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A Short Survey on Multi-Criterion optimization of Data forwarding Technique in Wireless Sensor Networks

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***Abstract*: The applications of Wireless Sensor Networks (WSNs) comprise a wide variety of scenarios. One of the limitations of WSN is their inherent limited energy resource and is the main design criterion for routing data in WSN. The network is composed of a significant number of nodes deployed in an extensive area in which not all nodes are directly connected, here the source nodes or intermediate nodes select a next node to forward the data to the destination based on different criteria, the data exchange is supported by multi hop communications. Routing protocols are in charge of discovering and maintaining the routes in the network. However, the appropriateness of a particular routing protocol mainly depends on the capabilities of the nodes and on the application requirements. So here we study various data forwarding techniques and we analyze the energy-efficiency and the useful lifetime of the system. This paper presents a review of the main routing protocols proposed for wireless sensor networks.**

***Keywords:* Wireless sensor network, distance based, energy based and multiple criterions based, energy efficiency**.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) have gained world-wide attentions in recent years. And are large collections of small sensor devices with limited processing and computing, sensor gathers information from the environment and based on some local decision process, they can transmit its data to Base Station (BS), and finally BS sends these data to end user as shown in the fig1.

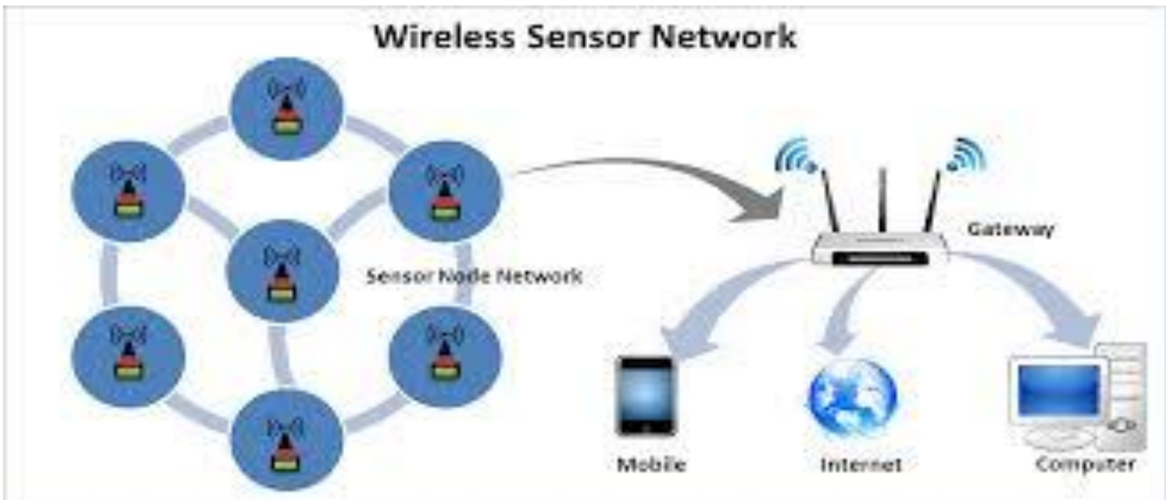

Fig.1. Wireless Sensor Network architecture.

Characteristics of wireless sensor network:

Wireless sensor network has several features such as mobility, switching characteristics and the limit capability of the battery power. Comparing to these wireless networks, WSN also has some distinctive properties. The characteristics of WSN are as follows [1]:

Computing capabilities: Due to the limit of cost, size and battery power consumption, program space and memory space of the sensor is very limited.

- ***Battery energy:*** Sensor node often become invalid and abandoned because the power is exhaust. The life of sensor node depends upon the battery energy. The energy consumption of the nodes transmit data information is more than the energy of the nodes.
- ***Communication capabilities:*** Senor Network includes communication bandwidth is narrow and changeable, and its radio frequency distance is only tens to several hundred meters. However the senor is easily influenced by the impact of natural environment such as mountains, buildings and storms, rains and lighting, the terrain obstacles and the weather.
- ***Dynamic:*** The sensor node exits from the networks because of the battery exhaustion and other failures. It is also possible that some new sensor nodes can be moved into network according to the task. These will bring about changes in the topology of network, so the WSN topology must have the function of the reconfiguration, and self-adjustment. It imposes difficulties in the research area.
- ***No centre, self-organization:*** The deployment of wireless sensor nodes does not need pre-installation of any network infrastructure.
- ***Multi-hop communications:*** Sensor node can communicate with direct neighbors in the WSN [2]. If one node require to communicate with other nodes, which are beyond the coverage of the node's radio frequency than it can be done via multi hop route transition data through the intermediate nodes. The traditional wired network multi-hop route is used in the gateways. WSN has centralized multi-hop communication, data gathering and many-to-one traffic pattern. WSNs are different from traditional networks and are highly dependent on applications, its ultimate work is acquiring the environment data.

