Performance Enhancement in Wireless Sensor Networks through a novel Scheduling approach

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Abstract - *Wireless Sensor Networks (WSNs) are conventionally designed to support applications in eternal deployments and thus WSN protocols are primitively designed to be energy efficient. Due to the limited computation capability and battery capacity of sensor nodes and unreliable wireless connections, it is basically, challenging to ensure Quality of Service (QoS) for applications. With various ambient conditions and applications, distinctive QoS measurements may apply in various perspectives for example, vitality effectiveness, network lifetime, latency, reliability, coupling cast time, security and privacy graduation. In this paper, we propose PlanEx, a heuristic scheduling algorithm, which guarantees a user-defined end-to-end reliability. The proposed method adds time slots for carrying data packets to each link in order to satisfy required reliability. In retransmission based methods, lost packets are recovered by the concept of redundancy, which is taken care by the MAC layer, there by achieving the reliability in the system. The proposed scheduling algorithm is evaluated and analyzed extensively through simulations. Simulation results demonstrate that the proposed strategy makes tremendous growth in packet reception rates, reduced energy consumption, adaptable planning, accomplishing competitive schedules to the existing scenario and achieving a highly qualified QoS feature for end-to-end reliability guarantees in wireless sensor network.*

Key Words: **Reliability constraints, Scheduling Algorithm, Packet reception rates, life improving ratio, probability criteria, time-division multiple access (TDMA).**

1.INTRODUCTION

Wireless Sensor Networks (WSNs) have recently attracted significant interest from the research community. However, the configuration and maintenance of wireless networks and devices with diverse protocol stacks and vendor-specific interfaces have become extremely complex and expensive.

Moreover, there is a lack of openness, flexibility, and scalability in the current wireless network architectures. The new multihop MAC protocols have been reinforced based on TDMA. A schedule assigns slots to links, in which the bandwidth of every link is furnished by the number of slots, which are allocated in the frame. The MAC layer outcomes are based on the routing perception on the network layer. So, the MAC layer plays an important role in guaranteeing end-to-end reliability qualities [1]. Other QoS studies in sensor networks focus on QoS domain, either timeliness or reliability. They are also restricted in differentiating services for traffic flows with different levels of timeliness and reliability requirements. It is not practically possible to reserve the resources, in the network because the end-to-end path based methodologies are not versatile because of excessive overhead of path discovery and recovery in huge scale sensor systems.

In communication network systems, end-to-end reliability is usually described as, that all transmitted packets arrive at their destination earlier than a not unusual deadline has been reached. Redundancy is also an important factor in achieving reliability. In this paper, we propose an effective scheduling algorithm with slot sharing to ensure per flow end-to-end reliability in WSNs. The proposed method adds time slots for retransmission to each link in order to satisfy the required reliability. We propose PlanEx, a low-complexity regular extension for existing slot-based scheduling algorithms. PlanEx ensures that the ensuing schedule frame guarantees end-to-end reliability bound ρ^*. PlanEx, in preference to the Incrementer supplied in [2], does not require a legitimate schedule body to start with. With PlanEx, schedules may be hastily calculated on the network manager or the sensors. In addition, the algorithm might be integrated into cross-layer optimization frameworks for rerouting and scheduling.

1.1 Related Work

Researchers have improved the reliability and delay in WSNs. In wireless medium the communications are by nature error-prone. In multi-hop networks such as wireless mesh networks, interference is because of the existence of hidden nodes which increases the likelihood of packet loss. Such probabilistic packet loss can make the end-to-end Packet Delivery Ratio (PDR) or throughput unacceptably bad for many of the applications which require reliable data transmissions in multi-hop wireless networks [3] .The proposed literature in [5] shows the mixed sound verification which shows to be robust and feasible for the envisaged application in a WSN-based source environment. As a contention-based method, Felemban et al. proposed multi-path and multi-speed routing protocol (MMSPEED) for probabilistic reliability guarantee in WSNs [4]. Thus, contention-based approaches need to take care of packet losses due to collision and channel quality. Therefore, contention-free based approaches are suitable for ensuring reliability and delay since they only consider packet losses due to channel quality. Hence for this purpose standard for Industrial WSNs such as ISA100.11a and WirelessHART gains TDMA as a data layer protocol as in [6]. In addition to this, recent researches to guarantee both reliability and delay requirements employ TDMA-based MAC and proposed scheduling algorithms to achieve them.

