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# VIRTUAL SENSOR NETWORKS (VSNS) OPTIMIZATION FOR THE DATA SENSING FREQUENCY OF THE SENSOR NODES

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**Abstract:**

*The problem of equitable allocation of scarce resources has been addressed repeatedly throughout the development of mobile cellular and other communication technologies. However, due to the quick advancements in technology and the increasing diversity of services with tight QoS criteria, the resource allocation problem requires more effective and cutting-edge solutions. This research shows the numerous dimensions of resource allocation that have an effect on the operation of wireless networks, which are under increasing strain due to the increasing volume and variety of network traffic. In addition, the feasibility of a fuzzy logic model for allocating resources has been demonstrated by simulation of the suggested work.*

***Keywords:*** *resource, QOS, wireless, network, traffic, etc.*

## 1. INTRODUCTION

Wireless sensor networks have the potential to be utilised in a variety of military application domains, including command and control, communications, computing, intelligence, and surveillance systems, amongst others. The fact that sensor networks can quickly be deployed, self-organize, and tolerate errors makes them a very intriguing choice for use in military applications. The destruction of certain sensor nodes by hostile activities does not effect a military operation in comparison to the loss of a traditional sensor since sensor networks are built by dense deployment of low cost disposable sensor nodes. Because of this, the notion of sensor networks is more suited for use on the battlefield. Battlefield surveillance, tracking and monitoring of ground soldiers, equipment, and ammunition, reconnaissance of opposing forces and terrain targeting, nuclear, biological, and chemical (NBC) attack detection and reconnaissance are some of the military uses of sensor networks. A subset of the sensor nodes that make up a WSN are used to create a Virtual Sensor Network. These sensor nodes are assigned to a certain activity or application at a particular point in time. In a WSN, each node in the network works together, more or less as equal partners, toward the common objective of sensor deployment. On the other hand, the subset of nodes that are part

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of the VSN work together to complete a certain task at a predetermined time. Because of this, VSN is dependent on the other nodes to offer the VSN support functionality necessary to construct, maintain, and run the network. According to the strategy that has been described, a single physical wireless sensor network can host numerous VSNs at the same time, and the membership of a VSN can shift over the course of time. Because the nodes that make up a VSN are likely to be dispersed over the physical network, it's possible that they won't be able to interact directly with one another.

## 2. LITERATURE REVIEW

**Jie Ren and Xiaolong Li (2022) -** In recent years, with the continuous development of the information technology industry, network virtualization technology has gradually developed into a hotspot of research and application in the field of communication. This is due to the fact that information technology enables the construction of a customised virtual network (VN) on shared physical infrastructure. In specifically, the suggestion of utilising virtualization of wireless networks in the context of the expansion of the improved Internet. In light of the fact that these technologies call for efficient algorithms known as virtual network mapping (VNE) in order to instantiate virtual networks on the SN, a resource allocation mechanism that is based on bilateral auction is proposed. This is done on the basis of satisfying the isolation between wireless network slices. At the moment, a multitude of scholars have suggested that the technology of network virtualization may be a workable solution to the problem of the inflexible Internet architecture. To accelerate the process of wireless skill for innovation and meet the demand of the difference in the emerging business, wireless network virtualization has become the research hotspot and focus of academia and industry. In the field of existing research, the emphasis is placed on cable network virtualization, which is primarily related to the network and backbone of data centres. On the other hand, research into key technologies for wireless access network virtualization is still in its early stages. However, the dynamic resource allocation technique has not been applied to the field of wireless network virtualization resource sharing by anybody. This section of the study will examine and provide a summary of the present virtual network resource distribution strategies both in the United States and internationally. Establishing the wireless virtual network resource allocation model and the cross-domain virtual network resource allocation model, introducing the network centrality theory in social networks and complex networks, and proposing two efficient virtual network resource allocation methods are all part of this research. The goal of this research is to analyse the topology properties of virtual networks and physical networks.

