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A Survey on Reliability in Wireless Sensor Network

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Abstract

Objectives: This study was conducted to identify Quality of Service parameters used in network. Different reliability types and performance metrics needed to predict reliability in wireless sensor network. **Methods/Analysis**: Sectoring scheme can be used for partitioning of network into different sectors. This scheme is used to improve reliability in wireless sensor network. **Findings**: In existing method various clustering algorithms are used for partitioning of network. Clustering consists of position of cluster head and if it far away from the sink in large network, the cluster node utilizes more energy. Therefore, for WSNs, it is especially vital to intend an algorithm to divide sensors in sectors to maximize the reliability (packet) and minimize the energy consumption apply for transformation of information from the sensor nodes to the base station i.e., sink node. **Application/Improvement:** Sectoring scheme is unique method used to acquire more packet delivery ratio i.e., the reliability of a sensor based network. To achieve reliability, different factors need to be considered for network review like number of sectors, angle between two sectors, packet size, node density, MAC protocols and Routing protocols.

Keywords: Clustering, Reliability, Sectoring Scheme, Wireless Sensor Networks

1. Introduction

1.1 Wireless Sensor Network (WSN)

Wireless Sensor Networks consist of group of dedicated transducers with a connectional infrastructure for monitoring and recording conditions at diverse locations as shown in Figure 1.They are competent to sense physical phenomena like pressure, sound, motion, temperature, humidity, vibration etc. A sensor node having a capability to sense the information, collect the sensed packets from its neighbor to perform aggregation[1] on it. With internet connection aggraded data will be forwarded to the user. As per the application requirements the data is to be used.

WSNs are used in different applications including: Remote Environmental Monitoring and Target Tracking[2], Earth sensing, Water quality monitoring[2], Forest fire detection[3], Air pollution monitoring, Area monitoring, Natural Environment Protection and Health care monitoring.

1.2 Quality of Services (QoS) in WSN

QoS is important for an assortment of technologies that allow network-aware applications to send and receive predictable competence levels in terms of QoS requirements. It is a set of service requests to be seen by the network while transferring a flow (upstream, downstream or bidirectional flow). In WSN, we have various kinds of QoS like: Reliability[4,5] consist ability to ensure successful delivery of packets towards both ends. Congestion[6] needs to be controlled to avoid packet loss. The causes for congestion occurrences are excess use of buffer, synchronized communication and most important is packet loss. In wireless environment both congestion and link level bit error are directly related to packet loss, which deteriorate End to End Reliability. Fairness, divide the network resources between all nodes, ensuring that all have an identical split of bandwidth to commune with the sink. Routing Overhead[7]- It is the count of routing packets needed in network communication. Routing and data packets have to share the same network bandwidth and hence, routing packets are considered an overhead in the network. Scalability- It is important because of WSN consists high node numbers and relatively high node density. Network should be scalable. Delay- Delay is another parameter plays a vital role in data transformation. So depending upon the requirement of an application, delay

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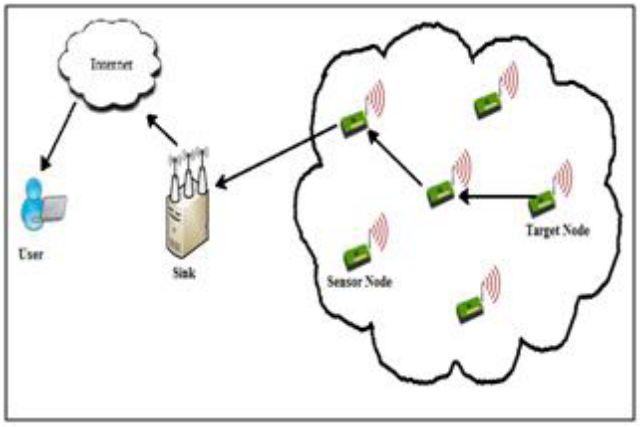

Figure 1. Overview of WSN.

is analyzed. Energy consumptions[8,9] also a limitation to be considered in WSN, since the sensors collect packets continuously till the end of application, so the power reduction is an important. Preferably, the energy consumption must be as small as probable. Throughput is rate of effectively broad casted data per second in the sensor network. The throughput is measured within bits per second (bit/s or bps). Heterogeneity: For large network and large number of sensor, nodes continuous and event driven flows should be supported in the same network.

