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Performance Comparison in Terms of Communication Overhead for Wireless Sensor Network Based on Clustering Technique

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***Abstract* – Wireless sensor network refers to a group of spatially distributed and dedicated sensors for monitoring and recording the physical conditions of environment like temperature, sound, pollution levels, humidity, wind speed with direction and pressure. Sensors are self powered nodes which also possess limited processing capabilities and the nodes communicate wirelessly through a gateway. The capability of sensing, processing and communication found in sensor networks lead to a vast number of applications of wireless sensor networks in areas such as environmental monitoring, warfare, education, agriculture to name a few. In the present work, the comparative evaluation of communication overhead for the wireless sensor network based of on clustering technique is carried out. It has been be observed that overhead in cluster based protocol is not much dependent upon update time. Simulation a result indicates that cluster based protocol has low communication overheads compared with the BBM based protocol when sink mobility is high.**

***Keywords* – BBM, Clustering, Cluster Head, Communication Overheads, Wireless Sensor Network.**

I. Introduction

A wireless sensor network (WSN) in its simplest form can be defined as a network of (possibly low-size and less complex) devices which are denoted as nodes that can sense the environment and communicate the information gathered from the monitored field through wireless channel or link. The data is forwarded, possibly via multiple hops relaying, to a sink that can use it locally, or connected to other networks (e.g., the Internet). The idea of development of wireless sensor networks was initially motivated by military applications. A WSN provides a reliable, low maintenance, low power method for making measurements in applications where cabled sensors are impractical or otherwise undesirable. So a WSN is a large network of resource-constrained sensor nodes with multiple preset functions, such as sensing and processing, to fulfill different application objectives [1–2]. The wireless sensor networks are interesting network to study due to the fact that large number of applications are being developed using these networks. A wireless sensor network of the type investigated here refers to a collection of sensors, or nodes that are linked by a medium which is wireless in nature. Connections between nodes may be formed using such media as infrared devices or radios. Wireless sensor networks will be used for such tasks as surveillance, widespread environmental sampling, security and health monitoring. They can be used in almost any environment, even those where wired connections are not possible, where the terrain is inhospitable, or where physical placement is difficult.

Wireless sensor networks are quite challenging networks as resources are limited and different network topologies is possible.

The proper optimization of communication overheads in WSN is an important issue which requires significant amount of effort on the part of designer. Large efforts are being made to optimize or minimize the communications overheads. Wireless sensor networks are dynamic in nature so resource optimization is very important. Establishing a secure communication link in a wireless sensor network is a challenging task due to little resource.

II. Overheads in Wireless Sensor Networks

In wireless sensor networks (WSN) data produced by one or more sources usually has to be routed through several intermediate nodes to reach the destination. Problems arise when intermediate nodes fail to forward the incoming messages. The reliability of the system can be increased by providing several paths from source to destination and sending the same packet through each of them. Using this technique, the traffic increases significantly primary path and therefore expend significantly more energy than that on the primary path.

The different network protocols like multi-path based routing, negotiation based routing, query based routing, quality of service based routing etc decides the overheads in wireless sensor network. In [3] authors have carried out a comparative evaluation of communication overhead due to sink mobility with speed variations, the effect of update time variation, the effect of number of nodes used in the wireless sensor networks. It has been demonstrated by authors that the communication overheads increase significantly when sink mobility is high. The communication overheads can be reduced by increasing update time.

In the past few years, intensive research that addresses the potential of collaboration among sensors in data gathering and processing, and coordination and management of the sensing activity was conducted. In most applications, sensor nodes are constrained in energy supply and communication bandwidth. Thus, innovative techniques to eliminate energy inefficiencies that shorten the lifetime of the network and efficient many routing, power management, and data dissemination protocols have been specifically designed for WSNs, where energy awareness is an essential design issue. Routing protocols in WSNs might differ depending on the application and network architecture.

III. Clustering in Wireless Sensor Network

Due to the large-scale deployment of wireless sensor networks and the need for data aggregation necessitate efficient organization of the network topology for the purpose of balancing the load and prolonging the network lifetime. Clustering has proven to be an effective approach for organizing the network into a connected hierarchy.
Sensors in many applications are expected to be remotely deployed in large numbers and to operate autonomously in unattended environments. To support scalability, sensors are often grouped into disjoint and mostly non-overlapping clusters.

