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Routing Protocols for Wireless Sensor Networks: A Review

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Abstract: Wireless Sensor Networks (WSNs) have been widely used in a variety of applications in wireless communication technologies. The performance of WSNs is generally based on the routing protocols. Many new protocols have been designed for considering energy consumption, packet delivery ratio and network life time. The quality of service (QoS) performance is also evaluated by routing protocols used in WSNs. The flat routing, hierarchical/cluster based routing and location based routing are the three types of routing used in WSNs. In this paper the authors survey the recent routing protocols used in sensor networks. The classification, merits and limitations of different protocols have been discussed.

Index Terms: Wireless sensor networks, Classification of Routing protocols, Energy Efficiency.

I. INTRODUCTION

A WSN is consists of wireless nodes with limited transmission range developed for dynamically changing environment. The efficient delivery of packets to destination is most important task in sensor networks. The routing strategy is the main issue for delivery the packets of information with minimum energy consumption. The routing selection for sensors is considered for characteristics of nodes with application and their required architecture. The deployment of large number of sensor nodes is results in many challenges in design and management of wireless sensor network.

In the middle of 70s, the first wireless sensor networks was designed by the military and defense industries. The first development of WSNs carried out many challenges such as large size of the sensors, limited network range and consumption of energy. The researchers had made a lot of work to eliminate the above challenges and developed the WSNs on different applications requirements with change of characteristics of networks. For efficient data delivery, several routing protocols with energy-efficient were developed.

The technology advances in wireless communications and also in other areas of research such as micro-electrochemical systems, the significant use of WSNs devices has been observed. In military and defense sectors the WSNs are used for detecting enemy intrusion. The WSNs have also tremendous application in monitoring the concentration of dangerous gases present in environment. The precision agriculture is one of the most promising application domains where wireless sensor networks may deliver a feasible or even optimal solution.

This paper is organized as follows. In section 2 we give a brief summary of the related work of routing protocols for WSNs. In section 3, hierarchical routing protocols are summarized. Location based and network flow modeling is described in section 4 and 5 respectively. Finally, in section 6, we conclude the paper. The architecture of sensor node is shown in Figure 1.

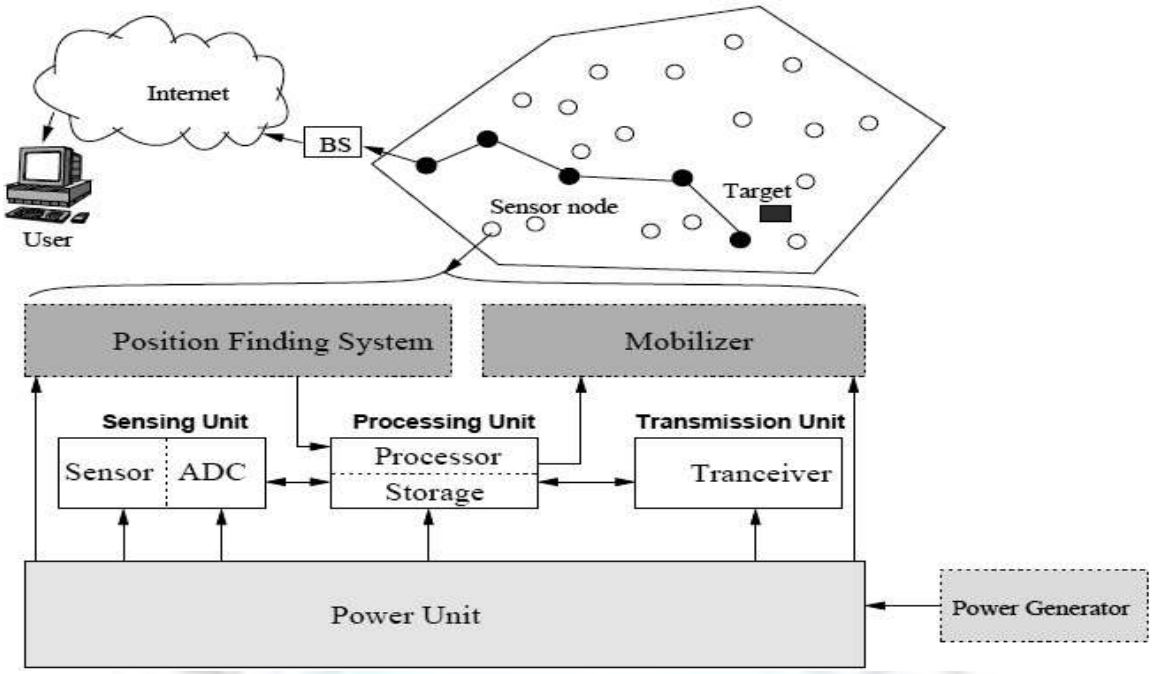

Figure 1: Schematic view of Sensor node architecture [1]

