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Performance Evaluation and Throughput Maximization of Wireless Sensor Networks: Survey

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Abstract

The benefit of using a mobile sink for reducing energy consumed by nodes and for preventing the occurrence of energy holes in WSNs has been shown in various studies. In applications having delay restrictions for a given time constraint all the data that is sensed must be collected. Hence these advantages are based on the route taken by the mobile sink. WSN is made of nodes having low battery power. Also changing battery is difficult as nodes may be located in unhostile locations and it is not practical to replace battery in thousands of embedded nodes. So it is of great significance to balance the total WSN load. Also total consumption of energy must be minimized. This paper addresses brief evaluation about resource allocation and congestion control protocols as well as the applications of WSN.

Keywords: WSN, Congestion control, resource allocation and Throughput maximization etc.

Introduction

A Wireless Sensor Network is used to provide important data for long duration hence we need to have best performance by reducing delays, reliable delivery of data and low overhead. A solution for this problem is to exert idle nodes to increase the overall throughput and remove congestion in WSNs. For achieving this goal, some of the packets should be scattered along different paths consisting of less loaded nodes or idle nodes and thus the packets are routed around the congestion areas. The main goal in WSNs is to increase network lifetime, increase QoS in terms of throughput and improve distribution of load. Therefore congestion needs to be handled in WSN.

In WSNs all the traffic flows towards a common sink as the primary job of WSNs is to collect information from the surrounding environment. WSNs' congestion control must cater to the fidelity required by the applications and the network capacity. Service oriented framework for WSNs have been recently suggested to reinforce the interoperability between variety of applications such as localization service, data aggregation service and data processing service.

The service based WSN combines wireless sensing technique with service providing, here the applications are treated as services. As battery energy is a very important resource in Wireless Networks various Power saving protocols have been suggested at various layers of the protocol stack. WSN is made up of sensor nodes that can sense and supervise the surrounding environmental conditions. For sending this information to the sink the resources belonging to the network must be used in an efficient manner. Hence the routing protocols have an important role for selecting the correct nodes and forwarding this data from the source to sink.

The routing protocols that are developed for wireless ad hoc networks can also be used for WSNs. When WSNs are used for applications having high data rate the possibility of occurrence of congestion also becomes high and that can lead to decrease in the performance of network.

Congestion happens when many traffic flows pass through a mono sink wireless sensor network that causes unnecessary energy utilization and extreme data loss. For removing congestion the congested node and link can be bypassed by rerouting the traffic to a less loaded and energy efficient path. This can gradually cause unnecessary energy utilization and extreme data loss. Hence congestion removal techniques are utilized. Congestion removal is the technique that reduces congestion from the network. It is a procedure that is started in order to recoup the network from congestion.

Optimizing energy utilization and reducing the job finish time often clash with each other and may affect the performance of the network. For getting optimal network performance such trade-offs need to be addressed.

Congestion in Wireless Sensor Networks

In WSN information in collected from nodes and it is passed in the network. There are source nodes and destination nodes and before sending information data is processed at one particular node i.e. sink node. In this whole process data collected at sink node could be large. While transferring data between these nodes congestion occurs and due to which performance decreases through the network causing more consumption of energy also the reduced data rate.

Other issues related for causing congestion in the wireless networks depends on capacity of the entire network. Also the issue arises depending on the application requirement in which WSN is used.

Hence depending on the service provided by the network, the architectures are developing WSNs with advanced communication rules along with device management used in the network. [2] Authors have proposed architectures which overcomes application based drawback for avoiding congestion.

Some of the issues related to enegy consumtion in the network by the nodes are taken care by implementing such protocols which are helping nodes to save energy.

Rate Control Based Congestion Control Protocols

***A.* Congestion detection and Avoidance in Sensor Network**

In [20] authors have proposed CODA protocol based on the data transformation taken place between nodes to check their state while transfer takes place and what speed they were communicating. It's like storing their details in the transformation. Depending on the information collected by node and the speed at which it was transferring data the traffic can be monitored. Based on thins information of the nodes this protocol works. It's like getting pressure information of each node.

B. CCF

CCF [5] provides information about traffic in the network as well as correctness of delivery of data at destination node. Based on the algorithm proposed by authors it distributes the data equally at each node as there is an assumption that the transfer takes place to avoid congestion and each node has equal responsibility to gather data and transmit to destination node.

C. ESRT

In [3] authors have given ESRT protocol which basically used to for saving energy at each node. Specifically the applications which are driven by events there to avoid traffic in the network while transferring data is controlled by this protocol.

D.RCRT

This protocol is used for wireless sensor network [14] provides reliable point to point delivery of data as well as controls congestion. In RCRT congestion control is done at the sink node. It is centralized at sink node in this protocol. Based on the time required to repair the loss the sink node decides congestion and depending the time more or less than the round trip time then congestion is detected. There is congestion index which gives RTT rate required for recovering loss. Based on the threshold value congestion is detected.