In applications like monitoring large geographical areas, Battle fields etc the data delivery to base station should be fast. But these applications uses large scale WSNs thus data may need to follow a long multi-hop communication path and each intermediate node has to receive and transmit the packets. The residual energy of the intermediate nodes reduces due to such communication activities. So it is necessary to design network in such a way that the number of hops for routing the data from source to destination remains as minimum as possible.

In this paper we focus on survey of data forwarding techniques for a partitioned network for fast and efficient delivery of data. The survey discusses routing techniques for data forwarding and compares theirs effectiveness.

The remaining part of the paper is arranged as follows, section II provides the related work done on data forwarding and their advantage & disadvantage, section III proposed Work, section IV conclusion.

II. RELATED WORK

Data forwarding plays an important role in wireless sensor Network, using minimum hops for sending data and extending the life time of the network is an important issue in WSN, there are different ways to achieve this. The following paper provide survey on different data forwarding techniques.

In depth research has been carried out on data forwarding techniques. In [3] Multiple Sink Dynamic Destinations Geographic Routing (MSDDGR) algorithm is used for data forwarding. In this routing, each node knows the location of its direct neighbors (neighbors within its radio range). The source inserts the destination location inside the packet. During packet forwarding, each node uses the location information of its neighbors and the location of the destination to forward the packet to the next-hop. Forwarding could be to a single node or to multiple nodes. Forwarding to multiple nodes is more robust and leads to multiple paths to the destination, but it could waste a lot of resources (energy and bandwidth) and thus forwarding to a single node is more efficient.

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A main component in this is greedy forwarding algorithm, in which the packet should make a progress at each step along the path. Each node forwards the packet to a neighbor closer to the destination than itself until ultimately the packet reaches the destination, fig2 shows Greedy forwarding technique. If nodes have consistent location information, greedy forwarding is guaranteed to be loop-free.

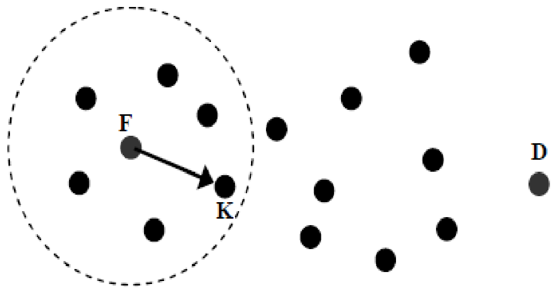

Fig.2. Greedy forwarding: Node F forward the packet to neighbor K, which is the neighbor closest to the destination D

Greedy forwarding is very efficient in dense uniform networks, where it is possible to make progress at each step. Greedy forwarding, however, fails in the presence of voids or dead-ends, when reaching a local maximum, a node that has no neighbors closer to the destination (Figure 3). In this case, it will fail to find a path to the destination, even though paths to the destination through farther nodes may exist.

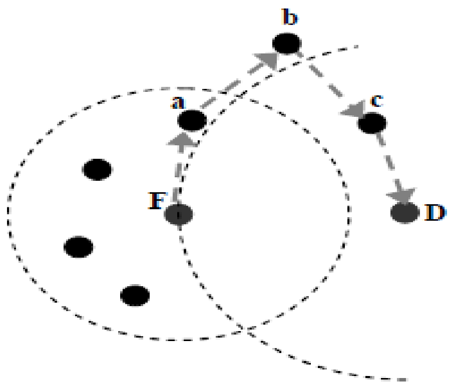

Fig.3. Greedy forwarding fails at node F, since there are no neighbors closer to the destination D, although a path through a farther neighbors F-a-b-c-D

In [4] one possible solution is to deploy multiple sink nodes simultaneously. In this paper, we propose a protocol called MRMS (Multipath Routing in large scale sensor networks with Multiple Sink nodes) which incorporates multiple sink nodes, a new path cost metric for improving path selection, dynamic cluster maintenance and path switching to improve energy efficiency. MRMS is shown to increase the lifetime of sensor nodes

We assume there are multiple sink nodes in the wireless sensor networks. There are three phases in MRMS: topology discovery, cluster maintenance and path switching. MRMS topology discovery is done with a number of significant differences. Firstly, MRMS must save the paths from different sinks, so that when the primary path is not reachable or if the residual energy of the sensors along the path fall below a certain threshold, another path will be selected. Secondly, during the cluster construction, it can construct an optimal or sub-optimal path to any sink node which is based on the path cost metric. Thirdly, the cluster is stateless and each cluster can be considered as a single node.