Suriyachai et al. [1] provide a latest evaluation of existing studies on QoS for mission-important WSN applications. Accordingly, preferred methods for guarantees on reliability, latency, and other measurements such as jitter, or throughput, considering community dynamics, are highly demanded [10]. A primarily study on scheduling for WSN with end-to-end transmission delay guarantees and stop-to-end reliability maximization can be found in [7]. The authors suggest scheduling algorithms, dedicated and shared scheduling, which includes those which can be used for comparison in [7] from [8], which is considered for the node-to-node packet reception prices by means of ordering the sensors according to hyperlink exceptional before scheduling.

PlanEx is found to be an adaptive, scalable, and a fast algorithm which is capable of ensuring the end-to- end reliability of packet delivery throughout the network. PlanEx successfully identifies network configurations, and hence integrates the routing and organizing resolutions for networks with varied traffic priority levels.

1.2 Proposed Algorithm

Design Considerations:

- Deployment of nodes in the network.
- Discovery of Routes by the nodes in the network.
- Source node generates packets and delivers to next hops.
- Upon receiving the sensor data, Split the data into fixed size packets.
- Applying scheduling algorithm [PlanEx] to decide the next slot(s).
- Transmits packets using multihop routing.
- Performance analysis is seen by scalable scheduling and guaranteeing end-to-end reliability.

Description of the proposed Algorithm*:*

The main aim of the proposed system is to make use of the PlanEx algorithm is to achieve end- to-end reliability in the communication network without any packet losses. Redundancy is also an important factor which can improve reliability by resubmission of lost packets, usually applying slotted scheduling which is addressed on the MAC layer. The proposed algorithm consists of three main steps.

Step 1: Calculating node-to-node probability:

We model the success arrival of a packet as node-to-node packet arrival which give a confirmation about the a successful reception of an acknowledgment (ACK) at the receiver facet earlier than the end of the time-slot has been reached. The packet submitted from a sender to a receiver r, the node-to-node Probability that a packet arrives in a sequence of n attempts can be calculated by using

$$P(\text{success} \geq 1 \text{attempts}) = \sum_{k=1}^{n} P(\text{success} = k \mid n \text{ attempts}) \quad ..\text{eqn}(1)$$

$$= 1 - P(\text{success} = 0 \mid n\text{attempts}) \quad ..\text{eqn}(2)$$

$$= 1 - (1 - v)^n \quad ..\text{eqn}(3)$$

Where, p is the Probability that a packet arrives,

n is the number of attempts of packet arrival in a series,
k is the discrete time for packet transmission and the success probability is gained by the packet reception rate v.[8]

Step 2: Node Selection criteria:

Initially all the nodes are deployed in the network. The parameters for all the nodes are configured, such as initial energy, propagation time, MAC, multihop, receiver power, transmission power, channel type, etc. The above mentioned parameters are monitored continuously by the sensor devices. Nodes send hello packets to their neighboring nodes and they exchange data packets with each other. At this stage selection of source and destination nodes are done. Now source node sends route request packet to neighbour nodes. The routing table(R) records all the packet information. The destination nodes send the route reply message to the source node. The proposed algorithm upon receiving the sensor data split the data into fixed size packets and forwards the data packets to the destination in multiple links. Here, the energy consumption is reduced and the schedule frames allow the transmitters to share slots among different sources. The proposed method first allocates additional time slots for retransmission to each link to meet the required reliability and hence we achieve an effective end-to-end reliability and delay requirements in the communication system.

Step 3: Finding the reliable path

Once the nodes are in active state they transmit the data packets to their neighboring nodes considering all the energy constraints in the network. The proposed PlanEx algorithm, works in a centralized manner. After receiving the data from the source nodes divides the data into fixed size packets and the algorithm is applied to decide the next upcoming slot in the frame for the transpose of packets, and append the slot(s) to the schedule frame and forward the packets using multihop routing. The average probability of node-to -node delivery, is calculated using the equation (3), and depends on the frequency at which messages are sent through the network. The packet information in buffers is updated according to the transitions held. The routing table is determined by the Dijkstra shortest path algorithm applying the expected transmission count (ETX) metric [11]. It transmits the packets in the short track to the destination in which the energy is saved. In this way the proposed system finds the reliable path to transfer the data packets and thereby, ensuring end-to-end reliability in wireless monitoring applications.

