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Reliability Analysis of Three Hop Reliability Model for Wireless Sensor Network

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Abstract: **Wireless sensor networks (WSN) have generated tremendous interest among researchers these years because of their potential usage in a wide variety of applications. Sensor nodes are inexpensive portable devices with limited processing power and energy resources. Sensor nodes can be used to collect information from the environment, locally process this data and transmit the sensed data back to the user. In the case of Two-Hop Acknowledgement (2H-ACK), two nodes are involves to make the copy of same data packets until first node receive the acknowledgement to increase the reliability of network, but still this technique have a problem of data packet loss. This thesis proposes a new reliability model in order to insure reliable data deliveries with the name of Three Hop-Reliability Model (3H-RM), in which every sender node of each group of three layers will maintain the copy of same successful transferred data packets without creating extra burden on the networks. The new model is designed that aims at providing 100% reliability when possible as well as minimizing overhead and network delay.**

Keywords: **Wireless Sensor Network (WSN), Protocol Overhead, One Hop Transmission, Reliability.**

I. INTRODUCTION

A wireless sensor network (WSN) is becoming very popular technology. Wireless networking which is comprised on number of numerous sensors and they are interlinked or connected with each other for performing the same function collectively or cooperatively for the sake of checking and balancing the environmental factors. This type of networking is called as Wireless sensor networking. A wireless sensor network (WSN) consists of a group of self-organizing, lightweight sensor nodes that are used to cooperatively monitor physical or environmental conditions. Commonly monitored parameters include temperature, sound, humidity, vibration, pressure and motion. Each sensor node in a WSN is equipped with a radio transmitter, several sensors, a battery unit and a microcontroller.

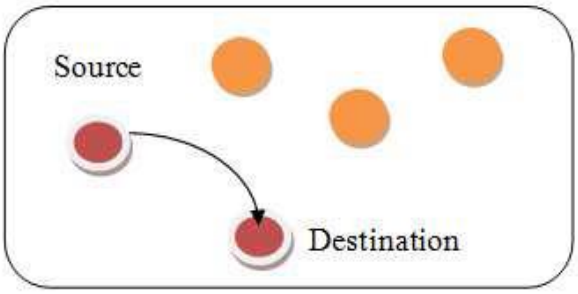

Fig.1.1 Wireless Sensor Network

Because of the size and cost constraints on sensor nodes, they are limited by energy, bandwidth, memory and other resources. Any protocol design for WSNs needs to consider the limitations of sensor nodes carefully. This thesis proposes a new Three Hop-Reliability model (3H-RM) for reliable data delivery protocol that aims to provide high reliability with minimal delay and overhead.

The design of a data transport protocol in Wireless Sensor Networks is focused on providing End-to-End Reliability, Mitigating Congestion, and achieving fairness in bandwidth allocation. The reliability issue in the data transport protocol usually involves loss recovery, congestion control, or both. Most of the reliable data transport protocols either use a retransmission-based loss recovery approach or a redundant data transmission method (sending multiple copies of a data packet into the network).

II. RELATED WORK

Wireless Sensor Networks (WSN) are highly distributed self-organized systems. Sensor nodes collect measurements of interest over given space, making them available to external systems and networks at special nodes designated sink nodes.[2] Moving nodes and failing nodes due to battery power depletion are problems that raise a significant number of routing problems, demanding the use of efficient routing protocols. If the sensed information is to be used for active control (e.g. industrial process control) rather than passive monitoring, estimation and detection, the additional design goal of predictable latency appears. Many control strategies can compensate for information delay and jitter (delay variations), provided that these can be deterministically bounded or statistically quantified in the design phase.

TCP has been successful due to its robustness and providing reliability on an end-to-end basis. To motivate the extension of this protocol to wireless networks. These networks pose some critical challenges to TCP. [2] The level of bit error rate (BER) is not negligible. High mobility. The focus of this paper is the interaction between TCP and the MAC layer. To present a strategy for decreasing medium contention as much as possible. The receiver may combine up to four ACK packets when the wireless channel is in good condition**.**

A highly precise, real time and continuous monitoring system is extremely important for various applications, such as off-shore oilfield monitoring, pollution detection, and oceanographic data collection. Most of the applications require long term monitoring of the selected areas when we are interested to collect the information. These networks are generally formed by acoustic sensor nodes and are deployed in the interested areas at different depth levels and surface sinks used for the real time data collection.

