Enhancing Network Performance in Wireless Sensor and Anonymous Networks

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Abstract

In Wireless Sensor Networks (WSN), congestion control plays a crucial role as the traffic load surpasses the capacity of each major channel. The WSN constrained resources must be taken in consideration while devising such strategies to get the best throughput. Various factors are contributed in the congestion; the primary factor is the over flowing buffer, packet loss, reduce network throughput and loss of energy. This research, studies path load distribution in novel networks, including anonymous communication. Initially there is a chance that the public Wi-current Fi approach will result in notable imbalances. We next modify an optimal path-selection algorithm and use flow level visualization to show that this results in a substantially improved network load balance. Web-based Congestion Control (WCC) needs to make it possible to give WCC channel flows a distinct quality of service (QoS) in order to overcome this difficulty.

Keywords: Traffic Load; Congestion Detection; Network Capacity; Path Load Distribution

1. Introduction

Congestion in WSN happened whenever various programs tries to utilize the same network. Delay is a critical issue for user facing applications, such as dynamic websites and search engines, while throughput is a primary issue for backend applications like email backups [1]. Depending on the apps being utilized, there are several ways to share network bandwidth. The different objectives of the algorithms for congestion control coincide. Over the past 20 years, there has been a rise in the quantity of radio access networks. Globally, there were about 10.19 billion active mobile customers as of the first quarter of 2020. By 2025, it is projected that the mobile route will grow by 45.18% yearly. The majority of the data path should be at a higher degree, as the movie illustrated [2]. The increasing number of people are protecting themselves from surveillance by using anonymous communication networks. Sensors are the foundation of contemporary data collection systems offer unprecedented precision and diversity with the Integrating technologies such as optical sensing, MEMS and wireless communication, enabling improvements in domains ranging from environmental monitoring to healthcare diagnostics [3,4].

2. Literature Review

There are many problems in wireless sensor networks including battery exhaustion issue, data collection issue, placement of sensor networks in different regions and more. Several researches have been carried out to gather minimum latency data in WSNs, although none of the suggested solutions could reduce latency of data gathering without data conflict. Literature review is performed based on the following specific criteria:

A. Load balancing and buffer occupancy parameters

In [5] Authors suggested an adaptive routing strategy within three phases to address congestion problem. First phase used (MFL) multi-stage fuzzy logic to specify the best level of information for queue control The weights obtained from parameters related to congestion are then transferred to the following modules, in second Phase, notification of congestion is modified to enhance the module's flexibility to increase the efficiency of route

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discovery and to minimize the possibility of losing within the routing phase. In the third phase, a novel navigation technique were used for the implementation of mechanism control and routing system using MFL along with angular and linear distances to generate weights for path evaluation. These 3 steps focuses on minimizing the congestion for WSNs in terms of energy consumption metrics, average hop count, packet loss ratio and network lifetime. In [6] a (WRF-RPL), Weighted routing forward technique, has been proposed to overcome the short lifespan of wireless sensor networks. This technique depends on load utilization to overcome congestion at the busy nodes. The author in [7] Utilized load balancing and combined energy replenishment to minimize traffic and get higher rechargeable rate to enhance lifespan. [8] Suggested a method for controlling congestion control and buffer switching depending on some factors such as: remaining buffer space, congestion level of sensor nodes and the remaining energy. [9] Suggested a novel technique for congestion control that use fuzzy logic for wireless sensor networks. In the suggested method the congestion control and declaration is implemented by using the remaining energy level, accessible detection bandwidth and load density. To save WSNs from losing packets, additional power consumption, and lower throughput.

