A Study of QoS algorithm for Wireless Multimedia Sensor Networks

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Abstract

Wireless Multimedia Sensor Networks (WMSNs) have entered the class of Wireless Sensor Networks to meet the multimedia requirements of new emerging applications, such as surveillance and telepresence. WMSNs commonly carry heterogeneous traffic with different Quality of Service (QoS) requirements. In this paper, the state of the art in QoS, protocols, Test beds, Simulators and the QoS requirements for Wireless Multimedia Sensor Networks is surveyed and open research issues and challenges are discussed in details.

Keywords- WMSNs, Quality of Service, algorithm, protocol, video packet scheduling

I. INTRODUCTION

Today's wireless communication is a gradually changing paradigm from its existing voice-alone services to a new world of real-time audio–visual applications. This ever-increasing popularity of multimedia applications has already started penetrating the domain of wireless sensor networks thereby giving birth to the new terminology wireless multimedia sensor networks (WMSNs). Video surveillance, telemedicine and traffic-control are going to be the killer-applications of these emerging WMSNs. While the need to minimize the energy consumption has driven most of the existing research in wireless sensor networks, these new applications require the sensor network paradigm to be re-investigated in view of application-specific quality of service (QoS).

The main component of wireless multimedia sensor network, are the sensor nodes, which are small in size, capable of self-organizing, sensing, processing data and communicating with other nodes. The availability of inexpensive hardware such as CMOS cameras and microphones that can ubiquitously capture multimedia content from the environment has fostered the development of Wireless Multimedia Sensor Networks [1], *i.e.*, networks of wirelessly interconnected devices that can retrieve video and audio streams, images, and scalar sensor data. International Telecommunication Union (ITU) [2] has defined QoS as:"Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service". Simply, QoS brings the ability of giving different priorities to varied users, applications, data flows, frames or packets by controlling the resource sharing, to provide better performance according to their requirements.

Each node consist of processing capability (Microcontroller, CPU or DSP chips), types of memory (program, data and flash memories), RF transceiver (single Omni directional antenna), power source (batteries and solar cells), sensors and actuators. Different standards for WMSNs [3] such as wireless HART, ISA100, IEEE1451, Zigbee, 802.15.4, Z-wave, wibree, ANT, 6LowPAN, MiWi, DASHT, ONE-NET.

Sensor network implementation is to create optimal and less-cost connectivity among sensor nodes. Communication between sensor nodes is based on multi-hop connection. Sensor nodes are generally unreusable; they are mainly assembled of low-cost and off-the-shelf devices in order to keep its cost cheaper.

Cross Layer Design for QoS Support in WMSN QoS parameters are Delay jitter, end-to-end deadline, bandwidth and reliability over unreliable medium. In multimedia applications delay jitter is compensated by carefully choosing the play out time. Packet deadline, bandwidth and reliability are dealt in the network at different communication layers jointly or separately, while distortion is the metric to measure the perceived QoS at sink node.

The remainder of this paper is organized as follows: Section 2 gives an overview of the QoS Routing Algorithm for WMSN. Section 3 discuss about the system background of WMSN. Section 4 presents challenges, Future study, Simulators and Test beds.

II. QoS Routing Algorithm for WMSN

The informative intensive data (eg: audio, video, image).Multiple QoS constraints which may deal with the delay, delay jitter and bandwidth. Genetic algorithm [4] imitates the mechanism of choice and the genetic in the natural biological evolution process and forms an optimized search algorithm. The general operating process of genetic algorithm consists of encoding, production of initial population, the determination of fitness function, method of selection, cross over operation and mutation operation etc.

Traffic classifier module classifies the types of frames i.e. I-frame &W-frame and stamps with their priorities to be dealt accordingly at the underlying layers and transfers it to the route classifier module.

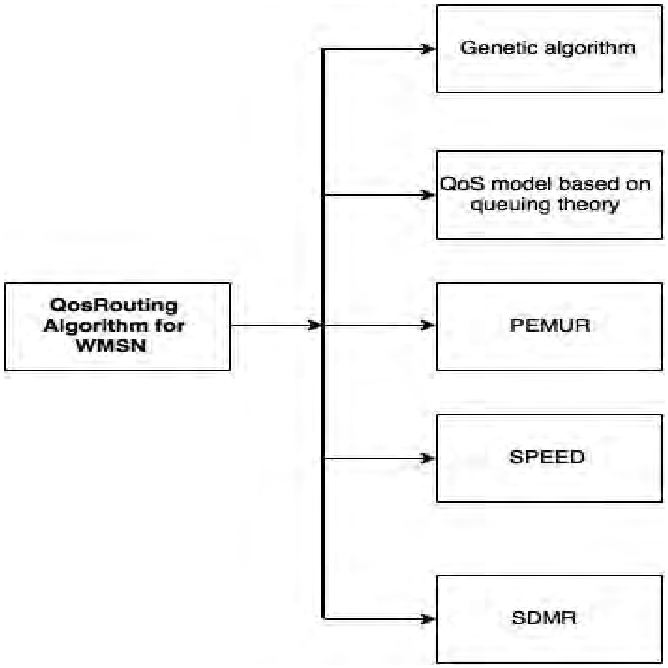

Figure 1. QoS Routing Algorithm for WMSN

Route classifier implement the source directed multiple path routing (SDMR) algorithms [5] and chooses an appropriate path for frame delivery. The performance metric is the quality of video measured as the signal to noise ratio (SNR) and packet delay. The increase the number of sources does not significantly increase the average end-to-end packet delay. SDMR follows multiple paths. If the higher delay is observed in one path, then the subsequent packet will be transmitted through alternative paths to distribute the load among three disjoint paths. Hence the admission of a new source does not necessarily increasing the delay of existing admitted sources.

