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Dynamic Node Selection Approach for 6G Heterogeneous Cellular Networks (HCN) to Enhance QoS and Low Latency

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Abstract: - A wireless multi-hop network is a group of nodes that can interact directly with one another or across longer distances by using other nodes as relay points and routers. 6G heterogeneous cellular network support several transmission modalities, such as single hop, multi-hop transmission and device-to-any device transmission. These transmission services can greatly increase 6G cellular network capacity, spectral efficiency, power efficiency, Quality of Service (QoS) and Ultra Reliable Low Latency Communication (URLLC). According to current research, Heterogeneous Cellular Networks (HCN) can benefit even more from the integration of demand-driven opportunistic networking into HCN. Devices can search look for the connections between nodes that are most efficient. in Proactive HCN connections by taking advantage of the URLLC acceptability of many mobile data services. Multiple Transmission modes necessitate node selection schemes that can determine the best node for each transmission. Previous proposals for node selection schemes have taken into account the introduction of D2X and HCN. Proactive HCN connections, however, cannot be incorporated into the selection process by current node selection schemes. By implementing outward the first node selection scheme that can incorporate Proactive HCN sharing information within 6G and beyond networks, this research work enhances the existing work. The analysis that was carried out shows the potential for Proactive HCN communications as well as the ability of the suggested node selection scheme to choose the best communication node to enhance QoS and Low Latency.

Keywords: 6G, node selection, multi-hop cellular communication, Proactive networking, device-to-any device.

I. INTRODUCTION

Cellular networks must be able to handle the steadily rising demand for data traffic by 6G and beyond [1]. Solutions that focus on infrastructure are the mainstay of 6G cellular networks. These include dense networks, which place additional infrastructure modules nearer the final user. This finding increase network capacity, lower the cost of infrastructure per bit, and give network management more flexibility. Additionally, steady movement of pertinent network functions out to the edge [2-3]. This lowers latency by bringing processing nearer to the points of information generation and consumption. The strategy presented in the smart networks vision shows how terminals or devices will play a major role in networks of the future. Smart electronic devices will carefully coordinate and cooperate with the infrastructure to enable active participation in network management [4-5]. The advancement of D2X (Device-to-Any device) and HCN technologies facilitates the realization of this new paradigm. The bandwidth utilization, QoS, and power consumption are all increased by these technologies [6-7]. D2X allows many devices that are near enough to interact with one other instantly with any devices. This facilitates the cellular infrastructure's traffic offloading. D2X communications can also improve the directional reuse of the bandwidth by using well-crafted interference management strategies. Using other devices as switches, mobile devices in HCN can establish a connection with the cellular infrastructure. Receiver nodes with adequate link budgets are necessary for HCN and Proactive HCN transmissions. If suitable routes cannot be located, there are risks associated with attempting to establish these networks. Therefore, node selection schemes are required to determine the best communication node for every transmission [8-9]. These techniques are crucial because a wrong node selection can result in significant signaling overhead and a decrease in end-user QoS. To choose between cellular and HCN transmissions or between cellular and D2X transmissions [10-11], node selection schemes have been put forth. However, according to recent research, no node selection scheme is currently available that can

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incorporate Proactive HCN connections into the selection process. It should be mentioned that gadgets are able to store and transport data until they find enough connections to send it, these connections entail less danger than HCN ones [12]. By presenting forward the first frequency selection technique that can incorporate occupied frequency channel HCN into the unoccupied frequency channel, this study improves the current state of the knowledge. Three types of HCN communications are supported by the designed frequency selection scheme: proactive HCN, traditional cellular, and HCN. The determination of how many available frequency channels to allocate for HCN connections is also incorporated into the selection process by the suggested frequency selection scheme.

This paper's primary contributions are

i. The first node selection technique combines Multi-hop and HCN communications. Among traditional cellular communications, single hop, multi-hop and Proactive HCN, the frequency selection technique can choose the best communication channel.
ii. An approximation based on probability of heterogeneous communication modalities in networks beyond 6G. The frequency selection process, which also considers the network conditions is driven by those forecasts.
iii. Each and every channel, advantages and disadvantages are calculated using data that is currently on hand at the cellular base station. This guarantees that there won't be any additional transmission latency introduced by our proposed frequency channel selection approach.
iv. The number of available frequency channels that should be employed in proactive HCN connections is likewise identified by the proposed frequency selection scheme. It is crucial to appropriately assess the advantages and disadvantages of proactive HCN connections while taking the surrounding circumstances into account.
v. The research provides a thorough analysis that shows how proactive HCN transmissions can significantly enhance the functionality of 6G cellular networks. The research that was done also shows that the proposed frequency selection can successfully incorporate proactive HCN communications in heterogeneous 6G networks. This lowers the energy consumption of cellular networks while increasing their cellular devices.

The remainder of the paper is structured as follows. Section II presents the Related Works. Section III presents the frequency selection approach preferred in this research, the Proposed approach selects the best channel route for communication depending on the circumstances. Sections IV presents proactive HCN Transmission, Performance Analysis of the proposed node selection system Presented in Section V, Section VI, which also serves as the paper's conclusion, summarizes the primary finding of the present analysis.

II. RELATED WORKS

The establishment of D2X and HCN in 6G has sparked interest in frequency selection scheme design research. The contributions in [13] and [14] suggest frequency selection approach that determine whether nearby users should communicate through a traditional cellular connection or a direct D2X. If the D2X link's channel loss is less than the BS cellular link's path-loss, the device in [14] chooses the direct D2X link. The impact of measurement errors in path-loss on the highest possible effective communication capacity is investigated. in Reference [15-16]. The authors show that when inaccuracies increase, the effective capacity reduces rapidly. D2X communications can share or dedicate resources with other ongoing cellular transmissions, as stated in [17-18].

The insignificant expense of obtaining all this information may jeopardize the viability of the channel selection strategy. Nonetheless, the authors demonstrate that the selection procedure minimizes device interference and increases system throughput overall. Dedicated resources are typically used by D2X connections to gain higher performance. However, when the user base grows, shared resources need to be taken into account. The end-user capacity, network bandwidth, and energy conservation can all be greatly increased using HCN [19-20]. The danger associated with attempting to build an HCN connection is that sufficient relay stations may not be found to provide better performance than traditional cellular communications. This issue has the potential to greatly reduce end-user capacity and add needless network signaling complexity.

