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A Novel Downlink Frequency Allocation (DFA) Technique for Enhanced Throughput in 5G and Beyond (B5G) Multi-hop Networks

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ABSTRACT

Multi-hop transmission is a viable solution for 5G and B5G networks, which offers better throughput, spectral efficiency, and less congestion in network and transmission power. In current mobile communications systems, weaker signal quality causes handoff mobile users to perform worse when more information content is downloaded straight from the Base Station (BS). For this instant requires many frequency channels and additional download time. Hence the quality of service from the service provider is degraded. To reduce the number of frequency channels and enhance network throughput, this research paper proposes a DFA technique for 5G and B5G networks via multi-hop transmission. There are two stages to enhance this technique. In the first stage, a novel frequency channel allocation technique is used in 5G or beyond 5G networks when the channel quality is poor. In the second stage, an intelligent hub selection scheme is used in 5G and B5G networks to minimizes data packet loss, download time, and frequency channel allocation, whereas it enhances the throughput of the network. Riverbed Modeler 17.5 simulation result shows that, proposed technique gives better result over other existing techniques.

1. INTRODUCTION

The telecommunications sector has seen growth during the last ten years. Better service quality and network performance are provided by a number of novel strategies that have been proposed. Due to the huge in demand of such wireless applications as Artificial Intelligence (AI), Machine Learning (ML), different multimedia applications, medical industry, Wireless users require more frequency channels from their mobile communication industry. Due to a lack of available frequency channels, the mobile communication industry as it currently exists cannot provide additional frequency channels [1, 2]. Base stations, a limited amount of available bandwidth, and various newly proposed technologies, it is required to adapt the current mobile networks and switch from a structural to an intelligent transmission strategy, or 5G. In recent years many research directions have been proposed for 5G and B5G multi-hop networks to provide enhanced data quality [3, 4]. Multi-hop transmission approach that addresses energy efficiency and seamless connection from the mobile user point of view. In 5G and B5G, multi-hop communication has become one of the more attractive approaches. Current research efforts concentrate on two main areas: either optimizing radio resource and power allocation techniques to increase throughput, or determining the optimal path based on the distance to the next hop [5, 6]. Nonetheless, there is a dearth of research that addresses enhanced throughput and resource allocation via multi-hop communication for 5G networks.

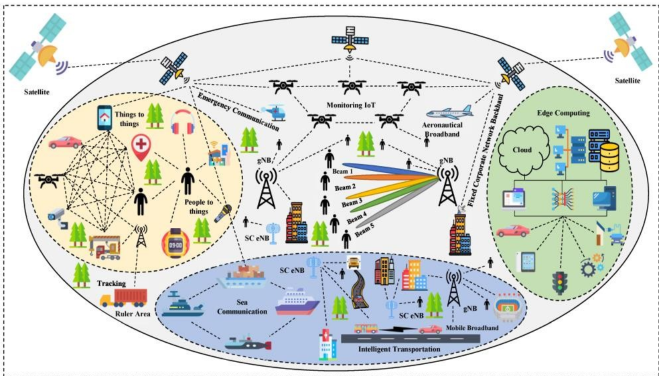

Figure 1. 5G wireless multi-hop networks-general diagram

5G wireless multi-hop communication general diagram is shown in Figure 1. User device equipment communicates with BS or MSC in the current 5G multi-hop communication system. Thus, there are fewer users on the BS side, less information is directed through and away from the BS, and less energy is used by end-to-end cellular devices [7, 8]. Furthermore, multi-hop transmission increases cell throughput as well as cluster throughput, particularly for handoff mobile customers when signal quality is substantially worse and cellular devices have poor wireless communication. Because multi-hop transmission enables many wireless devices to share the same data with limited mobile resources, it is the best option in this scenario [9, 10]. Since there are limited frequency channels available, efficient channel allocation is essential for increased network throughput. In particular, when there are few resources available, efficient resource allocation greatly increases network throughput while reducing traffic from the BS. The frequency channels are entirely allocated by the cellular base station (BS). Signal interference and noise ratio are used to gauge network quality [11, 12]. The wireless gadgets send information to the BS to allocate resources so they can communicate with other devices. The BS assigns frequency channels to the wireless devices in accordance with the availability of local and international wireless links, requests, and acknowledgements. The authors [13, 14] proposed a joint radio resource allocation method that uses frequency reuse and is an energy-efficient method for multi-hop transmission.

