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A SURVEY ON CONGESTION CONTROL SYSTEM IN WIRELESS SENSOR NETWORKS

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ABSTRACT- Wireless Sensor Networks are occasion based system that comprises of an accumulation of autonomous sensor nodes that arespatially disseminated and helpfully monitor physical and ecological conditions. At the point when an occasion has been distinguished these sensor nodes become active in transmitting the data what's more, the heap turns out to be overwhelming, expanding the information activity and this might prompt congestion that outcomes in packet drops, throughput reduction and degradation of channel quality which in turndiminish network execution. Congestion is a major problem in almost all kinds of wireless networks such as mobile ad-hoc networks; wireless sensor networks (WSNs). There are variety of applications of WSN such as defense, temperature monitoring, health monitoring. Congestion occurs in the sensor network because of limited resources such as low processing power of the sensor node. As all the sensor nodes are battery powered. Hence, congestion in the sensor network results in waste of energy of sensor nodes. All the layers of protocol suite of the network can be involved in the congestion control process. A congestion control scheme is important to monitor and manage the traffic levels at an satisfactory value. This paper survey different existing works utilized for recognizing and controlling congestion. Diverse execution metrics that are utilized for estimating congestion was moreover surveyed. Finally a comparison of various performancemeasures was presented.

Keywords: [wireless sensor networks; network congestion; congestion control.]

1. INTRODUCTION

A Wireless Sensor Network (WSN) is a collection of sensor nodes that are spatially distributed and organized into a cooperative network to monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion or pollutants. WSN serve as a key to gather information needed by smart environments such as buildings, utilities, industry, home, etc. Some of the unique characteristics of Wireless Sensor Networks include limited power, mobility of nodes, ability to withstand harsh environmental conditions, ability to cope with node failures and scalability. A large number of sensor nodes sense physical phenomenon and report the event through wireless links to sink. The base station acts as a gateway between sensor node and end user. Nodes communicate wirelessly and often self organize after being deployed in an adhocfashion. Each sensor node comprises

sensing, transmission and processing capabilities, memory, and RF transceiver and power source. When large numbers of sensor nodes are active in transmitting the information, the load becomes heavy and data traffic also increases and this might lead to congestion.

2. SOURCES AND CAUSES OF CONGESTION

A. A Wireless Sensor Network consists of tens or thousands of sensor nodes scattered in an area with one or more sinks. As the data traffic generated by such nodes grows, the offered load exceeds available capacity and the network becomes congested. The main sources of congestion include buffer overflow, channel contention, interference, packet collisions and many-to-one nature. Buffer overflow occurs when the number of incoming packets is greater than the available buffer space. Contention occurs between different flows and different packets of a flow. Interference is caused by simultaneous transmissions along multiple paths within physical proximity of each other. Packet collisions indicate lower level congestion and leads to packet drops. The many-to-one nature of event communication between multiple sources and sink causes bottleneck around sink.

B. Therefore network congestion causes channel quality to degrade, loss rate raises and leads to packet drops at buffers, increased delays and requires retransmissions. Congestion is detrimental to sensor networks because it lowers the throughput called fidelity. It also causes waste of communication resources, waste of energy, and hampers event detection reliability at the sink.

Types of Congestion in WSNs

C. Congestion has direct impact on energy efficiency and decreases the lifetime of wireless sensor networks. Generally two types of congestion occur in WSNs:

Node Level Congestion

A. Node level congestion occurs within a particular node if the buffer used to hold packets to be transmitted overflows. This results in packet loss, increased queuing delay and leads to retransmission that consumes additional energy.

Link Level Congestion

B. When multiple active sensor nodes within range of one another attempt to access transmission medium simultaneously, packets that leave the buffer may fail to reach next hop as a result of collision among sensor nodes. Thisincreases the packet service time and decreases link utilization.

