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Efficient Resource Allocation in UAV assisted Cellular Communications for Emergency areas.

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Abstract— **A scheme is put up to ensure effective resource allocation in disaster zones. In order to increase the number of Mobile Devices(MDs) that can communicate in the available bandwidth, reduce the total transmission power of UBS in relaying data from source to destination devices, and improve spectral efficiency, the Efficient Resource allocation scheme (ERA) is proposed. Our suggested plan gives priority to Source-Destination pairs with less bandwidth needs for allocating spectrum, allowing more Mobile Devices to transmit and more individuals to use the spectrum to send rescue messages. We have performed simulations to validate the suggested approach.**

Keywords— **Cellular Communication, Unmanned aerial vehicle mounted base stations, resource allocation, Mobile Devices.**

I. Introduction

Smart devices raises people's awareness of the world and makes modern life work more smoothly. Physical objects can acquire and communicate information because they are embedded with sensing and transmission capabilities. These MTDs, which are anticipated to be the IoT's primary consumers, include things like home appliances, smart metres, cars, sensors, and wearable and portable gadgets for people. Numerous uses including medical sector, local social media service,conveying data, safety andemergency areas, are made possible by cellular communications.

Currently majority of the cellular communications rely on its infrastructure as base stations (BSs) offer centralised scheduling and resource management, interference mitigation, is a low powered wide area networks and reliable services. This is because MTDs and IoT applications are widely used. However, local IoT services will be affected when a disaster damages the current cellular infrastructure, making it harder for people to get help.

Unmanned aerial vehicles have recently been integrated with cellular networks to support mobile networks. High-quality audio calls and real-time video applications are made possible by UAV-mounted BSs, which may give coverage across a 5 km radius. Due to the establishment of line-of-sight links, UBS also offers more rapid and adaptable deployment and connectivity, which can increase network throughput and improve QoS. Since the traditional network access scheme in the majority of cellular systems is not designed for disaster rescue and the resource allocation schemes in UAV-assisted cellular communications are not well investigated MDs, we propose deploying UBS in the disaster area to support disaster rescue by facilitating cellular communications for the mobile devices. This disaster rescue scenario's objective is to enable the connection and transmission of rescue signals at the required data rates by the greatest number of MDs.

In order to increase the number of MDs in provisioning transmissions, we suggest the UBS Network Access and Resource Allocation (ERA) system. Minimizing the transmission power for relaying data at the UBS to significantly increase the hovering duration is crucial and taken into consideration in this paper. As the UBS carries a limited capacity battery, the energy consumption is a fundamental concern. We have also used extensive simulations to verify the proposed ERA methodology.

II. Literature survey

In 2017, Mohamed Alzenad et.al proposed that Wireless services can be offered by base stations placed on unmanned aerial vehicles (UAV-BSs) in a number of situations. They have used UAV-BS placement technique that maximises the number of users that are covered by the lowest transmiting power. We separate the deployment of the UAV-BS without any vertical or horizontal dimensions issues loss of efficiency Additionally, we represent the horizontal UAV-BS deployment as a circle placement problem. And an issue with the smallest enclosing circle. Simulations are used to assess how well the suggested approach performs for distinct user spatial distributions.

A successful UAV-BS 3D placement technique that maximises the number of users covered while utilising the least amount of transmit power. In order to simplify the placement problem without sacrificing optimality, we decouple the placement of the UAV-BS in the vertical and horizontal dimensions. We demonstrate how the horizontal placement of the UAV-BS may be described as a problem of placing circles and a problem of finding the smallest enclosing circles. We show that for very diverse settings, there can be significant power savings by evaluating the suggested technique for various levels of user heterogeneity.

In 2018, Yu-Hsun Chen et.al proposed Network coding is a cutting-edge technology that has been shown to enhance the functionality of wireless networks. To effectively construct a quality-of-service (QoS)-satisfied routing protocol with network coding established, a coding host's bandwidth consumption should be minimal. Coding options should be broadened in order to boost network bandwidth. In a mobile ad hoc network, it can be challenging to determine whether a host can act as a coding host and how much bandwidth it consumes.