II. RELATED WORK

The large number of works is going on the development of different routing protocols used in WSNs. Many factors have been considered during development of routing protocols for wireless sensor networks. The are many factors that should be considered during the design development of energy-efficient routing protocols in WSNs .These factors are node deployment, node heterogeneity, data reporting model, energy consumption, scalability, network dynamics, fault tolerance, transmission media, coverage, QoS(quality of service) and data aggregation. Some discussion has been found out about the few routing protocols for sensor networks and classifies them into data-centric, hierarchical and location-based. The only routing protocols for WSNs were discussed but the energy efficient policies were not discussed [2]. Another study provides a systematical investigation of current state-of-the-art algorithms. Typically, the two main energy-aware metrics that are considered are: minimizing the total transmission power consumption of all nodes involved in the multicast session and maximizing the operation time until the battery depletion of the first node involved in the multicast session [3]. A top-down approach of several applications and reviews on various aspects of WSNs is discussed in the study [4]. The problem was classified into internal platform and underlying operating system, communication protocol stack, provisioning, network services and deployment.

A few routing protocols are presented based on their characteristics and the mechanisms they use in order to extend the network lifetime without providing details on each of the described routing protocols [5].Some challenges in the design of the energy-efficient Medium Access Control protocols for the WSNs are studied [6].The energy-efficient routing protocols developed on WSNs and a detailed comparison of the protocols were not discussed here. In [7], few energy-efficient routing techniques for Wireless Multimedia Sensor Networks (WMSNs) are presented. The classification of recent routing protocols for WMSNs is presented. This survey discusses some issues on energy efficiency in WSNs. The operation of routing protocols with safe energy consumption and also the impact factors in energy optimization was discussed [8]. The performance of SAERP (stable aware evolutionary routing protocol) was evaluated and compared with LEACH and SEP protocols [9].The waste heat from WSN devices can be reused to solve routing problems (identifying path and optimization) [10]. The cluster based routing protocol are useful in improvement of performance in WSNs [11]. The effect of location errors on location based routing protocols in WSNs was discussed [12]. The trade -off mechanisms must be rationally selected according to specific application needs in WSNs [13].

III. HIERARCHICAL PROTOCOL

Hierarchical Routing uses the nodes with higher energy levels for processing/sending data. Low Energy Adaptive Clustering Hierarchy (LEACH) protocol creates clusters and assigns special task to selected nodes. This allows Hierarchical Routing to evenly distribute available energy by reducing work load on weaker nodes; making the network more energy efficient. The job of the cluster heads is to collect all the data from other nodes in their cluster. Hierarchical Routing is able to reduce the size of routing tables with providing scalability [14]. The routing protocol is use to make the nodes which hold more energy to be the clusters header, then to divide the nodes into several clusters, and to transmit the clustering information from the head node to the sink node. The multiplex routing is only among the head nodes and it saves the energy of the whole networks LEACH routing protocol prescribes the dynamic some nodes for long time to be the cluster header exhausting the energy consumption of the whole networks is balanced [15]. The number of cluster members required by a cluster head is limited because a large number of cluster members can create overhead or high traffic loads at the sink. In surveillance application we cannot restricted to a specific number of nodes that have to sense an area like a war field .A continuous data-delivery model is opted for by LEACH to transfer a maximum amount of data to the sink. If we use LEACH in a habitat-monitoring application like retina scanning, there is a possibility that the performance is much better as the network density is small and requires only one time-node deployment. These lead it to pose low latency and high scalability with larger network life time. The one factor which is ignored in LEACH is the quality of service.

IV. LOCATION BASED PROTOCOL

Location Based Routing also known as geographic routing, directional geometric, or position based routing. Many nodes are able to identify their location using GPS technology. By receiving signals from other nodes they are able to identify their relative location from the sending node. The energy is saved by turning off unnecessary nodes in the network without affecting the coverage of the network. Rotating nodes, one at a time, stay awake to monitor the network while the others remain in sleep mode. Nodes are awakened when there is movement within their designated or relative location. The routing protocols make minimum use of the topology information and there is no necessity needed to keep routing tables up-to-date In this protocol each nodes know their geo coordinates and propagate geo info by flooding [16]. GAF (Geographic adaptive fidelity) routing protocol assumes that every node can get the self-location by GPS, and the covered area is divided into virtual grids. It's considered equation to transmit data if the nodes are in the same grid [17]. The analytical analysis demonstrates that the overhead issue in GAF is very low, while there are certain drawbacks like packet loss and route latency. The Table 1 shows the comparison between some clusters based routing protocol on the issues of energy efficiency, delivery delay, load balancing and scalability.

