Wireless Sensor Network: Random topology Vs. Regular Topology

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Abstract – Wireless Sensor Networks (WSNs) is group of sensor node with miniaturised energy source placed in remote location operate for certain amount of time without human interference. In such large network of WSNs the data generated by the sensor or command generated by the sink node must reach to the destination with accuracy. The data may not reach in single hope. It needs to take help from the multiple nodes present in the network, known as routing. The routing of information depends on various parameter of network like size of network, nature of network, topology of network etc… Topology of WSNs is most important parameter which affects the routing, coverage and network life time. WSNs normally assumed as random topology network, but if we see the current wide usage of WSNs regular topology is also a fruitful option.

Index Terms—Aggregation, Application Management, Deployment, Routing, Wireless sensor network

I. INTRODUCTION:

WSN is and will be dominant in wide area of application [1][2].In WSNs the topology decides the size of network, location of sensor nodes. The parameter like Network life time is directly depends on the topology of the network. . For example, energy consumption is directly proportional to the number of packets sent or received. The receiving cost depends on packet size, while the transmission energy depends on the distance between the nodes. The transmission path inherently relies on the topology of the networks. There are certain attribute which is expected from the reliable topology:

i) Neighbourhood Management: The Neighbour management in the WSNs is most important issue as it directly affects the routing and coverage area. . Normally the WSNs deployed with more number of sensor node. For example if two nodes are placed at a same place or near about place they covered almost same area and send the same data to the network. This results in duplication of coverage as well as duplication in data. It also deals with future modification in network like, how to incorporate new member or how to deal with dead node.

ii) Routing: The design of routing protocol greatly depends on the type and nature of topology. For example, if some node of the network goes in to sleep mode at random interval, at that time protocol needs to be adjust such a changes. If network contains mobile node or mobile sink node, then it also affects the routing protocol.

iii) Time synchronization: Time synchronization between the nodes of network plays a crucial role for data collection and aggregation. Time synchronization helps to take perfect decision about data collection or data transmission. It is also very important to reduce the waiting time of packet while transmission.

iv) Aggregation: Aggregation of data in WSNs is vital for network life time. The transmission energy directly depends on number of packet sends or receives. The data aggregation helps to aggregate a data for same destination and send it at time rather than sending it individual.

v) Application Management: The topology pattern and size greatly depends on application for which network is deployed. For example either we deployed the network forest cultivation information or marine life observation.

In general the topology plays a vital role in terms of Network life time, design of routing protocol, future modification of network and many more [3] - [5].

II. RANDOM TOPOLOGY VS REGULAR TOPOLOGY:

When we hear a name of WSNs the first word comes in mind is “Random Topology”. In this paper we discuss the above mention attributes with respect to Random topology and regular topology. In random topology the nodes are deployed in random manner in field while in regular topology approach nodes are deployed in predefine area.

i) **Neighborhood management in Random Topology vs Regular Topology:**

In random topology, the sensor nodes are deployed in unplanned manner. There isn't any predefine location planning for deployment. Sensors are dropped in random manner in field. Initial a sensor node is not aware about its neighbour so, to know the neighbour topology need to pass from the neighbour identification phase where by sending the beacon signal node identifies about its neighbour. Moreover it is possible that more than one node are deployed in nearby region which lead to the duplication of coverage area and duplication of data. That duplication of data further leads to more energy consumption in limited energy network results in dead node or blank area. As we don't know the where the sensor nodes fall when we drop it in random manner, it takes more number of node to cover a same area.

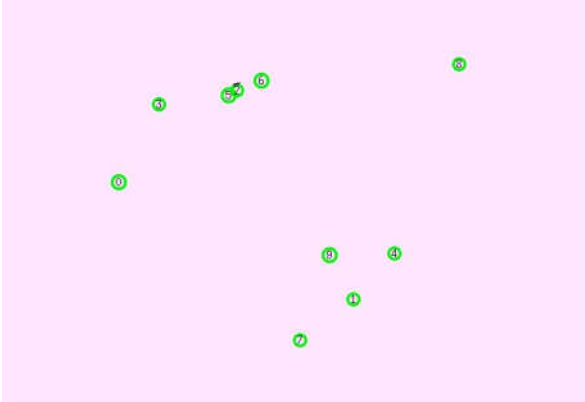
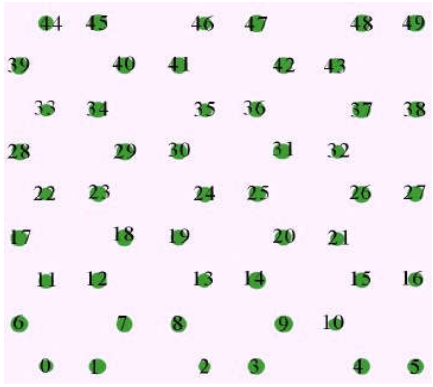
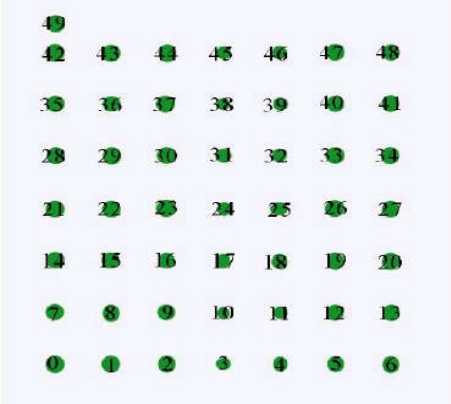