B. Energy and latency savings

The authors in [10] proposed a reliable and price oriented transmission protocol to obtain both energy efficiency and reliability in WSNs. [11] introduced a technique for an effective energy congestion control for congestion avoidance and detection to evaluate its effect on the sensing application. In [12] a new technique proposed for distributed traffic aware routing with the alteration of nodes data transmission for multiple sink wireless sensor networks to improve traffic performance from source to sink-node and enhance network congestion delay. [13], proposed a Delay Aware Congestion Control (DACC) for reducing the delay and mitigating congestion in wireless sensor networks. DACC enhance the reliability of the current model of congestion detection by taking into consideration both average transmission time for packets and time occupancy for the buffer in one node. [14], the authors in this study mentioned that WSNs delay is caused by a duty cycle adopted by sensor nodes in order to mitigate this problem, they suggest a DDC (dynamic duty cycle) technique. They believes that by conducting this scheme, they can improve the consumed energy and enhance the performance of WSNs.

C. Strength of Received signal and additional features

The latest developments in massive scale integrated circuits significantly reduced the volume of smart electronic circuits, improving both complex information processing and sensing capabilities. In [15] the authors offer a protocol with rate control, bidirectional dependability and congestion mechanism because the suggested method chooses the best route for transferring data using a technique for Order Preference by Similarity to Ideal method (TOPSIS), it's extremely dependable.

WSNs Congestion Detection and Avoidance (CODA) is a solution that Wan et al. [11] proposed to handle the congestion issue. This approach is an energy effective congestion control method, which includes open-loop hop-by-hop backpressure, receiver-based congestion detection, and closed loop multisource regulation. In contrast to other well-known methods already in use, the authors of [16] suggested a node priority based congestion control protocol (PCCP) for wireless sensor networks designed to quickly reduce congestion and use less energy. Using a hop-by-hop control strategy depending on the evaluated amount of congestion, PCCP manages traffic more effectively and efficiently.

Ren et al. [17] Tried to increase a network's utility by cooperatively regulating SNs' channel access and sampling rates in accordance with interference limitations, channel capacity, and energy usage. In order to successfully remove traffic problems by ensuring data integrity, [18] examined the impact of congestion control in WSNs and presented a resolution known as congestion adaptive data collection scheme (CADC). To guarantee that the overall data estimate error bound is determined fairly, it employs adaptive lousy compression. Various resource-based control algorithms were analyzed by Jan et al. [19] based on their effective bandwidth utilization strategies and route construction methodology. The authors also looked into these protocols' intrinsic functional mechanism for mitigating congestion. They concluded that the kind of application environment affects how effective different congestion mechanisms are.

According to Jing et al. [20], the optimal route for a mobile agent between the cluster and sink can be found by creating a cost function. The authors of [21] employed support vector machines (SVM) and the multi-classification approach to manage congestion. Additionally, differential grey wolf optimization (GWO) and evolution (DE) methods are used to reduce classification error.

Quality of service (QoS) is guaranteed by optimizing energy and delay in accordance with the data packet arrival rate within the network. A summary of the several congestion control algorithms or techniques to address the problem of traffic congestion in WSNs was provided by Shah et al. and Chughtai et al. [22,23]. For the purpose of controlling congestion in WSNs, the author in [24] presented traffic and energy aware optimization technique. Yan

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and Qi [25] combined network traffic and geographic distance to create a congestion aware routing algorithm with an infinite lifespan. To improve the fairness issue of the initial bottleneck bandwidth and round-trip propagation delays, Pan et al. [26] presented an adaptive congestion window for round trip adaptive congestion window and bottleneck bandwidth.

Despite the fact that the previously mentioned schemes can manage congestion in WSNs effectively, no congestion aware techniques have ever been tested for modulation schemes. Congestion at a node can occasionally cause a change in path, which, if the distance is too large, may need a node to exert additional effort in order to send packets from source to destination.

Therefore, checking the modulation strategy aids in increasing the packets' transmission range within SNs, especially as the distance increases significantly. Thus, after examining the aforementioned mentioned problems, it is essential to develop a solid architecture design to prevent SN congestion and enable long-distance transmission with the right modulation technique.

