Performance of QoS Aware Routing Protocol in WSAN

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Abstract-WSANs mean class of actors and sensors connecting by a wireless means of communication to execute the distributed actuation and sensing tasks. WSAN has made a boom in the technology of communication. With the help of sensors and actors the communication has been more fast and reliable. Moreover it can provide us the more accurate results in the case of any emergency appearing in communication. QoS plays a vital role to ensure that the requirements for the class of applications are met. We are presenting a QARP which is a QoS aware routing protocol with service differentiation for WASN and is used to support the communication among the sensor nodes, actor nodes and the sink. Here QARP is providing delivery assurance with low latency in the presence of failure. We are using a queuing model which assists lesser transfer rate for lower concern packet delivery if jam condition occurs. So QARP can be a potential solution for monitoring with subject to emergency situations. In WSN there are many challenges like power backup, mobility, route failure etc. Such problems are been taken care of by QARP.

Keywords- Queuing model, Quality of Service, Wireless Actor and Sensor Networks.

I. INTRODUCTION

A wireless sensor network (WSN) can be defined as being composed of a number of nodes having sensing, processing and communication facilities which are arranged within the phenomena or it's nearby. Each of these nodes collects data and route the information back to the sink. As the position of the individual (nodes) is not fixed so the network must possess the capability of self organising itself as per need and requirement. In other words collaboration of nodes becomes an important factor in WSN [1] functioning. Wireless sensor networks have been tremendously using in many applications like healthcare applications, home automation, machine health monitoring, environment, traffic control and habitat monitoring [15]. Important information must be delivered correctly without any error and in time. We re-evaluate the procedure for QoS support in traditional networks, examine new requirements of QoS in WSNs from a broad range of applications classified by data delivery models, and propose some non end-to-end collective QoS factor. Next, the challenges of QoS support in this new perception are presented [2]. The QoS- Aware Routing Protocol (QARP) provides low latency and reliable delivery in the presence of failures. QARP can be a potential solution for the monitoring of context aware physical environments subject to emergency situations.

WSNs have several distinctive features:

- *Unique network topology*
- *Diverse applications*
- *Traffic characteristics*
- *Resource constraints*
- *Small message size*

II. RELATED WORK

A literature survey is done on the subjects such as Design Guidelines for Routing Protocols in WSNs, Performance Metrics and Hop-by-Hop flow Control. Hop-by-Hop flow control has been proposed in wired local area and wide-area networks, as well as in sensor networks [3]. In the traditional circuit-switching network, alternate path routing was used to decrease the probability of packet blocking. In this scheme, the shortest path between two exchanges is used until it fails or reaches its capacity, when packets are routed through a longer, alternate path. In the present research train, lots of work is going on in routing protocols for wireless sensor network. Scenarios for emergency preparedness class of applications are not considered. Sensor nodes may have various sensing devices (e.g. temperature, light, pressure etc.) and no other protocols considered several sensing devices in the same node except STCP [4]. To maximize the lifetime of the network, all of these routing protocols considered energy efficiency as their main objective. Other challenges like the introduction of video and imaging sensors have also posed. In order to ensure efficient usage of the sensors, transmission of video and imaging data requires both energy and QoS aware routing and effective access to the gathered measurements. This paper presents, an energy-aware QoS routing protocol for sensor networks which can also run efficiently with best-effort traffic [5]. Differentiated services in the Internet [12] tell about the QoS for the Internet, introduce and motivate the Differentiated Services approach. The major advantages of this approach are that it is a superior match to the Internet architecture and that it can be primarily install with a simple approach and adding complexity as needed. QoS [2] is used to describe a set of measurable parameters, such as delay, throughput, and loss rate, that can be attached to some identifiable subset of the traffic of IP packets through a given network domain. In paper "A fast and reliable protocol for wireless sensor networks in critical conditions monitoring applications"[13], Sensor networks are increasingly being organized for monitoring of physical environments in case of critical conditions such as fire and explosions. The biggest problem to these networks is to provide a fast, reliable and fault tolerant channel for events distribution, which meets the needs of query-based, event-driven and periodic sensor networks application, even in the existence of emergency conditions that can guide to node failures and path distraction to the sink that receives those events. A fault tolerant and low latency algorithm, which are referred as PEQ (Periodic, Event-Driven and Query-Based Protocol) [5], meets requirements of sensor networks for crucial conditions surveillance applications.