In conventional mobile downloading systems, the interested mobile users download movie or bulk data from the cellular BS or cellular cloud get a request from the BS for allocation of frequency channels. Nowadays, there is an increase in high volume bulk data and exchanges of data among cellular users need a larger number of radio resources and downloading time [15, 16]. This process takes more time for cellular gadgets, particularly consuming more power if the handoff mobile users want to download movies or exchange information. Hence, directly downloading the movie or bulk data from the BS degrades quality of wireless service. Multi-hop is a possible solution for direct downloading movie or bulk data, whereas the handoff cellular gadgets search proximity gadgets that can avoid its data from the BS side [17, 18]. There are many different types of communication, but in this paper we concentrate on multi-hop transmission between wireless devices that are handoff to adjacent devices and mobile communication from nearby chosen devices to the base station. One of the main components of focus for wireless multi-hop transmission is hop selection. For wireless multi-hop transmission, there are numerous hop selection techniques. HRS (Hybrid Relay Selection) [19], BRS (Best Relay Selection) [20], Max-wireless channels [21] and Min-Max [22]. There has been discussion of the Max-Min hop selection strategies. This approach bases the choice of available wireless devices to hop between on data from the wireless channel. The Max-Min hop selection method does not take buffer data into account. The Max-Max with data buffering technique is another popular hop selection method. Performance gains over Max-Min hop selection are increased by buffering data at the hop device. This method selects the ideal channel from the source to the hub and from the hub to the destination.

As a result, the hop device might not be the same, increasing dependency, and the hub node has a small data buffer. If the hub has free buffer space and the information from the channel, maximum-wireless channels will at random assign each frequency channel to the source devices or hub transmission [23, 24]. For a secure transition from the source hub to the destination hub, the Maximum-Ratio hub selection technique is applied. According to this method, the ideal hub choice is determined by the presence of channel linkages between wireless devices [25, 26]. Moreover, there exists many hub selection techniques, they are either for multi-hop transmission or hub by hub transmission. With respect to handoff cellular gadgets that are searching to download data from the BS, two types of transmission are used, one is multi-hop transmission and another one is end- to-end transmission. Because multi-hob transmission offers a lower data rate than cellular connection, the current hub selection approaches do not work well. In addition, the multi-hop data rate over the same channel differs from the mobile data rate [27, 28]. Due to the hub's and source's uneven link conditions, there is a greater risk of information loss, which reduces network throughput and service quality in the present hub selection systems. As a result, a novel frequency selection technique that minimizes packet loss in multi-hop transmission also addressing throughput is adequate [29, 30]. In addition to considering signal power and noise power, the needed frequency and hub selection also takes the reliability of the device into account. The device will undoubtedly take part in the hub selection process if it has a high reliability value.

2. MOTIVATION BEHIND THE RESEARCH

In the current cellular system, the BS first assess the channel feedback before assigning a frequency channel to a cellular user who wants to download a lot of data from it [31, 32]. Hand-off cellular devices need more frequency channels and downloading time to download the bulk data because of path loss and deep fading. As a result, the network throughput and service quality suffer [33, 34]. Therefore, multi-hop transmission is a potential solution for Hand-off cellular users that reduces the amount of frequency channels and downloading time for maintaining quality of service. Multi-hop transmission mode is used for the first hop to second hop and hub by hub destination hop of transmission. Although numerous frequency allocation techniques have been proposed in the existing research. They do not consider Hand-off cellular device for frequency channel allocation [35, 36]. For the same Channel state information, the minimum data rate for multi-hop and cellular modes is different. The fact that the BS distributes frequency channels in a round-robin fashion, which increases the number of frequency channels and downloading time, is another disadvantage of the current resource allocation technique. Additionally, hand-off mobile devices require the hub for multi-hop communication. Despite the fact that there are many hub selection strategies, including Min-Max, HRS, BRS, and Max-Ratio [19-22], they do not perform better because mobile communication and multi-hop communication are two distinct types of communication, and the current data downloading strategy [37, 38] chooses the hub at random, which lowers network throughput. Because there are many different ways to communicate, selecting a hub that lowers packet loss and increases throughput is essential. As a result, the two types of communication scenarios are compatible with the current hub selection and bulk data downloading hub selection schemes. Another flaw in the hub selection method for bulk data downloading is that they do not take reliability into account. Reliability is an essential element for 5G networks to continue providing high-quality service. Current hub selection methods select any hub, but it's possible that the selected hub won't be able to function as a hub due of its short battery life [39]. A new hub selection technique is sufficient to handle all forms of communication and minimize packet loss when downloading. In order to download huge amounts of data from the BS, it's crucial to suggest an effective frequency allocation approach and a hub selection technique that minimize packet loss, cut down on the number of frequency channels, and speed up download times.