1.3 Role of Reliability in WSN

In WSN, Reliability plays in both hardware and software reliability. In this paper, Software reliability in terms of packet requires to be clarifying for successful release of data. The desired reliability depends on the natural world of the application. Therefore, such kind of reliability[10] called Application Level Reliability. In Wireless Sensor Network, reliability is observed by various ways, Redundancy based and retransmission based reliability[11] observation which is common at the time of observing reliability in various types. Figure 2 shows the relation between the types of reliability.

Packet Reliability is used when scenario is sensitive for drop of packets and needs unbeaten transmission of the packets. Event Reliability: Application requires only successful event detection. In Hop-by-Hop Reliability, the hop is conscientious for reliable communication of data to sink. End-to-End Reliability concentrates on end packets that are responsible for ensuring reliability in a network. Retransmission Based Reliability is the habitual approach of checking reliability, on predefined path sender node sends a packet for communication, after transmitting its

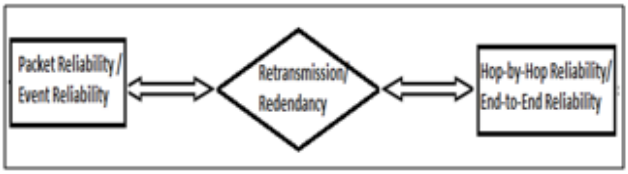

Figure 2. Types of reliability in WSN.

packet sender waits for the acknowledgement from next hop sensor node. If after a threshold value if sender does not received ACK, it seems to be packet has been lost. To achieve reliability sender needs to retransmit the packet. In Redundancy Based Reliability approach instead of retransmitting lost packet, they directly deal with lost bit/corrupted bits from the packet. They can perform it with the help of extra information provided with the packet.

At the time of transferring data packets one node to another, it is observed that the flow of data packets also affects the reliability. Upstream reliability is nothing but reliable transmission of packets from sensor s to the sink node. Downstream reliability gives assurance of data delivery from the sink node to intermediate sensor nodes. Bidirectional Reliability is in both ways, i.e., sink to sensor node and vice versa data delivery conducted.

In addition, reliability can be divided in Observed and Desired reliability. Observed Reliability consists of the actual number of data packets received in an interval at the sink and Desired Reliability is defined as the total count of data packets needed to achieve more reliability for an application[12,13].

2. Discussion on Partitioning of Network in WSN

Partitioning becomes a challenging issue in wireless sensor network based on application. Network consists of huge number of sensor nodes. It is time-consuming communication if sensor node is placed far away from sink node, which also reflects to the energy consumption of a node. The solution is to partition or divide the sensor network in to some categories. In wireless sensor network, partition is carried out with various ways:

Partitioning the network into a cluster, aims to keep same number of sensor nodes in each cluster to acquire fairness into the network and energy utilization of each sensor node is balanced. Every cluster has its own cluster head. This is responsible to transfer the packets to the sink node. Cluster head[14] transmits aggregated data to the sink

node. In such kind of communication, clustering reduces the number of sensor nodes involvement in participation towards transmission and reduces the overhead of a network with energy consumption. Clustering also improves scalability of a large network.

Clustering[15–18] can be performed using Level wise and Region wise. In Level wise Clustering method, all the sensor nodes are divided into different levels as shown in Figure 3. In Level wise clustering, network is divided into different levels. Each level elects the cluster head as per their energy levels. Cluster head is now responsible for transmission of data.

In Region wise Clustering method, network is divided into different regions as shown in Figure 4. As per the event occurred region each cluster head is trying to transfer the packets.

Partitioning the network can also be done with the help of Voronoi-based approach[19] as shown in Figure 5. It divides network into convex polygons called as voronoi cell. Each point or sensor deceits in exactly one voronoi cell with edges and vertices. It is helpful to increase coverage area. Points are located as per the global information of positions of a set of points/sensors in a polygon.