To incorporate HCN into various networks that are 6G and beyond, device selection algorithms that may take into consideration the advantages and disadvantages of utilizing HCN connections must be designed. The context, such as the density of devices in the cell, substantially influences these benefits and hazards. The frequency selection issue is still rarely addressed in studies that take HCN connections into account. When there is a distance greater than a certain threshold between the devices and the base station (BS), the authors of [21-22] suggest a location-based channel selection strategy that chooses HCN links. Conventional wireless connections are used in cases where the distance is shorter. The authors presented a frequency selection system that balances the benefits and drawbacks of each communication channel [23-24]. Conventional cellular and HCN communications were taken into consideration as potential communication channels when the study was undertaken. The strategy chooses the communication route that best balances advantages and disadvantages. The capacity performance attained with a specific communication route is referred to as the benefit. Risks are the likelihood that these anticipated benefits won't materialize. When D2X links in an HCN connection divide radio frequencies with mobile subscribers, a frequency selection strategy is suggested [25-26]. The transmission power, the communication device, and the frequency allotment for D2X links are determined by the scheme in that order. With this method, frequency receives more precise information regarding the potential performance of each channel of communication. The findings presented in [27-28] demonstrate that the suggested plan can raise the mobile phone coverage's quality.

The study does not, however, analyze the communication complexity and possible lags brought on by changes in power delivery and frequency allocation for all feasible lines. The frequency selection plan offered in [29-30] also takes transmission power into account. The method selects the HCN connection for that specific device if the overall power consumed by the HCN connection is less than the power of a standard network connection. The suggested plan lowers the likelihood of an outage and electricity consumption. The authors expand on their suggestion in [31-32] to take caching enabled HCNs into account. Content is dispersed among certain devices within a cell in [33-34]. When downloading content, the device has the option to select between cellular, D2X, or HCN connections. If a device close by has cached the content, the device chooses a D2X connection. If not, if it finds a device within a certain range of the BS, it can choose the HCN channel to download the content from the BS. In the event that this is once more not feasible, the device downloads the data from the BS using a traditional cellular connection. Like prior studies, [35] and [36] make the assumption that every gadget is aware of its location. However, one should not undervalue the expense of gathering this data. Current frequency selection techniques select between D2X links and conventional cellular connections. Despite their substantial influence on availability of service, cost effectiveness, and network capacity, none of the current proposals take proactive HCN connections into account during the selection process [37-38]. By putting forth the first frequency selection system that takes into account proactive HCN connections as a potential communication channel, this research enhances the existing state of the technology. The authors' unique frequency approach [39-40], which assesses the advantages and disadvantages of potential communication channels during the selection process, serves as the foundation for the proposal. Here, the approach is expanded to take into consideration the potential for leveraging proactive HCN connectivity.

III FREQUENCY SELECTION APPROACH

[41-42] The User Equipment (UE) frequency selection is the end user in uplink transmissions, which are the subject of this work. We believe that there are various methods of communication that can be used to transmit data from the UE to the BS. i. Conventional Line of sight transmission ii. Hop by hop heterogeneous transmission iii. Combine proactive heterogeneous transmission into traditional cellular transmission iv. The approaches are shown in Fig.1. Line of sight is equivalent to traditional cellular communications, where the UE and BS are directly connected shown in Fig.1(a). The receiver node in hub by hub connects the UE and BS and acts as an interface to the wireless networks in Fig.1(b). At the commencement of the session, the BS-UE broadcast begins. The moment UE_2 begins transmitting data to the BS, the UE_1 -BS transmission begins. The combine proactive transmission into cellular transmission is shown in Fig. 1(a) and Fig 1(b).

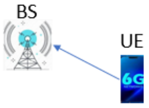


Fig 1 (a) Single hop Communication

Fig 1(b) Multi- hop Communication

Fig 1(a) and Fig 1(b) : Types of Communication

The figure shows how UE frequency can transmit and retain information until it establishes a suitable D2X connection with another UE frequency. In this instance, the establishment of connections between UEs are determined by their ability to meet an operational or system request. In order to establish high-quality connections between UEs, this method takes use of the buffering endurance that defines the majority of wireless data transmissions. In order to transfer the throughput that the intermediate node experiences to the base station, proactive connections are formed in this study based on the quality of their links. D2X connections must guarantee a minimum of that amount of throughput of the BS-UE cellular link in order to achieve this goal. As a result, the greatest distance that may be traveled between D2X nodes connected to a proactive HCN connection is limited. The frequency selection strategy to combine proactive HCN connections presented in this work is an evolution of the strategy based on RISKs method in [43-44]. The approach chooses the frequency of communication that best balances advantages and disadvantages. The advantages measure the quality of service (QoS) that a user may obtain from a communication frequency provided that the connection is made under suitable circumstances.

In frequency selection approach, the hop node is selected at the start of the communication is shown in Fig. 2