In one approach to managing frequency allocation is to apply particular transmit power limitations or frequency-time constraints on the radio resources that each Base Station (BS) uses [40]. For instance, by prohibiting a cell from using these Resource Blocks (RBs) or by capping the maximum transmit power permitted within, inter-cell interference can be minimized. These resource allocation restrictions, for instance, might be set using Fixed Frequency Reuse Schemes (FFRS) or Centralized Frequency Reuse Schemes (CFRS) [41]. However, most of these reuse strategies are based on frequency-time allotments that are planned and cannot adapt to the temporal and geographical variations in 5G network traffic [3]. Centralized Dynamic channel Assignment (DSA) methods with equal transmit power per RB have been developed as a solution to this problem. Previous research has demonstrated that the benefits of allocating different transmit powers to distinct subcarriers in cases where a wide range of users want diverse signal quality are minor, which serves as the motivation for these systems [10, 11]. A centralized architecture with dynamic frequency allocation is described by the authors [8]. Based on cell loads, users are allotted frequency resources, and a central broker solves the graph coloring problem on a regular basis. However, when several cells require a lot of frequency resources, the effectiveness of this technique may be seriously compromised because those resources may not be reused in an adjacent channel to minimize inter-cell interference and packet loss. The spectrum assignments [13] are based on the needs of secondary users in cellular networks; these assignments, however, are also not immediately applicable to 5G networks. The authors [14] optimize transmit power and channel allocations among users in tandem to maximize the DL throughput of a multi-user beamforming cellular network; subcarrier allocation is not considered.

2.1 Research objective

The following research objectives help us advance our research in this paper.

1. To investigate an effective resource allocation technique that is dynamic base station oriented for downloading movie or bulk data from the Base Station.
2. To investigate a novel hub selection strategy for 2 various forms of communication in hops with the least amount of packet loss.
3. The hub selection technique chooses the parameters, such as battery power, energy efficiency, and dependability, signal power and noise power.
4. In the case of downloading bulk data and movies, the proposed technique reduces the number of frequency channels, downloading time, and packet loss and signal and noise interference due to dynamic base station.

The paper is structured as follows: Discuss the proposed methodology and problem formulation in section 3. Propose an effective frequency channel allocation technique for downloading bulk data and movies in section 4. Addressed the simulation result and discussion in section 5. Conclusion is presented in section 6.

3. PROPOSED METHODOLOGY AND PROBLEM FORMULATION

The communication scenario supporting a mobile network is taken into consideration in this research. The network situation for downloading bulk data from the BS is shown in Figure 2.

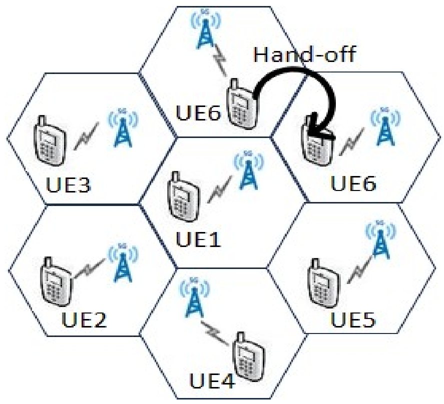

Figure 2. Proposed model for downloading movies in 5G multi-hop network

Any mobile user (UE1, UE2, UE3, UE4, UE5, UE6) can assist the Handoff users (UE6) in bulk data transmission. All cellular users (UE1 to UE6) directly communicate with BS to interfere with the hub device.

3.1 Proposed network model

We take into consideration the cluster cell for downlink example, which includes 7 BS and n devices under the coverage of a centralized BS and an MSC. Centralized BS, which is selected by MSC as given in Table 1, evaluates channel quality, acknowledgement, modulation schemes, and error control coding schemes.

Table 1. Efficiency comparison of multi-hop transmission with conventional cellular transmission

Channel Quality Index Mapping	Downlink Modulation Technique	Efficiency Multi-hop [bits/sec]	Efficiency Cellular [bits/sec] in GHz
2	OQPSK	0.322	0.211
4	OQPSK	0.621	0.224
6	OQPSK	0.933	0.277
8	OQPSK	1.100	0.512
10	OQPSK	1.233	0.671
12	128 QAM	3.122	1.222
14	128 QAM	4.155	1.323
16	128 QAM	4.566	2.346
18	264 QAM	5.223	2.455
20	264 QAM	6.566	3.124

Additionally, frequency channels are assigned to the requested user from the channel frequency that is not in use. If direct transmission is unable to deliver the required minimum data rate, the MS (Mobile Station) looks for a nearby device so that it can receive data from the BS and BS can send data to the MSC with the assistance of the adjacent MS device.

3.2 Problem formulation

The BS distributes the frequency channel for cellular costumers based on their downlink acknowledgement of their immediate and global channel condition information. Enough frequency channels are assigned in the downloading situation using the multi carrier frequency division multiple access. Depending on the channel bandwidth, the number of frequency channels might range from 10 for 2.0 MHz to 200 for 40 MHz. Due to the constrained number of frequency channels, effective frequency management is required to maximize network capacity. Here, we focus on the frame structure type 3 configuration and time division duplex TDD-MC FDMA mode. If the transmission time interval is 0.5 ms, this ensures the largest number downlink subframes, with five out of a possible total of ten. Users of Handoff cellular user who want to bulk download data from the BS receive request signal from the BS. To test the channel quality and interference and to assign the frequency channel, the BS initially transmits at the same signal strength to every device. The BS then distributes the frequency channel in accordance with established schedule regulations. Due to the Hand-off user equipment's poor channel condition, this scheduling is unable to deliver the full throughput; Consequently, more frequency channels, greater power, and longer download times are needed. Because it utilizes more power when downloading data, this user equipment interferes with other devices. This lowers throughput.