In PEMUR (Power Efficient Multimedia Routing) algorithm [6] video packet scheduling models ensures low power consumption overall sensor nodes and high perceived video QoS. Video packet scheduling algorithm enables the reduction of the video transmission rate with the minimum possible increase in distortion by using an analytical distortion prediction model that is able the predict the resulted video distortion due to any error pattern. Video packet scheduling performs with distortion prediction model(DPM).The correlation among video frames during the intra frame period and the impact that the uses of reference frames has on the distortion propagation phenomena in the case of a frame loss. Three types of losses are single or isolated losses, bursts of losses and losses separated by small lags. The video distortion is measured in term of Mean Square Error. Video packet scheduler allows every sensor node to determine in the current transmission window several combinations of packets to drop, suitable for different ranges of transmission rates that may be imposed by the network at the next transmission window.

The depletion of nodes over time is typical metric of the energy efficiency of a routing protocol. The PEMUR protocol is significantly better than the TEEN protocol in retarding the time of node depletion. The enhancement in energy performance metric provided by PEMUR becomes even greater in the case of a non-uniform node energy distribution.

The more unbalances the energy distribution in a WSN is the more beneficial the use of PEMUR becomes, this is a great advantage of PEMUR. The PEMUR maintains the perceived video quality (PSNR) at higher levels than TEEN for both uniform and non-uniform energy distribution.

The original video sequence has mean PSNR=38.76 db. The mean PSNR is reduced for both PEMUR and TEEN. PEMUR has a lower reduction of PSNR than TEEN. These advantages of PEMUR enhance the belief that this scheme is indeed capable of achieving efficient video communication in real life application. In PEMUR the quality of the video measured through the value of the peak signal to Noise (PSNR) ratio.

Power-aware QoS routing [7] protocol find the next hop among the available nodes based on local information. Achieve latency requirements the shortest hop-wise paths are selected and considering both delay at sender and receiver the forwarding node chosen. Nodes are evaluated based on their recent link quality and the transmission power.

QoS metrics should have direct relation to energy consumption. All QoS should be modeled so that it would diminish power usage and increase network life. In this QoS model based on queuing theory in order to control multimedia packets in the queue and decrease packet loss. Decrease in the number of retransmission of dropped packets will result in less energy consumption.

The SPEED protocol [8] provides real-time unicast, real-time area-multicast and real-time area-any cast communication services. SPEED takes the first step in addressing the concerns of real-time routing in WMSNs.

III. SYSTEM BACKGROUND

A. Conventional WMSNs

There are three way to awake sensor board to collect data.

a) Event-driven in this way sensor boards are automatically activated to gather data. Even though a mobile sink is desirable, it poses new challenges for designing energy-efficient sensor network protocols. As the sink moves in the sensor field, it leads to high control overhead to find a route to the sink and route packets to it, which may potentially offset the energy saved from a mobile sink strategy. Furthermore, frequent changes to the sink location can result in an increase in packet latency. The majority of published methods assume periodic sensing, where sensors are continuously monitoring the network and reporting data to the sink. However, there are a large number of applications (e.g., intrusion detection, environmental monitoring, habitat monitoring) where an event-driven approach is more appropriate. In event-driven sensor networks, data is only generated when events occur.

b) Periodically in this way sensor nodes are configured manually by administrator to act on specific time.

c) Query-based in this way an administrator send query on particular task to all nodes in the network through a sink. As a destination node gets request, it starts sensing an environment and responses back to the sink.

B. Protocol stack

Buffering and queue mechanism in the MAC layer in order to increase QoS by preventing data loss. Decreasing probability of data loss leads to minimum retransmission which in turn results in less power consumption.