**Jingrong Lu and Hongtao Gao (2022) -** The technology behind wireless networks is currently improving at a quick pace, and intelligent equipment is increasingly becoming more widespread. This has resulted in the rapid development of the mobile streaming media industry. People's lives have been vastly improved as a result of the proliferation of diverse mobile video applications, which collectively transport an enormous amount of random traffic. Wireless networks (WNs) are currently dealing with a load that has never been seen before, which is allocating extremely vital wireless video resources. In a similar vein, the traditional method of video transmission is incapable of catering to the requirements of users in WNs due to the dynamic nature of the network state and the diverse nature of the terminals. As a result, Scalable Video Coding, often known as SVC, has been included into the

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system that handles video transmission in order to accomplish the goal of bit rate adaptability. Nevertheless, in a strictly hierarchical conventional computer network, the wireless resource allocation technique will often consider throughput as the sole option to improve the aim, and it is a horrible idea to attempt any further optimizations for scalable video transmission. In order to gain optimal performance from both the wireless base station and the video server, the author of this paper recommended a cross-layer architecture with a design that would allow information to be exchanged between the two. The wireless resource allocation problem and the video stream scheduling problem are concurrently studied in order to increase the level of pleasure that end customers have with video services. This helps to maintain the optimization space as big as possible. We further investigate the design of wireless resource allocation algorithms as well as rate-adaptive algorithms for the situation of multiuser transmission of scalable video in the Long-Term Evolution (LTE) downlink. Our research is based on the architecture that was described before. The results of the experiments have demonstrated a significant improvement in the functioning of the planned task.

**Fahd Al-Wesabi, et al (2021) -** Users have a growing demand for data as a result of the fast development of technologies associated with the Internet. The fast development of the communications sector has been fueled in large part by the ongoing proliferation of applications that generate enormous volumes of traffic, such as high-definition video, 3D visualisation, and cloud computing. It is imperative that 5G networks be quick, adaptable, dependable, and environmentally friendly if they are to be able to keep up with the massive traffic demands of today's consumers. The academic community has put up the idea of direct-to-device communication on the basis of these research foundations. The primary benefit of D2D communication is that it makes it possible for devices to communicate directly with one another. As a result, resource utilisation is effectively improved, and dependence on base stations is effectively reduced. As a result, the throughput of multimedia data is effectively improved. The co-channel interference that arises as a consequence of the multiplexing of multiple D2D users accessing the same channel resource as cellular users is one of the most significant factors that affects the performance of D2D communication. This interference is caused when multiple D2D users use the same channel resource. In this research, a hybrid method for time scheduling and power control is proposed as a potential solution to this problem. The primary objective here is to successfully optimise the total amount of resources that are allotted throughout each scheduling period while also meeting the quality of service standards. The constraint problem may be broken down into its constituent subproblems of time scheduling and power control. The power control subproblem exhibits the features of an NP-hard mixed-integer linear programming problem. These features include: As a result, we suggested a way of controlling the power gradually. Because the time scheduling subproblem is an NP-hard problem with convex-cordinality, we came up with a heuristic solution in order to maximise the use of available resources. The results of the simulations reveal that the suggested algorithm substantially enhanced resource allocation and overcame co-channel interference in comparison to other methods already in use.

**Hancheng Hui (2021) -** In this paper, a deep learning technique is utilised to perform an in-depth investigation and analysis of intelligent resource allocation in wireless communication networks. The goal of this research is to improve the efficiency of resource allocation

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decisions. After that, the long short-term memory network (LSTM) model is used to predict the mobile location of users, and the transmission conditions of users are scored based on two conditions, namely the mobile location of users and whether or not the small base stations to which users are connected have their desired cache states, and the small base stations. To begin, the concepts related to CSCN architecture are discussed, and the throughput of small base stations (SBS) in CSCN architecture is analysed. After that, the idea of game theory is presented to model the problem of maximising network throughput as a multi-intelligent noncooperative game problem; finally, a deep augmented learning-based wireless resource allocation algorithm is proposed to enable the small base station to learn autonomously and select channel resources based on the network environment to maximise throughput. The results of the simulations demonstrate that the algorithm that was suggested in this study leads to a considerable improvement in network throughput in comparison to both the conventional random-access method and the algorithm that was proposed in the literature