PSEUDOCODE

Step 1: Deploy the nodes in the network
Step 2: Calculate the probability (P) of the node using
equation (3)
Step 3: if (P ≥ 1attempts)
nodes are in active mode
else
nodes are in sleep mode
Step 4: Then the nodes discover the routes to transmit the
packets

Step 5: Apply scheduling algorithm to decide the next
slot(s)

Step 6: Data is divided into fixed size packets and
Step 7: Append the slot(s) to the schedule frame

transmitted to the neighbouring nodes
Step 8 : Then forward the packets using multihop routing
Step 9: Update packet buffers and routing table according
to transitions
Step 10: Finally from source node all the data packets are
transmitted to the destination node
Step 11: End

2. SIMULATION RESULTS

The simulation results show the deterministic topology of sensor network with 35 nodes as shown in chart 1. The proposed PlanEx algorithm is implemented using NS2.35 simulator, using the network animator NAM window. Initially all the nodes are configured with the parameters such as propagation time, MAC layer, antenna, constant bit rate and initial energy is set to 200 joules. The nodes are deployed randomly in the NAM window. The packet delivery is through single path and multipath routing. As sensor nodes have very less energy resources, the network application domains have energy efficiency as the main design goal. Hence, existing network protocols are very energy efficient, but they provide very simple and best-effort data delivery. This type of behaviour poses no problem in this application scenario as long as data transport delays can be tolerated [2]. In the simulation results, we show that, through proposed system the energy efficiency of the nodes and reliability constraints are achieved in a greater height.

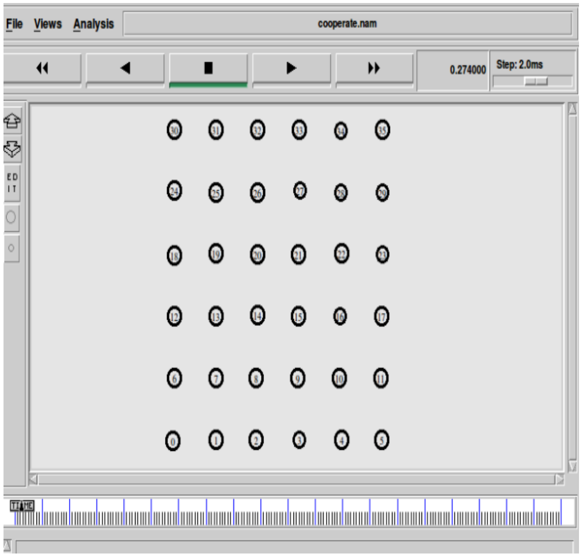

Chart- 1: Wireless Sensor Network of 35 Nodes

Life Improving Ratio

Chart 2 depicts the average life improving ratio of the nodes in the current existing network. In Chart 2, X-axis indicates the time in milliseconds whereas, Y-axis indicates the life improving ratio of the nodes. In the graph, green color indicates the existing system where the energy level decreases, whereas red color indicates the proposed system, here the energy level is increased at a greater altitude, thus increasing the average life improving ratio of the communication systems.

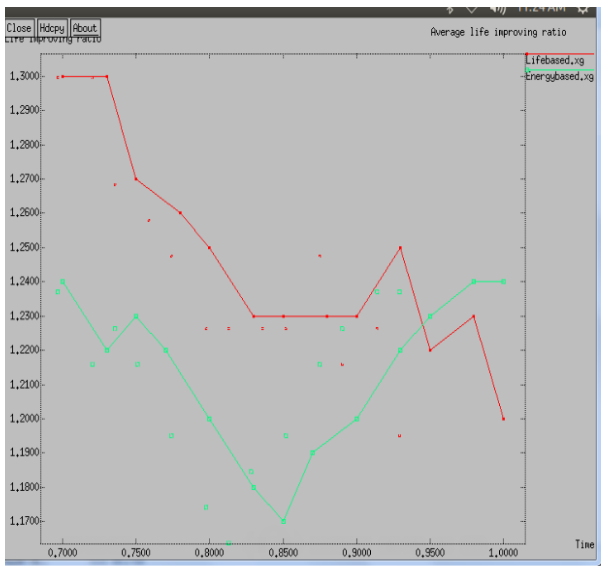

Chart- 2: Life improving ratio of the proposed system

Packet Receiving Ratio

Chart 3 depicts the Packet Receiving ratio of the nodes in the current existing network. In the graph X-axis indicates the elapsed time in seconds whereas, Y-axis indicates the packet receiving ratio of the nodes. In the graph, the existing system indicates that the Packet Receiving ratio is stable and decreases gradually, but in proposed system Packet Receiving ratio is constant for a longer time, and then decreases at a certain point of time, as the energy level reduces while conveying the data packets to the neighboring nodes.