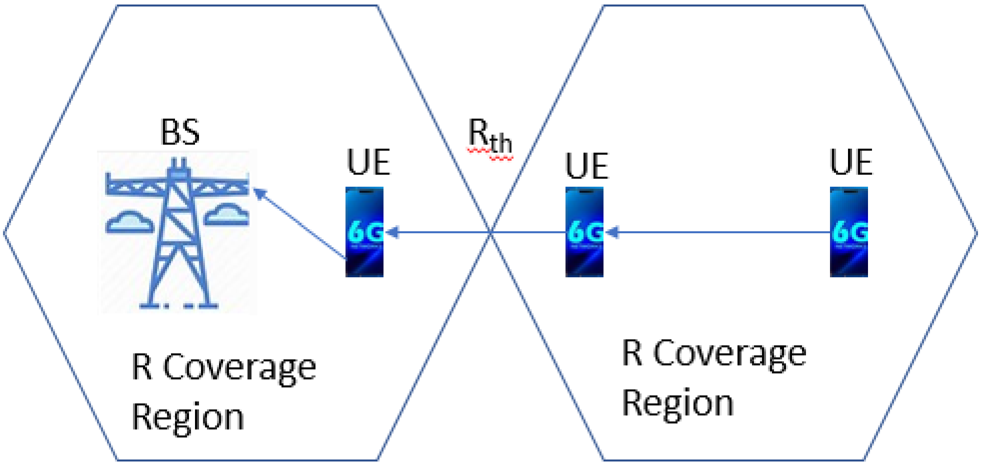


Fig.2 Condition for Proactive HCN

As soon as the hop node sends data to the BS, the transmission from the BS to the hop node begins. The coverage region where UE is located is indicated by C_i. If the following requirements are met, UE can perform better across a single hop or multi-hop connection while using an HCN connection. The UE needs to be situated in a cellular coverage region (C_i) with greater data rates as the first requirement. According to research now available, if the distance between a hop node and a UE is less than a maximum threshold R_{th}, then hop node can perform at the same level as UE. The distance between the UE and the Hop node must then be less than R_{th}, which is the additional requirement. Then, if the chosen hob node is situated inside a specified coverage area, HCN connections might function better than multi-hop ones.

IV Proactive HCN Transmission

When specific criteria are met, Proactive HCN communication can perform better than single hop and multi-hop communications. Fig.4 shows the channel allocation using Proactive HCN Transmission.

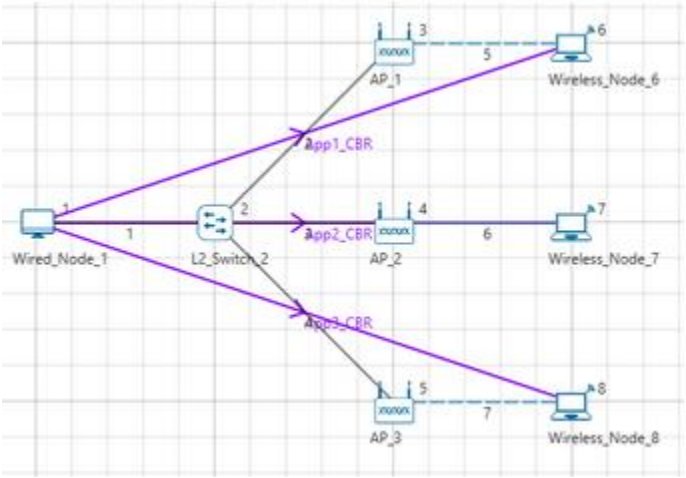


Fig.4 Channel Allocation Network Set up Scenario

This scenario was created using the following set of steps. Using the "Internetworks" Network Library, a network scenario with one wired node, one L2 switch, three wireless nodes, and three access points is created in the Riverbed Modeler GUI. Positions of the devices are set according to general attributes. IEEE 802.11 ac is the Protocol Standard in the interface heterogeneous cellular network > Physical Layer Properties of all the Nodes and Access Points. Medium Access Protocol is set to DCF on all Wireless Nodes and Access Points under Interface (Wireless) > Datalink Layer Properties. Bit Error Rate and Propagation Delay are both set to 0 for all Wired Links. Path loss exponent 3.5 determines the Wireless Link Properties. The Riverbed Modeler GUI is set up to allow plots.

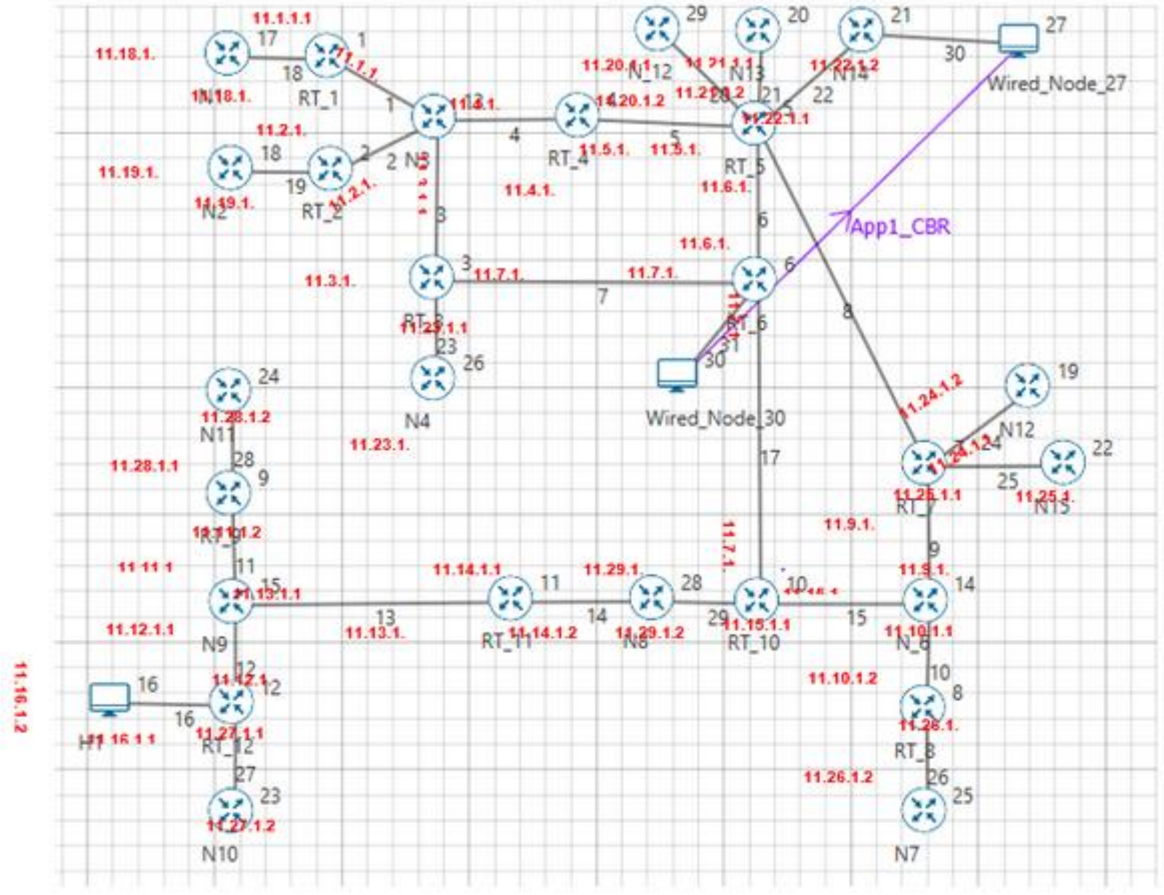


Fig. 5 Topology of the network displaying IP addresses at each router interface and on end nodes

Fig.5 illustrates the heterogeneous network topology with IP addresses shown in each router interface and on end nodes. Using the "Internetworks" Network Library, a network scenario with three wired nodes and twenty-seven routers is created in the Riverbed Modeler GUI. Every router in the network has an output cost that is determined by the network. Since the Riverbed Modeler GUI has packet trace enabled, we can follow the path that the packets have taken to get to their destination based on the specified output cost. From Wired Node 29 (the Source) to Wired Node 28 (the Destination), a CBR application is created with the remaining packet size of 1460 bytes and the remaining inter-arrival time of 10,000 microseconds.