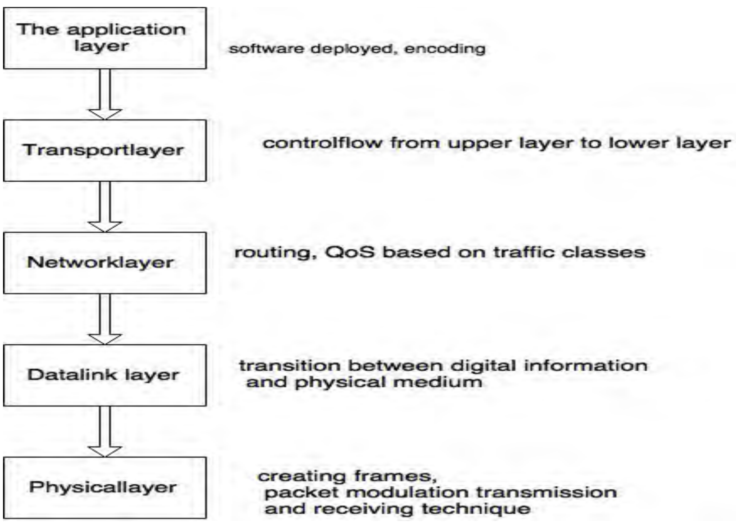

Figure 2.Layers in MWSN

C. QoS requirement

QoS in WMSN has some techniques such as reliable and authenticated information .QoS requirement are low delay and maximum reliability.

a) Application specific WMSN are quality of application itself. The requirements are lifetime coverage, deployment, quality of sensing, number of active sensors.
b) Network specific WMSN means delivery of data by communication network. The requirements are latency, packet loss, reliability.

D. Parameters to Measure QoS

a) Bandwidth: Bandwidth is commonly measured in bits/second is the maximum rate that information can be transferred and available SNR determine the maximum possible throughput. Number of tasks in fixed time.
b) Throughput: In throughput the number of such actions executed or results produced per unit of time. This is measured in units of whatever is being produced per unit of time. The actual rate that information is transferred. It is controlled by available bandwidth.
c) Latency: The delay between the sender and the receiver decoding it, this is mainly a function of the signals travel time and processing time at any nodes the information traverses. The time required to perform some action or to produce some result. Latency is measured in units of time-hours, minutes, seconds, nanoseconds or clock periods.

   T=d/cm.

   Where

   d=the distance.

   Cm=the speed of light in the medium.
d) Jitter: The variation in the time of arrival at the receiver of the information
e) Bit Error Rate (B.E.R): The number of corrupted bits expressed as a percentage or fraction of the total sent.
f) Delay: The time taken for a packet to be transmitted across a network from source to destination
g) SNR: Signal to noise ratio will quantify how much a signal has been corrupted by noise.

IV. Test bed and Simulator

A.Testbed

The WMSN-test bed includes three different types of multimedia sensors: low-end imaging sensors, medium-quality webcam-based multimedia sensors and pan-tilt cameras mounted on mobile robots.

Low-end imaging sensors such as CMOS cameras can be interfaced with Crossbow MICAz motes. Medium-end video sensors are based on Logitech webcams interfaced with Stargate platforms. The high-end video sensors consist of pan-tilt cameras installed on an Acroname GARCIA robotic platform [1], which we refer to as actor. Actors constitute a mobile platform that can perform adaptive sampling based on event features detected by low-end motes. The mobile actor can redirect high-resolution cameras to a region of interest when events are detected by lower-tier, low-resolution video sensors that are densely deployed. The test beds also include storage and computational hubs, which are needed to store large multimedia content and perform computationally intensive multimedia processing algorithms.

B. Simulator

Simulator is universally used to develop and test protocol of MWSN. The tool which is using firmware as well as hardware to perform the simulation is called emulator. Emulation can combine both software and hardware implementation. MWSNs simulators including NS-2, TOSSIM, OMNET++, Mat lab, Emstar, J-Sim, ATEMU, Tinyos and AVrora

OMNET++ is an extensible, modular, component-based C++ simulation library and framework, primarily for building network simulators. OMNET++ and Castalia simulators are used in MWSN. It supports multimedia transmission for fixed and mobile scenarios with QOE (Quality of experience). Castalia and WiSE-Mnet frameworks are in M3WSN framework. It support wireless video sensor network model.

WiSNAP is a Mat lab-based test bed designed for wireless multimedia sensor networks. In Mat lab Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

V. Open Issues and future research directions

The challenges brought about by WMSNs in QoS due to highly resource constrained nature of sensor nodes, unreliable wireless links and harsh operation environments. Stem from the end-to-end bandwidth hungry multimedia applications and reservation based approaches such as integrated services.

Novel QoS-aware protocols should be developed to meet the requirements of multimedia wireless sensor networks. Implementing existing and new protocols on real hardware and comparing their performances on test bed environments. Application-specific cross-layer QoS support mechanisms might be a promising solution for QoS provisioning in resource constrained sensor networks.

In multi-constrained QoS unicast and multicast routing problem which has energy confinement mechanisms needs. Applying scalable video coding after the existent uncorrelated routing paths have been discovered, base layer video streams are routed via the paths having the superior transmission characteristics while the enhancement layers are routed through the paths that possess lower QoS features. The utilized network topologies in mobile nodes are continuously dynamic reconfigured.

VI. Conclusion

In this paper we have presented a study of QoS algorithm for Wireless Multimedia Sensor Networks and outlined the main research challenges. Algorithms, protocols and simulators for the development of WMSNs were surveyed According to the study we observe QoS should be modeled so that it would diminish power usage and increase network life and avoid congestion.

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