The Study on Supporting Big Data Framework in Wireless Surveillance Networks

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Abstract: Nowadays, Wireless Sensor Networks (WSNs) are based on techniques more and more oriented towards image, video and sound processing, hence the recent need of Wireless Multimedia Sensor Networks (WMSNs). One of the important challenges for real-time surveillance system is end-to end delay QoS for packet deliveries. Providing end-to-end QoS is difficult due to two reasons. As wireless sensor nodes may require multichip transmissions to reach the sink and some of the wireless transmissions may be not successful. Multimedia data are characterized by their large volume, and have strict requirements in terms of quality of service (QoS) such as bandwidth, delay, packet loss, delay jitter, etc. In this paper, we are interested in routing protocols based on clusters that aim to reduce congestion in order to have reliable data transmission and a reduced loss rate. This is achieved by balancing the traffic load, which results into a balanced energy consumption within the network.

1 INTRODUCTION

Nowadays, Wireless Sensor Networks (WSNs) (Takaishi, 2014) are based on techniques more and more oriented towards image, video and sound processing, hence the recent need of Wireless Multimedia Sensor Networks (WMSNs) (Nadkarni, 2014). Examples of applications for WMSNs include the monitoring of elderly people, the monitoring of fields in precision agriculture, intruder detection through video cameras, etc.

With recent developments in low cost hardware such as CMOS cameras, microphones and PIR sensors, the wireless nodes can be equipped with these modules and have contributed to the development of Surveillance Wireless Multimedia Sensor Networks (SWSNs). One of the important challenge for real-time surveillance system is end-to end delay QoS for packet deliveries. Providing end-to-end QoS is difficult due to two reasons. As wireless sensor nodes may require multihop transmissions to reach the sink and some of the wireless transmissions may be not successful (Hou, 2015). Due to significant growth in data volume, WSNs require protocols to support big data which are characterized by 3Vs. These sensor nodes gather a large volume and wide variety of the sensed data. Due to sensor nodes constraints, many protocols are designed and proposed to conquest these constrains which include energy, self-management, wireless networking, decentralized management, design constraints and security (Dargie, 2010; Luo, 2011; Xu, 2015). Conventional layered approaches enhances the performance of these individual layers but the cross-layer approaches have proved to achieve better optimization results than their layered counterparts (Mendes, 2011).

Multimedia data are characterized by their large volume, and have strict requirements in terms of quality of service (QoS) such as bandwidth, delay, packet loss, delay jitter, etc. In this paper, we are interested in routing protocols based on clusters that aim to reduce congestion in order to have reliable data transmission and a reduced loss rate. This is achieved by balancing the traffic load, which results into a balanced energy consumption within the network. Our ESCC balance the clusters based on neighbor, it make a comparison between number of members in clusters. The current CH search between its neighbor the CH that have more members, if the number of members of the CH found is more than

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the members of the current CH plus 2, A FORCE-JOIN is sent to the CH that have the more members.

We propose two cross layer protocol for surveillance wireless sensor networks. The first is suitable for high ratio of packet deliver at the sink. The proposed load-balancing algorithm enhances the ratio of packet delivery. But in the second, the performance of the proposed end-to-end delay QoS protocol is superior for providing end-to-end QoS. The packet delay is important in many surveillance systems. In this system, there is a limited admissible delay if the packet delay is higher than that, this packet is no longer useful and after that it is discarded.

2 THE METRIC FOR WIRELESS SURVEILLANCE NETWORKS

CAA (Congestion Avoidance and Alleviation routing protocol) is designed to avoid congestion in nodes. It detects congestion and sets the rate of packets arriving at the nodes equal to the rate of packet service. CAA uses a clustering method based on residual energy to elect its cluster-heads, and a CDMA (Code Division Multiple Access) method for the inter-cluster communication, and a TDMA method for the communication between members and CH. In the transmission phase, a centralized method is established by the sink for routing. The sink broadcasts a flooding message with hop number 0 in the network, and the CHs rebroadcast this message with their distance to the sink. The congestion detected using a congestion degree. The cluster-heads forward their data over the route that has the minimum degree of congestion. An additional technique to avoid congestion is the use of a local buffer to store data during the congestion period.

CRAP (Cluster based congestion control with Rate Adjustment based on Priority) monitors proactively the congestion and adjusts the traffic rate when a cluster has a high priority data flow to be transmitted. The adjustment rate is done by exchanging the estimated rate of traffic between clusters. This reduces the number of broadcast packets and the energy loss. Three kinds of nodes are present: the CH which schedules the transmissions, the gateway node which interconnects adjacent clusters, and the node members. The member nodes send data, traffic rate and other information to their own cluster-heads. This collected data is transmitted over routes using ZRP (Zone Routing Protocol). CRAP calculates the rate of traffic in the clusters in order to alleviate the CH congestion. The congestion degree is analyzed by the CH. If this degree exceeds a given threshold, the CH broadcast this value to all neighboring CHs to adjust their congestion rate.

In summary, these protocols aim to reduce congestion by reducing the traffic rate. This solution causes a problem for the multimedia data. Indeed, the video data transmission tolerates only a small margin of packet loss. The MPEG compression codec provides three type of frames: I-frames, B-frames and P-frames. The most important frames are I-frames and P-frames. Losing one of these frames degrades significantly the video quality. In WMSNs, CHs receives process and aggregate the multimedia data from all their members. Thus, their load and energy consumption is related with the number of members they have. In the following, we propose a new metric called MCUR, an optimal election and our ESCC.