When configuring the program, the "Start Time(s)" parameter is also set to 20. This duration, which rises with network expansion, is typically designed to be longer than the time required for convergence.

The number of UE devices in the Proactive HCN connection determines these requirements. Prior to determining these circumstances, a few factors and variables that are important for proactive HCN operation must be defined. N number of UEs are used in a proactive HCN connection that spans numerous UEs from the source to the destination. Nodes are assumed to travel at a constant V speed. Based on their distance from the base station, UEs are named from UE_1 to UE_{N-1}. The UE_1 serves as the UE_2 and is the UE nearest to the BS. The closest UE is UE_{n-1}. Until suitable circumstances are found to transfer the data to other intermediate nodes, UE nodes are able to retain and transport the data. But we have to make sure that the total amount of time required to forward all data to the UE from the BS is less than an amount dependency on service time limit T_L. This duration is the total of the time required for the D2X and cellular transmissions, as well as the moment the information is transported and stored by the UEs. The highest amount of time T_{Max} that each UE can keep and transport data is equal to

$$T_{Max} = T_L - N.T_{D2X} - T_{PHCN} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

T_{Max} − Maximum amount of time for each UE

T_L − Dependent Time Limit

T_{D2X} − The proportion of the total data to be transmitted to the throughput of the D2X link

T_{PHCN} − Total time required for proactive HCN Transmission

Using the existing models in [45] and [46], the D2X throughput is calculated under the assumption that the distance between D2X nodes is equal to R_{Max}. T_{PHCN} is calculated as the ratio of the cellular link's throughput to the total quantity of data to be transmitted. We believe that only the radio resources needed to ensure minimum are allotted in order to compute T_{PHCN}. We analyzed that the available frequency channels required to ensure channels are assigned in order to compute T_{PHCN}. [47-48] Since the evaluations are used to calculate T_{D2X} and T_{PHCN} represent the worst-case situation, they offer a conservative estimate of the potential benefits of using T_{PHCN}. Since they offer greater forwarding options, UEs traveling in the direction of the BS are favored for establishing an downlink T_{PHCN} connection. We define D with k ∈ [1, N] and m ∈ [2, N] as the greatest separation at which (N – k) D2X proactive linkages can be formed between the UE and the BS. This separation is equivalent to

$$D = R_{max}\,.\,(m-k) + T_{PHCN} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

Auxiliary node distance from the BS must be equal to or less than R_{max} after T_{PHCN}, according to Eq. (2), in order for the end-to-end transmission to successfully complete before UE. It is then necessary to locate N-2 intermediary nodes that meet the following requirements in order to establish an N-PHCN connection with $N \geq 3$. A five-kilometer-radius cluster cell scenario is used to assess the suggested frequency selection strategy. A 1GB file is requested by UE nodes, and a 30-second upload limitation is imposed. At first, UEs are dispersed throughout the cluster according to an identical random distribution with a standard network density. The average network density values of 100, 200, 300, 400…. 1000 UEs/km have been simulated. The names of the scenarios are S1, S2, S3, S4, and S5 in that order. UEs randomly choose their trajectory as they go across the cluster at an average speed of one meter per second. Within the cluster, UEs are evenly distributed as a result of this movement structure. One can then compute the possibility P(A) of discovering at least one UE in a Cell (C) using a distribution modeled by

$$P(C) = 1 - \exp\,(C) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

First-order cellular transmissions are modeled at 1 THz. One of the 15 Channel Quality Indicator values specified, Orthogonal Time Frequency Space (OTFS) Modulation and Coding Schemes is used in these broadcasts. Table 1 presents various channel index values. Depending on the distance between the wireless network and the base station, the modulation technique is dynamically chosen. The structure of the cell circle in which the cellular node is situated determines the cellular data rate. We assume that each circle uses the modulation technique that ensures an error rate of less than 5%. The cellular data rate is calculated as:

$$Cellular\ Region = Data\ Rate\ x\ (1 - \text{Error rate}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

We take into consideration IEEE 802.11ac off-band D2X broadcasts in the 3.5 Gbits/s range. Note that the sixth-generation mobile takes into account cellular and IEEE 802.11ac technology for D2X communications. The D2X transmissions are modeled using the D2X throughput model based on IEEE 802.11ac modelled as

$$\text{D2X Region} = \text{Data Rate}\ .\ \acute{\eta}.\ \text{(1- Error Rate)..}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

We take into consideration that, depending on the link quality conditions, the modulation methods are dynamically adjusted to maximize the throughput. To calculate the D2X data rate, we employ the model.

Table 1: Modulation schemes, Code rate and Transmission Rate for Various Channel Index

S.No	Channel Index	Modulation Schemes	Code Rate	Transmission Rate (Gbits/s)
1	2	OTFS	140	37.563
2	4	OTFS	178	56.176
3	6	OTFS	210	70.468
4	8	OTFS	243	95.237
5	10	OTFS	274	120.356
6	12	32 OTFS	295	150.452
7	14	32 OTFS	326	170.347
8	16	32 OTFS	358	193.562
9	18	32 OTFS	376	201.873
10	20	32 OTFS	396	223.541
11	22	64 OTFS	422	250.245
12	24	64 OTFS	456	278.217
13	26	64 OTFS	479	296.145
14	28	64 OTFS	496	320.563
15	30	64 OTFS	519	341.813

We consider that, depending on the transmission performance circumstances, the coding scheme is continuously determined to maximize the throughput.

