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Holistic Approach Towards Inclusive Understanding of Quality of Service In Wireless Sensor Network

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ABSTRACT
Data is being communicated over a traditional network since a very long time and too much research and development has been carried out in the past. The Wireless communication is very different from that of the traditional network in a manner that resource availability is limited; channel is free space, and power constraints. Considering all these issues, It becomes very important to address the Quality of Service issues in WSN which still requires lot of research and development so as to provide the expected result in the during the last mile. In this paper we have tried to address some of the challenges for QoS support and provisioning, metrics and parameters that help in evaluating the QoS of the system for proper throughput of the network. The issue of QoS on all layers of WSN are also addressed so as to have a holistic approach towards the issue concerning QoS in WSNs.
Keywords: Challenges, parameters of QoS, QoS provisioning, Quality of Service

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I. INTRODUCTION TO QOS

A lot of research [1] has been carried out concerning aspects of WSNs such as architecture, protocol design, energy conservation, localization to name few but still the aspect of Quality of Service (QoS) in WSNs is not much researched about. One of the primary reason for this is that Wireless network is very much different from the traditional network. Different researchers have different perception about QoS and they interpret it differently [2]. When concerning application scenario, QoS is perceived as quality received by user or application while concerning with network situation, it is perceived as the network quality offered to the user or application. The above mentioned two perspectives can be shown in the figure below. The requirement of a network is to provide high end-to-end throughput for various applications. Different applications have different QoS end-to-end parameters requirements.

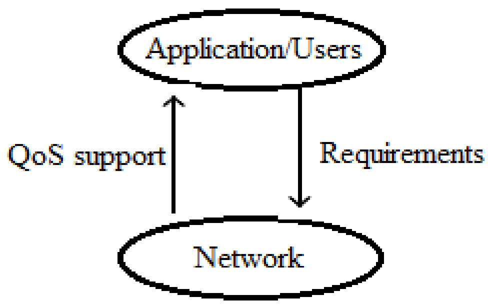

Figure 1: a simple QoS model

As discussed the QoS has two perspectives:

Application Specific:

For such perspectives, parameters such as network coverage [3], exposure [4], measurement errors, and optimum number of active sensors [5]. Thus every application is very concerned about the type of sensor deployment or the lifetime of sensor network or the accuracy in measurement relates QoS directly to the applications quality.

Network Specific:

While concerning with network, we look for how efficiently the data can be transferred over a channel while utilizing the available resources and maintaining the QoS. For delivering of data we usually classify the delivery into three general categories: event driven, query driven, and continuous delivery model [6].

Due to resource constraints like processing power, memory, bandwidth and power sources in sensor networks, QoS support in WSNs is a challenging task [7]. In RFC 2386 [8], QoS has been defined as a set of service requirements to be fulfilled when transmitting a stream of packets from source to destination. Measurement of parameters for QoS is particularly important as the wireless sensor network is fairly different from that of a traditional network [9]. Due to these differences between networks, several issues and challenges arises such as Energy efficient protocol design, scalability, self-configuration, unbalanced traffic, redundancy in data transmission, and energy management.

Since the network is constituted as a sensor nodes which in certain applications may be mobile, the most concerning parameter in designing a network topology for a sensor network is the residual power as the sensor nodes are battery operated and carry limited amount of power. When we are looking from an application point of perspective, we have to remark upon the QoS issues so as to make the applications and network work as efficiently as possible while increasing the network lifetime. In wireless sensor network, the QoS is still a topic of much research and many QoS issues need to be addressed. Most of the time while developing a wireless sensor network design, we consider the stationary nodes where as many applications exists where we need mobile nodes and due to non-scalability issues, those same designs cannot be used over for the mobile network where we have to address the topic of dynamic topology as-well. Therefore, for efficient system design we have to address both the issues of dynamicity and mobility in the network.

We can also integrate this issue with real time monitoring using the Internet-of-Things (IoT) for global sharing of resources in the form of data gathering and data processing. Here the sensed data can be used for data analysis and comparisons so as to take undertake necessary arrangements for the given applications. Thus in this project work we intend to study the issues of mobility and dynamicity of the network in QoS provisioning of available resources in order to efficiently provide the end-to-end data transmission. The rest of the article is planned as follows. In section I, an introduction to QoS concerning the communication in wireless medium is concerned. In section II, a short summary of various QoS Protocols are presented tabulating their advantages and disadvantages. In section III, various QoS parameters affecting the data transmission in wireless mediums are discussed. In section IV, a conclusion is given about the article.

II. CHALLENGES FOR SUPPORTING QOS

Wireless Sensor Network is different from the traditional network in a manner that the data that has to be communicated from one node to another node is the data that is sensed in the vicinity of that node. Now this data is gathered, processed (depending upon the protocol) and forwarded to the sink node. The basic of QoS of a network is to provide the expected result in the transmission of data over the channel. Now in transmitting this data many challenges arises which leads to deteriorating the Quality of Service of the data communications. These challenges are:

Resource constraint: Like traditional Network which is supplied with ample amount of resources, the wireless network is severely constrained [10]. The resources required for WSN includes energy which is battery supplied, bandwidth which is a free space channel, transmission capacity of the sensor node to name few [11]. We have to ensure that while transmitting the data, a trade-off is maintained between latency and residual power of sensor nodes. The data in WSN is a mixture of real time and historic data. So, priority should be allocated to different types of data depending upon their applicability.

