedata about adjacent clusters, i.e. whether the links are bi-directional or unidirectional.
- **The Two-Hop Topology Database**: The two-hop topology database comprises all nodes that are at most two hops away.

The routing process works in two steps:

- Findthe route from a source node to a destination node.
- Actual transmission of the data packets.

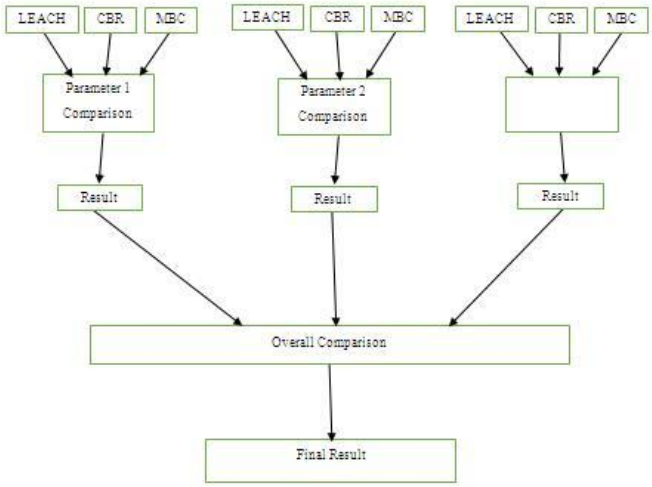
MBC (Mobility Based Clustering) Protocol:

In MBC protocol, a sensor node elects itself as a cluster-head based on its residual energy and mobility. A non-cluster-head node aims at its link stability with a cluster head during clustering according to the estimated connection time. Each non-cluster-head node is assigned a timeslot for data transmission in ascending order in a time division multiple address (TDMA) plan based on the estimated connection time.



- **Step 1:**The network has converged
- **Step 2:**Some of the mobile nodes move,breaking links and forming new ones
- **Step 3**:The nodes react to new topology and adjust according to their height
- **Step 4:**The network converges with directed graph. Notice how the change is localized.

PROPOSED SYSTEM:



We will be comparing three protocols for wireless sensor network i.e. LEACH, CBR and MBC. The parameters chosen for the comparison are X,Y and Z. The resultant analysis will be visually depicted to evaluate the most efficient protocol.

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SCOPE:

1. Military Applications

- Observingsociable forces, equipment, and ammunition
- Battleground surveillance
- Exploring opposing forces and territory
- Targeting
- Post-battle assessment
- Atomic, organic, and chemical attack discovery

2. Environmental Applications

- Forest fire discovery
- Bio-complexity plotting of environment
- Flood discovery
- Accurate Agriculture
- Air and water pollution

3. Health Applications

- Tele-monitoring of human physiological information
- Tracking and nursing doctors and patients inside a hospital or infirmary
- Drug organization in hospitals

4. Home and Office Applications

- Home and workplace automation
- Smart environment

5. Automotive Applications

- Decreasescabling effects
- Measurements in chambers and spinning parts
- Distant technical assessments
- Observing circumstances e.g. at a bearing

Objective:

- To calculate, examine and relate three routing protocols (LEACH, CBR, and MBC) in wireless sensor networks.
- To deliver a performance comparison of these three protocols using parameters such as
  - Packet Loss
  - Average Energy Consumption
  - Average Control Overhead
  - Better adaptivity to a mobile environment
- To calculate and implement these protocols in Linux OS using NS-2 simulator, which is an event-driven simulation softwareis useful in learning the dynamic nature of communication networks.

LITERATURE SURVEY

Sr.No.	1
Title	Mobility-based clustering protocol for wireless sensor networks with mobile nodes
Year	March 2011
Author	Deng, S. Nat. Mobile Commun. Res. Lab., Southeast Univ., Nanjing, China Li, J. ; Shen, L.
Conclusion	MBC protocol can reduce the packet loss by 25% compared with the cluster-based routing (CBR) protocol and 50% compared with the low-energy adaptive clustering hierarchy-mobile (LEACH-mobile) protocol. Moreover, it outperforms both the CBR protocol and the LEACH-mobile protocol in terms of average energy consumption and average control overhead, and can better adapt to a highly mobile environment.

Sr.No.	2
Title	Cluster Based Routing protocol for Mobile Nodes in Wireless Sensor Network
Year	May 2009
Author	Awwad, S.A.B. Dept. of Comp. &Comm. Syst. Eng., Univ. Putra Malaysia, Serdang Ng, C.K. ; Noordin, N.K. ; Rasid, M.F.A.
Conclusion	The performance of proposed CBR Mobile-WSN protocol is evaluated using MATLAB and it has been observed that the proposed protocol reduces the packet loss by 25% compared to LEACH-Mobile protocol.