V PERFORMANCE ANALYSIS

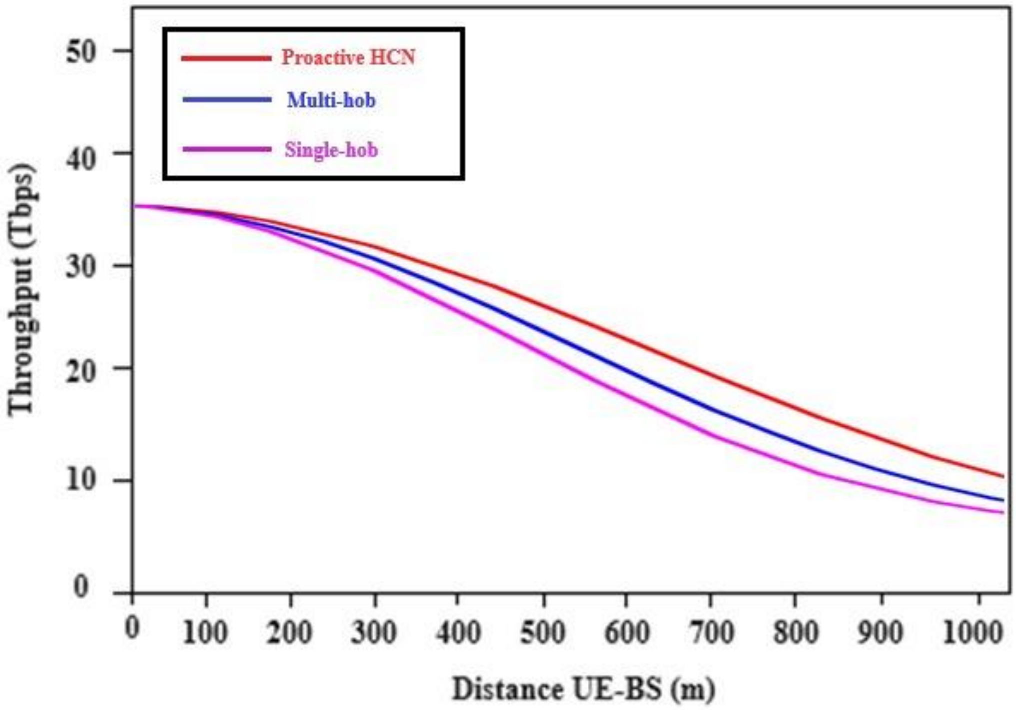
The performance attained with the suggested hub select strategy is examined. The strategy is called proactive HCN. The results of using Proactive HCN are contrasted with those of using traditional cellular communications, existing method that just chooses between the single hop and multi-hop modes. The proactive mode can function with more than 2 hops, but the multi-hop mode is always restricted to two hops. The mode selection system determines the number of hops by considering the present circumstances. The percentage of uploads that are finished within the allotted time is displayed in Table 2. With the exception of scenario1, the table demonstrates that the suggested scheme Proactive HCN performs better than signle hop and Multi-hop alternatives.

Table 2 Percentage of approved uploads submitted before the scheduled time

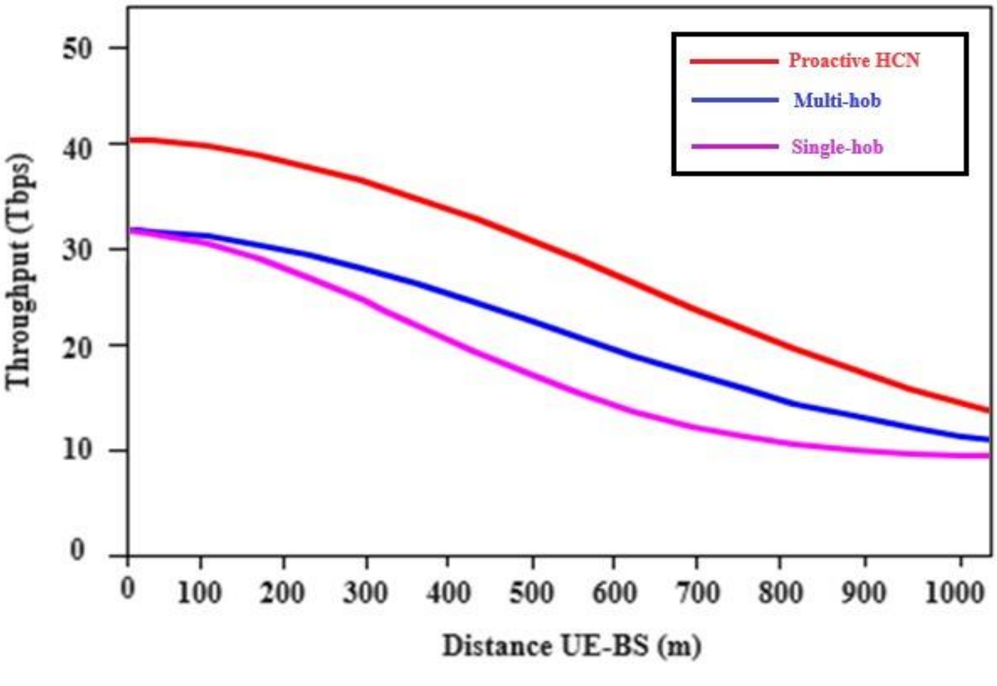
Scenario	Single hop	Multi-hop	Proactive HCN
1	85.61	85.61	88.76
2	85.61	86.12	88.92
3	85.61	86.52	89.12
4	85.61	86.78	89.96
5	85.61	86.87	90.12
6	85.61	86.98	90.45
7	85.61	87.15	90.78
8	85.61	87.43	90.97

Scenario ‘1’ is separated by an extremely low node density. Finding suitable node is difficult in this situation, therefore Proactive HCN typically chooses the Multi-hop mode for transmissions. This explains in Scenario ‘1’ Proactive HCN outperforms with single hop and Multi-hop.