In order to identify a coding host, we first explain and specify the coding conditions in this study. The bandwidth usage of a coding host is then calculated using wireless networks that use a random access technique and are based on contention. Finally, suggest a multicast routing protocol that is bandwidth-satisfied and mindful of coding (BCMRP). The suggested technique can meet the bandwidth needs of the requested flow and other active flows by accounting for the remaining bandwidth of the forwarders' carrier-sense neighbours. Because the suggested multicast protocol takes coding chances into account when building multicast trees, the overall bandwidth usage can be decreased. The simulation results demonstrate that, in terms of reception ratio, admission ratio, and overall bandwidth consumption, BCMRP performs better than the previous multicast routing methods.

In 2015,Feiran Wang et.al Cellular networks' underlying device-to-device (D2D) communication is anticipated to have a substantial positive impact on how resources are used, user throughput, and battery life. D2D communication can interfere with cellular communication, thus the distribution of radio and power resources for it requires careful planning. To increase the energy efficiency of user equipment, we examine joint channel and power allocation in this article. We present an iterative combinatorial auction approach to efficiently address the problem, where the cellular network is treated as the auctioneer and the D2D users are viewed as bids competing for channel resources. We show numerical simulations to test the suggested approach as well as examine significant D2D underlay communication features.

We created a hybrid channel and power allocation algorithm and organised the optimization problem as a combinatorial auction to improve the energy efficiency for each. In a finite number of rounds, the recommended method can converge. Compared to a pure cellular system, D2D communication underpinning cellular networks can boost the system's energy efficiency. Additionally, both analytical Simulations show that the maximum number of D2D couples is Distance-based D2D communications have detrimental effects on the effectiveness of individual UEs. M2M Communications in 3GPP LTE/LTE-A Networks: Architectures, Service Requirements, Challenges, and Applications.

In 2011, Guodong Zhao et.al proposed that the power and channel allocation for cooperative relay in a three-node cognitive radio network are investigated in this research. The three forms of cognitive radio relay channels—relay, direct, and dual-hop—offer three distinct types of parallel end-to-end transmission, in contrast to the normal cooperative relay channels. All three nodes have access to the aforementioned spectrum bands, which can be used for relay diversity transmission or to provide single-hop or dual-hop channels of transmission. Contrarily, the relay node employs dual-hop transmission and relay diversity. The proposed power and channel allocation schemes significantly improve the end-to-end throughput of cooperative relay in cognitive radio networks. We continue to develop a low complexity strategy that can deliver the vast majority of power and channel allocation's benefits with only a tiny performance penalty hit.

III. Methodology

When local cellular infrastructure in a disaster area's latitude and longitude coordinates is lost, the UBS first communicates with an area above that particular place. The local cellular interactions between MDs can be supported once the UBS's altitude has been determined. UBS will pick the open spectrum band in that area to facilitate local cellular connectivity amongst MDs. According to the UBS report, the system uses and is timed to use Long-Term Evolution (LTE) connectivity.

The goal is to make it possible for the most MDs to connect and transmit rescue messages with the necessary data rates when a calamity interrupts the local cellular infrastructure. The devices that rescue team used to access the catastrophe region, the BSs carried by vehicles near its boundary, or other MDs within the disaster area can all be considered destination MDs in this situation. MDs are transmitted with a greater priority than other source MTD kinds during disaster relief. The Media Access Control (MAC) addresses of the MTDs are used by the UBS to first identify the MDs through the control signal, and then the UBS intelligently allots network resources to them in accordance with our suggested ERA methodology.

The MDs in the coverage area are divided into two groups, according to channel state information at the UBS. If the channel gain between the source and destination (SD) MDs is greater than that between the source MD and the UBS, the SD pair is classified as belonging to the direct group. In this D group, the source MD will send information directly to the destination MD. If not, this SD pair is classified as a relay M2M group. Data will initially come from the source MD and go via the UBS before being forwarded to the destination MD.