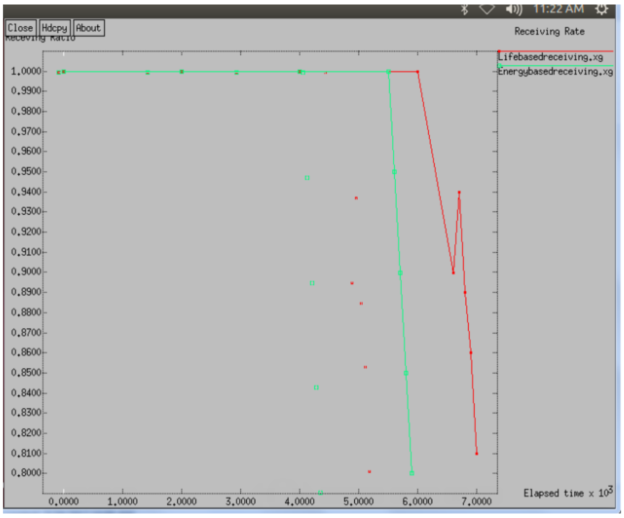

Chart- 3: Packet Receiving Ratio of the Proposed System

Reliability Constraint

Chart 4 depicts the Reliability Constraint of the nodes in the current existing network. In the graph X-axis indicates the reliability demand whereas, Y-axis indicates the time. The proposed system along with the PlanEx reliability and energy constraints configure many parameters in the network. In the proposed system, the delay for transmitting packets is reduced and reliability factor reaches a significant gratitude and thereby, increasing the overall performance of the system.

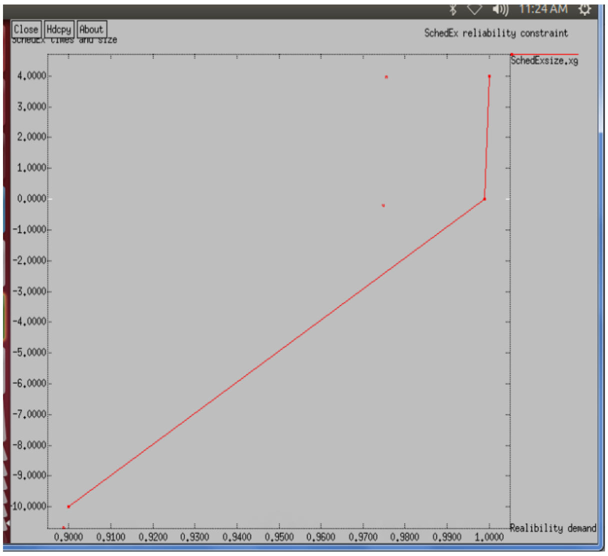

Chart- 4: Reliability Constraint of the Proposed System

3. CONCLUSIONS

In this paper, we have proposed PlanEx, a general scheduling algorithm, which enhance the reliability guarantees for the network topologies. Constant node-to-node reliabilities and topologies with a set of sensors and sinks are assumed in this paper. Sampled information is transmitted through multihop from the sensors to the sinks, and all packets have the same reliability necessities. The proposed algorithm splits the data into fixed size packets and transfers to the destination nodes through multiple hops. Simulation results show that the proposed method makes expressive growth in packet reception rates, life improving rates, reduced energy consumption, scalable scheduling and achieving a highly required feature for end-to-end reliability guarantees in wireless sensor network. As future work, we plan to implement the other scheduling algorithms and making some modification in the design considerations and analyzing the performance metric of sensor nodes and then assess its effectiveness in test-bed WSNs in a real world.

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BIOGRAPHIES

Dr. Mary Cherian has 32 years of experience in professional field spreading over Education, Research and Industry. Currently she is working as Associate Professor in the department of Computer Science in Dr. Ambedkar Institute of Technology, Bangalore, India. She has publications in national and international conferences and journals. Her areas of interests include computer networks, sensor Networks, real time routing protocols, and cognitive routing. **Dr. Mary Cherian** has life membership of professional bodies like CSI, ISTE, IE and IETE.

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