The UWSN consists of a number of sensor nodes that depend on the area of deployment, are used to sense any event occurring in the surroundings and after some required processing, route this sensed data towards any surface sink. An important fact about the UWSN is that, an individual node can be resource constrained, but a collection of these nodes can cover large areas, first sensing and then forwarding this useful data towards the surface sink with an acceptable degree of accuracy[6]. We consider three metrics in order to check the performance of our algorithm. Packet delivery ratios with different number of nodes, packet delivery ratios at different time intervals and then we compared the effect of packet we compared the effort of packet losses and duplications after specified time interval.

A fundamental challenge in underwater wireless sensor networks (UWSNs) is that acoustic links are subject to high transmission power with high channel impairments [5]. These channel impairments result in higher error rates and temporary path losses which restrict the efficiency of these networks. Besides this, the availability of limited resources and continuous node movements are major threats for reliable data deliveries. With these constraints, it is a difficult task to design a protocol which has the ability to maximize the reliability of these networks. The findings on the relationship between data packet size, throughput, bit error rate (BER), and distance between both communicating nodes are also presented [3].No dimensional location information required and node movements can be handled easily without maintaining complex routing tables.

III. PREVIOUS IMPLEMENTATIONS

Single Hop:

In a single hop network, the data's are transferred to least leading hop. In this network, only one transmission can be take place from source to destination at the time, there is no subsequent packet transmission between one hop to other. Wireless station can be linked to wireless access points (WAPs) that are connected to the router through wired network, for instance, wireless access points like Wi-Fi, WiMAX, cellular being connected to a bigger network the Internet.

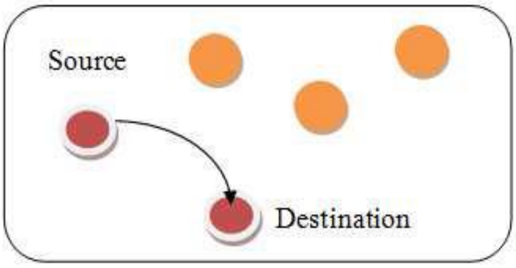

Fig. 1.2 Single Hop Communication

Two Hop:

In Two-hop model where two copies of the same data packet are maintained in the network without extra burden on the available resources. In Two-hop model information-based routing protocol is proposed for real-time wireless sensor networks. Two-hop model in wireless ad-hoc network, some distributed algorithms and efficient information exchange schemes are reported. By the study of generic routing with multi-hop routing information it is observed that the number of hops required from the source to sink decreases significantly from one-hop to two-hop information-based routing. The choice of two hops is a tradeoff between performance improvement and the complexity cost. The idea of two-hop routing is straightforward but how to use or integrate the information effectively so as to improve energy and real-time performance is generally nontrivial.

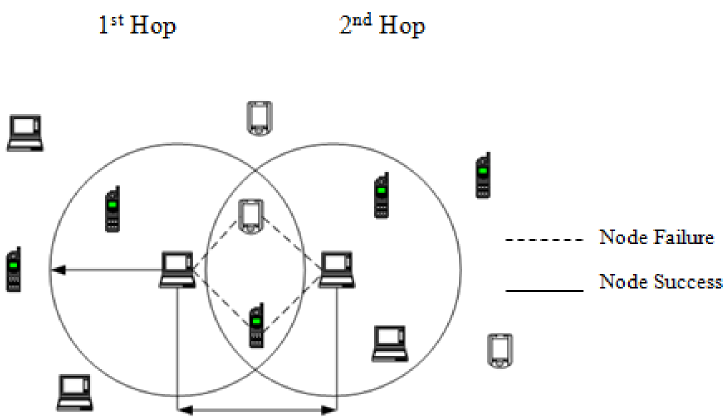

Fig 1.3: Two-Hop Communication

IV. SYSTEM IMPLEMETNATION

Three-Hop:

Reliable model with the name of Three-Hop Reliability Model, in which every sender node of each group of three layers will maintain the copy of same successful transferred data packets without creating extra burden on the networks. Three Hops Reliability model is used to increasing the reliability of Packets. While in Three Hop Reliability model has many advantages such as not requiring any specialized hardware, no dimensional location information required and easiness in handling node movements without maintaining complex routing tables.