Our protocol, called ESCC (Equal Size Clusters to reduce Congestion), aims to reduce the MCUR in a distributed manner. It adds a new period to the election phase called balancing, that balances the size of clusters using a Force-Join message. Each member keeps track of neighbors CH (by receiving ADV message) and on their members (through overhead Join messages). We introduce in the election step a modified method to elected CH and to join CH from that in LEACH to reduce the number of CH neighbors and to eliminate the isolated node. In the election part, the nodes do not send their ADV messages together but it send it in randomly delay, so if one neighbor receive more than th ADV before sending its own ADV it decide to become a member. In the join part, the nodes that do not receive any ADV message, they called isolated nodes, decide to become CH or member of new CH (isolated node become CH in join step) in order to maintain connectivity over network.

3 THE QOS OF THE PROPOSED FRAMEWORK

Many approaches are presented to overcome the limitations of wireless multimedia sensor networks in different applications. According to network subjects, their efficiency comparison is most important. The assignment of the WMSN must be

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consider to compare proposed protocol, for instance, throughput maximization is not as important for event-based application as it for monitoring application. One of the important challenges for real-time surveillance system is end-to-end delay QoS for packet deliveries. Providing end-to-end QoS is difficult due to two reasons. As wireless sensor nodes may require multihop transmissions to reach the sink and the some of the wireless transmissions may be not successful. Load balancing is used to increase network lifetime by reducing energy consumption in wireless sensor networks. Some papers considered the overview of load balancing algorithm. Using clustering for load balancing can also decrease energy consumption and increase network lifetime and scalability. The cluster head needs to send aggregated data to the base station. It consumes more energy for data aggregation than the member nodes.

In my network, the nodes are randomly deployed and gather information by its sensor and periodically send it to a sink node. To send node data to sink, each node sends data to a neighboring node which is nearer to the sink. Other neighbors go to sleep until transmission ends. We propose a cross-layer design to increase network lifetime. This protocol divides the network to several levels. Each level shows the distance between the node and the sink. Each node acquires its level in the initial phase. After the initial phase, the node knows the number of hops to the sink node. For instance, a node neighboring the sink, knows that there is not any hop between itself and the sink node. Thus the node sets its level to ‘one’. A node, neighboring the ‘level-one’ node and is not a neighbor of the sink node, knows that it is one hop away from the sink node and then sets its level to ‘two’ and the rest of the nodes set their levels likewise.

When the surveillance system needs to provide end-to-end delay QoS, We propose new algorithm providing end-to end delay QoS. This protocol uses a route table and only a first initial phase for sending data to sink. A node operates the same as the aforementioned first initial phase with the exception that it saves the mac address of each get-level massage receiving from the lower level nodes. Each nodes estimate *Minimum Delay Time* (MDT) that it can deliver a packet to sink and knows the MDT of its lower level neighbor. It finds the minimum MDT of its lower level neighbor and selects this lower level neighbor for next hop to send a packet. For providing the end-to-end delay QoS, a delay field is inserts to data packet and when the delay field value become bigger than end-to-end delay QoS, this packet is discarded. For end-to-end delay QoS, when a node generates a data and send it form the application layer to the cross layer, the cross layer inserts a delay field to the data packet. This field is henceforth called *delay field* throughout the present paper. Each node adds a delay time, which a packet stays in the queue until it is sent, to delay field. When a node receives a data packet, it checks the sum of the delay field and Minimum Delay Time (MDT), which the node can deliver a packet to the sink and the detailed descriptions are explained in the following paragraph. If the result is bigger than the admissible end-to-end delay, the packet is discarded otherwise the receiver node push the packet to its queue. The RTS/CTS handshaking is used to data transmission. This transmission is the same as the previous section but in this case, the sender node select the next hop from its route table therefore there is no longer receiver contention to send CTS packet. The next hop is the node that its MDT is minimum value in the route table. Each node sends the packet that its delay field is maximum value in the queue.

4 SIMULATIONS

We evaluate our proposed cross-layer protocols using MIXIM package and Omnet++ simulator. Each sensor node periodically samples the data and sends it to sink node. The simulation result for 10 random network topologies with 100 sensor nodes in 400*400 m2 area is presented with the sink position (250,250). When sensor node samples data with low rate, the energy consumption is high. In low sampling frequency, when data rate increases, the average energy consumption decreases severely. After the node sends its data, it stays awake and listens to the channel until the next transmission starts. The node wastes energy in this time. When data rate increases, the time the node stays awake and wastes its energy in a way that energy efficiency of the node increases. In order to solve this problem, many papers use duty cycle mechanism. This mechanism increases the delay and is designed for low rate data but our aim is to support the big data. In high data rate, the energy efficiency of the node slowly increases because the node has to be more competitive for getting channel. The second initial phase has a significant impact on average energy consumption. It tries to balance energy consumption through the network therefore the local congestion decrease and energy efficiency increase. When the

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data rate is bigger than 50 packet per minute for each node, the probability of a collision increases and the energy efficiency decreases.

5 CONCLUSIONS

Nowadays, Wireless Sensor Networks (WSNs) are based on techniques more and more oriented towards image, video and sound processing, hence the recent need of Wireless Multimedia Sensor Networks (WMSNs). One of the important challenge for real-time surveillance system is end-to end delay QoS for packet deliveries. Providing end-to-end QoS is difficult due to two reasons. As wireless sensor nodes may require multichip transmissions to reach the sink and some of the wireless transmissions may be not successful. Multimedia data are characterized by their large volume, and have strict requirements in terms of quality of service (QoS) such as bandwidth, delay, packet loss, delay jitter, etc. In this paper, we are interested in routing protocols based on clusters that aim to reduce congestion in order to have reliable data transmission and a reduced loss rate. This is achieved by balancing the traffic load, which results into a balanced energy consumption within the network.

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