APPLICATION OF SOFT COMPUTING FOR PROPOSED TECHNIQUES IN CONTROLLING CONGESTION IN COMPUTER NETWORK

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ABSTRACT

The computing industry's communication infrastructure is expanding at a lightning-fast rate. New technological devices, particularly in the communication industry, contribute to the ongoing development of technology. The growth of the internet is astronomical. These days, it's impossible to imagine life without a device that can connect to the internet. Now, it's hard to imagine life before the Internet. To accommodate future mobile communication needs, the Internet's infrastructure may be upgraded. In order to facilitate faster data sharing between wired and wireless devices, congestion plays a crucial role in controlling the flow of data.

Keywords: Congestion Controlling Techniques, Computer Network, Soft Computing

1. INTRODUCTION

In 1984, when a congestion collapses reduced network speed from 32 Kbps to 40 bps, it became clear that some sort of congestion control mechanism was required. Eventually, TCP was updated to include mechanisms for controlling congestion. As long as TCP continues to drive the majority of traffic, it will remain the dominant protocol. After the advent of multimedia and wireless technology, however, TCP began to exhibit serious performance limitations; this necessitated the adoption of new protocols.

However, multimedia applications place greater emphasis on latency than on reliable delivery, while the TCP is well-suited to those like FTP and the Web, which place less emphasis on latency. This means that pure TCP is not used by multimedia applications.

Additionally, the Internet's inherent heterogeneity presents a barrier to enhancing TCP performance. Due to multiplexing, mobility, and access control, TCP connections can use a variety of available bandwidths. It's common for multiple flows to share a single bottleneck, each of which suffers as a result. Furthermore, in a shared medium, the channel utilization and access control protocols also affect the available bandwidth to different flows.

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Another significant difficulty with TCP exists for computer networks. The dropped packet cannot be traced back by the TCP. In addition to network congestion, other factors such as a weak signal or interference can cause a packet to be lost in transit.

Because the TCP does not know the reason the packet was dropped. Without considering that a dropped packet could have been lost for reasons other than congestion (such as fading, mobility, etc.), TCP wastes resources by lowering the congestion window and slowing down the retransmission timer whenever a packet is lost.

1.1. The Uses of Adhoc Networks

The field of wireless communication is making rapid strides in recent years. As its use spreads, more and more people will be able to share and receive information at their convenience, whenever and wherever they may be. Traditional mobile computer networks rely on a combination of wired infrastructure and direct, one-hop wireless radio waves to exchange data. However, as shown in fig. 1.1, Ad hoc networks are a distributed, infrastructure-less collection of mobile nodes communicating via wireless interface. Individual ad hoc network nodes can act as hosts, routers, or both.

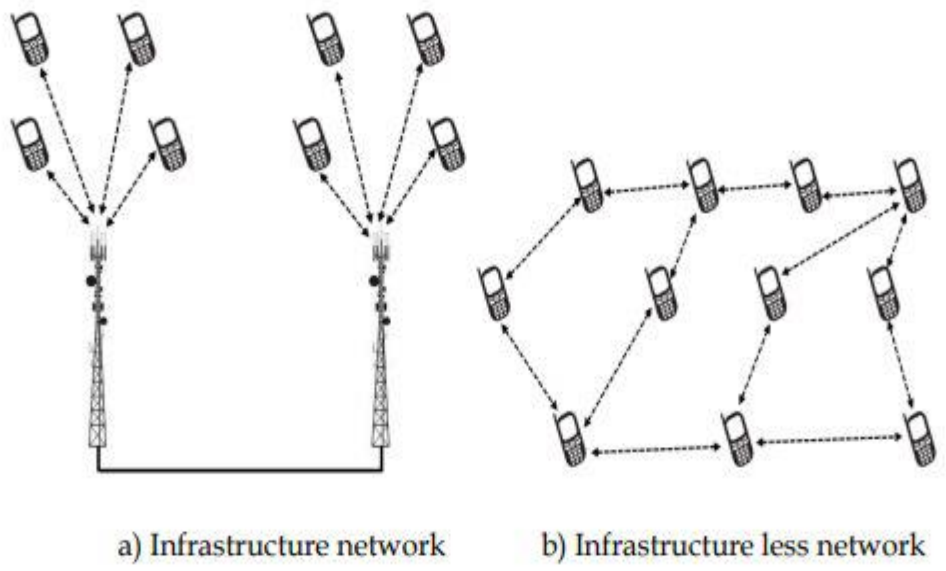

Figure 1.1: Traditional Wireless Mobile Networks Versus Mobile Ad Hoc Networks

1.2. Characteristics Of a Wireless Ad Hoc Network Include:

- The ability to hop between networks.
- The system is completely decentralized.