Reliability performance is better than comparing to One Hop and Two Hop Reliability Model. It has Three nodes will take the responsibility to keep the copy of same successful transferred data packet. The process of keep the copy of data packets and forwarding by using the three-hop reliability model.

For getting more precise results, it furthermore still requires some reliability mechanisms to handle the problem of node or packet loss. Following are the purposes to design this reliable model:

- Assure the delivery of data packets

- To control the congestion in the network
- To save the energy consumed.

Protocol Used in Three-Hop Model:

In Layer by Layer Angle based Flooding (L2-ABF) protocol is commonly used in three-hop reliability model. The Angle-based flooding approach is used in this proposed routing protocol. This routing mechanism is not based on sensor node location information and has been designed for delay and power efficient multi-layer communication in three-hop networks.

Anchor nodes flood the sensed data towards the surface sinks via the upper layer nodes. The forwarder node will define the flooding zone by using the initial angle. After defining the flooding zone, the node will send Hello Packets (HP) within the defined zone and wait for the Hello Reply (HR). If there is no HR received, the node will increase the value of variable in the initial angle, to increase its flooding zone until the basic condition is met. The selection of the random values for variable depends on the movement of the nodes.

Three-Hop Reliability Model:

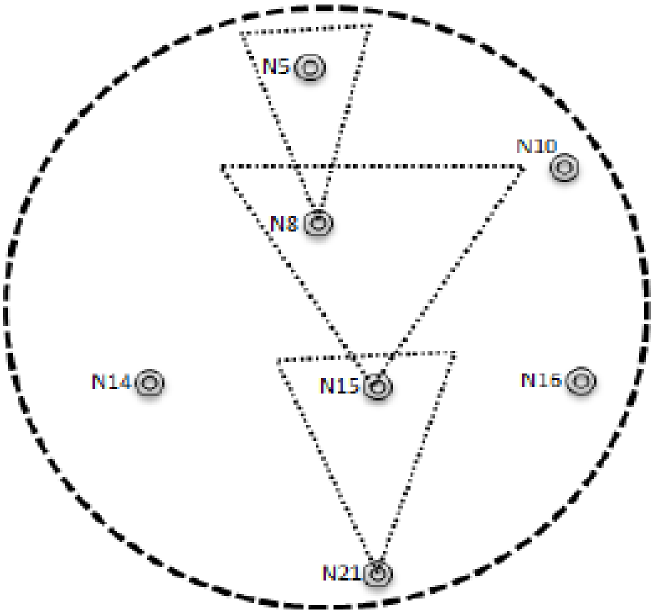

Fig.1.4 Keeping the Copy of the Packet between Three Nodes

The process to keep the copy of data packets and data packet forwarding by using the Three-Hop Reliability Model. Here it is important to note that every node will check the field "Step" value of the final message. If it is less than three, nodes will forward the data packets to next hop; otherwise node sends the final message to the previous forwarder when send the data packets to next layer nodes. The node N21 has data packet and it ready to send towards the destination on water surface (Sink). Node N15 resides in the upper layer and inside the flooding zone which is calculated by node N21.

S-Node-ID	Layer-ID

Fig. 1.4: Hello Packet Format

Node-ID	Layer-ID	Energy Status	Priority	Buffer Size

Fig.1.5: Hello Reply Format

Source Node-ID	First Forwarder ID	Second Forwarder ID	Step

Fig.1.6: Three Step Final Message Format

To save the memory and remove the extra burden on the network, nodes can delete the save copy of data packets with the time limit which is after sending the packets and did not receive the final message.