1 Resource allocation for direct group:

The "I" active mobile devices in the time slot are indexed by D and P for each MD, and the needed data rate of each SD pair is specified and known to UBS by control signal.

$$C = W * \mathrm{Log}\left(1 + \frac{P * gain}{N * W}\right)$$

N is the power spectral density of additive white gaussian noise, P is the required transmission power, and C is the channel capacity between source and destination between bits per second. W is the required bandwidth for the MD to transfer data. The only variable in the aforementioned equation is W, and C is a concave rising function of W for a fixed power. The Efficient Resource Allocation technique will be used to allow the greatest number of MDs to transmit data effectively. The ERA algorithm allows the most MDs to send data by first allocating spectrum to the MDs with comparatively low necessary bandwidth. The ERA algorithm is a polynomial time algorithm since it has a computational complexity of O($I^2 \log I$)), which makes it possible to quickly find the solution.

2 Resource allocation for relay group:

The D group has already used up all of the available bandwidth in the first time slot, and the R group is given the leftover bandwidth i.e., $W_R = W_{Total} - W_D$

To maximise the number of MDs transmitting data in the R group and distribute the required bandwidth to each MD, the UBS first executes the algorithm in the timeslot (by swapping out W_{Total} for W_R)). In the next half time slot transmissions from the UBS to the target MDs once more, this time making full use of W_R). For relay communications, the source MD transmits the data to the UBS in the first half time slot, and the UBS transmits the data to the target MD in the second half time slot.

This ERA technique outperforms the conventional RAS in any scenario when bandwidth is available because our suggested plan gives priority to SD pairs with low bandwidth requirements, allowing more MDs to utilise the spectrum for transmission. In the second time slot, the hovering time is important for rescue because the UBS only has a small capacity battery. As a result, it is important to maintain the required data rates while reducing the UBS's transmission power.

$$\text{with } \min\{w\} \sum_{n=1}^{R} P \leq P_{Total}$$

The hardware restriction for transmission power P Total for UBS must be adhered to when it comes to total transmission power for data relaying. It is possible to show the convexity of this optimization problem and develop an effective solution. By modifying the aforementioned equation, the transmission power P of the UBS to serve the target MD is represented as.

$$P = \sum_{r=1}^{H} (2^{\frac{c}{w}} - 1) * \frac{N * W}{gain}$$

For the above objective function, calculating second-order differentiation reveals that the Hessian matrix is convex and positive semidefinite. Even though the data rate that may be transmitted over the available bandwidth in both approaches is about the same, our suggested ERA technique enables more MDs to communicate. This is because more users are able to access the spectrum to send messages thanks to the ERA strategy, which initially distributes the spectrum to the SD pairings with low bandwidth requirements.

IV. Simulation Results And Discussion

These are the setups for the simulations. The radius of coverage area of UBS is 500 metres. The UBS is positioned 80m above the area's geographic centre. In this area, a Poisson Point Process produces the MD distribution. Each time slot has 10ms of set MD locations. Each MD's transmission power is randomly distributed between 8mW, 10mW, and 20mW. The pairing for the SD pairings in the UBS coverage is chosen at random. The required data rates for the SD pairings are randomly distributed among 200Kbps, 250Kbps, and 350Kbps. The UBS has 10MHz of total available capacity. Fig. 1 shows the typical number of MDs that can transmit data using our recommended ERA system and the conventional RAS, depending on various amounts of UBS's overall bandwidth availability. If there is more available bandwidth on the UBS, more MDs can broadcast.

