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Performance Analysis of Reliability in Wireless Sensor Network

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Abstract- ***Nowadays Wireless Sensor Network (WSN) is top rising field .It is broadly used in lots of application areas since previous few years. Sensor is the mainly significant and fundamental part in WSN. Reliability is one of the key aspects of WSN. Reliability is nothing but the consistency in measuring the results. It is necessary for efficient and reliable data transmission process. Congestion control is required for increasing reliability of network. In this paper, we are discussing the effects of node density and reporting rate on the network performance.***

Keywords- ***Wireless Sensor Network, Reliability, Congestion, Data Transmission, Node density and Reporting Rate.***

I. INTRODUCTION

Wireless Sensor Network consists of sink node called as base station with unlimited energy and multiple sensor nodes with limited energy. Out of these sink node is secured but sensor nodes are unsecured. In WSN, sensors nodes are randomly distributed in given environment to collect the information about the changes occurred in the atmosphere like temperature, pressure, humidity, soil content, etc and send these noted readings back to the base station.WSN is most widely used in real world applications such as weather forecasting, tsunami detection, volcano sensing, and earthquake predictions and so on. It is an easy and good solution to the various applications. Since it is used in great extent from last few years it will useful in future works also. It introduced a new way to perform our jobs within specific time durations. It can be establish a connection between different sensor nodes across the given network [1].

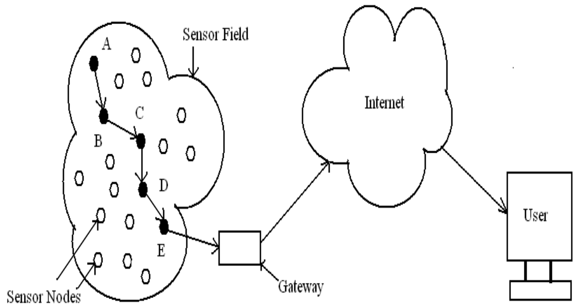

Fig. 1. Wireless Sensor Network.

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The fig. 1 shows wireless sensor network. Different sensor nodes are placed in sensor field. These sensor nodes are densely deployed in a given network. Fig. 1 shows the five sensor nodes as A, B, C, D, E. These sensor nodes are able to collect data and send it back to the user via gateway and internet. We also shows the path taken by these nodes from A to B ,B to C,C to D,D to E ,E to gateway. The fig. 1 helps us to clearly understand the concept of sensor nodes, its working and WSN. Tiny sensor nodes are capable of sensing, data processing, and communicating with each other. Sensor network protocols and algorithms must process on self organizing capabilities. One of the unique features of WSN is that the cooperative effort of sensor nodes. Instead of sending raw data to the nodes, sensor nodes use their processing abilities to carry out partially processed data locally. Sensor nodes use limited power and memory. It is also supports broadcast communication [2].

There are various types of sensor nodes such as seismic, magnetic, thermal, infrared, acoustic, and radar.WSN is cost efficient than wired network because wired sensor networks are more costly to implement across the network. It is beneficial for many users to used WSN which minimizes the establishments cost of the network. But in case of the node failure, we can replace nodes easily and quickly. But it is difficult in case of wired network. As the sensor nodes are widely distributed in a given surrounding, noted down the readings and send them back to the sink node. There may be possibilities of packet loss during this data transmission process hence we need to resend the packets to the destination which may results in multiple copies of single packet. It may increases the reliability of packet data. There are various applications of WSN as for telemonitoring human physiological data, which is useful for doctors to monitor and understand patient's current condition in better way. In environmental applications such as tsunami detections, large numbers of sensor nodes are widely distributed in ocean with the help of which we get alert instruction within a specific time in more clearly manner. In military application for monitoring friendly forces, in detection of nuclear, biological, and chemical attack, also in monitoring enemies different activities. We can also used sensor nodes in vehicle tracking and detecting, it is also used in home applications as in vacuum cleaners, microwave ovens, refrigerator, and in VCR player [3]. Reliability is most important factor in WSN. If the transmitted data from source completely received at destination end with or without minimum packet loss then transmission is said to be reliable. Reliability is consistency in measuring results of any test. A test is said to be reliable if and only if it produced same results repeatedly.

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It is the most challenging task that sending packets with high speed and more reliability. As the number of packets reached to destination increases, reliability of system also increases. Congestion may be occurring during this process which puts an extra load on the one hop away node from sink. This decreases the life of sensor nodes; hence it's necessary to replace them after regular interval of time. If we want to achieve more reliability of the system then we must control other WSN parameters like congestion, energy, throughput and delay. There are many advantages of reliability as, reliability will help to improve system performance, and reliability is able to produce effective results. Reliability can minimize execution speed and time. In this way it is useful to achieve high reliability for given system so that it is ultimately responsible for increasing overall performance of given system [4].