The node N15 will check if the value of "Step" field still is less than 3 and will follow the same process as N21 and send data packets to node N8 with the increment 1 into the current value of "Step" field. N8 will check if the value of "Step" field is still less than 3. So node N8 will send the data packets to node N5. When node N8 will receive the acknowledgement from N5 and the "Step" field value becomes 3, the node N8 send the final message to the lower layer nodes that have a save copy of these data packets by reducing the value of "Step" into zero.

After receiving the final message to node N8, it will delete the save copy of data packets and rebroadcast the final message to previous forwarder nodes so they can delete the data packets from the memory. Although, nodes delete the saved data packets when nodes will receive the final message but the deletion of data packets is not fully depend on the receiving of final message**.**

Advantages of Three-Hop Reliability Model:

- Three-hop Reliability Model can achieve better delivery ratios
- Three-hop network model need guaranteed data deliveries of packets on time.
- Three-hop reliability model uses varying amounts of energy.
- The maximization of throughput is the key aim of these networks rather than providing fairness among the nodes.
- Three-hop reliability approaches are available for reliability to increase the performance of network.
- This reliable model is used to increase the reliability for our designed routing protocol.
- Three-hop reliability model assures the delivery of the packets.
- To control the congestion in three-hop network model and it also save the energy consumed.

V. EVALUATION RESULT

Cygwin is free software that provides a Unix-like environment and software tool set to users of any modern x86 32-bit and 64-bit versions of MS-Windows (XP with SP3/Server 20xx/Vista/7/8) and (using older versions of Cygwin) some obsolete versions (95/98/ME/NT/2000/XP without SP3) as well. Cygwin consists of a Unix system call emulation library, cygwin1.dll. With Cygwin installed, users have access to many standard UNIX utilities. They can be used from one of the provided shells such as bash or from the Windows Command Prompt.

Contains both merits and limitations when people use it to simulate WSNs. To the merits, firstly as a non-specific network simulator, NS-2 can support a considerable range of protocols in all layers. For example, the ad-hoc and WSN specific protocols are provided by NS-2. Secondly, the open source model saves the cost of simulation, and online documents allow the users easily to modify and improve the codes. However, this simulator has some limitations. Firstly, people who want to use this simulator need to familiar with writing scripting language and modeling technique; the Tool Command Language is somewhat difficult to understand and write. Secondly, sometimes using NS-2 is more complex and time-consuming than other simulators to model a desired job. Thirdly, NS-2 provides a poor graphical support, no Graphical User Interface (GUI) the users have to directly face to text commands of the electronic devices. Fourthly, due to the continuing changing the code base, the result may not be consistent, or contains bugs.