To download bulk data from the BS, we construct the problem of assigning and controlling the frequency channels that achieve the highest throughput and the fewest frequency channels with the shortest download time without deteriorating quality of service. Downlink (DL) can be achievable at the same multi-channel carrier frequency; we haven't split DL frequency channels. User equipment in the cellular network's DL phase uses Ps power to receive a signal from the BS while multi-hop transmission uses Pd power. In the absence of a better rate from direct communication, the device tries multi-hop communication. We consider multi-hop communication in this circumstance. The first and second hops use a multi-hop transmission mode, whereas the third and fourth hops use cellular communication. Other equipment that uses the same band as it can cause interference. Additionally, other devices engage in multi-hop communication and produce interference.

4. DFA ALGORITHM

DFA algorithm is an essential component of 5G networks, providing reliable communication between network elements. With the advent of 5G technology, the volume of data transmitted and the number of connected devices have significantly increased. This surge in data traffic and the growing complexity of the network architecture necessitate DFA Algorithm measures to safeguard the confidentiality, integrity, and availability of information exchanged within the network. DFA Algorithm primarily responsible for ensuring data integrity during transmission. It achieves this by applying channel allocation techniques to minimize data packet loss and downloading time of user data and control plane messages exchanged between various network elements. DFA algorithm employs a symmetric channel allocation function, often based on the authenticated encryption scheme. DFA combines the AES (Advanced Encryption Standard) algorithm with a counter mode of operation, providing both confidentiality and integrity of the transmitted data. This algorithm is widely recognized for its efficiency and throughput enhancement.

DFA algorithm operates in conjunction with other security mechanisms, such as user derivation functions (UDFs) and message authentication functions (MAFs), to establish a robust framework in 5G networks. These mechanisms ensure that the data remains unaltered during transmission and detect any tampering attempts, whenever a mobile user initiates a communication session in a 5G network, the NIA Integrity algorithm plays a vital role in establishing a secure channel between the user equipment (UE) and the network. It accomplishes this by generating integrity protection keys that are used to secure the communication links.

This section presents a downlink channel allocation technique after a dynamic channel allocation and subcarrier technique for 5G and B5G downlink systems. At the BS, the packets from different users are buffered in separate queues with presumably infinite lengths. Packets are served in a first-in, first-out method within a single queue. Packets are served across the networks in accordance with the proposed resource allocation method.

Let $S_{m,n}$ be the indicator of subcarrier allocation; $S_{m,n}=1$ indicates that user m has been allotted subcarrier n; $S_{m,n}=0$ indicates otherwise. The multiuser dynamic frequency allocation optimization issue turns into

$$DFA = \sum_{m=1}^{M} \sum_{n=1}^{N} S_{m,n} L_{m,n} \quad (1)$$

The above-mentioned channel allocation problem can be solved in three phases. Finding the quantity of subcarriers Sm needed by every user m is the first stage. Assigning the designated subcarriers to every user in accordance with the suggested subcarrier assignment methodology is the second phase. Channel allocation to every Eigen subchannel is the final stage. The following is a description of the detailed procedures:

Phase 1: For user m, the number of subcarriers S_m is found. The number of subcarriers for each user is originally assigned using the following Eq. (2) in order to preserve equality across various users.

$$N_k = \frac{S_m}{S_{Avg}}, m = 1,2,3 \dots M \quad (2)$$

where, $S_{Avg} = \frac{1}{M}\sum_{n=1}^{N} S_m$ represents the average channel count allotted to each subcarrier when the minimum data rates of all users are met.

Phase 2: For every user m, assign the S_m defined subcarrier. It is simple to calculate $L_{m,n}$, m=1,.., M assuming that the data rate $S_{m,n}$, m=1,..,M on each subcarrier n is constant. The following equation designates the assigned subcarrier n to user m:

$$S_{m,n} = \begin{cases} 1, m = \arg\min (K_{j,n}) \\ 0, \quad \text{otherwise} \end{cases} \quad (3)$$

Phase 3: The algorithm is used to assign channels to every user on the eigen subchannels once all subcarriers have been assigned to users.