**Jie Liu and Li Zhu (2021) -** The majority of the conventional resource allocation methods are based on single interface networks, despite the fact that resource allocation has always been one of the most important technologies in wireless sensor networks (WSN). The emergence and development of multi-interface and multichannel networks solve many bottleneck problems of single interface and single channel networks. It also brings new opportunities to the development of wireless sensor networks. However, the technology of multi-interface and multichannel networks not only improves the performance of wireless sensor networks but also brings about significant challenges to the resource allocation of wireless sensor networks. The old approach to cloud computing processing, known as centralised cloud computing, is replaced by edge computing, which is a strategy that moves computational storage capacity closer to the network's edge, where it is closer to users and terminals. Take advantage of the benefits that come with having reduced latency, larger bandwidth, and faster reaction times. As a result, the purpose of this study is to present a joint optimization technique for the allocation of resources that is based on edge computing. Following the establishment of a model for the allocation of wireless sensors, we offer our algorithm model, which takes into account the benefits of edge computing. In comparison to the conventional allocation algorithms (PCOA, MCMH, and TDMA), it is able to further enhance resource usage, reduce the amount of energy that is used by the network, raise the capacity of the network, and minimise the complexity of the schemes.

## 3. METHODOLOGY

In order to create the suggested fairness index, a fuzzy logic model is being created. The input stage, the processing stage, and the output stage are the three phases that make up the fuzzy logic model that is seen in figure 1. At this point, the information is being provided in the form of couples $<x_i, x_f>$ for a user $i$ indicates the user's allotment of resources $x_i$ is the benchmark for equitable distribution $x_f$. The input pair is converted into the fuzzy couple during the processing step $< i_{xfuzy,}\ f_{xfuzy,} >$ utilising the fuzzy membership functions that are demonstrated in section 5.1. The formulation of the fuzzy pair is what the output stage is comprised of $<f_{fuzzy}(x_i),\ d_{fuzzy}(x_i)>$ utilising the fuzzy rule foundation that is presented. In addition to this, the fuzzy rule base includes rules that may be used to formulate a system fairness index.

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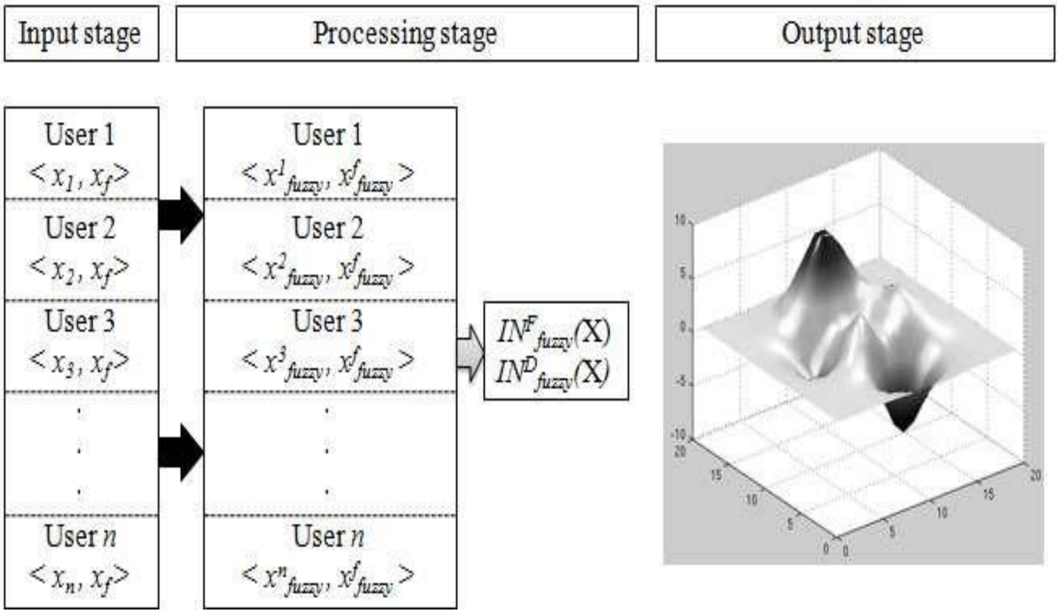