3. LITRETURE SURVEY

1. Ravinder Kaur, Harmandeep Singh (2017) proposed a graphical user interface based technique in order to consume the bandwidth of the network in an efficient way. The proposed technique works on the basis of priority of the data and the size of the data along with the size of the bandwidth. There are some aspects that can effects the performance, reliability and efficiency of the system in negative way i.e. degrades the performance and lifetime of the network. This section lists some of the aspects out of them. • Energy Consumption • Data traffic • PDR (Packet delivery Ratio) • Lifetime or existence of nodes • Delay

2. Prof. Sachin Patel, Prof. Rakesh Pandit, Mr. Abhijeet Rathod (2014) proposed on Congestion detection, congestion notification and congestion mitigation through rate control to avoid congestion in a network and propose an efficient scheme to perform multipath congestion control for heterogeneous traffic which avoids packet loss and thus enhances the probability of achieving the desired throughput of heterogeneous traffic. Wireless Sensor Network consists of one or more sinks large number of sensor nodes scattered in an area. The downstream traffic from the sink to the sensor nodes usually is a one-to-many multicast. The upstream traffic from sensor nodes to the sink is a many-to-one

communication. Due to the focused nature of upstream traffic, congestion more probably appears in the upstream direction. Congestion control is achieved by distributing the network bandwidth across multiple end-to-end connections.

3. R. Beulah Jayakumari and V. Jawahar Senthilkumar (2013) proposed Priority based congestion detection and avoidance protocol for wireless sensor network to alleviate congestion using data priority assignment for prioritizing packet, dual queue scheduler to provide differentiated services to packets which are sensed in sensor field as High Priority (HP) packet or Low Priority (LP) packet and congestion aware routing algorithm to route packet to base station using buffer occupancy of all the intermediate forwarder in the path. Wireless Sensor Network (WSN) is composed of a large number of cooperative sensor nodes, which are densely deployed either inside the phenomenon or very close to it, can communicate in broadcast fashion. The number of sensor nodes deployed in studying a phenomenon may be in the order of hundreds or thousands. Depending on the application, the number may reach an extreme value of millions.

4. Kamini , Prabhjit Singh (2017) proposed priority scheduling along cluster and produced better results. Recreation result demonstrates the assessment of the execution of different Cluster based steering conventions. Remote sensor organize faculties the physical world whether it is temperature, weight, stickiness and some other condition exercises. WSN is utilized as a part of a situation where the wires or link are unrealistic to reach. It is anything but difficult to introduce contrasted and alternate links arrange. Presently, these day's WSN are utilizing basically for the information exchange reason. Sensor hubs in the remote system exchange the information parcels from source to goal. Remote sensor organize incorporates sensors hubs and a base station (sink) and there are such a large number of sensors which make a system.

5. Prabu Rajkumar P , Arul Treesa Mathew , Sruthi N Paul , Sujitha B Cherkottu (2013) proposed control congestion thus decreasing packet loss and delay in network. In Wireless Sensor Networks, packet loss due to congestion cannot be eliminated, but can be mitigated. Various congestion control algorithms and the techniques they use to control congestion, so that the packet loss can also be lowered. Over the various congestion control techniques being used for WSNs and based on this result we are proposing a simple algorithm for congestion control. The communication in WSNs has two components: An Upstream traffic and a Downstream traffic. While upstream traffic refers to the data flow from the individual sensor nodes or motes to the sink node, downstream on the other hand refers to the data flow from sink node to the motes. WSN are believed to follow a hierarchical structure and hence the upstream traffic tends to converge as it moves towards the sink node.

6. Vikas Srivastava , Karan Singh and Sachin Tripathi (2017) proposed various approaches (protocols, techniques, mechanisms) in WS.Ns along with the discussion and summarization of various attributes of protocols. Wireless sensor networks (WSNs) is a collection of "nodes" - a small embedded device which interfaces with sensors and do communication with small range wireless transmitters, from few to hundreds or thousands. The node is grouped in a rational way in which data packets are directed hop-by-hop towards sinks or BS. Based on the applications, WSNs generate large enough information which should be conveyed to a tiny amount of sinks. This rate of data may lead to congestion.

7. Prabhdeep kaur , Jaswinder singh (2016) proposed on congestion avoidance in clusters

of wireless sensor networks and presents an improved version of PASCCC (Priority Based Application Specific Congestion Control Clustering Protocol) There are different types of wireless sensor networks. Mainly it can be classified into two categories:- Unstructured and structured. When sensor nodes are deployed in a region in an adhoc way, it is called unstructured WSN .When sensor nodes are scattered in a particular manner in the region then this type of network is called structured WSN. Congestion control protocols can be classified into different types. On the basis of control policy it can be classified into two categories i.e. resource control and traffic control. Resource control policies are further categorized based upon the resource type to be utilized. Traffic control protocols can be divided into two types reactive and preventive .The reactive protocols are further classified according to the scale of reaction and preventive solution are categorized into two categories according to the limitation of the buffer and control of interference.