For 5G and B5G cellular users as well as handoff users, an effective spectrum allocation technique that takes advantage of multi-hop transmission-based downloading has been proposed in this section. Our technique is separated into two stages to minimize packet loss, smooth connection, spectrum utilization, downloading time, and enhancing throughput. Between the BS and Hand-off cell users, a new hub selection system that chooses the best hub feasible from those that are available has been proposed for the first stage. In the next step, a brand-new method of spectrum allocation has been presented enabling hub-by-hop communication in the downlink. Initially, the BS sends out a packet over the network to determine the channel quality for direct transmission between the cellular device and the BS. The path loss and deep path fading experienced by hand-off cellular device users are significant. As a result, they have found that their channels are of poor quality or that direct connection cannot deliver the required minimum data rate. This process takes more frequency channels, lengthens download time and causes more packet loss. In order to provide multi-hop communication, the Hand-off cellular device moves from the current location to nearest location. In multi-hop communication, the Hand-off cellular device searches for the closest hop device that can convey its information towards or away from the base station (BS). The second hop is where the chosen hub sends data to the BS.

The BS verifies the communication mode between the Hand-off cellular device and Centralized BS. Only when the minimal channel gain in multi-hop communication is superior to direct communication will the device opt for multi-hop communication. In Algorithm 1, a fictitious code for multi-hop communication is presented.

Algorithm 1. Hop-by-hub selection for multi-hop transmission

If end-to-end Gain < Minimum of hub-by-hub Select for multi-hop communications
Choose next hop
Allocate the frequency channel else
Select end-to-end transmission Allocate the frequency channel
End if

4.1 Hub selection technique

The suggested technique selects the appropriate hub, and the BS then initiates the frequency channel allocation procedure. The transmitted power in the current cellular network is uniformly distributed in the frequency assignment situation. The BS then distributes frequency channel to each user that requested it using a round-robin system. Each device is given a separate channel by the BS for downloading bulk data. High path loss and extensive path fading are problems with direct downloading. The Hand-off user therefore requires more frequency channels, requires longer download times, and uses a lot of energy on the device side. This lowers the performance of the entire network. Multi-hop-based downloading frequency channel minimization has been suggested to minimize the number of frequency channels and shorten downloading times. The authors proposed that terminating end-to-end transmission into hub-by-hub transmission is required to reduce the number of frequency channels. In this technique, the BS allots the frequency channels in a randomized system method for the initial hop reducing the frequency channels for the second hop. As a result, the spectrum, downloading time are not greatly decreased by this technique. The authors also contribute relatively little to the hub selection and frequency channel allocation processes. To dramatically reduce the frequency channel of downloading time compared to the current cellular scheme, we propose a novel downloading scheme. The Hand-off cellular users send a request to the BS for frequency channel allotment. The base station (BS) broadcasts a packet for assessing channel information as well as an associated coding technique for frequency channel allocation. The mobile data rate Rr (where r=1,2,3,...,10) per allotted frequency channel is limited by the channel state information, channel link, and channel quality, as well as the appropriate modulation methods and coding technique. While downloading directly, the channel information and associated minimum cellular data rate are poor. The BS determines performance measures, such as the reference necessary number of frequency channels and the reference downloading time for downloading and downloading bulk data for the Hand-off cell user using this cellular data rate,

$$Rr = Rm \times n.rb \quad (4)$$

The required performance metrics are computed once by the BS. This enables the direct communication in multi-hop communication to be broken. The channel information from the Hand-off cellular gadget to the chosen hub and from the chosen hub to the BS is measured by the MSC. The reference matrices have previously been computed by the BS. Here, we look at two situations. With the reference time limitation, we reduce the total number of frequency channels in the first example compared to the reference frequency channel that is necessary.

In the second scenario, we use the reference frequency channel limitation to shorten the downloading time in comparison to the reference downloading times. Before allocating frequency channels, the BS examines the link capacity for both hops to minimize frequency channel utilization for downloading. The BS thus assumes that r numbers of number of frequency channels are needed for each hop rather than assigning the frequency channel in a round-robin scheme. Therefore, r frequency channel in total is needed for multi-hop communication. Assume that n GB of data are downloaded from the BS. The BS first allots rbfrequency channel for direct transmission mode data downloads. The required downloading time is:

$$T_D = \frac{n}{Data\ link\ rate \times r_b} \quad (5)$$

where, TD is the downloading time to download data.

For two users known as Hand-off cell user and hop user, frequency channel allocation is done using a round-robin system. The BS allocates $2rb$ for the first hop communication, hence the hop side's necessary reference time for downloading the data is:

$$T_D Ref = \frac{n}{Data\ link\ rate \times 2r_b} \quad (6)$$

where, $TD\ Ref$ is the Reference downloading time.

The number of frequency channels can only be decreased for a limited amount of time at the moment, therefore:

$$N_3R = \frac{n}{Data\ link\ rate \times T} \quad (7)$$

For multi-hop based downloading, there is a total number of frequency channel requirement is:

$$MRBexisting{=}N2R{+}N3R \quad (8)$$

Assume that the frequency channel represents the total number of downlink frequency channel allocations. Thus, the total number of frequency channels for multi-hops is $2rb$. The required amount of Frequency Channel Allocation (FCA) is for downlink channel is:

$$FCADFA{=}FCADFA/2 \quad (9)$$

The downloading time needed for DFA technique is:

$$FCA_{DFA} = \frac{m \cdot (\text{ Link data rate in cell user } + \text{ Link data rate in Handoff user })/2}{\left(r_b \cdot (\text{ Link data rate } + \text{ Link data rate in Handoff user })/2\right)}$$

The frequency channel and downloading time are both greatly reduced by the proposed DFA technique

In Algorithm 2, a fictitious code for frequency channel allocation, downloading time minimization.