The nodes can be divided into a number of small groups called clusters or access points to support data aggregation. Each cluster has a coordinator, referred to as a access head, and a number of member nodes.

Clustering results in a two-tier hierarchy in which access heads form the higher tier while member nodes form the lower tier. Several WSN applications require only an aggregate value to be reported to the observer. In this case sensors in different regions of the field can collaborate to aggregate their data and provide more accurate reports about their local regions. Data aggregation reduces the communication overhead in the network leading to significant energy savings. Most clustering algorithms utilize two techniques which are selecting cluster-heads with more residual energy and rotating cluster-heads periodically to balance the energy consumption of the sensor nodes over the network. These clustering algorithms do not take the location of the base station into consideration. This lack of consideration causes hot spot problems in multi-hop WSNs [6]. The cluster-heads near the base station die earlier, because they will be in heavier relay traffic than the cluster-heads which are relatively far from the base station.. In order to solve this problem and to balance energy consumption of cluster-heads, a periodically rotating cluster-head mechanism was proposed by Yu and Chang [5], namely low-energy adaptive clustering hierarchy (LEACH), which is a clustering algorithm that utilizes randomized rotation to balance energy consumption of cluster-heads over the network.

Clustering has been shown to improve network lifetime, a primary metric for evaluating the performance of a sensor network. Although there is no unified definition of “network lifetime,” as this concept depends on the objective of an application, common definitions include the time until the first/last node in the network depletes its energy and the time until a node is disconnected from the base station. In studies where clustering techniques were primarily proposed for energy efficiency purposes (e.g., [4, 5]), the network lifetime was significantly prolonged.

Clustering has been extensively studied in the data processing and wired network literatures. The clustering approaches developed in these areas cannot be applied directly to WSNs due to the unique deployment and operational characteristics of these networks. Specifically, WSNs are deployed in an ad hoc manner and have a large number of nodes. The nodes are typically unaware of their locations. Hence, distributed clustering protocols that rely only on neighborhood information are preferred for WSNs (however, most studies in this area still assume that the network topology is known to a centralized controller).

Grouping sensor nodes into clusters has been widely pursued by the research community in order to achieve the network scalability objective. Every cluster would have a leader, often referred to as the access point or cluster-head. Although many clustering algorithms have been proposed in the literature for ad-hoc networks [7-10], the objective was mainly to generate stable clusters in environments with mobile nodes. Many of such techniques care mostly about node reachability and route stability, without much concern about critical design goals of WSNs such as network longevity and coverage.

Recently, a number of clustering algorithms have been specifically designed for WSNs [11–15]. These proposed clustering techniques widely vary depending on the node deployment and bootstrapping schemes, the pursued network architecture, the characteristics of the cluster head (CH) nodes and the network operation model. A CH may be elected by the sensors in a cluster or pre-assigned by the network designer. A CH may also be just one of the sensors or a node that is richer in resources. The cluster membership may be fixed or variable. CHs may form a second tier network or may just ship the data to interested parties, e.g. a base-station or a command center. In the present work, the communication overheads in WSN are compared with cluster based and Broadcast Based Method (BBM) based protocol. Simulation was also carried out to compare communication overhead in cluster based and BBM based protocol with different sink velocity.

IV. Simulation Results

Figure 1 shows the physical layout of nodes spread over a 1000 metre square area with 5 access points. Figure 2 shows the topology of access points in hexagonal distribution. Simulation was carried out in MATLAB software package [16].

Simulation parameters for velocity vs. communication overhead are taken as follows.

- No. of nodes: 100
- Sink : single
- Update time : 10 sec
- Velocity : 10 m/s to 100m/s

Simulation parameter for update time vs. communication overhead are taken as follows.

- No. of nodes: 100
- Sink : single

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- Update time : 5 to 40 sec
- Velocity of node 10 m/s