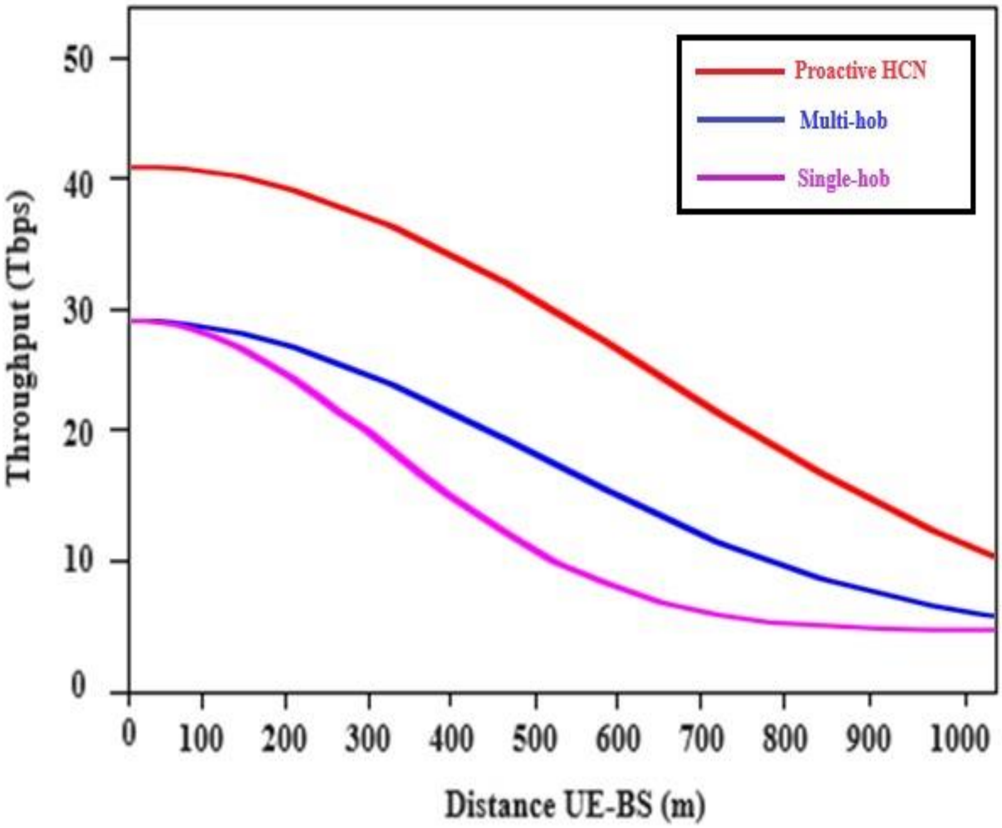
Demonstrates that Proactive HCN causes a significant portion of uploads to be carried out via the multi-hop method in the majority of circumstances, and that this proportion rises as node density does. By establishing connections under favorable link quality circumstances, the Proactive HCN node guarantees high data speeds and effective utilization of spectrum. The potential links and the use of the Proactive HCN node rise with node density. In situations where the node density is extremely low, HCN can identify the dangers associated with attempting to create Proactive HCN connections in Scenario ‘1’. Proactive HCN chooses the single hop node or Multi-hop node in this instance for every upload.



(a) Throughput vs Distance UE-BS (m)



(b) Scenario 2



(c) Scenario 3

Fig. 5: Average Throughput in different Scenarios

The average cellular throughput is shown in Fig. 5. The average cellular channel occupancy reduction attained with HCN and Proactive HCN in relation to single hop and multi-hop is displayed. The entire amount of time that cellular radio resources are used to upload data is known as the channel utilisation. When the number of nodes is low, Fig. 5 illustrates how Proactive HCN increases the throughput experienced by receiver node that are farther distant from the base station. This is because these receiver nodes greatly benefit from employing the proactive HCN node because they encounter the worst circumstances for the intermediate hop connection level. When the density of nodes rises, proactive HCN raises the cellular throughput for every receiver node, regardless of location. High throughput levels shorten transmission times, allowing for the utilization of the same cellular radio resources to be used for more services, this in turn affects the cellular performance.

The cellular throughput of the suggested scheme (Proactive HCN) is on average 98% higher than conventional cellular communications, as shown in Fig.5. Only a 25% increase in throughput over single hop is achieved by HCN. Proactive HCN only yields a 24% increase in throughput over single hop network. In Fig.6, HCN increased throughput results in a more than 62% decrease in average cellular channel occupancy when compared to single hop network.