Algorithm 2. Downloading time minimization and DFA technique

Step 1: Initialize data_rate
Step 2: Initialize data_rate for multi-hop
Step 3: r_b,n
Step 4: Calculate T_D

$$T_D = \frac{n}{Link\ rate \cdot r_b}$$

Step 5: Calculate frequency channel
Step 6: Calculate total frequency channel and overall required time for download
Step 7: Select the proper hub gadget for multi-hop transmission
Step 8: Calculate reference frequency channel allocation
Step 9: Compare proposed technique with existing technique

5. RESULTS AND DISCUSSION

In this discussion, numerical analysis of an effective frequency channel allocation technique using multi-hop communications for downloading Hand-off cellular users has been proposed. The program has been run 100 times using simulations from Riverbed Modeler 17.5, and the average has been computed in order to create the graph.

A virtual network environment called Riverbed's Modeler simulates the behavior of the complete network, including its servers, routers, switches, protocols, and individual apps. 5G networking scenarios can be simulated using Riverbed Modeler, a modeling and simulation environment. The Academic Edition of the proprietary software, which is being utilized in this research, has fewer features than the full version. Unlike the open-source discrete event simulator NS-3, Riverbed Modeler has a Graphical User Interface that enables the user to quickly generate simulations without needing to develop simulation scripts or coding. Owing to the research time constraints, we choose Riverbed Modeler Academic Edition version 17.5 over NS-3.

In scenario 1, fixed wireless network workstation nodes are used in the topology. The server is linked to the WLAN Ethernet router via a 1000 BaseX Ethernet connection. The application nodes are located ten to fifteen meters away from the router. The distance between the router and the three application nodes is equal. During this simulation, the impact of the distance between the router and server is not considered. The configuration used in scenario 1 is depicted in Figure 3.

In order for the wireless network workstations to identify that they are part of the same local area network as the router, the BSS Identifier is set to one for both the router and the workstations. In this situation, the router and wireless workstations have the physical characteristics and data rate configured to IEEE 802.11 ac 2.4 GHz and 100 Mbps (base)/1 Tbps, respectively.

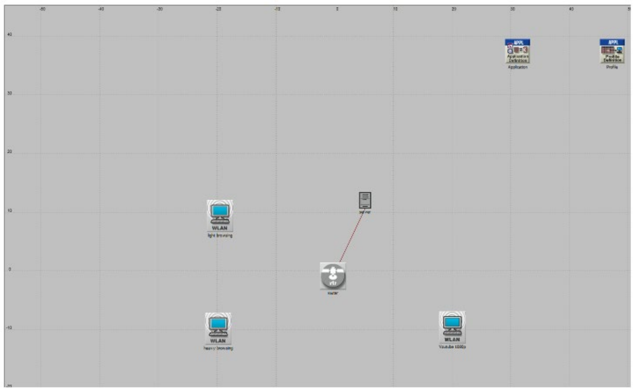

Figure 3. Wireless network topology

In this research, we think about how eager mobile customers want to download huge amounts of data from the BS that contains premium movies. According to the exponential effective SIR mapping, the effective SNR is calculated and mapped to the channel quality level with an error rate of less than 5%. The gadgets were placed in a cell at random. We determine the reliability constraint's dynamic threshold value.

It has been determined that what is the average value of all participating hub reliability. To determine the reliability constraint threshold in multi-hop networks where different communication devices have different numbers of participating hubs. The sub-urban channel model is taken into account for small-scale multipath fading, whereas the shadowing standard's route loss exponent is set to 16 and 7.5 dB for large-scale fading. We employ OQPSK, 128 QAM modulation, and error control coding for the throughput and efficiency. Due to the network's unpredictable behavior, scheme 1 may occasionally outperform other schemes, whereas scheme 2 may occasionally outperform other schemes. Therefore, the appropriate significance scheme is determined in this case using statistical methods. The Friedman test is utilized in this research to determine the optimum strategies for overall throughput. our scheme eventually outperforms existing technique. We list the simulation parameters and their default values in Table 2.

The graph between data packet loss and various numbers of Hand-off users is shown in Figure 4. In the beginning, there are 7 Hand-off cellular devices and 7 hops in close proximity to it, each with a different location is shown. Then, between each Hand-off cell device and the BS, we adjust the number of devices from 1 to 7 and the number of Hand-off cell devices from 1 to 100.