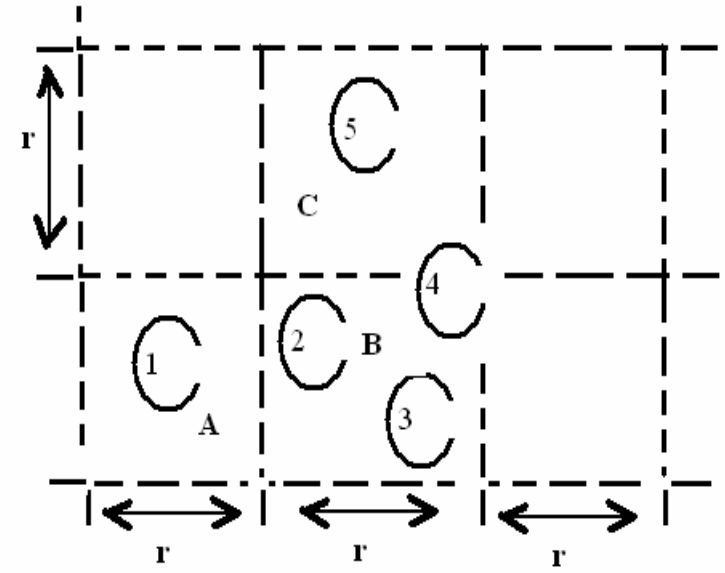

Figure 2: Virtual Grids in Geographic Adaptive Fidelity [20]

Table 1: Comparison between some clusters based routing protocols

Routing Protocol	Energy Efficiency	Delivery Delay	Load Balancing	Scalability
LEACH	Very low	Very Small	Medium	Very low
HEED	Medium	Medium	Medium	Medium
PANEL	Medium	Medium	Good	Low
TEEN	Very High	Small	Good	Low
GAF	Medium	Very Small	Medium	High
SLGC	Medium	Very Small	Medium	Very Low
TSC	Medium	Medium	Bad	Medium

The three states (discovery, active and sleeping) of state transition of GAF is shown in Figure 3.

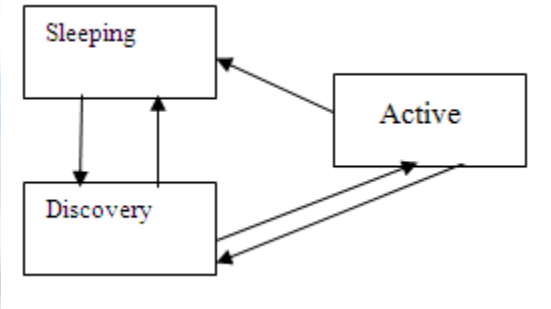

Figure 3: State transition diagram of GAF

V. NETWORK FLOW AND Q_oS PROTOCOL

In this protocol the route set-up is modeled and also solved as a network flow problem. The quality of service (QoS) aware protocol end to end delay requirements during of setting the path in the network [18]. The class –based queuing model is used for supporting the best effort and also for real-time traffic. The DEED protocol is a completely distributed, high energy-efficient data communication protocol [19], and its feature is that the nodes are organized by clustering. The area covered by clustering is limited in a range, and the nodes make the decision independently to be the head or to be a member in a cluster. The cluster headers organized a routing tree according to the weight. In the tree, the root node collects other cluster headers' data and transmits to the sink node. the area covered by the cluster is limited with the radius r, that is to say the nodes can be member of one cluster only when they can be communicated with the cluster header in the distance less than r. The factor 'r' is called the radius of the cluster. In DEED protocol, the communication between member and header or between header and header is free-space based low-power attenuation. The DEED protocol consumes less energy as compared to LEACH protocol, since the cluster is limited in the area whose radius is 'r', and the nodes in the cluster work on free-space transmission mode.

Table 2: Classification of some routing protocols in sensor networks

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Routing Protocol	Hierarchical	Location Based	QoS	Data Aggregation
LEACH	Yes			Yes
TEEN/APTEEN	Yes			Yes
MECN/SMECN		Yes		
GAF	Yes	Yes		
GEAR		Yes		
SAR			Yes	
SPEED		Yes	Yes	

CONCLUSION

In recent years, we have seen a great improvement in the field of wireless sensor networks. In different applications, we may choose suitable routing protocols, but the energy control is still the most important problem in wireless sensor networks. In this paper we have described a number of routing protocols- Hierarchical, network based and Geographic position assisted routing protocols and compared the various routing protocol in WSNs. For a large network can be either hierarchical or geographic routing protocols are suitable. We focus mainly on the energy-efficient routing protocols discussing strengths and weaknesses of each protocol in such a way as to provide information to choose the most appropriate energy-efficient routing protocol for a specific network.