**Figure 1: Fuzzy logic model for proposed fairness index**

The description of input stage is given next. The input stage of the proposed fuzzy logic model maps a user's allocation $x_i$ and the fair allocation mark $x_f$ to the input couple represented by:

$$Input: < x_i, x_f >$$

For an *n* user system, *n* such input couples are formulated. These couples are then fed to the processing stage which maps the input variables to fuzzy variables and the output is computed based on a fuzzy rule base. The processing stage is divided into two sub-stages: the first sub-stage is responsible for transformation of input couple to fuzzy couple and the second one generates fuzzy outputs using fuzzy rule base.

## 4. RESULT AND ANALYSIS

The operation of this simulator begins with the creation of a simulation scenario for an exemplary LTE network, followed by the application of the required RAA to the simulation scenario. Because of this, it is possible to easily validate the performances of the various RAAs by doing a comparison examination of how they handle the same case. The following are the parameters that were acquired as a result of running the simulation:

- ***Delay***: The delay of the service as perceived by users of the system is measured in seconds after it has been obtained. During the simulation of the suggested fairness measurement methodologies, this metric is retrieved for GBR users, particularly video flows.

- ***Packet Loss Ratio (PLR)***: The ratio of the number of packets received to the number of packets broadcast is expressed as a percentage and may be calculated to obtain this ratio. During the simulation of the proposed fairness measurement methodologies, this parameter is fetched for GBR users, particularly VoIP flows. This is

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because VoIP flows require it.

- ***Throughput***: The data rate that is observed by users of the system once RBs have been allocated is described by this value, which is obtained in Mbps. During the simulation of the suggested fairness measuring methodologies, this parameter is retrieved for users who do not have GBR support.

- ***Spectral efficiency***: It is measured in bits per second per hertz and provides a description of the number of bits that are sent in a cell over a specific bandwidth. This parameter is unique to the cell that we are looking at.

- ***Fairness***: It is a description of the equality of allocation for the users of the system and is obtained as an index. In addition, this parameter is unique to the cell in question.

The simulation settings that have been mentioned above have been produced for the scenario that has been taken from figure 2. This figure has been taken from. The example LTE network is made up of 10 cells, and each cell supports 1 non-GBR flow, which is simulated using the BE traffic model. In addition, each cell supports 4 GBR flows, which are simulated using 2 video flows (128 kbps each), and 2 VoIP flows. 10 MHz of downlink bandwidth is the resource that is currently accessible.

| **Simulation parameter** | **Value** |
|---|---|
| Number of cells | 10 |
| Number of users per cell | 5 |
| Type and number of flows | Video = 2; VoIP = 2; BE = 1 |
| DL bandwidth | 10 MHz |
| Maximum delay | 0.1 sec |
| Video bit-rate | 128 kbps |
| Cell radius | 1 km |
| Speed | 3 km/h |
| Mobility model | Random direction |

**Figure 2: Simulation parameters and values**

The remaining sections of the chapter are laid out as follows:

**4.1 LTE RAA simulation**

The RAAs that are utilised in LTE systems have been modelled in order to recreate the scenario shown in figure 1. MT, PF, M-LWDF, EXP-PF, EXP-RULE, LOG-RULE, and FLS

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are some of the algorithms that fall under this category. Simulations have been run in order to investigate the performance of these algorithms for a variety of users, including GBR users whose data includes video and VoIP flows, non-GBR users whose data includes best effort flows, and GBR users who do not use GBR. Plotting the QoS class-related metrics against the total number of users allowed for an examination of the performance levels.