Table 2. Parameters and values

Simulation Parameters	Values
Considered model	Cluster
Cell radius	500 meters (about 1640.42 ft)
Carrier frequency	5 GHz
Bandwidth	20 MHz
BS Transmitted power	92 dBm
Antenna gain	30 dBi
Transmitted power for end-to-end mode	46 dBi
Transmitted power for multi-hop mode	20 dBi
Active users in cell	20,40,60,80,100
Proximity distance	50 meters
Simulation type	Riverbed modeler simulation tool

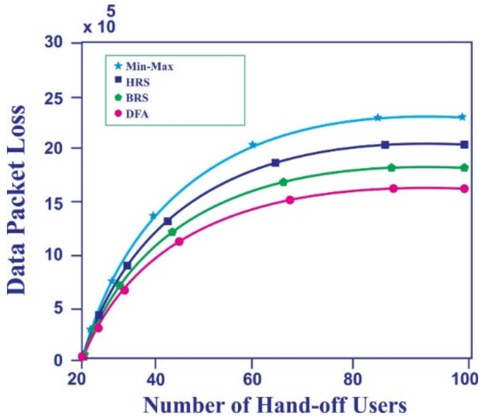

Figure 4. Data packet loss vs number of hand-off users in bulk data or movies download from the BS

For each downlink, a dual frequency channel is assigned. When multi-hop connectivity is not able to provide a higher data rate, it has been found that more packets are dropped at the devices. The best relay in BRS system is determined by the channel quality, whereas in the HRS and Min-Max scheme, the hub is chosen at random. As a result, more packets are lost in these systems, whereas DFA only chooses the device that provides the highest throughput with the least amount of packet loss. Compared to the BRS, HRS and Min-Max selection strategies, DFA provides enhanced throughput.

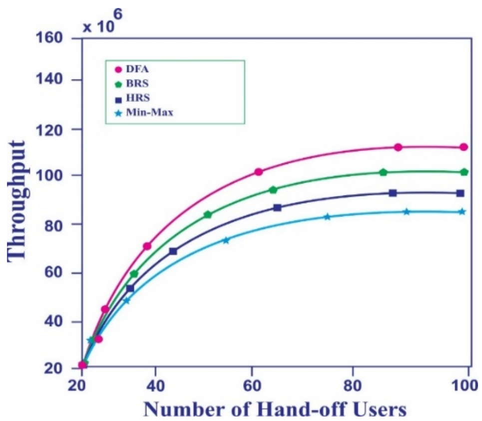

Figure 5. Throughput vs hand-off users for various hub selection technique

The graph between multi-hop users and enhanced throughput is shown in Figure 5. Between each cellular device and the BS, there are between 10 and 50 devices. They initially produce results that are almost identical due to network randomness, however Min-Max and HRS results in a lower throughput as a result of relay selection that is also random. Later, our DFA performs significantly better than Min-Max, HRS and marginally better than the BRS. Through analytical and numerical research, we can determine the most significant technique.

The impact of the hop selection technique's reliability restriction is examined in Figure 6. We presume that devices are ready for multi-hop in the 5G cellular communication system, but in a genuine network environment, a device's limited battery life could cause it to be rejected and could try to call any other device. The BRS, HRS, and Min-Max techniques do not consider reliability, whereas DFA simply selects the trustworthy apparatus. One of the performance matrices for 5G networks is reliability. We randomly eliminate 5% of the total number of relay devices with a very low reliability rating in order to evaluate the reliability performance of the relay selection processes. The selected relay may be removed from consideration because the BRS, HRS, and Min-max select the relay based on SNR. DFA chooses the relay with a high enough reliability value. It has been found that DFA relay scheme outperforms other relay techniques.

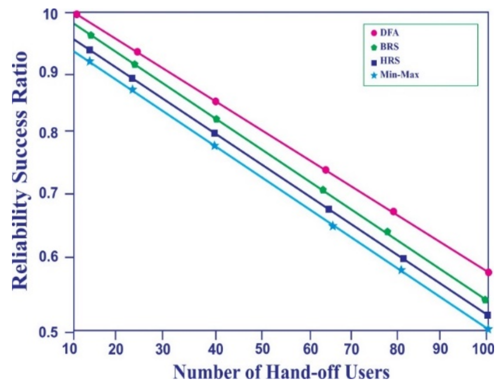

Figure 6. Reliability success rate vs number of hand-off users for relay selection

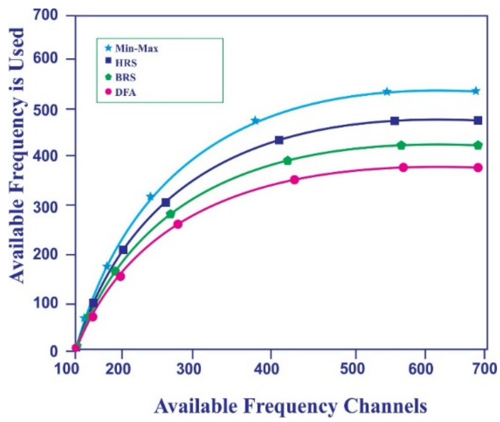

Figure 7. Available frequency used vs available frequency channels in terms of GB