3. Prototype

In terms of approach, we employ to represent vectors like X with Xi as the ith factor. For instance, constants like Y, X, Z, or RI, P and Q. These utilized for the identification of basis factors, conditions, or vectors, specifically Ri, Xi, Yi and Zi. The network was displayed by the collection of P-links that are one-way and have a set of 'n' being the discovery of source route and Finite Capacities (FC) = (FCl, l=1... P), for source 'n', which corresponds to R×Xn 0-1 matrix Xn, there are Rn acyclic paths displayed.

$$X_{n,0}^{n} = \begin{Bmatrix} 0 & Path \\ 1 & Re\,path \end{Bmatrix} \qquad (1)$$

A collection of all Xn represented as 'n' routing paths may be denoted by Xn. Assume that R = £n Rn in the Q×R matrix, and that X determines the architecture of the network. Make Xn = Rn×1 vector such that the percentage of source 'n' on its jth path is represented by the ith entry.

$$X_i^n \geq 0, \forall j \qquad (Xn=0) \qquad (2)$$

Where 1 is a vector with the appropriate 1 dimension that allows for multi-path route discovery and necessitates 1-hop routing. R=i1, i2...in are vectors entered into the block-diagonal matrix X. Let X set represent the matrices collection that define the 1-hop routing.

$$X = \{X^1, X^2, \ldots . X^n\} \in [0,1]^{RxP} \qquad (3)$$

Where P denotes the network's topology and specifies the acyclic pathways for every basis. According to X, the source routes' load balance is established. The R=XP matrix defined by its product necessitates the fraction of (n) flow on every linked node. Every one hop routing matrix is configured.

$$P = \{P^1, P^2, \ldots, P^n\} \in [0,1]^{XxY} \qquad (4)$$

The constraint on P and Q distinguishes 1-hope route discovery from multi-hop route discovery. The 1-hope routing matrix's 0-1 matrix in Qs

$$X_n \in [0,1] \qquad (5)$$

A [0, 1] range multi-way routing matrix for Rm

$$X_n = \begin{bmatrix} > 0 \\ = 0 \end{bmatrix} \qquad (6)$$

The nth column of the direction matrix X, Xn = [Xn... Xni], represents the n'.

A. Selection of the Path Allocation Algorithm

The Python programming language have been used to create a code that mimics the random assignment process. With the delivery over relays and three relays used without substitution, this code creates paths where each relay is balanced based on its volume. We assess the performance of our algorithm regarding to parameters related to public Wi-Fi networks. We calculated that roughly 1.4 million (94.15%) of the system's modes are now in use. Thus, a random approach was used to generate 1.4 million paths, and fair max minutes was used to determine bandwidth distribution. We can see that the majority of nodes are assigned an average of about 11.19, however there‘re notable rebounding at both ends of the spectrum: the module's smallest allocation is 1.12, while its maximum is 200.

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B. Allocation of Random Paths

First:	Enter: DA
Second:	DA=DA1, DA2, DA3
Third:	DA= Data Size depends on Weight
Fourth:	Return Route: DA1, DA2, DA3

By this definition, an active circuit is one that is in use to transfer data, yet most circuits are in use all the time. It is illustrated by contrasting the results of a steady download that takes around 12 seconds with the total traffic on the Tor network, which is roughly 1 gigabyte. Each system is carried by three relays, indicating that one Gbps is in use (figure 1). Take note of the significantly larger imbalances: a typical 566.18 out of 10100 falls below half of the standard deviation of 1210. Additionally, 50 receives less than 10.19% of the typical bandwidth, and a minimum allowance of 20 is a maximum of 510.9.