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- Being completely independent.
- Freedom of movement.
- There is no requirement for a pre-existing network infrastructure.
- It runs on batteries
- Capable of being set up by the user
- Strength in the Green.

As the world shifts to more affordable, powerful, and energy-efficient wireless devices, computing technology has seen phenomenal growth. The proliferation of Internet-enabled gadgets has resulted in a flood of information. This generated data must be transmitted without sacrificing speed or reliability, without compromising service quality.

1.3. Control of Congestion-Related Work

Over multiple sinks, hundreds or even thousands of sensor nodes make up a typical wireless sensor network (WSN). Although over time a number of multipath routing protocols have been proposed with the intention of load balancing and attaining high reliability, these protocols suffered from various limitations like overhead, so in this paper, a technique was proposed to alleviate congestion in wireless sensor networks in a way that avoided packet loss and obtained the desired output.

In this paper, we define a combined solution for routing and scheduling as well as a mechanism to regulate congestion in Computer networks, and we conduct research into this approach. This optimality of the primal-dual congestion controller is supported by the fact that different layers of the network protocol stack use knowledge of the queue length to ensure equitable distribution of resources without compromising the resilience of the buffer.

The maximization approach is used to address the congestion issue in mesh networks. As more and more people rely on wireless mesh networks as their primary means of connecting to the internet, the number of users and the volume of data they generate can quickly overwhelm the available bandwidth. A method was proposed to maintain the higher throughput while decreasing congestion, ensuring inter flow fairness for both real-time and non-real-time data. Congestion is avoided by restricting the flow of traffic based on three parameters: the rate of service, the occupancy of buffers, and the arrival rate of packets. Priority queues are used to differentiate between different kinds of information.

2. Review of Literature

Pandey, D., & Kushwaha, V. (2020) In Wireless Sensor Networks (WSNs), congestion is a constant problem because of the limited processing power, storage space, bandwidth, and power available. Over the past decade, numerous survey operations have been conducted to probe and address a wide range of congestion-related issues and problems. Review articles published in the literature primarily focused on traditional approaches to congestion management, including traffic-based, resource-based, and hybrid strategies.

Singh, Karishma, Karan Singh, and Ahmed Aziz (2018) In this paper, we propose a novel algorithm for managing congestion in Wireless Sensor Networks. Due to retransmission and congestion control accomplished via a straightforward Poisson process, the currently available algorithms for this problem are both computationally intensive and power hungry. Since the batteries in a wireless sensor network are already low, resending packets that have been lost due to a collision is a waste of resources.

Hussain, M. W., Jamwal, S., & Zaman, M. (2015) When the combined needs for a network's resources exceed those resources, the network is said to be congested. Congestion occurs whenever there is an increase in load in a network and a corresponding decrease in service quality for end users. Consider the case of acquiring a file measuring one gigabyte. Downloading the file takes only a few minutes on a day with no network congestion, but it can take several hours on a day with heavy traffic. Today, traffic congestion is a major problem that needs to be addressed.

Ingoley, S. N., & Nashipudi, M. (2012) As with any large system, congestion in the computer network is a major problem. Packet traffic becomes congested when the rate of data transmission exceeds the available bandwidth. Congestion occurs when there is an excessive amount of data flowing through a network and not enough capacity in terms of bandwidth, buffers, queues, processing time, etc. When multiple users try to access a shared network's limited resources, this is known as congestion. When the total number of requests exceeds the supply, lines begin to form.

Flora, D. J., Kavitha, V., & Muthuselvi, M. (2011) When it comes to collecting data from various sources, wireless sensor networks (WSN) are currently in first place. Because nodes in a WSN have finite resources, the strain of congestion can severely compromise the network. The problem has been the subject of numerous proposed solutions. Different algorithms proposed for congestion detection, notification, mitigation, and avoidance are

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listed and discussed in this paper. We have analyzed these algorithms and discussed the benefits and drawbacks that we found. This paper gives researchers and students a solid foundation on which to build their studies of congestion control strategies for wireless sensor networks.

Sirajuddin, M. D., Rupa, C., & Prasad, A. (2016). In a mobile ad hoc network (MANET), nodes communicate with one another via ad hoc connections, meaning there is no permanent network in place. The MANET's congestion is one of its main problems. This causes a decrease in overall network performance. Using TCP, real-time data can be transmitted securely over a MANET. However, due to node mobility and dynamic topology, the TCP's congestion control techniques are insufficient for such networks.