8. N.Thrimoorthy and Dr. T .Anuradha (2016) proposed Congestion control techniques are based on detection of congestion and control, but they cannot completely eliminate or prevent the occurrence of congestion. To mitigate congestion, either the available resources have to be increased (resource control) or the source transmission rate should be restricted (traffic control). Significant work on congestion control in WSNs has focused on traffic control. The problem of congestion in sensor networks remains largely open yet. Congestion control is a three step process: congestion detection, congestion notification and congestion mitigation. Congestion detection: congestion detection step involves finding the occurrence of congestion and location at which node congestion has occurred. Various congestion detection metrics are packet loss, queue length, channel load, channel busyness ratio, throughput measurement, packet service time, packet inter-arrival time, delay etc.. Congestion notification step: After detecting the congestion, that node must send information to neighboring nodes about congestion to control it.

9. Muhammad Zeeshan, Fazlullah Khan, Syed Roohullah Jan (2016) revives different routing protocols used in wireless sensor networks to mitigate and control congestion and to provide consistency for different applications and prolong the life of the wireless sensor network. **Hop-by-hop flow control**. Using hop by hop flow control a sensor node present congestion detection and congestion mitigation congestion is discover through both queue occupancy and channel sampling techniques. The hop by hop flow control scheme in FUSION is similar to backpressure scheme in CODA. The only difference in fusion is that each sensor node sets a congestion bit in the header of every outgoing packet instead of using backpressure messages.

10. Mr. Bharath kumara , Mr. Murthi Mahadeva Naik G (2012) proposed to avoid the buffer overflow and it's not taking an excessive amount of energy consumption within the communication. This theme can assist to enhance the throughput, potency and resource saving. Node level congestion management is effectively required for WSN, because the node deployment will be anywhere. The congestion management is followed to induce rid of the congestion. However the congestion avoidance is employed for preventing congestion. When the network load will increase the packet loss attainable conjointly increased. To regulate the sending rate of the info packets from the supply and intermediate nodes, we've got to regulate the generating rate of packets. The efficient rate allocation could assist to regulate the congestion in the network. In networking concept, network congestion happens when a link or node is carrying most information in order that its quality of service is degraded.

Typical effects embody queuing delay, packet loss or the blocking of latest connections.

4. DISCUSSIONS

Congestion control has to consider network capacity and application requirements. A number of schemes were proposed to address these challenges:

A. Local Cross Layer Congestion Control

This technique [1] is based on buffer occupancy. Input to buffer is of two types: a) Generated packets and b) Relay packets. A sensor node has 2 duties a) Source duty and b) Router duty. During source duty, the sensing unit of the node senses the event and generates packets to be transmitted. A node as a part of router duty receives packets from its neighbors to be forwarded to sink. It has two measures: a) It explicitly controls the rate of generated packets in source duty. b) It regulates the congestion in router duty based on current load on node.

B. Adaptive Duty Cycle based Congestion Control

Adaptive Duty Cycle based Congestion Control (ADCC) [2] is energy efficient and lightweight congestion control scheme, with duty cycle adjustment for wireless sensor networks. It uses combined mechanism of resource control scheme and traffic control scheme. ADCC periodically calculates the required service time using incoming packet information of child nodes and infers there is congestion or not based on calculated service time. If the congestion degree is below a certain threshold, this scheme adjusts its own duty cycle to reduce congestion. On the other hand if the congestion degree is above threshold, it notifies child nodes of congestion so that transmission rates of child nodes can be adjusted.

C. Receiver Assisted Congestion Control

In Receiver Assisted Congestion Control (RACC) method [3] sender performs loss based control and receiver performs delay based control. Receiver maintains 2 timers, one for recording the packet interarrival time and other for measuring RTT. Sender uses this information from receiver to adjust the congestion window. The receiver can estimate the rate the sender should adapt to make best use of measured bandwidth based on packet interarrival timer. The RTT timer at receiver times the arrival of the next packet and detect packet drop if timeout occurs. Since receiver detects packet drop earlier than sender, it can send ACK to inform sender thereby reducing the waiting time of sender to retransmit a lost packet.