E. ECODA

ECODA [24] defines three buffer state based on two threshold values. (ECODA) It consist of three functionalities. (i)Congestion detection based on dual

buffer threshold (ii)Packet scheduling based on flexible queue scheduler and (iii)Source sending rate control scheme based on bottleneck.

Due to tree like nature of WSN the bandwidth allocation for different nodes is unfair. It uses flexible queue scheduler for ensuring fairness.

F. CCF for WSN

CCF in wireless sensor networks [10] provides distributed scheme for congestion controls which is based on adapt probable rate of transmission for the objects. It basically provides fairness in bandwidth and avoids congestion. It is for WSN first calculated considering total input and output values change and how they differs is considered. the decision is taken based on the clear value of the increase and decrease in the data rate is evaluated. In CCF at each node for each control interval this protocol measures the average output rate, average input value and minimum number of packets in the queue. Based on the difference between each of these measures, change in the data rate is calculated .The calculated aggregate change in rate is distributed among individual flows to ensure fairness in the network.

At individual flow the bandwidth is calculated and the parent nodes bandwidth and the lesser bandwidth is propagated toward the source nodes. Gateway node is the node which is away with one hope from the sink object and at these gateway nodes at every control interval this congestion control cycle runs.

G. UHCC

Congestion detection component and rate adjustment component are used by this protocol [8] in networks. For detecting congestion UHCC considers the unoccupied buffer size and the traffic rate to calculate congestion index. Basically consists of difference in both values.The buffer un-occupancy is calculated based on the difference between the total buffer size and buffer occupancy where the traffic rate can be calculated based on the total generated packets subtracted by the outgoing traffic rate and added with the incoming traffic rate. Based on this congestion index less than zero value it is predicted that that at next interval there will be congestion in the network.

H. WFCC

The importance of data generated at different nodes is of different importance levels hence WFCC assigns weights to each and every node and it is done by proposed protocol [12].

Resource Allocation Based Congestion Control Protocols

A. TADR

In [13] authors have proposed methodology to detect congestion in wireless sensor networks is a resource control type congestion control protocol. TADR is used in the application where it is undesirable to decrease the rate and the alternate path is found dynamically. It is alternate method for providing path which was disadvantage in one of the protocol BGR, where random bias was used to alleviate congestion. So if congestion is there based on the potential filed model TADR decides the nest node to transmit the traffic.

B. DA1PaS

This chooses alternate path if there is congestion.DA1PaS considers the energy consumption, congestion level as well as nodes remaining power to take the decision of the alternate path. For Setup phase the algorithm proposes a technique by using which the level of each and every node is found out and neighbor table is updated.

C. TARA

In [6] authors have proposed an algorithm to find sensor network congestion which is a resource control type of protocol. In this protocol more number of nodes becomes active in case of congestion. Because of that overall network capacity increases which can detect the congestion. Due to blind extra resource allocation which can worsen the congestion scenario, based on capacity analysis mode TARA estimates the capacity of various topologies possible and based on that the extra nodes are made active. TARA takes three congestion scenarios 1) source hotspot 2) sink hotspot and 3) intersection hotspot. Graph coloring algorithm is used to build this formulation of capacity analysis model.

D. General Self-Organized Tree -Based Energy-Balance routing protocol

This is the algorithm built based on tree proving path where each nodes are categorized into root node and share the information with other nodes in the networks. *GSTEB* algorithm is used to enhance performance and proves that wireless sensor networks consume less energy as the methodology built.

Applications

Due to potential for many applications to change the fundamental properties for adopting new paradigms henceforth accessing information after interacting to the entities in physical environment Wireless sensor networks are widely used. To fill the gap between traditional Wsn and the recent trends in application usage based on different levels service based wireless sensor networks are built such as service for processing data gathered from different sourses,service which provides localization details.

Some of the applications proposed are in robotics and motes. The USC Center has developed Robomote is a tiny robot for Robotics.In the large scale[32] sensor based networks which are supported by embedded systems where participation of robots can be seen there this robomote used.Gradient sources[33] are discovered and found in the field of scalar which uses mobile sensor networks and it limits bacterial function.[34] simplified algorithms are used to trace light source. In [35] coverage problem is solved with the help of robots.

Research in this area is carried out by some companies such as Intel. The input given to the sensors is by robots and the service for supporting such actions is given in [36]. In [37] the dection of location for the moving entities is discussed.

Other application could be virtually based musical equipments,physical movements, wearable devices performance based on wireless connection etc.

Conclusion

Congestion control algorithms help us to reduce the End–to–End delay. TADR approach provide topological benefit to determine depth of destination node & queue design provide enhanced packet routing by storing particular size of packet at single node. This helps in transferring additional load to other node to avoid congestion. Due to limited resources and traffic the congestion can cause to more energy consumption because of the overhead of data dropped and subsequent packet retransmission. So it must be controlled efficiently. In this paper we have discussed the different techniques for congestion detection and congestion control which in turn helps to increase throughput and performance in WSNs.

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