There are two major processes within cluster maintenance: energy monitoring and cluster reconstruction. The residual energy of the sensors is monitored and when it falls below some threshold, cluster reconstruction is initiated. In cluster reconstruction, if the Cluster Header's (CH) residual energy is below some threshold, it will select new children whose residual energy is the maximum in this cluster to take over. On the other hand, if the delivery node's residual energy is below the threshold, the CH will select a new delivery node whose path cost is the minimum

The main function of the third phase, path switching, is to switch path to another sink when the primary path to some sink is not usable any more. After a primary path has been in use for an extended period of time, the energy level of the sensors along this path will dissipate faster than other sensor nodes, and some nodes may run out of energy altogether leaving the path unusable. By switching paths, energy consumption is distributed more equitably.

We see that MRMS outperforms other protocols significantly, with MRMS close to doubling or tripling the time to first sensor node failure in some cases. MRMS by combining multiple sink nodes, cluster reconstruction and path switching, can best balance sensor energy consumption and prolong the duration for sensor network which is fully functional. But the main drawback of this algorithm is iteration can cause large overheads. The most important point is that, neglecting the significance of the overhead energy dissipation would result in a considerable amount of energy waste.

These Geographical Routing Protocols (GRP) algorithms [5] take advantage of the location information to make routing techniques more efficient. Specifically, neighbors exchange information about their location so when a node needs to forward a packet, it sends it to the neighbor which is assumed to be closest to the final destination. To operate, the source inserts the destination's coordinates in the packets. The location information used in geographical algorithms can be derived from specific devices such as GPS or it can be modeled by virtual coordinates [10]. Concerning geographical protocols, geocasting is the process by which a packet is delivered to the nodes placed in an area. This primitive is especially suitable in wireless sensor networks since the sink usually demands information from the nodes that are in a zone. The zone can be statically determined by the source node or it can be constructed dynamically by the relaying nodes in order to avoid some nodes that may cause a detour. On the other hand, in geographic-based rendezvous mechanisms, geographical locations are used as a rendezvous place for providers and seekers of information. Geographic-based rendezvous mechanisms can be used as an efficient means for service location and resource discovery, in addition to data dissemination and access in wireless sensor networks [10]. The most popular forwarding techniques in geographical routing protocols are:

In GAF (Geographic Adaptive Fidelity)

[6] author proposed this protocol aims at optimizing the performance of wireless sensor networks by identifying equivalent nodes with respect to forwarding packets. Two nodes are considered to be equivalent when they maintain the same set of neighbor nodes and so they can belong to the same communication routes. Source and destination in the application are excluded from this characterization. To identify equivalent nodes, their positions are necessary. Additionally, a virtual grid is constructed. This grid is formed by cells whose size allows to state that all the nodes in one cell can directly communicate with the nodes belonging to adjacent cells and vice versa. In this way, the nodes in a cell are equivalent. Nodes identify equivalent nodes by the periodic exchange of discovery messages with the nodes in their cells. With the information contained in these messages, the nodes negotiate which one is going to support the communications. The other nodes will stay powered off. With this procedure, the routing fidelity is kept, that is, there is uninterrupted connectivity between communicating nodes. However, the elected node periodically rotates for fair energy consumption. To do so, the nodes wake up periodically, this is the drawback of SAR.

In [7-9] these protocols, a source knows multiple routes to a destination. The routes can be simultaneously used or one of them can be active while the others are maintained for future needs.

SAR (Sequential Assignment Routing) [7] is one of the first protocols for wireless sensor networks that provide the notion of Quos routing criteria. It is based on the association of a priority level to each packet. Additionally, the links and the routes are related to a metric that characterizes their potential provision of quality of service. This metric is based on the delay and the energy cost. Then, the algorithm creates trees rooted at the one-hop neighbors of the sink. To do so, several parameters such as the packet priority, the energy resources and the QoS metrics are taken into account. The protocol must periodically recalculate the routes to be prepared in case of failure of one of the active nodes.

In [8] Maximum Lifetime Routing in Wireless Sensor Networks. This algorithm combines the energy consumption optimization with the use of multiple routes. In this algorithm an active route (also called the primary route) is monitored to control its residual energy. Meanwhile other routes can be discovered. If the residual energy of the active route does not exceed the energy of an alternative route, the corresponding secondary route is then used. Energy Aware Routing in Wireless Sensor Networks Once multiple paths are discovered, this algorithm associates a probability of use to each route.

This probability is related to the residual energy of the nodes that form the route but it is also considers the cost of transmitting through that route.

In [9] M-MPR (Mesh Multipath Routing) This protocol presents two operation modes . Firstly, in the disjoint MPR (D-MPR) with Selective Forwarding each packet is individually analyzed by the source and it is routed through different routes. Secondly, the D-MPR with data replication is based on the simultaneous emission of multiple copies of the same packet through different routes. Specifically, all the known routes that communicate the source and the destination propagate the packet. For the route discovery, information about the position of the nodes and about their residual energy is exchanged.