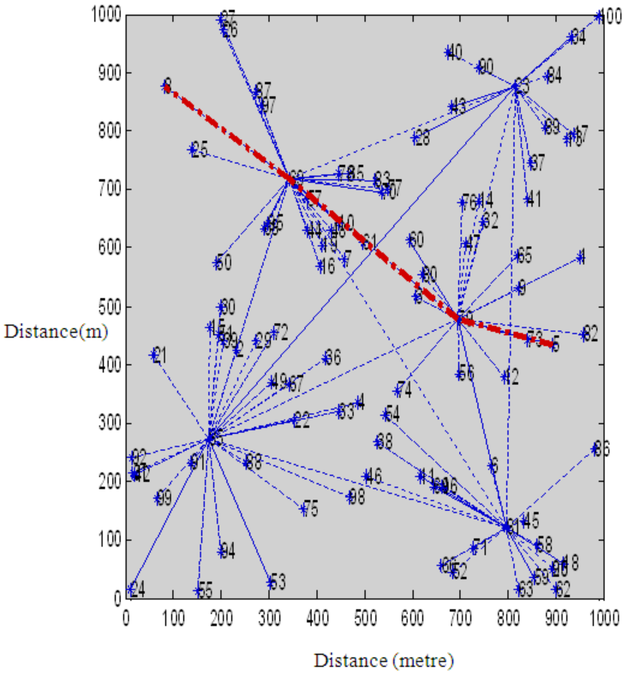

Fig.1. Cluster based approach for 5 access points

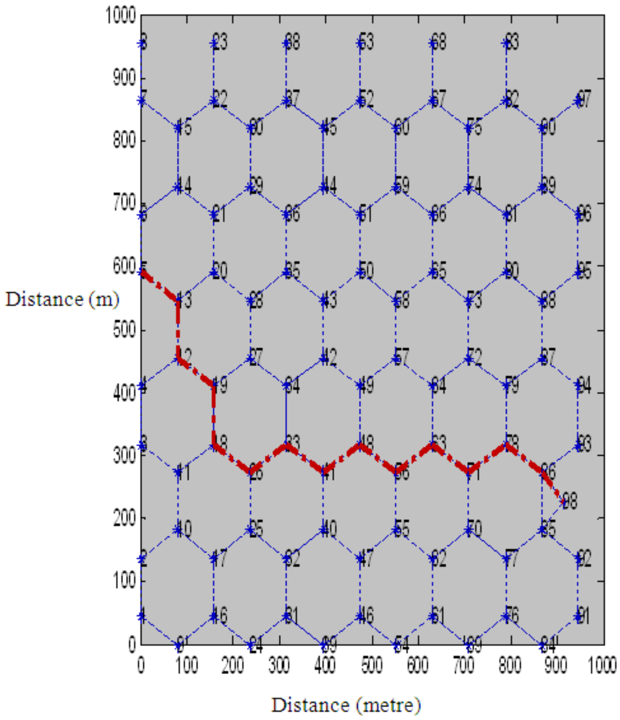

Fig.2. BBM hexagonal distribution of access points

As can be seen from figure 3 the communication overhead in cluster based protocol is much less than the BBM based protocol as the velocity of nodes increases. In BBM protocol overhead increases almost linearly with nodes velocity. It can also be observed from figure 4 that overhead in cluster based protocol is not much dependent upon update time. These simulation results indicates that cluster based protocol outperforms the BBM based protocol.

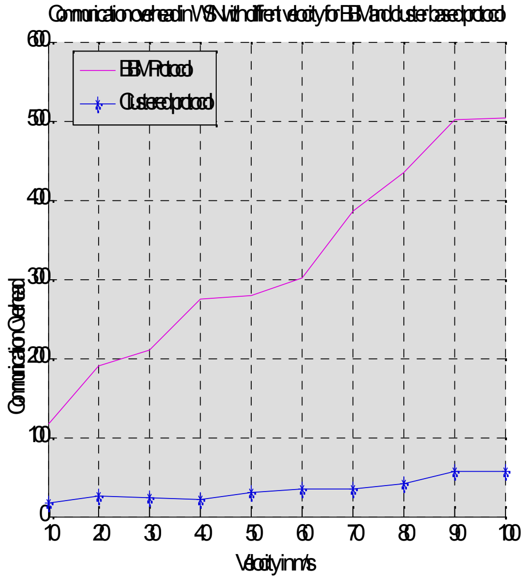

Fig.3. Communication overhead in WSN with different velocity for BBM and cluster based protocol