III. QOS AND QARP IN WIRELESS ACTOR AND SENSOR NETWORKS

The Sequential Assignment Routing (SAR) [6] is one of the QoS aware routing protocols applied to plane networks. SAR uses tables and multiple paths to save energy and achieve fault tolerance. SAR protocol creates trees of nodes considering the residual energy in each path as well as the priority level of each packet. Multiple paths are created through the use of trees. Any of these paths is chosen according to its quality of service. Fault recovery is achieved through routing table consistency maintenance between the source and destination nodes of each path. SAR can keep numerous paths from the nodes to the sink that guarantees fault tolerance. But SAR suffers from high overhead to keep the routing tables and states at each node and that overhead increases for dense network. QARP means QoS-aware routing protocol with service differentiation. In the QARP, the wireless actor and sensor network is configured through hop trees, which are built in during the initial network configuration step. The proposed system is used to promote the interaction between the sensor nodes, actor nodes and the sink. QARP gives minimum latency and consistent delivery in the case of failures. QARP is a hybrid protocol for WASNs whose main goal is to meet QoS requirements for three communication schemes between the network and the application: periodic, event-driven and query-based.

This paper present QoS- Aware Routing Protocol and also performs an analysis of the proposed protocol in meeting the requirements of QoS[11] for the emergency class of applications. The proposed protocol is designed with certain considerations about the network model and the queuing model. Fig. 1 depicts the network model with sensor nodes as Si with sensor nodes S1 to S9 delivering data to the actor node. The actor node in turn interacts with the sink node. The lines between nodes show the path of communication.

The important criteria considered for this network model are:

- Each node can sense various application data.
- All the nodes have the same transmission range.
- Actor node should work as intermediate sink for sensor nodes.
- Actor node should have more communication capability than sensor nodes.

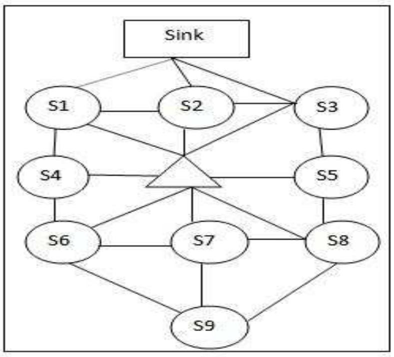

Fig. 1

The queuing model is implemented at every sensor node, to differentiate between high priority packets and low priority packets. The queuing model is particularly designed for the co-existence of real-time and non-real time traffic in every sensor node [7]. The model we use is inspired from class-based queuing model [8]. Packets are labelled according to their type. We assume that the MAC layer is collision free and will not create significant delay.

A. Protocol Description

The main aim in implementing this scheme is to route the real time traffic in Wireless Actor and Sensor networks to provide low latency. QARP routing algorithm will be realized in three steps.
In the first step, hop trees are built. The sink initiates the construction process, which will be used to flood the subscription messages and data on the network. Similarly, actor nodes also initiate their hop tree construction aiming to divide the network in acting areas. After the hop tree construction, subscription of messages takes place. The sink node informs its interest to sensor nodes, each sensor node consists of a requirement table and a routing table. The interest is stored in the requirement table by each node. When sensor node captures some event, it compares it with the entry of the requirement table. Accordingly finds best path from routing table to forward the report about the event to the sink of that interest. While sending report message, the sensor node which captures event sends packet to actor node by hop-by-hop, and then the actor node sends it directly to the sink node. The path used to send subscription message from the sink node to the sensor node is used in reverse to send report by the sensor node to the sink node in the same area. Finally, the last step is responsible for the packet delivery from the sensor nodes to the sink. For this delivery, faster paths are used for higher priority packets and lower cost paths are used for lower priority packets. During this step, if any path failure occurs, path repair techniques are applied. The node energy level is updated at every node that is part of the path used for the packet delivery. This scheme includes initial network configuration, subscription message propagation and sending the notification message.
Path updating mechanism is also incorporated in this protocol. It is an ACK-based mechanism. The sender node sends a packet and starts a timer, waiting for an ACK message. If it does not receive an ACK message within the time out period the node selects an alternate path from the routing table.