The above routing protocols, their main disadvantage lies on the cost of maintaining the paths. This cost comprises memory resources as well as network overhead. Therefore, they are not appropriate for networks critically constrained by their reduced batteries. However, they become necessary when reliability is a strong requirement in the application business.

III. PROPOSED WORK

A. Routing Mechanism

The following sections will introduces Multiple Criteria Decision Based Routing (MCDR) algorithm. Our proposed MCDR based routing algorithm considers the following two criteria:

a. Remaining energy of a node, and

b. Distance of the node from sink

We use the same scale to measure both the criteria, i.e. a 0to 100 scale. In this we consider equal weight value for each criterion, i.e. 50% for remaining energy and 50% for distance from sink. These two steps are explained below.

1) Measurement of all criteria on similar numerical scales:

a) Remaining Energy of a node: It is assumed that the worst value of remaining energy of a node is 0.0005 J (for one receives and one transmits according to the First order radio model and best or maximum remaining energy of a node is 0.5 J (here initial energy of a node).

b) Distance of the node from sink: When the Euclidean distances from sink to the nodes (alternatives) are measured, maximum value is considered to be the distance from a source node to the sink node within its partition. This maximum value is taken as the worst value. The best value is considered to be 0 (unit is m). Thus if a node is far from the sink, it will get less priority and if it is closer to the sink, it will get higher priority.

B. Algorithm

The routing algorithm is described in this section. This algorithm is run by each node (either the source or any intermediate node) on a path that has some data to disseminate. The first step is similar to the previous two algorithms. Selection of the next node is made using the two criteria and the values of the neighbor nodes received by the node which is running the algorithm. After receiving the values, the node calculates the utility value for each alternative (nodes in the eligible neighbor set) and chooses the best node among the alternatives which has the highest utility.

IV. PERFORMANCE ANALYSIS

Performance metrics as described in this section are used to evaluate the performances of the proposed routing algorithm. In this paper, performance metrics are used for evaluation:

- ***Energy consumption:*** Total expected energy consumption for transmitting a packet to sink from source node will be less.
- ***Number of dead nodes:*** Expected dead nodes in this algorithm will be less.

V. CONCLUSION

Algorithms for data forwarding in a wireless sensor network are proposed here. It has been demonstrated that the proposed algorithm show better over other described algorithms. Thus multiple criteria to choose the next node is the best choice in terms of increase in the life time of the network.
Future work will focus on including additional criteria, fine-tuning of the weight values etc. The route hole problem discussed in this paper will also be handled in future.

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REFERENCES

[1] Shuai Gao ; Hongke Zhang ; Tianfei Song ; Ying Wang "Network Lifetime and Throughput Maximization in WSN With a Path-constrained Mobile Sink" Communications and Mobile Computing (CMC), 2010 International Conference

[2] Bhupendra: Vidushi Sharma;"An Energy efficient communication overhead Algorithm in WSN ",2013 International Conference .

[3] L.Cao, C.Xu, W.Shao, "Multiple Sink Dynamic Destination Geographic Routing in WSN". 2010 International Conference

[4] Y. Chen, E. Chan, S. Han, "Energy Efficient Multipath Routing in Large Scale Sensor Networks with Multiple Sink Nodes", in: Procs. of APPT, 2005, 390-399.

[5] Q. Li, J. Beaver, A. Amer, P.K. Chrysanthis "Multi-Criteria Routing in Wireless Sensor-Based Pervasive Environments", Journal of Pervasive Computing and Communication, 1 (2005).

[6] Xu, Y.; Heidemann, J.; Estrin, D. Geography-informed "Energy Conservation for Ad Hoc Routing. International Conference on Mobile Computing and Networking (MOBICOM)" international conference 2009

[7] Al-Karakin, J.N,; Kamal,A.E "Routing Techniques in Wireless sensor Networks"; international conference. 2012.

[8] Chang, J.H.; Tassiulas, L "Energy Conserving Routing in Wireless Ad Hoc Networks". In Proceedings of the 19th Conference of the IEEE Communications Society (INFOCOM).

[9] De, S.; Qiao, C.; Wu, H. "Meshed Multipath Routing with Selective Forwarding: an Efficient Strategy in Wireless Sensor Networks". Comput. Netw.

[10] Rao, A.; Ratnasamy, S.; Papadimitriou, C.; Shenker, S.; Stoica, I "Geographic Routing without Location Information". In *Proceedings of the Ninth Annual International Conference on Mobile Computing and Networking (MOBICOM)*

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