Sectoring Scheme[20–22] is used to partition the sensor networks into some sectors as shown in Figure 6.

In existing method, if the network consists of large number of sensor nodes then the cluster head needs to utilize more energy for the nodes which are far away from

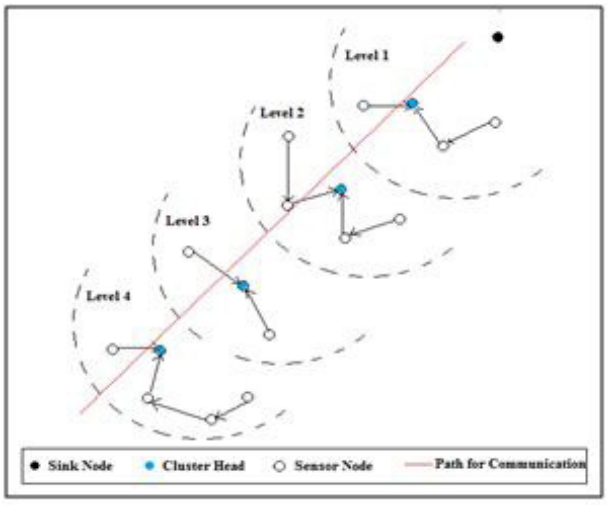

Figure 3. Level wise clustering in WSN.

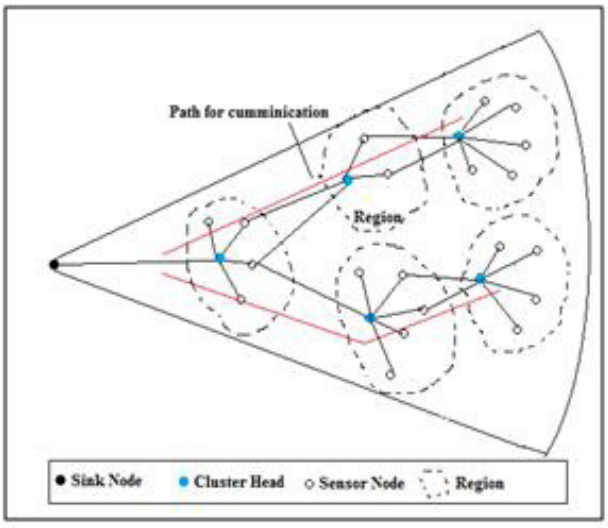

Figure 4. Region wise clustering in WSN.

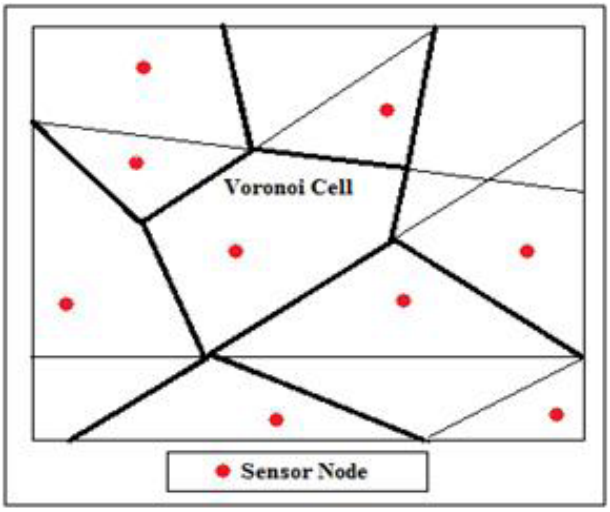

Figure 5. Voronoi diagram.