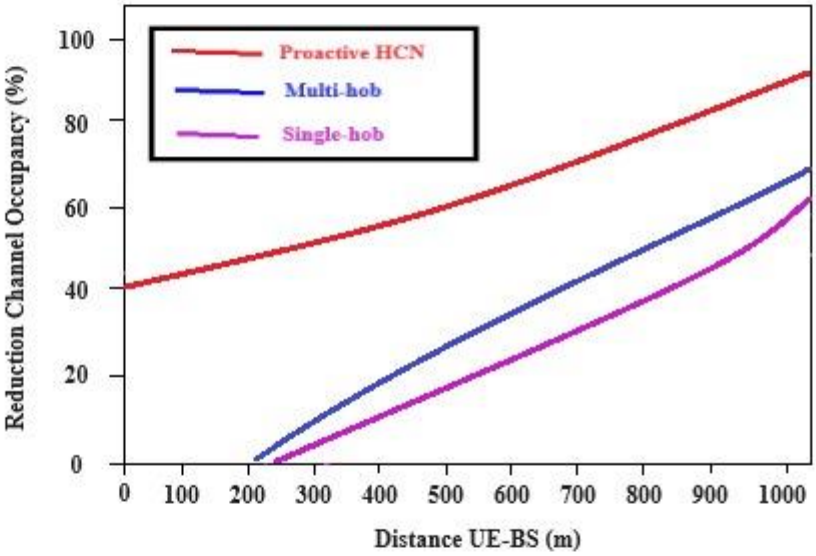
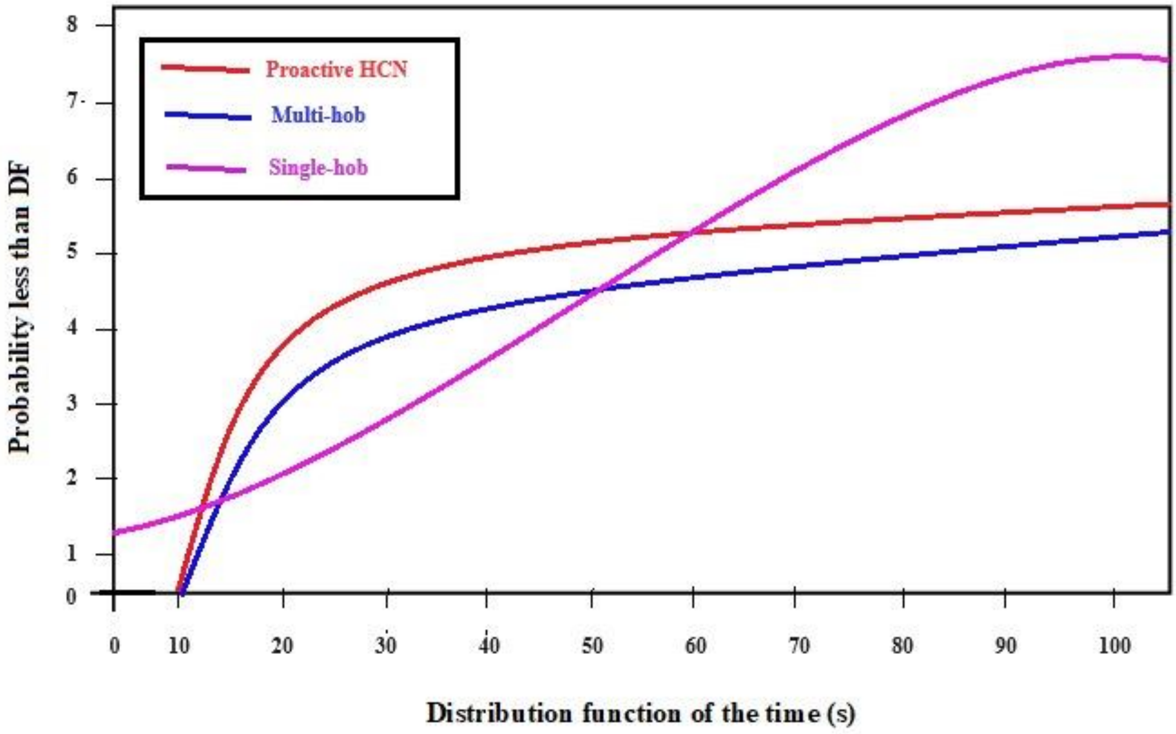


Fig.6: Reduction Channel Occupancy vs Distance UE-BS(m)

Compared to Single hop and Multi-hop, The proactive HCN can only lower the channel occupancy by 20%. The utilization of the Proactive HCN communication mode yields the benefits associated with HCN. Intermediate nodes with good D2X connection quality characteristics are sought for by this node. This ensures effective spectrum usage and high throughput numbers. The length of the end-to-end transmissions rises when looking for the best D2X Channels.

Table 2, on the other hand, demonstrates that HCN really raises the proportion of downloads completed by the deadline. These findings demonstrate that it is preferable to wait for ideal circumstances rather than initiating transmissions as soon as connections are established. Additionally, the energy usage is improved by using the Proactive HCN node. The average energy used for each download is contrasted as a function of the distance between the Transmitter node and the Receiever node in Fig. 8.



This energy is calculated taking into account the energy required to migrate and preserve procedure for Proactive HCN communications as well as in cellular and D2X transmissions. The findings are displayed for four distinct densities. Fig.8 makes it abundantly evident that the proposed proactive HCN drastically lowers energy usage. The Transmitter Node - Receiver Node distance and node density both contribute to the improvements that are realized.

For distances up to 500 meters in Scenario 3, HCN lowers the average total energy consumption by 9% when compared to single hop network. For distances more than 500 meters, the decrease increases to 52.4%. However, in comparison to single hop, Proactive HCN only lowers the average total energy usage by 8.5% and 12.6%, respectively. As the number of nodes in the scenario increases, the gains made with HCN also increase considerably. For instance, HCN uses 85.4% less energy than Single hop network in Scenario 5 (distances greater than 500) and 52.4% less energy. Because HCN may create more Proactive HCN connections when there are more possible relay nodes, higher energy reduction values are seen as density rises.

This makes it possible to establish connections with improved link quality conditions, which in turn boosts throughput, shortens transmission times and uses less energy overall. The average energy consumption gains in upload communications with HCN come at the cost of a slight increase in energy consumption per node. This is the amount of energy that devices use when acting as relays for other uplink connections. However, we would like to point out that compared to cellular transmissions using Single hop, Base Station, Intermediate Nodes, Multi-hop, intermediate nodes, the energy used at the intermediate nodes per transmission is substantially lower.

This is because D2X links with low energy usage and good link quality conditions are what HCN looks for. We also want to stress that uplink communications are the main focus of our investigation. Devices using multi-hop and Proactive HCN communications will save a lot of energy in their uplink broadcasts using HCN. The authors demonstrated these savings in [7] and [8]. According to existing Research [7], multi-hop HCN communications can cut the overall energy used for uplink transmissions by 80% when compared to traditional cellular communications. These benefits take into account the energy used by the relay nodes and the source device. As a result, devices uplink broadcasts can achieve notable energy gains. When proactive networking and HCN communications are combined, energy consumption can be reduced by more than 95% when compared to traditional uplink cellular communications, as the authors of [8] analytically show. This gain takes into account the energy used at the relay nodes and the source device once more. Therefore, the energy saved in uplink transmissions will offset the energy used per node for uplink communications.