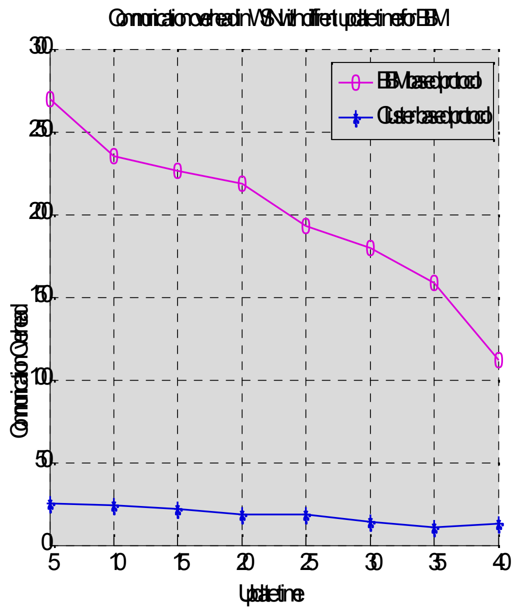

Fig.4. Communication overhead in WSN with different update for BBM

V. Conclusion

Significant attention has been drawn by wireless sensor networks (WSNs) over the past few years. There is large growing list of civil and military applications of WSNs especially in hostile and remote areas. Examples include disaster management, border protection, combat field surveillance. In these applications a large number of sensors are expected, requiring careful architecture and management of the network. Grouping nodes into clusters has been the most popular approach for support scalability in WSNs. Significant attention has been paid to clustering strategies and algorithms yielding a large number of publications. In this paper, we demonstrated that cluster based protocol leads to less communication overheads.

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REFERENCES

[1] F. Akyildiz et al., "A Survey on Sensor Networks," IEEE Commun Mag., vol. 40, no. 8, Aug. 2002, pp. 102–14.
[2] J. M. Kahn, R. H. Katz, and K. S. J. Pister, "Next Century Challenges:Mobile Networking for Smart Dust," Proc. ACM Int'l. Conf. Mobile Computing and Networking MobiCom'99), Aug. 1999, pp. 217–78.
[3] Shiv Prasad Kori and Dr R K baghel "Evaluation of Communication Overheads in Wireless Sensor Networks"International Journal of Engineering Research (ISSN : 2319-6890) Volume No.2, Issue No.2, pp : 167-171 01 April 2013.
[4] O.Younis, M. Krunz and S. Ramasubramanian. "Node clustering in wireless sensor networks: Recent developments and deployment challenges. IEEE Network 20(3) (2006), 20–25.
[5] J. Yu and P. Chong, "A survey of clustering schemes for mobile ad hoc networks," IEEE Communications Surveys & Tutorials, vol. 7, pp. 32-48, 2005.
[6] S. H. P. Y. J. H. J.M. Kim and T. M. Chung, "CHEF: cluster head election mechanism using fuzzy logic in wireless sensor networks," in ICACT, 2008, pp. 654-659.
[7] V. Kawadia, P.R. Kumar, Power control and clustering in Ad Hoc networks, in: Proceedings of IEEE INFOCOM, San Francisco, CA, March 2003H. Poor, An Introduction to Signal Detection and Estimation. New York: Springer-Verlag, 1985, ch. 4.
[8] M. Chatterjee, S.K. Das, D. Turgut, WCA: a Weighted Clustering Algorithm for mobile Ad Hoc networks, Cluster Computing 5 (2) (2002) 193–204.
[9] A.D. Amis, R. Prakash, T.H.P. Vuong, D.T. Huynh, Max-Min Dcluster formation in wireless Ad Hoc networks, in: Proceedings of IEEE INFOCOM, March 2000.
[10] A.B. McDonald, T. Znati, A mobility based framework for adaptive clustering in wireless ad-hoc networks, IEEE Journal on Selected Areas in Communications 17 (8) (1999) 1466–1487.
[11] G. Gupta, M. Younis, Load-balanced clustering in wireless sensor networks, in: Proceedings of the International Conference on Communication (ICC 2003), Anchorage, Alaska, May 2003.
[12] S. Bandyopadhyay, E. Coyle, An energy efficient hierarchical clustering algorithm for wireless sensor networks, in: Proceedings of the 22nd Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM 2003), San Francisco, California, April 2003.
[13] S. Ghiasi, A. Srivastava, X. Yang, M. Sarrafzadeh, Optimal energy aware clustering in sensor networks, Sensors Magazine MDPI 1 (1) (2004) 258–269.
[14] O. Younis, S. Fahmy, HEED: A Hybrid, Energy-Efficient, Distributed clustering approach for Ad Hoc sensor networks, IEEE Transactions on Mobile Computing 3 (4) (2004) 366–379.
[15] W.B. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, Application specific protocol architecture for wireless microsensor networks, IEEE Transactions on Wireless Networking (2002).
[16] Mathworks(http://www.mathworks.com)

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