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Sr.No.	3
Title	An Improved LEACH Protocol for Data Gathering and Aggregation in Wireless Sensor Networks
Year	Dec 2008
Author	Wei Bo Nat. Digital Switching Syst. Eng. & Technol. Res. Center, Zhengzhou Hu Han-ying ; Fu Wen
Conclusion	The node with the minimum mobility or in group motion with other members is more likely to be elected as a cluster head. The remaining energy of a cluster-head node and the total number of nodes in a cluster, together with the distance between a cluster-head node and a non-cluster-head node should be taken into account during clustering.

DESIGN:

Thewholeprotocolcan bedescribedby Algorithm1 in Fig.12andAlgorithm2inFig.13.

```
Wait for
if node's turn to send data then
    adjust transmission power
    send data to CH
    check Δt
    if Δt ≤ the total time of a frame then
        send joint request message
    end if
end if
if did not receive send ACK message then
    send joint request message
end if
if the end of a frame then
    if sent joint request message & receive CHs advertisement message then
        estimate each new Δt
        calculate the value of each CH
        select a suitable CH
        send a registration message
    end if
end if
```

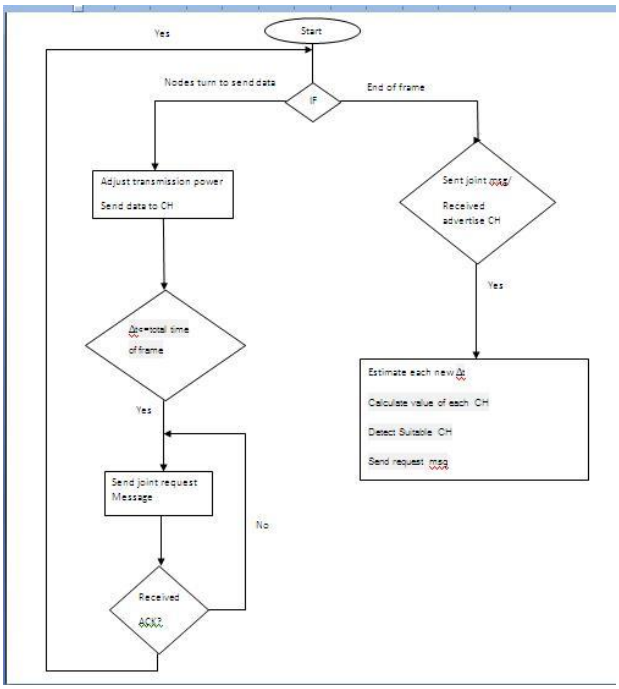

Fig.12 Algorithm1fornon-cluster-headnodes

```
if node's turn to send data then
    if recv complete data then
        send ACK msg
    end if
end if
if the end of a frame then
    if receive joint request message then
        send CH advertisemet message
    end if
    if receive registration message then
        reorder the TDMA schedule according to Δt
    end if
    check the TDMA schedule
    if Δt ≤ total time of of a frame then
        remove the node from the TDMA schedule
    end if
    rebroadcast the TDMA schedule
end if
```


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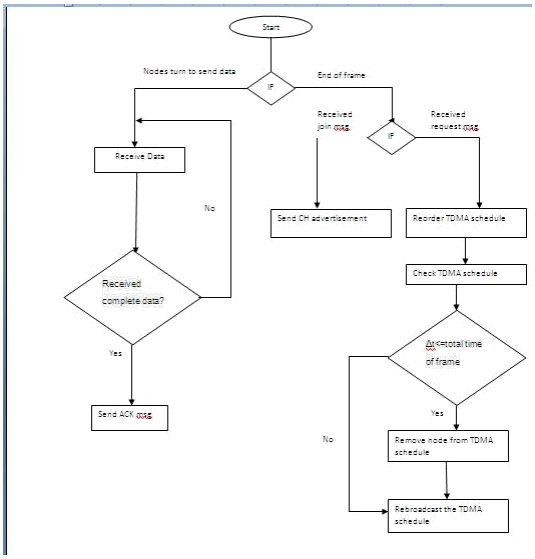

IV. CONCLUSION

In the existing system maximum work goes manually and it is error prone system, takes time for any changes in the system.