### 4.2 User parameters for the GBR class

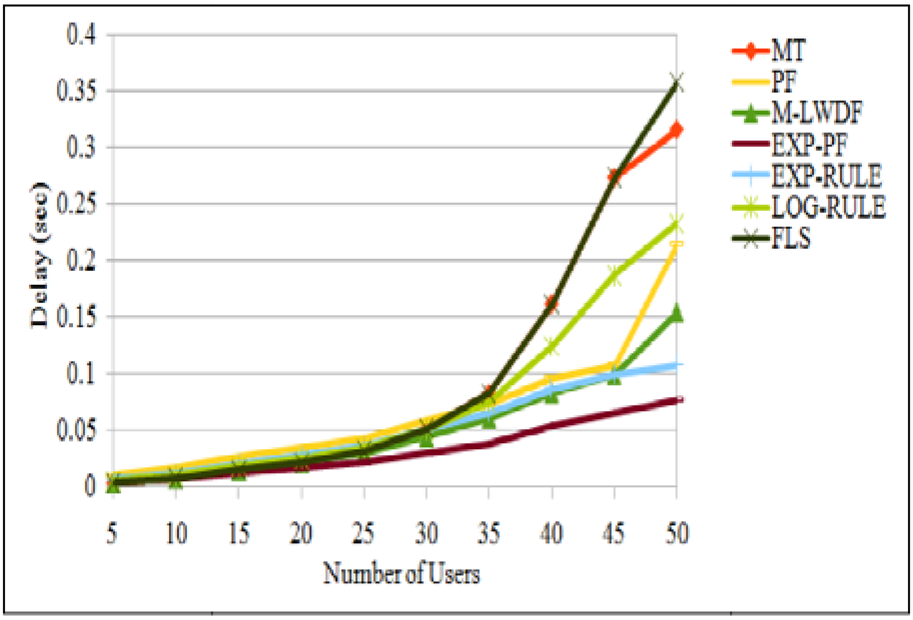


**Figure 3: Video users have experienced a delay**

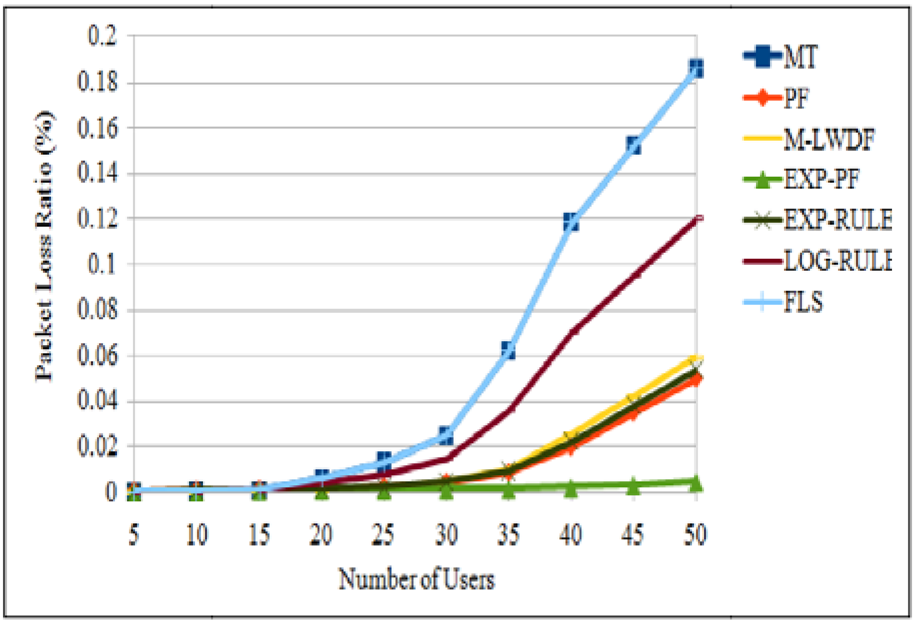


**Figure 4: PLR (Packet Loss Ratio) for video consumers**

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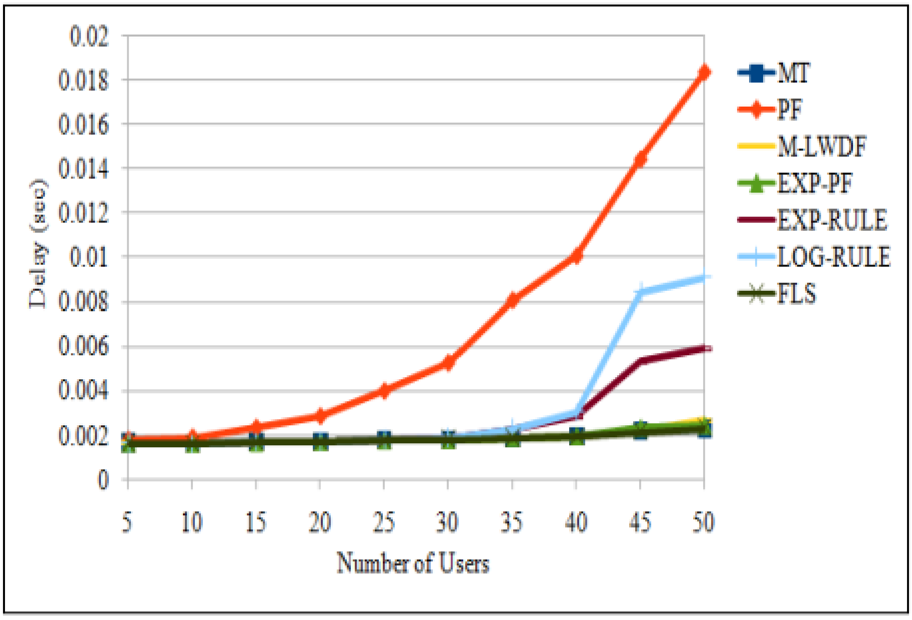


**Figure 5: Observed delay for VoIP users**

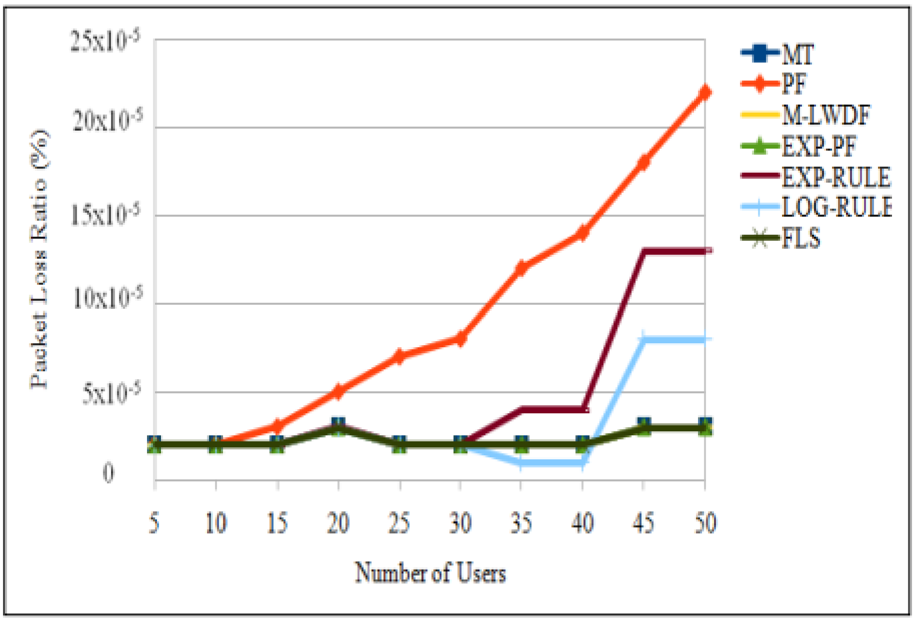


**Figure 6: PLR (Packet Loss Ratio) measurements for VoIP consumers**

## 5. CONCLUSION

Modules in the proposed QoS analysis framework measure intra-class fairness, where a novel discrimination index and the popular Jain's Index determine fairness and discrimination indexes for allocation values of users, and inter-class fairness, where a novel utility function determines fairness as utility of satisfaction of QoS requirements. In addition, fuzzy logic models were developed for both modules to make the proposed QoS analysis methodology workable in dynamic and unpredictably changing channel environments.

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