Gupta, H., & Pandey, P. (2013) Since each node in a mobile ad hoc network can theoretically move anywhere at any time, the network itself is in a constant state of flux. Since the behaviour of nodes and the traffic load on each node in a MANET are unpredictable, the network often experiences congestion. To address this issue, we have developed a survey paper outlining the different methods for preventing and alleviating congestion in MANET.

3. DIFFERENT METHODS OF REGULATING TRAFFIC CONGESTION

3.1 Congestion in The Network

Network congestion occurs when overall demand for resources exceeds supply. Congestion can be defined mathematically as follows: if (total demand) > (total available resources), then there is congestion. When more data packets are being sent than the network can handle, a condition known as congestion occurs. When there aren't enough available resources to meet the demand on the network, congestion is the result. In many cases, adding more resources—such as a bigger buffer, faster processing, or a higher-speed link—does not eliminate the congestion issue. Despite the lack of a generally agreed-upon definition, "a network is said to be congested from the perspective of a user if the service quality noticed by the user decreases because of an increase in network load" is a definition that is widely used.

3.2 Collapse of Traffic Congestion

When the network is experiencing congestion collapse, useful information announcements are severely hampered or unable to be made at all.

In 1984, the first instance of congestion collapse was reported; at that time, the network's capacity dropped from 32 Kbit/s to 40 bit/s and remained stagnant until the deployment of Jacobson's congestion control at the end nodes.

Among the possible causes of a collapse in congestion are the following:

3.2.1 Irresponsible Currents

Unresponsive flows are those that don't use end-to-end congestion control. Due to the lack of end-to-end congestion control, the network will not be able to compensate for packet loss by altering the rate at which data is transmitted.

Retransmission of the packets in transit or that have been received but will be discarded later causes the congestion collapse in unresponsive flows. Classical congestion collapse describes the situation where packets are resent repeatedly until the network reaches capacity.

More accurate timers and the latest congestion control mechanism in TCP can prevent the onset of classical collapse.

3.2.2 Undeliverable Packets Cause a Collapse in Congestion

When packets are being transported across the network but are being dropped before they reach their destination, this type of congestion collapse occurs. When open loop applications are used instead of end-to-end congestion control applications, the situation deteriorates. When using a rate-based application, where the packet rate is increased in response to packet drop, the problem becomes even more severe.

End-to-end congestion control algorithms applied to all traffic, irrespective of flow type, can prevent this kind of collapse (UDP, TCP).

3.2.3 Collapse of Congestion Based on Fragments

In this congestion collapse scenario, the cells/fragments are eventually discarded because they cannot be reassembled into a valid packet. This breakdown typically happens when the transmission units of the data link layer and the higher layer (datagram/fragment) don't match up. When information is shared between layers, it can prevent the collapse that occurs when relying on fragments. Path MTU discovery and Early Packet Discard are two examples of such mechanisms.

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Another type of fragment-based congestion collapse occurs when a packet makes it to the transport layer but is then dropped by the destination node.

3.2.4 Increased Traffic Under Control Causes a Collapse in Congestion

When the network's load increases, congestion can occur. Thus, only a small percentage of the total bandwidth is used for actual data transmission, while the rest is taken up by control data (such as DNS messages, packet header messages, routing updates, etc.).

3.2.5 Invalid Packets Cause a Collapse in Congestion

In this case, the overloaded connection is working hard to send the outdated or unwanted packets on their way. Imagine a scenario in which a user requested web content but, after waiting in a long queue, no longer cares, but the requested packet has arrived at his location anyway.

3.3 Hierarchy of Congestion Management Techniques

Congestion control schemes are classified according to their ability to make decisions and the efficiency with which relevant data can be extracted from congestion control algorithms. The two primary types of congestion control algorithms are open loop and closed loop.

3.3.1 Algorithm for Open-Loop Congestion Management

In an open loop congestion scheme, the congested node does not provide any kind of feedback. As there is no dynamic network monitoring, the decision is made based solely on static information about individual nodes, such as their bandwidth and buffer size. The open loop, which is based on an admission control mechanism, is effective at maintaining a constant flow of incoming traffic but is inefficient under the most common conditions. The open loop can be further subdivided into source control and destination control, depending on the location of decision making or control.

3.3.2 Traffic Congestion Regulation Via Closed-Loop Systems

In order to make more informed choices, the closed loop congestion scheme incorporates feedback data. There are two possible sources for the feedback: the final node in the network (the destination) or the node in immediate proximity (the immediate node). Since the closed loop receives feedback information, either globally or locally, it is able to dynamically monitor the network.