IV. SIMULATION RESULTS

The details of simulation parameters are as follows: In an area of 50mx50m sensor field 50 sensors are deployed randomly. Sensors are having a transmission range of 10 m and actor nodes are having a transmission range of 100 m. Actor nodes are provided with more transmission capabilities than sensor nodes. It is assumed that there is no interference from other nodes.
The lifetime of a wireless sensor network is constrained by the limited energy and processing capabilities of its nodes. Sensor nodes have limited energy. To extend the life time of the sensor networks it is very important to have high energy efficiency at all the processing nodes [9]. As the actor nodes collect the data from the sensor nodes, which in turn forward the data to the sink node, the energy consumption [10] is less since the number of hops to reach the sink node from the sensor node is less.
The diagrams below illustrate the different phases of the protocol, hop tree construction, propagation of the subscription messages, and the data collection by the actor node and the sink node.

In Fig. 3, we describe the status of sensor node 6 after the HOP tree construction by the sink node.

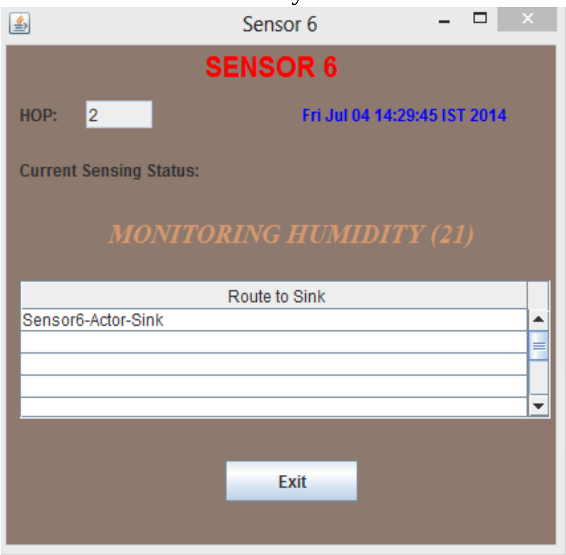

Fig. 3

The subscription of the interest by the sink node is shown in Fig. 4. Here the sink requires the humidity of the specific area to be gathered and delivered by the sensor nodes monitoring the specific area.

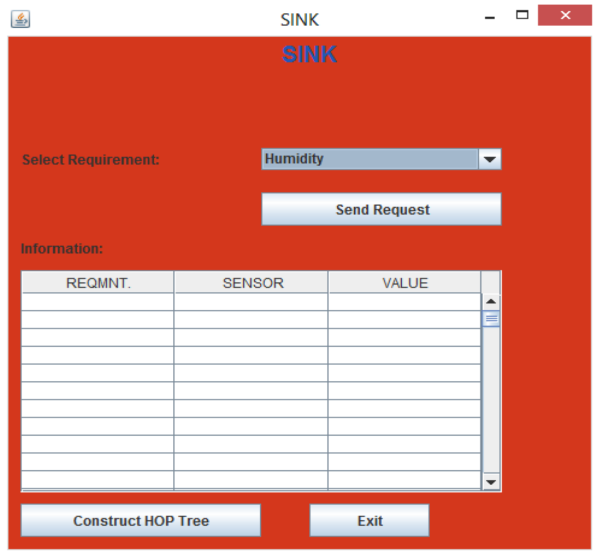

Fig. 4

Fig. 5 indicates actor node receiving the report message from the sensor nodes about the interest.