VII. REFERENCES

1 Misra,S.,Reisslein,M.,Xue,G.:'Asurveyonmultimediastreamingin wirelesssensornetworks',IEEECommun.Surv.Tutor.,2008,10,(4), pp.18– 39

2 Lim,K.W.,Ko,Y.B.:'Multi-hopdataharvestinginvehicularsensor networks',IETCommun.,2010,4,(7),pp.768–775

3 Ekici,E.,Yaoyao,G.,Bozdag,D.:'Mobility-based communicationin wirelesssensornetworks',IEEECommun.Mag.,2006,44,(7),pp.56–62

4 Felemban,E.,Liu,C.G.,Ekici,E.:'MMSPEED:multi-pathmulti-speed protocol forQoSguaranteeof reliabilityand timelinessin wireless sensornetworks',IEEETrans.Mob.Comput.,2006, 5,(6),pp. 738–754

5 Zhang, Y., Dai, H.: 'Energy-efficiency and transmission strategy selectionincooperativewirelesssensornetworks',J.Commun.Netw., 2007,9,(4),pp.1–9

6 Yuan,Y.,Chen,M.,Kwon,T.:'Anovelcluster-based cooperative MIMO schemefor multi-hopwirelesssensor networks',EURASIP J.Wirel.Commun.Netw.,2006,(2),pp.38–47

7 Heinzelman,W.,Chandrakasan,A.,Balakrishnan,H.:'Anapplication-specificprotocolarchitectureforwirelessmicrosensornetworks',IEEE Trans.Wirel.Commun.,2002,1,(4),pp.660–670

8 Shu, T.,Krunz,M.,Vrudhula,S.:'Jointoptimizationoftransmitpower-timeandbitenergyefficiency inCDMAwireless sensornetworks', IEEETrans.Wirel.Commun.,2006,5,(11),pp.3109–3118

9 Liu,Y.,Xiong,N.,Zhao,Y.,Vasilakos,A.V.:'Multi-layer clustering routing algorithm forwireless vehicular sensor networks', IET Commun.,2010,4,(7),pp.810–816

10 Lin, K., Wang,L., Li, K.: 'Multi-Attributedatafusionforenergy equilibriumroutinginwirelesssensornetworks',KSIITrans.Internet Inf.Syst.,2010,4,(1),pp.5–24

11 Kim,D.S.,Chung,Y.J.:'Self-organizationroutingprotocolsupporting mobile nodesfor wirelesssensor network'.Proc. First Int. Multi-Symp.onComputerandComputational Sciences, Hangzhou,China, June2006,pp.622–626

12 Santhosh,G.K., Vinu, P.M., Poulose,K.J.: 'Mobilitymetricbased LEACH-mobile protocol'. Proc. 16th Int. Conf. onAdvanced ComputingandCommunications,San Francisco, American,December 2008,pp.248–253

13 Lan,T.N.,Xavier,D.,Razvan,B.,etal.:'Anenergyefficient routing schemeformobilewirelesssensornetworks'.Proc.IEEEInt.Symp. on WirelessCommunication Systems, Reykjavik, Iceland, October 2008,pp.568–572

14 Samer,A.B.,CheeK,N.K.,Mohd,F.R.,etal.:'Cluster basedrouting protocolformobilenodesinwireless sensornetwork'.Proc.ThirdInt. Conf. onQuality of Service in Heterogeneous Wired/Wireless Networks,Waterloo,Ontario,Canada,August2006,pp.233–241

15 Wang, J.Z.,Milstein,L.B.: 'CDMAoverlaysituationsformicrocellular mobile communications', IEEE Trans. Commun., 1995, 43, (2), pp.603–614

16 Van, G.J., Rabacy, J.: 'Lightweighttimesynchronizationfor sensor networks'.Proc.SecondACMInt.Conf.onWirelessSensorNetworks andApplications,SanDiego,Canada,September2003,pp.11–19

17 Zhang,X.B.,Wang,H.P.,Kokhar,A.:'Anenergy-efficientdatacollection protocolformobilesensornetworks'. Proc.IEEE64thVehicular TechnologyConf., Montreal,Canada,September2006, pp.1–5

18 Lazos,L.,Radha,P.,Capkun,S.:'ROPE: robust positionestimationin wirelesssensornetworks'.Proc. FourthInt. Symp.on Information ProcessinginSensorNetworks,LosAngeles,California, American, April2005,pp.324–331

19 Cerpa,A.,Estrin,D.:'ASCENT:adaptiveself-configuringsensornetworks topologies'.Proc.11thJointConf.onIEEEComputerandCommunications Societies,NewYork, American,June 2002,pp.1278–1287

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