Figure 7 shows the frequency channel minimization for downloading data from the BS without a time limit. While the HRS, BRS, Min-Max plan has the BS first allocating half the available frequency channels for 1st hop user, the current 4G mobile system has the BS doing frequency distribution in a Round Robin process. Calculating the necessary number of frequency channels for the multi-hop is necessary to download the bulk data from the BS due to the cellular time constraint. The BS measures the SNR, maps the channel quality and the amount of frequency channels when using the DFA technique. Without a time limit, it has been found that DFA has a 30% lower number of frequency channels than BRS, HRS and Min-Max.

Finally, we graph the relationship between download time in sec and download file size in GB is shown in Figure 8. The Min-Max, HRS, BRS and DFA techniques initially take about the same amount of time when the data capacity is low (up to 1000 MB), however regular cellular connection takes longer. Because of the deep path fading in one hop, cellular communication needs enough time to download additional data, whereas Min-Max, HRS, BRS, and DFA approaches download data over several hops. However, round robin techniques are used after the first hop frequency allocation in the Min-Max and HRS, BRS schemes. which means that more time is needed, whereas DFA technique calculates the frequency channel for each hop and assigns it. Consequently, DFA technique outperforms BRS, HRS and Min-Max.

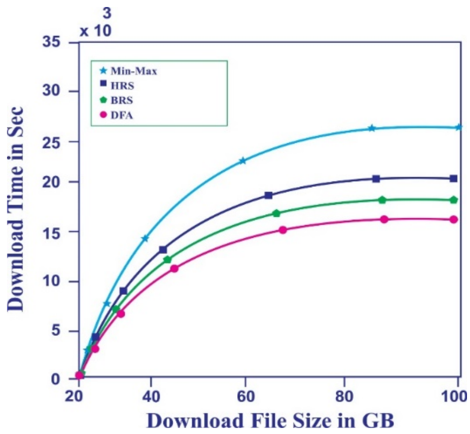

Figure 8. Download time in sec vs download file size in GB

5.1 Comparative analysis

To assess the relay selection schemes' dependability performance, 10% of all relay devices with extremely low reliability values are randomly removed in order to assess the reliability performance across the relay selection schemes. Since the max-min, HRS and BRS choose the relay based on SINR, as we have seen, there is a potential that the relay that has been chosen will be dropped. DFA chooses the relay with a high enough dependability value. It has been noted that our approach outperforms other relay schemes.

In the proposed DFA system, the receiver node computes the data rate as well as the number of resource channels. It also maps in CQI and assesses the SINR. Compared to HRS, BRS and cellular, our DFA technique is seen to minimize the amount of frequency channels as much as 52% when faced with time constraints.

When we upload more data, cellular communication takes longer because Deep path fading happens in a single hop, while our DFA method, HRS, BRS, and Max-Min download data in two hops. In the case of the max-min, HRS, BRS schemes, resource allocation occurs round robin in the first hop. As a result, our approach takes longer to assign and calculate the frequency channel for each hop. As a result, our DFA approach outperforms HRS, BRS, max-min, and conventional cellular communication. Its validated through simulation results.

6. CONCLUSION

In this paper, we provide an DFA method for mobile users who are interested in downloading large amounts of data from the BS, such as movies. The suggested method is split into two steps. In the first stage, a cellular device is chosen among the available devices between the user with the Hand-off signal and the base station (BS) if multi-hop communication is necessary. A more effective method of allocating frequency channel is used in the second step, which decreases the number of frequency channels and download time in the downloading situation. While the frequency allocation technique is network assisted and the BS allocates frequency channels, the device selection method is centralized. Our DFA technique outperforms BRS, HRS and Min-Max techniques in terms of throughput.

The initial optimization issue was broken down into a limited number of related subproblems with lower computational complexity in each of the aforementioned experiments. Performance loss is therefore inevitably introduced. Furthermore, as optimization entails running algorithms until convergence is reached, the answers might not be available instantly. As such, its deployment could be prohibitive in scenarios with significant demands. An ideal answer in one time slot or interval may not always be the best option for the subsequent time interval in the same context, as was also mentioned in the introduction, particularly when there is a short coherence time. Therefore, it is recommended to execute the corresponding iterative optimization methods on a regular basis. This is also true in high mobility scenarios where the environment is constantly changing, such high-speed trains, vehicular ad hoc networks, and UAV communications. Prospective study areas may encompass the creation of appropriate algorithms that leverage 5G and B5G configurations to facilitate the implementation of advanced services and applications within 6G networks, in addition to efficient techniques for dispersed training.

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