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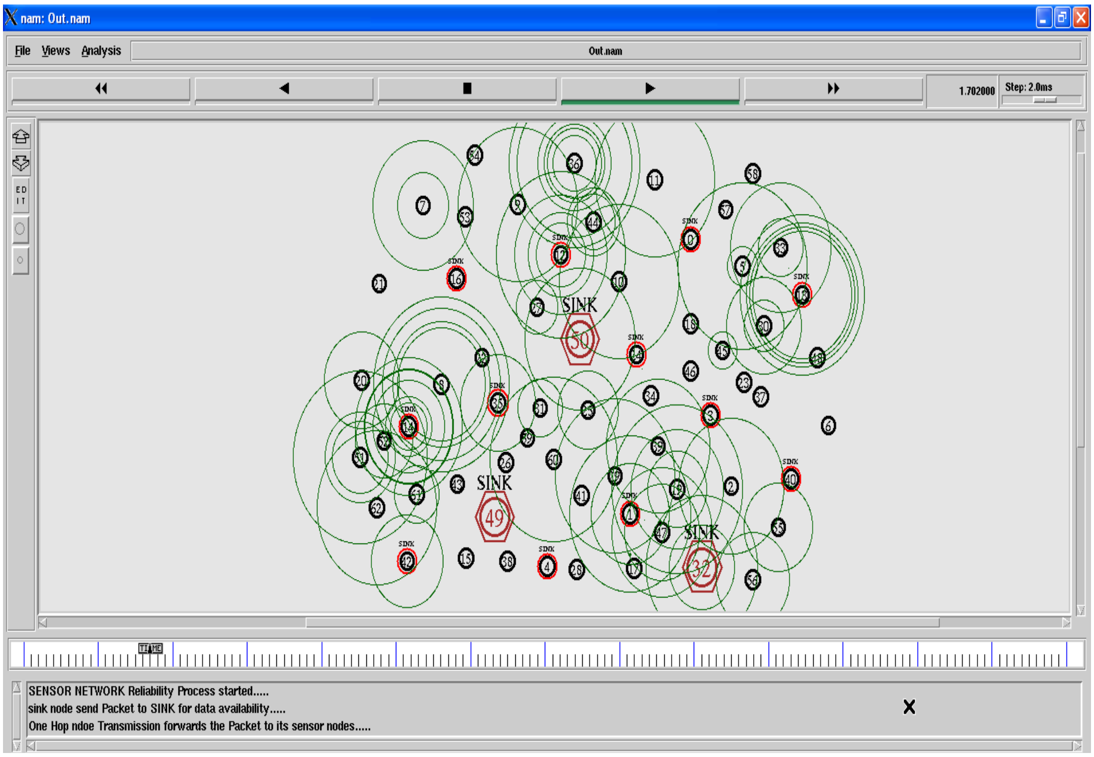