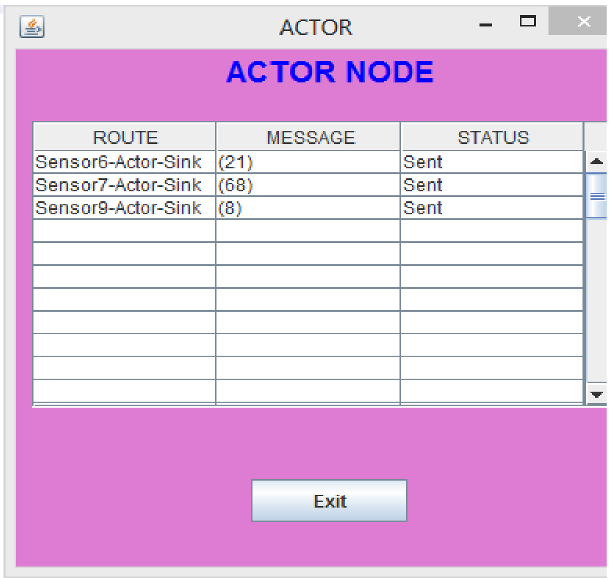

Fig. 5

The propagation of the collected data by the actor node to the sink node is depicted in Fig. 6. The actor node promotes the interaction between sink node and the sensor node.

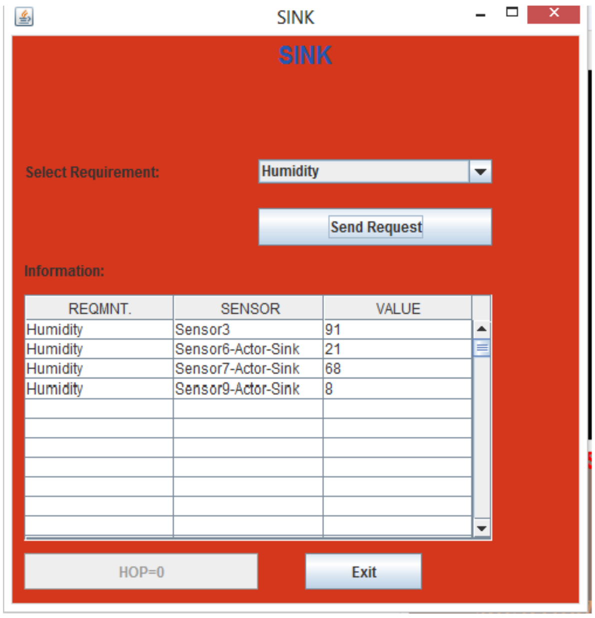

Fig. 6

V. CONCLUSION

Wireless sensor and actor networks (WSANs) can greatly get better accuracy in observing the surroundings of physical environments which are related to the emergency conditions [16]. This class of application poses strict requirements, such as low latency, fault tolerance and reliable packet delivery. Wireless sensor and actor network presents a new QoS-Aware Routing Protocol with Service Differentiation (QARP), which meets the requirements as above. QARP uses the subscribe concept to promote the communication among the sensor nodes, actor nodes and sink. It also provides a fault tolerance mechanism, which allows low latency and reliable delivery even in the presence of failures. QARP uses the low costlier energy path for low concern packets that do not need low latency. In case of jam conditions, a queuing model is used which helps in supporting lower transfer rate for lower priority packet delivery. QARP performance evaluation shows better results for delivery rate and end-to-end latency for higher priority packets when compared to PEQ (Periodic, Event-Driven and Query-Based Protocol) [5, 6]. QARP can be a potential solution to the monitoring of context aware physical environment subject to emergency situations where delivery reliability and lowest possible latency are prime requirements.

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