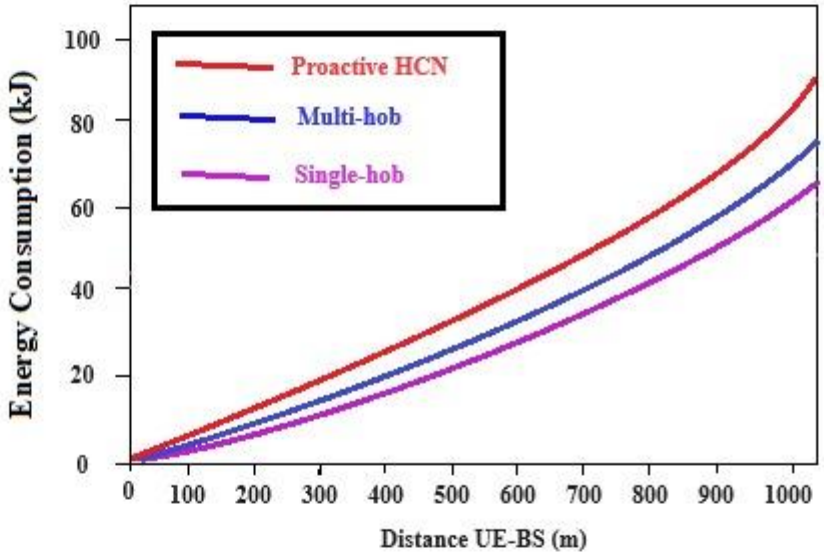


Fig.9 Energy Consumption (kJ) vs Distance UE-BS(m)

The choice of how many hops to include in Multi-hop Proactive HCN connections is included into the node selection procedure by the suggested node selection scheme HCN. This enables the proactive HCN configuration that is, one with two or three hops to be dynamically chosen based on the context parameters. We evaluate the performance using HCN with that obtained when the Proactive HCN mode can only function with three hops or more in Fig. 9. Fig. 10 to demonstrate this. HCN increases the average cellular throughput at all node densities and distances, as seen in Fig. 9. This is so that, depending on the context settings, HCN can choose the Proactive HCN connection configuration that maximizes cellular throughput.

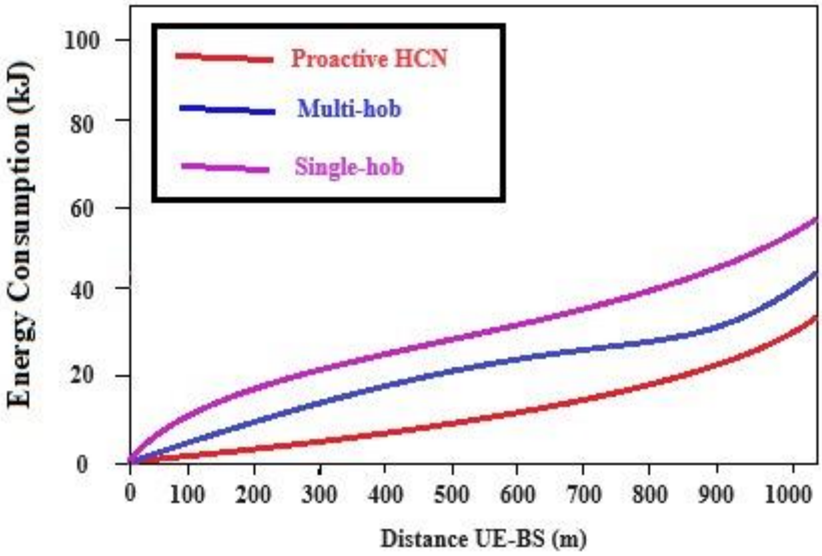


Fig.10 : Energy Consumption for various transmission

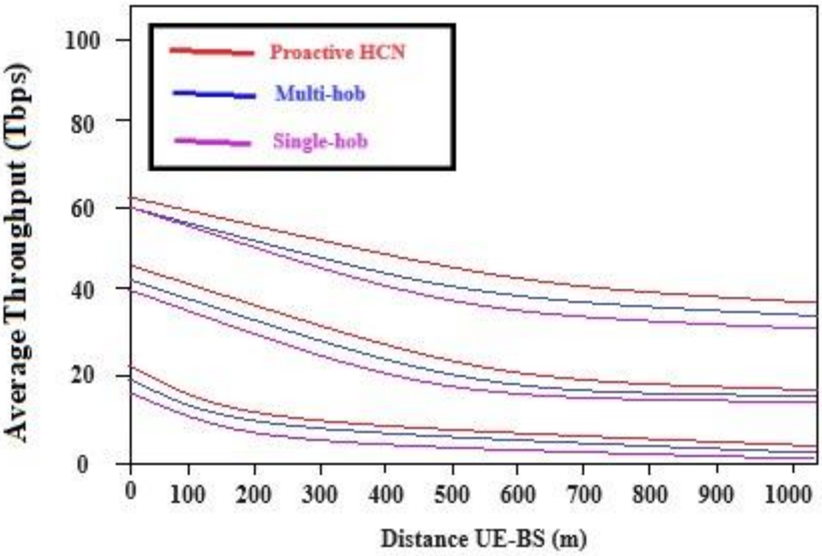


Fig.11 Average Throuhput for different configuration

Fig.11 Illustrates that, in low densities, an arrangement of Proactive HCN connections with just three hops performs better than one with four hops. When densities are higher, the trend is the opposite. There's little chance of discovering sufficient intermediate nodes at low concentrations. In this instance, the more hops, the higher the chance of creating Proactive HCN connections. An increase in node density lowers this danger. The performance in this instance is enhanced by Proactive HCN connections with three four hops since intermediate nodes nearer the BS can be chosen. Table 3 and Fig. 10 also display the trends seen in Fig. 9. According to Table 3, HCN has the highest percentage of uploaded files that are completed. In a similar vein, HCN lowers energy consumption overall and enhanced throughput achived with low latency.

VI CONCLUSION

The first node selection approach that incorporates proactive HCN communications in heterogeneous 6G networks has been presented and assessed in this paper. The communication medium that accomplishes the proactive trade-off between advantages and dangers is chosen by the suggested technique. More precisely, the proposed method gives consumers the option to select between typical single-hop cellular communications, multi-hop cellular communications, and proactive multi-hop cellular communications. The suggested method connects the proactive number of hops choice into the node selection procedure as well. The effectiveness of the suggested technique has been contrasted with results from multi-hop and traditional single-hop cellular communications. The results collected show that 6G and beyond cellular networks can function much better when proactive HCN communications are used. Furthermore, the research has shown that the suggested node selection technique can choose the connection node that optimizes performance across various parameters such as successful upload files, throughput, capacity and power consumption. According to the existing research, the suggested node selection scheme completely utilizes the benefits of HCN communications and Achived Enhanced QoS and Low Latency.

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