Node Deployment and Dynamic network Topology: In Random deployment, the path routing updating overhead leads to incurring loss of sensor battery power. Also, the dynamic topology and neighbourhood determination increases latency. In WSN, most application based scenario requires unstructured deployment of nodes which leads to improper transmission of data and reducing the overall QoS of the system. Since the nodes are also mobile in most of the situations, and with dying of sensor nodes, the network has to keep on rearranging itself into a well structure topology so as to keep the sensing region to maximum.

Scalability: When more number of nodes join the network or when some nodes leave the network or die out, it should not affect the QoS of the network. The network should behave the same whether having hundred nodes or thousands of nodes.

Multi-Source Multi-Sink System: Wireless sensor-actuator system, apart from some basic challenges, issues regarding heterogeneity of the network, resource management and security requirement are also present [12]. As per the application, a network may have a multi-source and multi-sink to maintain a variability of QoS support.

Diversified Application: With increase in acceptance of wireless network in various applications, variably type of QoS requirements arises. Among all these applications, the most demanding are the ones where data is required in real time. The real time QoS can be classified into two parts [13]: Hard real time and Soft real time. Due to network failure probability hard real time is difficult at achieve where as soft real time is fairly better tolerant to delays but have probabilistic end-to-end delay guarantee.

Diversification in traffic types: Due to variability in applications, the generated data to be transferred from one place to another is also varied. Also their quantity is dependent on various factors which lead to proper acknowledgement of QoS issues for proper resource management.

Link reliability: The channel in WSN is free space or radio, thus it may be affected by any of the numerable environmental factors leading to link failure. In such situations, Short links are preferred over larger links.

Data overload: To conserve limited resources, it becomes utmost important for a network to make sure that redundant data is not communicated. To ensure this, different data aggregation protocols [14] are available. In conjunction with these challenges of QoS, there are various other Metrics integrated into the QoS support and provisioning. When application is concerned with audio and video real time data, parameters such as jitters, latency and bandwidth are the issues. For military based applications, security metric is the challenging task. Also challenges such as limited battery power, control over data dissemination, Throughput are matter of research.

III. QOS IN WSN LAYER

In WSNs to provide QoS, there are two approaches: layer and cross-layer approach. In layer approach, QoS is maintained in each of the several layers of WSN communication protocol stack where as in cross-layer approach, there exists inter-dependency among each layers to maintain the QoS. For QoS provisioning, the goal is to provide desired level of QoS in the network while increasing the residual power of the sensor nodes. This in turn increases the network life time of the system.

MAC layer: In the layer structure of the protocol, MAC is at the bottom and unless it provides an efficient channel through medium sharing and reliable communication support, Transport layer and network layer cannot be provided with QoS support [15]. Thus, QoS provision is the most important for overall QoS for the system. In [16] a promising evaluation was carried where an approach based on quantitative modelling based on information processing and wireless communications was performed. Also, in [17] a scalable QoS MAC is proposed by the author guaranteeing QoS provisioning to multimedia based applications. This SQ-MAC is divided into four parts: synchronization period, Random access Period, Switching period, and adaptive schedule access period.

Network Layer: Network layer is mainly associated with the task of routing of data form one node to another. While doing do, ensuring that energy conservation is given its due priority while designing the routing protocol. This is done with an assumption that data does not have stringent QoS requirements [18]. These protocols are classified as data-centric, hierarchical, location-based or network-flow. Different QoS parameters for Network layer QoS provisioning are (i) conservation of energy which includes increasing the residual energy and decreasing the energy required for data transmission, (ii) reliability of link or route used for data transmission, and (iii) delay in transmission. A protocol was developed in [19], which considered all these QoS provisioning parameters using a modular approach with traffic differentiation being the underlying concept. These data traffics are classified as Regular traffic, reliability-sensitive traffic, delay-sensitive traffic, and critical traffic.

Transport Layer:

Transport layer design goal includes controlling the transmission of the source, effective message delivery, and reduction of congestion. Prioritizing the source during data transmission, a QoS provisioning protocol was developed [20, 21]. In this protocol, data reliability and reduction of congestion were addressed. The protocol was simulated under three different scenarios: no priority, complete priority, and distributed priority. The distribution of priority showed improved result regarding data storage and data dissemination. This led to improved throughput.

Some other parameters for QoS provisioning for other communication protocol layers are given. The Physical Layer addresses the issues of actual data transmission and QoS parameters for this layer includes data processing and data communication, and capability of sensing components [22]. The other layer is the application layer which is in direct contact with the user. The QoS provisioning parameters for this layer includes consistency of data, time required for response, network life time, data resolution, and originality of data [23].

IV. CONCLUSION

A thorough study about challenges and parameters for addressing those challenges has been carried out. Several of the important challenges are acknowledged with the drawback that these challenges bring about in the wireless sensor network. Different parameters in different communication protocol layers are also discussed exclusively. Some of the protocols developed by researchers are also addressed giving their various technicalities.

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