II. RELATED WORK

Dae Young Kim et al. [6] explains that in wireless sensor network, there was high packet loss rate during multi-hop network but we require more reliable and end to end data transmission so that we are able to satisfy communication reliability of given system. In this paper, recovery mechanism is used for lost data. There are two types of recovery mechanism used as End-to-End loss recovery mechanism (E2E) and Hop-by-Hop loss recovery mechanism (HBH). In E2E loss recovery, there are large end-to-end delays occurs high packet loss during multi-hop transmission for 100% reliability. In HBH loss recovery, data at every node requires large memory over routing path. For minimizing the memory requirements, we used a method called Active Caching (AC). It solves every sub problems just once and save its answer in table to avoid recalculating given work. In case of packet loss, the caching node will send NACK message to the previous catching node along the path and retransmit lost packets. Its main advantage is that we can build a flexible E2E data transmission system with high reliability. Its main disadvantage is more memory is required for data catching process.

Yunhuai Liu et al. [7] said that in large scale WSN, for reliable packet delivery two methods are used .First is packet loss avoidance and second is packet loss recovery. In packet loss avoidance there is reduction in occurrences of packets and in packet loss recovery there is recovery of lost packets takes place. It has some major challenges as how will we recover the lost packets having long transmission path may be in meters or few kilometers? Retransmission of packets may results in reducing bandwidth and also occurs congestion at forwarding nodes. There may be possibility of bad link propagation which occurs due to unreliable links. To overcome these, there is a new concept introduced called 'in middle recovery' which fills the gap between traditional E2E recovery and HBH recovery. In this type, we estimate the packet loss in several hop manners and generate new packet copies after certain steps. So that we are able to balance packet loss and packet generation. The E2E service quality can be maintained with any length of data path and scale of network. It helps to increase the speed of transmission process which ultimately increases utility of system.

D.G.Reina et al. [8] discuss that the Route Selection Scheme (RSS) is improve the reliability of network using routing packets. As mobile ad-hoc network is wireless network route selection is main part of it. As the topology of network changes, it will affects on route selection. That is routing protocol either repairs route or finds an alternate route to reach destination. The arrival angle is angle at which neighboring nodes arrives and remains in caution zone. Caution zone is the area at which there may be chance of congestion. The critical angle is maximum range of angle at which two nodes are meeting with each other and form a new route for effective data transmission process. If arrival angle is lower than critical angle then node is part of route. But it is equal or less than critical angle then node is bad neighbor and is not part of possible route. Generally route life is dependent upon the distance among nodes which will determined by Received Signal Strength (RSS). The nodes arrival angle and relative speed between nodes both determine the life of communication link.

III. PERFORMANCE ANALYSIS

Now we are selecting the Network Simulator (NS2) tool for simulation of nodes present in our network. We take the scenario as 50 nodes with one node as a sink node; packet size of node is 50 bytes. We use random topology on given network area about 1000* 1000 sq. m. We take IEEE 802.11 Media Access Control (MAC) protocol. As the packet generation rate is variable, we also use Ad-hoc on demand routing protocol. Reporting rate is 7 allocated to a node which is one hop away from sink node.

On the basis of above scenario, we can draw following three graphs. Fig. 2 shows graph, number of packets is function of node density in nodes per unit area. According to this graph, initially packet generated rate is minimum at node density 10. As the node density increases, packet generated rate is also increases up to the maximum threshold point 20 as shown in fig. 2. After that as the node density further increases, packet generation rate is decreases.

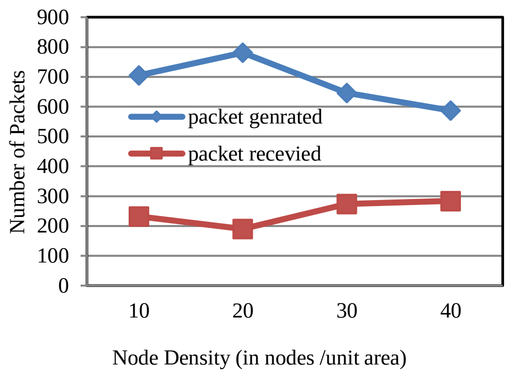

Fig. 2. Number of packets as a Function of Node Density in nodes per unit area.

Because after maximum threshold point, initial nodes are busy in congestion so that new nodes are added in the network goes in starvation mode so that they are not performing any functionality such as either transmitting or receiving data from other nodes present in given network. But in case of packet received data, initially packet received rate is minimum at node density 10.