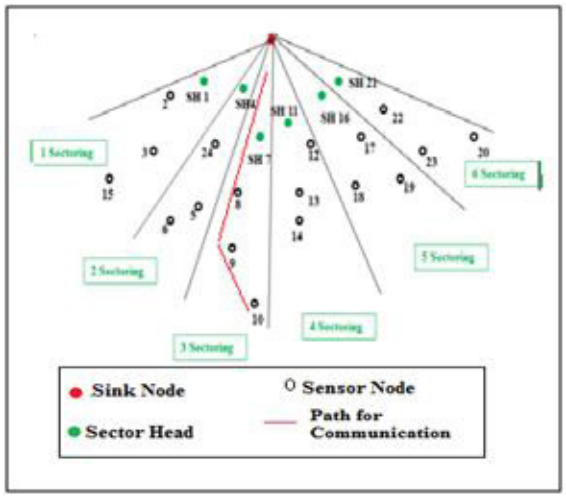

Figure 6. Static sectoring scheme for reliable data communication.

it. Therefore, for WSNs, it is especially vital to intend an algorithm to divide sensors in sectors to maximize the reliability (packet), minimize the energy consumption apply for transformation of information from the sensor nodes to the base station i.e., sink node.

Mechanism for Adaptive Reliable Sectoring (MARS) algorithm is used to achieve reliability at highest in WSN. Sectoring scheme can be used to acquire more reliability for sensor network. The network is divided into different sectors and Sector Head (SH) is elected as first node of an each sector. When target event invokes, event occurred sector is only alive and other sectors are in sleep mode. That particular sector head is now responsible for packet transformation. Consider the scenario where event occurred node is 10. In such situation only 3 sectoring sector is awaked and other sectors are in sleep mode. Node is then transmitting the packets towards the Sector Head 7 through the path shown in Figure 7. SH7 is then aggregates the data packets and sends it to the sink node for next operations.

Sectoring can be achieved with various types, like:

Once network is partitioned into sectors, it can work as static sectoring or dynamic sectoring. In Static sectoring scheme, the partitioning of sectors angles remain constant/static as shown in Figure 4. We cannot change the angle during transferring of packets in a network.

In Dynamic sectoring scheme, we can change the angle between two sectors as per the requirement of reliability of an application. Dynamic sectoring works with Adaptive sectoring scheme and Proactive sectoring scheme. In Adaptive sectoring scheme, the angle between two sectors is flexible. If predefined angle is not giving the desired reliability, then change the angle between two sectors and check the observed reliability as shown in Figure 8.

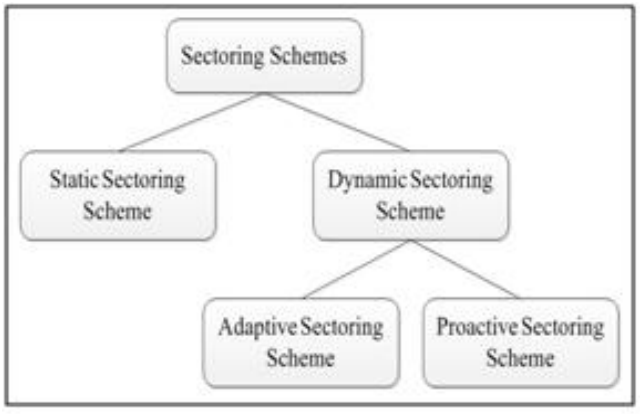

Figure 7. Types of sectoring scheme.

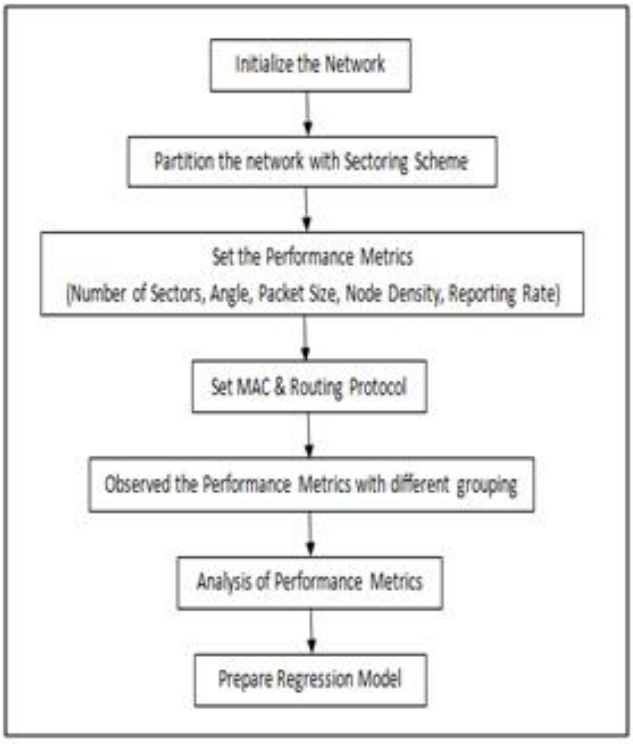

Figure 8. Dynamic sectoring scheme for reliable data communication.