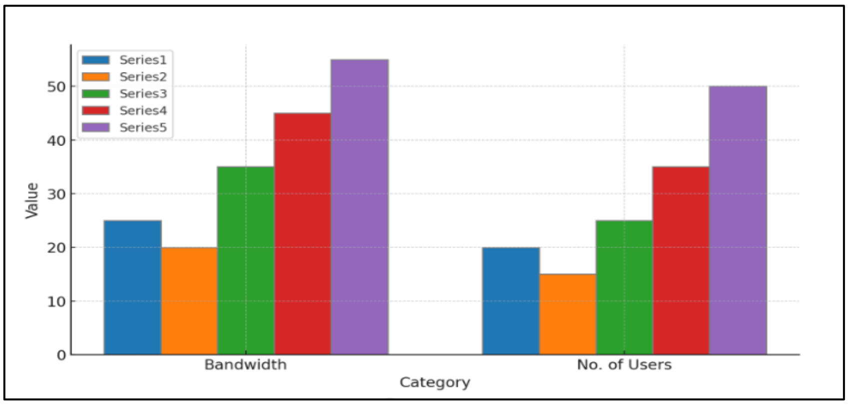

Figure 1. Random Path Selection for Bandwidth Allocation.

C. Allocating Optimal Paths

The route is presented to the system network within the highest available bandwidth, and the designed algorithm searches for relays within the collection of relays [n]. Initially, we devise a method encompassing network information, meaning all network pathways and route relays. The algorithm was created under the presumption that the bandwidths of the current network paths are distributed as fairly as possible. The algorithm knows the pair's iterative processes' names. This article displays the amount of data traffic assigned to a newly constructed network path.

That would be the transmission path's bandwidth appearing in a fresh mobile data path (figure 2). A method is proposed to model the future behavior of the Max-Min algorithm within the network. We are able to determine the allocated bandwidth thanks to this visual aid. The fact that each of the three relays introduces a new route, so limiting the number of routes in one, is a significant problem. The network size for every other relay was constant. Moreover, the path bandwidth distribution set 1 is determined by the relay selected from a path. We are looking for relays that substantially boost the bandwidth amount used for the new path, so the model computes the many viable assumptions depending on various crucial factors.

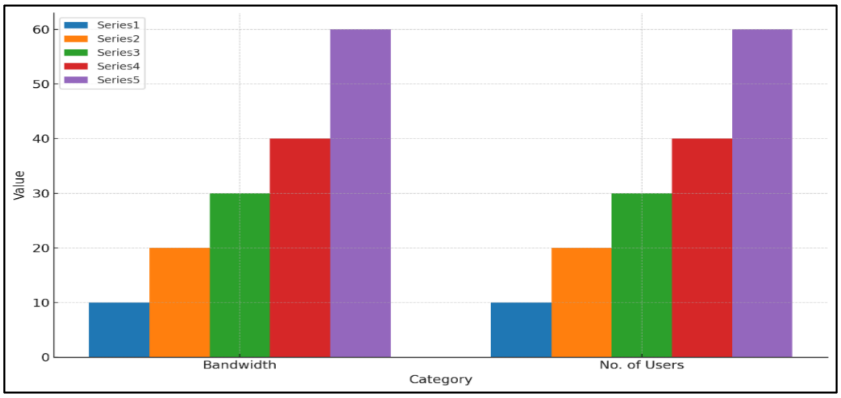

Figure 2. Optimal Path Selection for Bandwidth Allocation.

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4. Experiments and Results

In order to log each user's maximum data rate, we principally designed FTP using a UDP path. The TCP congestion control method does not lessen download when UDP is attempted. The relationship between the maximum bandwidth and cross-layer parameters can be examined using this original data set. The data set was tested and the models were pre-trained.

After that, the simulator was loaded and secured. Performance was evaluated against web-based algorithms. Simulation provides a specified amount of FTP users that are running within the system. The number of users per cell varies depending on user position and physical constraints. The performance of the network varies dynamically during the experiment. By random means, the active users are dispersed over the simulation region. UEs travel at a walking speed of five kilometers per hour at the beginning (Table 1) shows Simulation Setup for Data Gathering.