Fig1: Random Topology of WSNs

In regular topology, the nodes are placed in planned manner based on its coverage area. Its first advantage is it reduces the duplication of data by avoiding the duplication of coverage area. Ultimately it leads to cost reduction and increase network life time [6]. As it is deployed in organize manner every nodes knows about its neighbour as well as overall network scenario. Due this overall knowledge of network the routing becomes simpler. The main concern with strategy is to find optimum location of node so that we can cover maximum area with minimum number of node. More over the location of node is known to us so it is easy to find and replace the dead node. All it need careful deployment and little bit more memory which can store overall location of network. Z.zang et al. [7] design regular hexagon, planned grid and equilateral triangle topology for WSNs. They compare the regular topology with each other and found that length of communication for same size of region is shorter in hexagon topology and longer in triangle topology. Planned grid



(a)



(b)

Fig.2: : Regular Topology : (a) Hexagon Topology (b) Grid Topology

topology provides the best reliability and throughput is highest in triangle topology. It gives quite better result in than the random topology.

ii)**Routing in Random Topology vs Regular Topology:**

Routing of data needs the information of best suitable neighbour for destination. In random topology nodes are not aware about the neighbours so when it initiates the transmission process first it needs to find the best neighbour for destination. This process repeats at each node. It adds latency in data delivery. For example we want tp use any hierarchical based routing algorithm where a cluster need to be form in randomly deployed network. First we node need to find nodes which falls in to its coverage area then send the beacon signal to initiate cluster formation and cluster head selection. In regular topology each node aware about its neighbour so routing process become very easy and fast. There are some location based routing algorithm are available for randomly deployed network but, it required GPS or other device which can detect the location which is not feasible for small size devices. If we use hierarchical based routing algorithm in regular topology, node already know about its neighbour node which falls in to its coverage area. It can directly start with cluster formation and cluster head selection process.[8]

iii) **Time synchronization in Random Topology vs Regular Topology:**

Time synchronization is very important for wireless sensor network. It used to find the location, energy efficiency, mobility etc.. of the node. Ultimately it helps in TDMA schedule. For time synchronization a time stamped message is broadcast in the network. Here if we use the regular topology the node are already at known position, so we can omit the location information in time synchronization which reduces the complexity and data. More over in organized architecture we can use systematic way of sending the time stamped message rather than simply broadcast it.

iv) **Aggregation in Random Topology vs Regular Topology:**

Data aggregation is essential part of large WSNs. As it reduce the multiple transmission of packet destined for the same node which leads to increase the network life time.[9] In random topology it is difficult to fine the best node which can aggregate the data from other node. For that it needs to pass through selection process based on several criteria. Whereas, in regular topology, it is very easy to find the best suitable node for aggregate the data.

v) **Application management:**

The topology is greatly depends on the application of network. For certain application of wireless sensor network in hazardous location like, war field or area under nuclear effect, or a marine life where it is very hard to reach for human being. In that case we need to use random topology of network as it is very difficult and risky to deploy the sensor node in predefine location.

But application likes cultivation monitoring, forest conservation, monitoring probable nuclear risky area, health monitoring system etc.. In such case regular topology provide more benefit compare to random topology. [10]

CONCLUSION:

Topology plays the vital role in wireless sensor network. Carefully optimize topology will results in northward journey in network lifetime, throughput and efficiency of the network. It reduces the setup time, data latency and duplication of data as well as coverage. It also helps to reduce the cost of overall network. There is no gain without pain. As the structure is well organized it required advance planning of deployment. Node must come with little more memory so that it can accommodate location of its neighbour and structure of network. But the advantage surpasses the pains. Moreover certain application where regular topology is hard to deployed. Overall the regular topology outperforms the random topology.

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