REFERENCES

[1]. Al-Karaki, J.N.,A.E. Kamal, " Routing Techniques in wireless sensor networks: a survey," IEEE Wireless Communications,2004,Vol.11,pp. 6-28.
[2]. K. Akkaya, M. Younis, "A Survey on Routing Protocols for Wireless Sensor Networks," Ad Hoc Network, Elsevier, 2005, Vol. 3, Issue 3, pp. 325-349.
[3]. S. Guo, O. Yang, "Energy-Aware Multicasting in Wireless Ad hoc Networks: A Survey and Discussion," Computer Communications, Elsevier, 2007, Vol. 30, Issue 9, pp. 21292148.
[4]. J. Yick, B. Mukherjee, D. Ghosal, "Wireless Sensor Network Survey," Computer Networks, 2008, Vol. 52, Issue 12, pp. 2292-2330.
[5]. R .V. Biradar, V. C.Patil, S. R. Sawant, R. R. Mudholkar, "Classification and Comparison of Routing Protocols in Wireless Sensor Networks," Special Issue on Ubiquitous Computing Security Systems, 2009, Vol. 4, Issue 2, pp. 704-711.
[6]. R. Yadav, S. Varma, N. Malaviya, "A Survey of MAC Protocols for Wireless Sensor Networks," UbiCC Journal, 2009, Vol. 4, Issue 3, pp. 827-833.
[7]. S. Ehsan, B. Hamdaoui, "A Survey on Energy-Efficient Routing Techniques with QoS Assurances for Wireless Multimedia Sensor Networks," IEEE Commun. Surveys Tuts. 2011, Vol. 14, Issue 2, pp. 265-278.
[8]. Ali Norouzi, Abdul Halim Zaim, " An Integrative Comparison of Energy Routing Protocols in Wireless Sensor Network" Wireless Sensor Network, Journal, 2012, Vol. 4,pp. 65-75.
[9]. Enan A. Khalil, Bara'a A. " Stable-Aware Evolutionary Routing Protocol for Wireless Sensor Networks" Wireless Pers Commun, 2013, Vol. 69,pp.1799-1817.
[10]. Vijey Thayananthan, Ahmed Alzranhi."Enhancement of energy conservation technologies in wireless sensor network" Procedia Computer Science, 2014, Vol.34.pp79-86.
[11]. S. Pal Singh, S.C. Sharma ."A Survey in Cluster Based Routing Protocols in Wireless Sensor Networks" Procedia Computer Science, 2015, Vol.45.pp687-695.
[12]. M. Kadi, Iyad Alkhayat, "The effect of location errors based routing protocols in wireless sensor networks", Egyptian Informatics Journal, 2015,Vol.16,pp 113-119.
[13]. Teng Gao, Jin-Yan Song, Jin-Hua Ding, De-Quan Wang, Ren-Cheng Jin, " An overview of performance trade-off mechanisms in routing protocol for green wireless sensor networks", Wireless Netw. Journal, 2015, DOI 10.1007/s11276-015-0960-x.
[14]. A. Kanavalli, D. Sserubiri, P. D. Shenoy, K. R. Venugopal and L. M. Patnaik, "A Flat Routing Protocol for Sensor Networks," Proceeding of International Conference on Methods and Models in Computer Science,2009, pp. 1-5.

[15]. Kiran K. Rachuri, C. Siva Ram Murthy, "Energy efficient and low latency biased walk techniques for search in wireless Sensor Networks" The Journal of Parallel and Distributed Computing, 2011,Vol.71,pp 512-522.
[16]. Sridharan, A. & Krishnamachari, "Maximizing network utilization with max-min fairness in wireless sensor networks" Wireless Networks 2008, Vol.15, pp. 585–600.
[17]. M. Babazadeh, I. Lal, W. Lang, "Energy Saving by using Floating Input Approach in a Wireless Sensor Network". IEEE, 2009,pp. 595-599.
[18]. Chao Wang (IEEE Member), Halling Wang, XiangyuJia "The Studies on Energy Control of Protocols in Wireless Sensor Networks" 2006, IEEE conference on signal processing.
[19]. K. Akkaya, M. Younis, "Energy and QoS Routing for Wireless Sensor Networks," Cluster Computing, 2005, Vol. 8, Issue 2, pp. 179-188.
[20]. YaXu, John Heidemann, Deborah Estrin "Geography informed Energy Conservation for Ad Hoc Routing" Proceedings of the Seventh Annual ACM/IEEE International Conference on Mobile Computing and Networking (ACM Mobicom), 2001.