Table 1: Simulation Setup for Data Gathering

Layout	Parameters
AP Count	3
UE Count	10, 12, 14, 16, 18, 20
Resource Count	200 (Duplex)
Movement Pattern	Linear
Velocity	5 km/h
Propagation Model	5GPP
Downlink Scheduling	FCFS
Channel Bandwidth	Hz

A. Testbed Topology

The 200 Mbps Ethernet ports of the N1 and N2 nodes are connected to the Wi-Fi access point. The N3 and N4 nodes using WiFi reach the AP. One TCP flow and five Web-RTC flows are used to evaluate Web-RTC under various traffic scenarios. The wireless radio channel is crowded using the N2-N4 link (figure 3).

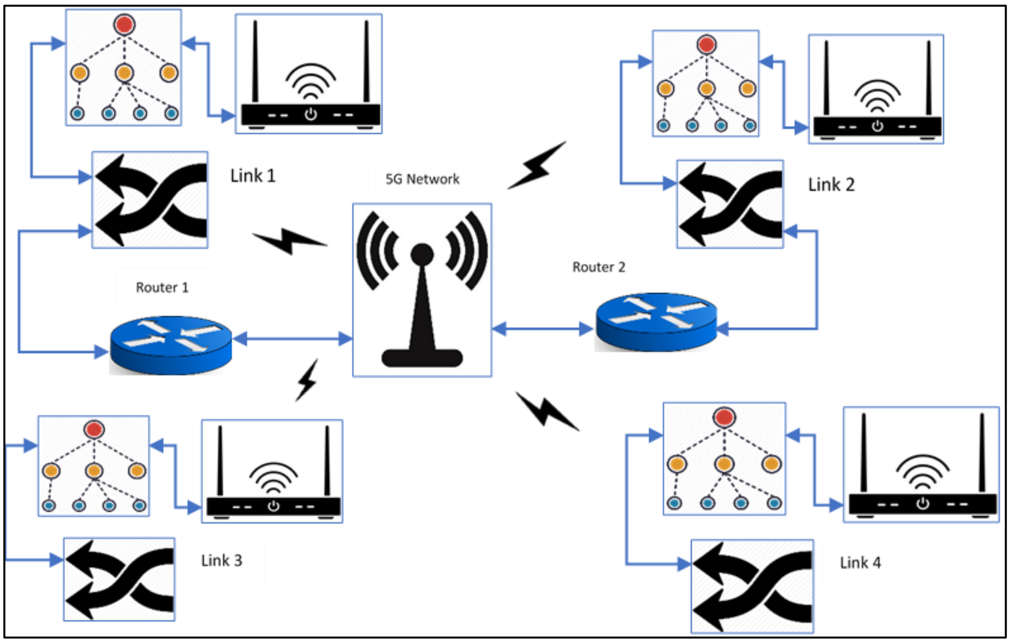

Figure 3. 5G network configuration.

B. Performance Analysis

The connection control may result in a substantially lower TCP throughput than the WCC. (Figure 4) shows that 1.19% of the system's users are active, which is a much higher percentage than the other classic approaches examined.

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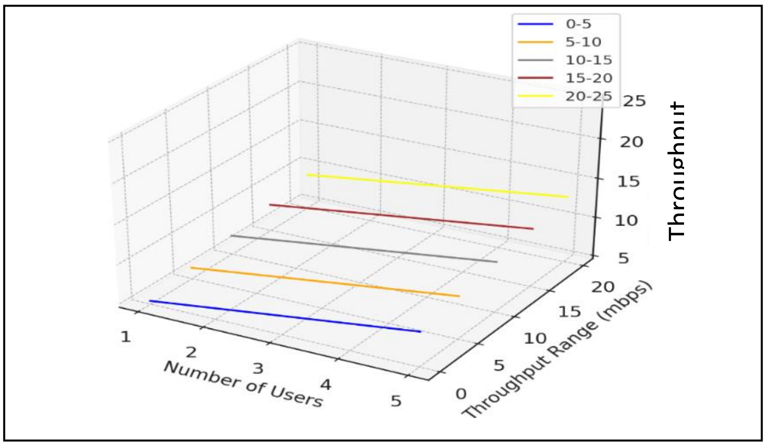

Figure 4. Average performance of TCP with different user loads

All evaluated methods can have a lower delay than 120 ms for 94.18% of users. The customers' TCP throughput is somewhat increased by the web-based RTC technique (figure 5).