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As the node density further increases, packet receiving rate is go on decreases up to the maximum threshold point 20 as shown in fig. 2. After that as node density increases further, packet received rate goes on increases. These is because, there is increases in number of possible paths which ultimately helps to increase packet receiving rate.

Fig. 3 shows the graph, number of packets as a function of reporting rate in packets per second. According to this graph, initially when the reporting rate increases, the packet generation rate is also increases continuously. Because number of packets sends to the destination all of them get received at destination. But in case of packet receiving rate, as the reporting rate increases, number of packets received at destination also gets increases. Because it gets sufficient time to reach to the destination .Hence the graph of packet received rate is increasing but slowly as compared to packet generated rate.

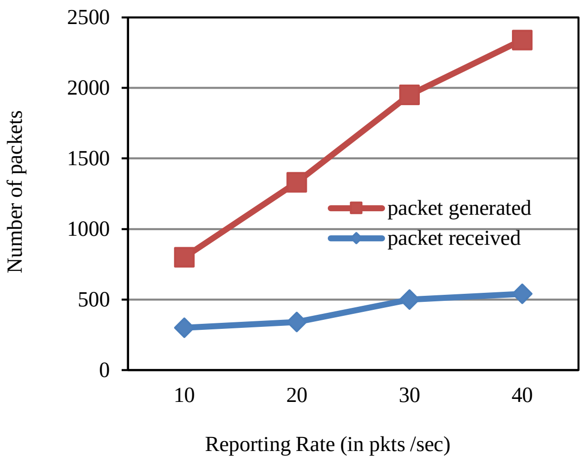

Fig. 3. Number of packets as a function of Reporting Rate in packets per seconds.

Fig. 4 shows the graph, packet percentage as a function of node density in nodes per unit area. It shows the graph of packet delivery ratio (PDR) and packet loss ratio (PLR). According to this graph initially at node 10, PDR rate is minimum as node density increases PDR rate decreases.

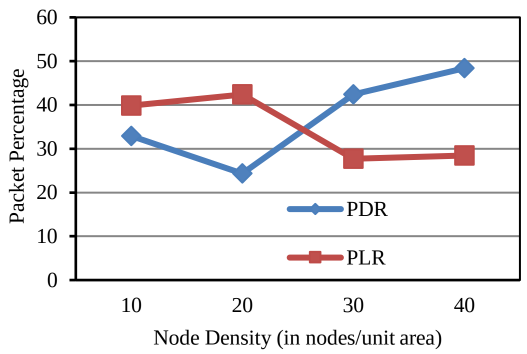

Fig. 4. Packet Percentage as a Function of Node Density in nodes per unit area.

Because due to increase in node density there may be decrease in the possibility of packet received at destination end. But up to certain threshold point 20 after that as the node density increases further PDR also get increases. But in case of PLR, at node density 10 PLR is minimum after that as node density increases PLR also increases up to certain maximum threshold frequency 20 as shown in fig. 4. Then as node density further increases, PLR decreases because there may increase in the possibilities of packet loss during data transmission process. At node density 25, PDR and PLR intersect with each other. At this point, packet delivery ratio and packet loss ratio is same for a while. After 25 as node density increases, there is respective increase in PDR while decrease in PLR. This is because of there is increase chances of reliable packet delivery to the destination. It will automatically reduce chances of packet loss during data transmission process.

Here we are discussing many ways to increase reliability of a system. We firstly changes node density in nodes per unit area as well as we changes reporting rate in packets per seconds. From these we note down some important readings with which we are able to conclude following conclusion and also proposed future works.

IV. CONCLUSION AND FUTURE WORK

In this paper we analysis above three graphs and with the help of which we noted down some useful changes take place during data transmission process. After observing graph first as shown by fig. 2, we can says that with change in node density, there is respective change in number of packets generated and number of packets received. Similarly from second graph as shown in fig. 3, we can say that the changes occurred in number of packets, respective changes are found in reporting rate of packets per second. From third graph as shown in fig. 4, we conclude that increases in node density will also increases in PLR but decrease in PDR. At node density 25, PDR and PLR rate will intersect each other so that PDR and PLR both are same but after that, as the node density further increases PDR increases while PLR decreases respectively.

Hence it is prove that during the data transmission process, node density in nodes per unit area and reporting rate in packets per second will affects on number of packets present in given network .But it has certain limitations as there may be possibilities of congestion occurrence along data transmission path which may results in delay of data transmission process. Enhanced work will be achieving to find out an successful and efficient way of data transmission process. So that we can achieve high reliability along with minimizing the other parameters like congestion, energy and delay. All these issues are worth for further research studies.

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