Fig.1.7: Data Availability to Send Packet

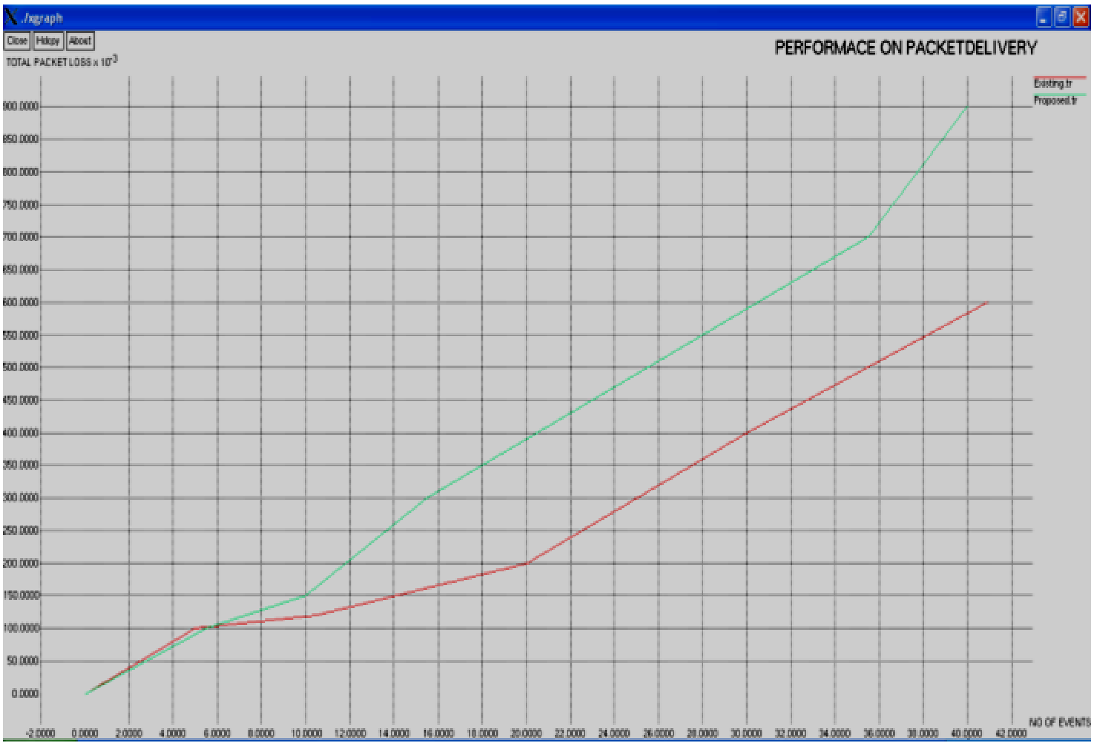

Fig. 1.8: Three-Hop Packet Delivery Ratio

A Sensor Network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source

A Wireless Sensor Network (WSN) is a collection of nodes organized into a cooperative network. Each node consists of processing capability which acts as transceiver. Packet dropping is a compromised node which drops all or some of the packets that is supposed to forward. Packet modification is a compromised node which modifies all or some of the packets that is supposed to forward. Packet dropping and modification are common attacks that can be launched by an adversary to disrupt communication in Wireless Sensor Network

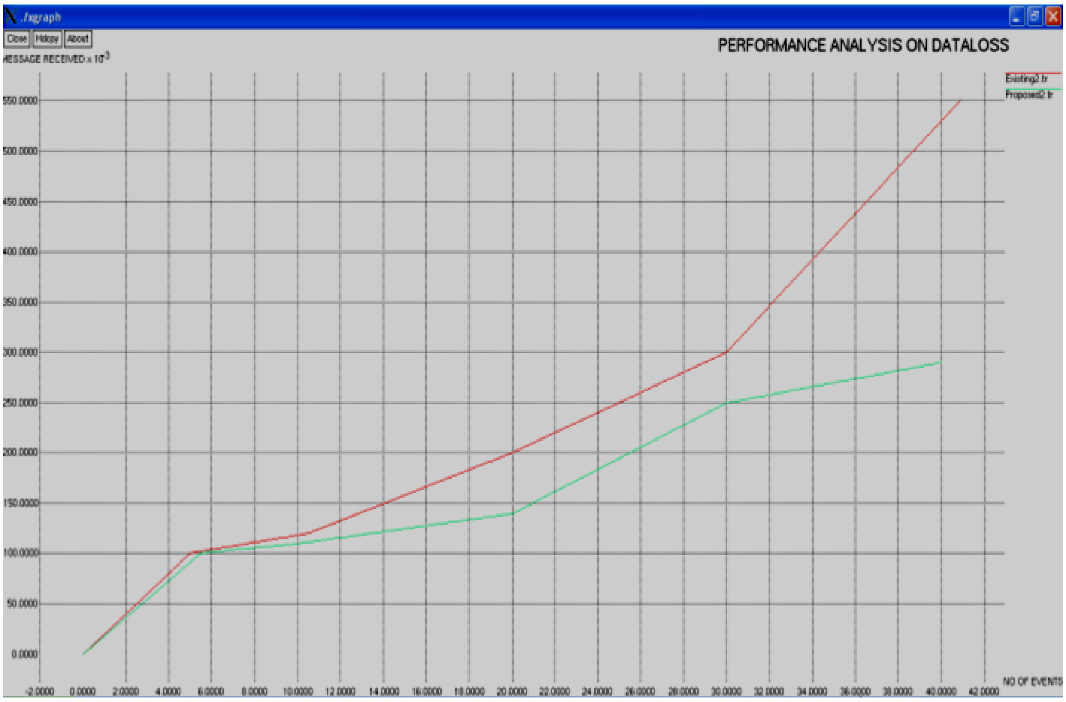

Fig 1.9: Three-Hop Packet Drop

Most of studies only consider that wireless sensor networks are equipped with only Omni-directional antennas, which can cause high collisions. It is shown that the per node throughput in such networks is decreased with the increased number of nodes. Thus, the transmission with multiple short - range hops is preferred to reduce the interference. However, other studies show that the transmission delay increases with the increased number of hops. Found that using directional antennas not only can increase the throughput capacity but also can decrease the delay by reducing the number of hops.