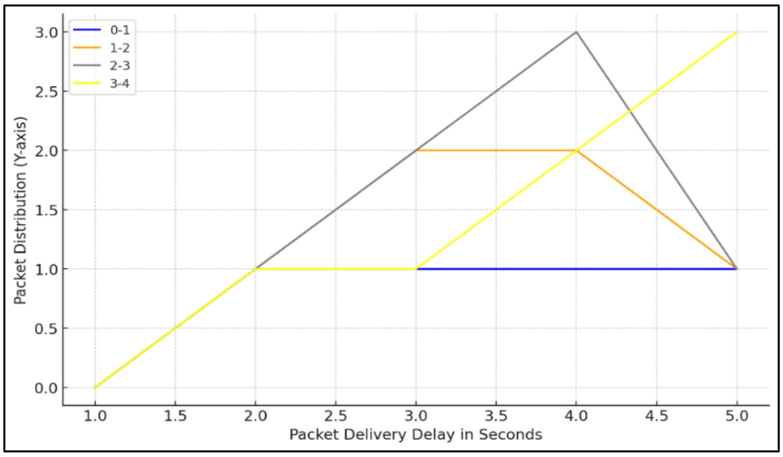

Figure 5. IP Packet Delay Distribution.

Higher size distribution output is achieved by the other methods by increasing the amount of available components within the network. WCC methods maintain a highest cell throughput while the defaults maintain the lowest. Since all of the investigated algorithms are able to maintain high network connection utilization, device performance gain is not statistically significant (figure 6).

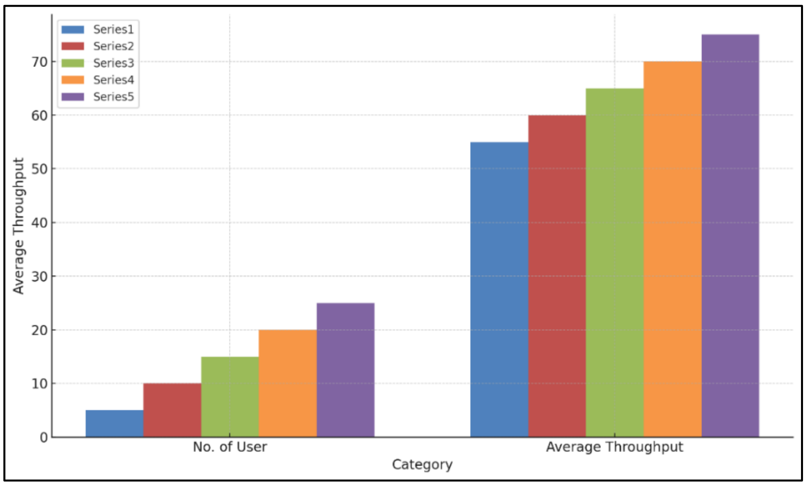

Figure 6. Average throughput for varying user loads.

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5. Conclusions

The proposed WCC models utilized both system and physical layer elements to estimate the bandwidth availability for system users. This process involves transmitting packets at an estimated network rate to avoid network congestion. An algorithm have been developed that optimally balances the load in a public Wi-Fi network while protecting user privacy. The results suggest that additional studies into maintaining load balancing in anonymous networks using privacy preserving inputs is warranted. Findings from the 5G network demonstrate that having WCC shares available enhances facilitates sharing among other users and accuracy for long-term TCP flows. This capability is enabled by the 5G protocol approach. To prevent resource starvation for WCC, procedures to enhance the QoS of WCC communication must be explored.

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