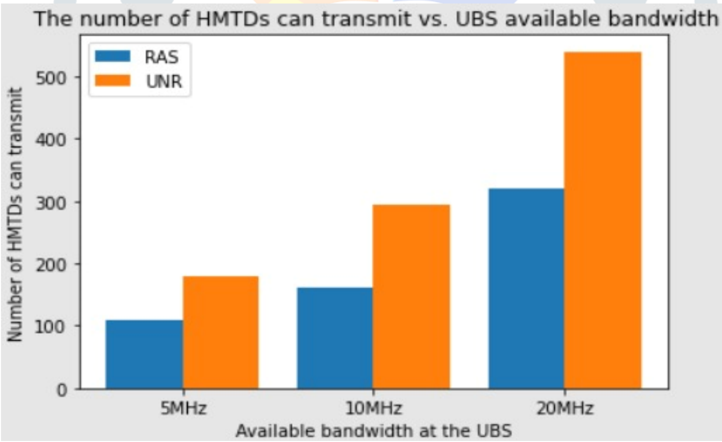

Fig1:The number of MDs can connect vs available bandwidth at UBS

This ERA technique outperforms the conventional RAS in any situation when there is bandwidth available since our suggested scheme gives preference to SD pairs that need less bandwidth, allowing more MDs to access the spectrum for broadcasting. The overall number of MDs that utilizes the spectrum is not optimal in RAS because UBS allots the active MDs in its coverage area at random, some of which might need high bandwidth.

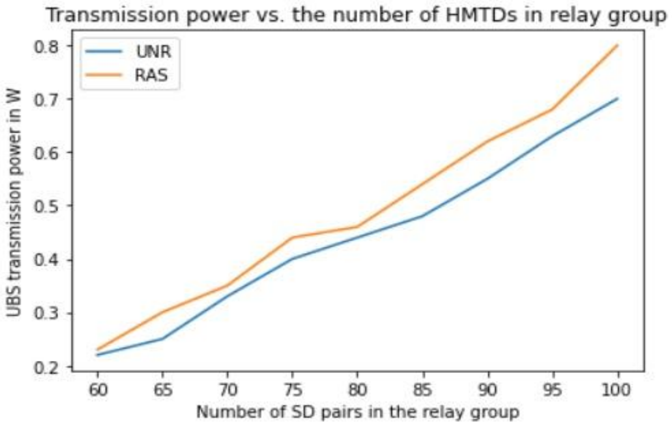

Fig2: Transmission power vs the amount of MDs in relay group

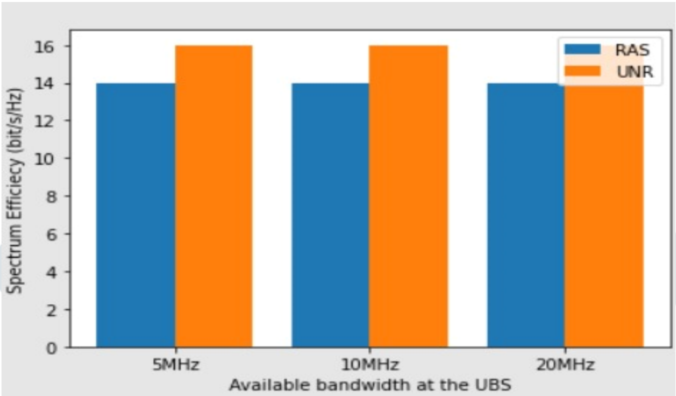

Fig3: spectral efficiency vs available bandwidth at the UBS

Due to the fact that the spectrum in both schemes is efficiently allotted once the MDs are selected, while having differing amounts of UBS available bandwidth as shown in fig3, the spectrum efficiency of our proposed ERA scheme and that of RAS is roughly the same. One or more MDs may be arbitrarily disconnected by the UBS if the bandwidth is insufficient to meet all of the MDs' demands. Some bandwidth may not be allocated when the resources are allotted at the end.

CONCLUSION

We have suggested the ERA technique to choose the MDs and assign them with network resources in compliance, to allow a greater number of MDs to deliver data and facilitate cellular communications for disaster aid. For the MDs in the relay group, the ERA scheme has decreased the transmission power at the UBS in order to extend its hovering time. Through the use of numerous simulations, the efficiency of the proposed ERA mechanism has been confirmed.

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