D. Learning Automata based Congestion Avoidance Scheme

Learning Automata based Congestion Avoidance Scheme (LACAS) [4] deals with congestion problem for many-to-one traffic patterns. A simple autonomous learning machine called automata that can be constructed as small pieces of code capable of taking intelligent actions is stationed at each intermediate node of network. It intelligently learns from the past and controls the rate of flow of data at intermediate nodes based on probabilistically how many packets are likely to get dropped if a particular flow is maintained.

E. Decentralized Predictive Congestion Control

Decentralized Predictive Congestion Control (DPCC) [5] is a methodology that utilizes both rate control and back-off interval selection schemes along with distributed power control scheme. The rate selection scheme implemented at each node takes into account the buffer occupancy and target outgoing rate and acts as a backpressure signal to minimize the effects of congestion on a hop-by-hop basis by estimating the outgoing traffic flow. The target rate at next hop node indicates what the incoming rate should be. The back off interval selection scheme for a node plays a critical role in deciding which node gains

access to channel since multiple nodes compete to access the shared channel.

F. Topology-Aware Resource Adaptation

Topology-Aware Resource Adaptation (TARA) technique [6] activates appropriate sensor nodes whose radio is off to form a new topology that has enough capacity to handle increased traffic. As soon as hotspot node detects that its congestion level is above watermark, it needs to quickly locate 2 important nodes :a) Distributor node a) Merger node. The distributor node distributes the traffic between original path and detour paths. The detour paths are formed by backup nodes around hotspot node that are woken up. The merger node merges these two flows. Thus TARA serves the dual purpose of alleviating congestion during crisis state and conserving energy during dormant states.

G. Priority based Congestion Control

Priority based Congestion Control (PCCP) [7] is an upstream congestion control protocol that is used in case of many-to-one communication. It introduces the concept of node priority index. PCCP consists of 3 components: a) Intelligent Congestion Detection (ICD) b) Implicit Congestion Notification and c) Priority based Rate Adjustment (PRA). ICD detects congestion based on joint participation of packet inter-arrival time and service time that reflects the current congestion level and provide rich congestion information. Thus PCCP achieves efficient congestion control and flexible weighted fairness for both single path andmultipath routing. It leads to higher energy efficiency and better QoS in terms of both packet loss rate and delay.

H. Buffer based Congestion Avoidance

This method is based on lightweight buffer management [8]. It prevents data packets from overflowing the buffer space of intermediate sensors. When buffer at an intermediate sensor node is filled, the forwarding rates of its upstream sensor nodes are forced to slow down according to its forwarding rate. When the buffers at the upstream sensor nodes are filled up, the further upstream sensors are forced to slow down. This process repeats towards the furthest sensor nodes and eventually the whole network adapts towards the maximum congestion-free-throughput. Thus the buffer based scheme automatically adapts sensor nodes' forwarding rate to nearly optimal without causing congestion.

I. Long Term Path Congestion Control

In this scheme [9], the basic idea is that the intermediate nodes along active paths detect onset of congestion and notify the source to reduce the loading rate to next predefined rate. The source eventually settles at the highest possible rate supportable by active paths. Intermediate nodes along active paths detect long term congestions by monitoring their data transmit buffers using exponential weighted average. It informs the source to reduce its loading rate by sending a congest packet. The source on receiving the congest packet eventually reduce the loading rate. Thus it increases throughput by loading the paths for load balancing at the highest possible rate supportable.

J. Event to Sink Reliable Transport

Event to Sink Reliable Transport (ESRT) [10] is a novel transport solution that seeks to achieve reliable event detection with minimum energy expenditure and congestion resolution. The sink is able to detect congestion based on local buffer level monitoring in sensor nodes. Any sensor node, whose buffer overflows due to excessive incoming packets, sets congestion notification bit in the header of the packet it transmits. The sink on receiving packets whose CN bit is marked, infers that congestion is experienced and ESRT determines new network state that is repeated until optimal operating region is reached.

The various congestion control techniques that are reviewed follow different strategies for controlling congestion and have different

performance measures. Based upon that, the techniques used for controlling congestion, how the congestion is identified, which node is responsible for taking initiative action to control congestion and what is the mechanism used for controlling congestion are compared in this section.

CONCLUSION

In this paper a far reaching overview of various congestion control systems in wireless sensor network was done. Diverse execution metrics that are utilized for estimating congestion was also surveyed and a correlation between different techniques was presented. In spite of the fact that these congestion control techniques have been devised to monitorand regulate the traffic levels, still there are numerous difficulties that should be explained in wireless sensor network in this respect.

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