3.4 Algorithms for Controlling Congestion in TCP Connections

One of the earliest and most popular end-to-end protocols for providing dependable data transfer is TCP (Transmission Control Protocol). To send and receive data, TCP was developed by Cerf and Kahn, who also introduced the concept of variable-length segments. In 1988, Jacobson made changes to the TCP that provided the first end-end control algorithm, thereby ending the congestion collapse. By adjusting the congestion window, retransmission time out, slow start threshold, and round-trip time, TCP is able to control flows and congestion. These four fundamental algorithms make up TCP.

3.5 Tools for Regulating Traffic Congestion in Mobile Adhoc Networks

Because of their inherent properties—such as mobility, shared wireless media, Multihop nature, and the nature of the media—MANETs are not a good fit for the TCP mechanism to control congestion. So, a unique strategy is needed to manage the traffic. Either existing protocols are tweaked or new methods are developed to achieve this goal, with MANET characteristics in mind.

4. DISTANCING STRATEGIES FOR CONGESTION

As technology continues to advance in the realms of computing and telecommunication, more and more people are opting for wireless methods of communication. With their revolutionary characteristics, mobile ad hoc networks (MANETS) have changed the networking landscape forever.

- Characterized by multiple hops
- No central authority required
- Independence From Outside Influence
- Freedom to Move
- There's no need for a pre-existing network framework.
- Powered by batteries
- Self-configurable

Adhoc networks are ideal for use in surveillance, military applications, law enforcement, disaster management, relief operations, etc. due to the aforementioned advantages.

There is a cost to using ad hoc networks, just like there is a cost to using anything else in the world. Since large networks are so dynamic, it is challenging to make accurate predictions about their performance. The multihop nature also poses a significant challenge in relation to multiple layer issues, including packet routing, MAC techniques, etc. Additionally, the situation is exacerbated by the fact that some nodes are mobile while others may remain stationary for a considerable amount of time.

Congestion in ad hoc networks is a major problem because of the exponential growth of both the number of users and the volume of data being transmitted between them. Congestion occurs in a network when the number of available resources is inadequate to meet the amount of traffic that is being generated.

Because of fundamental differences between wireless and wired networks, congestion relief in the former is notoriously difficult to achieve.

The current methods for dealing with congestion are becoming antiquated, so it's important to instil highly dynamic techniques that are nonlinear in nature and quick to respond and learn. Since neural networks make decisions in real time, they are the most promising candidates for resolving the congestion issue.

Neuro-BP and Neuro-RTT are two proposed solutions that aim to deflect the congestion issue. The former (Neuro-BP) is a two-step process that employs the algorithms Neuro-Congestion and Neuro Path. In the first phase, Neuro-Congestion uses a feed forward neural network to detect congestion based on input parameters like the average number of packets, packet variance, and the congestion window. The results from the first stage are fed into Neuro Path, a second stage that uses a recurrent neural network to predict the best route based on a set of additional inputs including the starting and ending addresses. C++ code was used to create the neural networks, and ns2 was used for simulation. Neuro-BP, the proposed solution, was evaluated against state-of-the-art methods for dynamic congestion detection and control routing (DCDR). The outcomes show that the proposed solution outperformed the existing DCDR in terms of throughput, packet delivery ratio, and routing overhead. The latter (Neuro-RTT) method predicts the round-trip time with the aid of a recurrent neural network (RNN) (RTT). There are four inputs to the network and one output. There are two distinct structures for the data, each of which is determined by the step size. To foretell the next RTT, first form only allows the replacement of a single earlier input value. New data points are substituted for the original four in the second form in order to make RTT forecasts. Using the packet analysis program Wireshark, we gathered nearly 1,000,000 packets from which we randomly sampled 4,003. With MATLAB and Jacobson's formula, we were able to determine the total travel time. This finding substantiates the hypothesis that RNNs were superior predictors of RTT.

5. CONCLUSION

Network congestion occurs when the supply of resources to fulfil requests is lower than the demand for those same resources. Congestion can be caused by a number of factors, including a slow processor, a lack of available memory, an overload of the outgoing link, or a sudden increase in traffic. Overprovisioning resources is often thought to eliminate congestion, but in reality, it may make things worse. Network throughput and delay may suffer as a result of congestion. No packets will be delivered if the congestion collapse scenario occurs because the wrong congestion control method was chosen. For this reason, the congestion control mechanism must be put into place. The various subclasses of congestion control schemes can be broken down into two main categories: open loop and closed loop. TCP is the backbone of Internet traffic because it guarantees delivery from beginning to end. Since TCP's inception, many different algorithms have been proposed, each of which can be further subdivided according to the central processing unit's location and the congestion control metric employed. Due to the unique properties of Adhoc networks, TCP is not optimal for use in these environments. Since this is the case, either the current TCP algorithms are tweaked or new algorithms are proposed to regulate ad hoc network congestion.

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