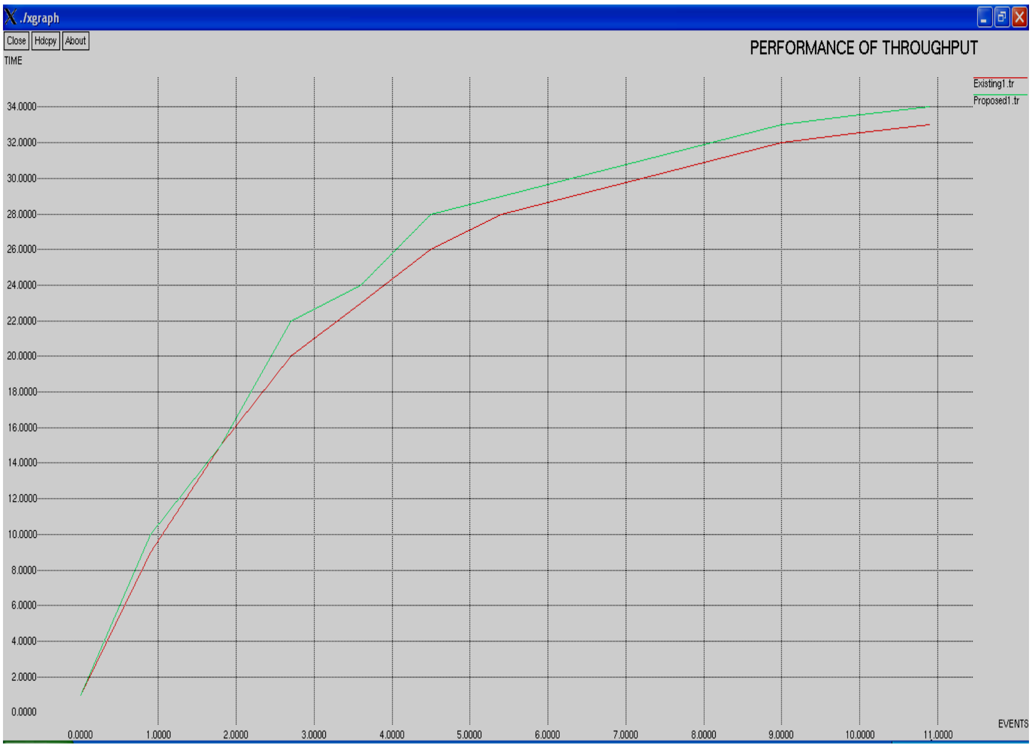

Fig. 1.10: Proformance Throughput

VI. CONCLUSION

WSNs hold the promise of many applications in the area of monitoring and control systems. Many properties of the environment can be observed by the monitoring system with the advent of cheap and tiny sensors. All these applications are meant for the specific purposes, and therefore maintaining data transport reliability is one of the major concern and the most important challenge. To address the reliability, to survey the various existing techniques; each of them has its own unique working to ensure the reliability. Some of the techniques use retransmission mechanism while others use redundant information for insuring the reliability. Few of the above objectives may be considered in the future by the researchers.

Generally, for networks that are multi-hop, hop-by-hop is thought to be superior in regards to reliability. On the other hand, sensor nodes in WSNs are more likely to die because of energy loss which causes a tremendous number of packets to be lost. Therefore Three Hopes Reliability Model (3H-RM) is proposed that deals with the problem. In our model, three nodes keep a copy of the same data packet. Data packets in environments, no matter at which place in the network they are created, usually need at most 6 to 8 hops to get to their destination. The proposed approach, under these conditions, can deal with the loss of packets and also aids in the reduction of the issue of congestion with no extra toll being put on the network. The proposed approach is supported by simulation results that were achieved using a variety of parameters.

VII. FUTURE WORK

Wireless Sensor Networks (WSNs) in which each sensor node randomly and alternatively stays in an active mode or a sleep mode. The active mode consists of two phases, called the full-active phase and the semi-active phase. When a referenced sensor node is in the full-active phase of the active mode, it may sense data packets, transmit the sensed packets, receive packets, and relay the received packets. Finally, a packet loss approach will be evaluated and studied in order to mitigate the effects of nodes failure while sending a data packet. Handling these packet losses also helps to reduce the congestion problem without creating any extra burden on the network. The energy efficiency can be the future work in Three Hop Reliability Model (3H-RM).

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