In Proactive Sectoring Scheme, Initially consider some performance metrics (refer Section 3) who directly related to the network reliability. Proactively predict the observed reliability by keeping combination of changing values of those performance metrics.

3. Proposed Work

In Wireless Sensor Network, Reliability can be achieved and can be measured as per the application requirements. Figure 9 shows different performance metrics can be considered for prediction of reliability.

Number of Sectors: Division of sensor nodes in a network into the different number of sectors as per the requirement. By varying number of sectors for a network observed the reliability. Angle: Angle between two sectors should be flexible. Reporting Rate: It is allocated to sensor nodes depending on their sub-tree sizes. Packet Size: Packet size may perhaps in a straight-line influence the reliability and the quality of the communication between wireless sensor nodes. We have long packet size, shorter packet size and too shorter packet size data. Node Density: Total number of sensor nodes in a network need to be

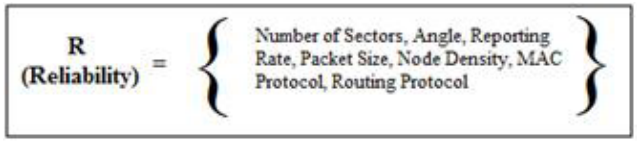

Figure 9. Reliability prediction factors.

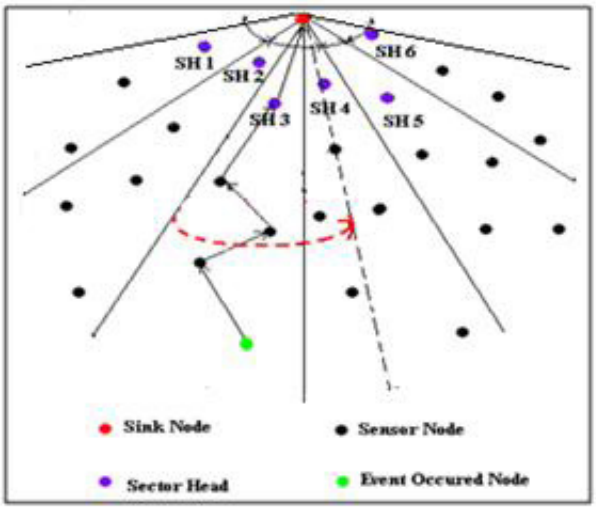

Figure 10. Workflow of performance metrics.

considered for transmission of packets. More the sensor nodes more would be the reliability. Routing Protocol[23]: Data collected by the sensor node/sink node might have chances of redundancy. To reduce it we need different routing protocols[24,25]. MAC Protocol: It ascertains the communication link between sensor nodes. It also commune and contribute to the communication medium fairly and efficiently[26].

Based on above performance metrics, we need to predict the observed reliability for an application proactively.

Figure 10 shows the execution of performance metrics to a network to achieved reliability. To begin with initialize the network, which consist different sensor nodes. Partition the network into different sectors with the help of MARS algorithm. Set performance metrics; initialize MAC protocol as an IEEE 802.11 and Routing protocol as AODV i.e., Ad hoc On-Demand Distance Vector. Keep on metric varying and other should be constant/static. Star with Keep on changing number of sectors and set angle, packet size, node density, reporting rate constant. Perform the same operation for other combinations and observe the reliability. Finalize the regression model based on the observations.

4. Conclusion

In Wireless sensor network, requirement of reliability is getting changed based on an application. MARS algorithm is used to build sectoring scheme for a networking. Performance metrics like number of sectors, angle between two sectors, packet size, node density, reporting rate, MAC protocol and routing protocol play an important role to analyze the reliability in WSN. By grouping these performance metrics we can plan regression model for a network.

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