

Enhancing System Spectral Efficiency in Cellular Networks via Full-Duplex D2D Communications

¹Dadi Vinod Kumar, ²D. Rajitha

¹PG student, ²Head Of the Department

¹Electronics and communication

¹Chaitanya Engineering College, Visakhapatnam, Andhra Pradesh.

Abstract: The solution for the difficulty in providing users wide band spectrums very complicated due to its increase in access points brings burden on backhaul links. So the alternate one is that D2D communication, it is a caching based process thereby improves spectrum efficiency. In previous applications attribute mobility of user is ignored, where as in D2D communication it plays a major role. Here the mobility attribute improves practical approach with the user. By considering mobility of a user data off-loading ratio is increasing, where data-offloading ratio defines the throughput via cellular links over D2D communicational links. The computation of caching process is very complex, so it is solved through many methods. Initially it is a NP-hard caching placement problem, by solving through many methods such as. With Optimal Dynamic Programming Algorithm, the performance reaches benchmark, unlike in exhaustive search its complexity is almost minimized. Solution generated is monotone submodular maximization, which is in the form of matroid constraint. The conventional solution for monotone submodular maximization over matroid constraint is greedy algorithm. Using joint caching the data offloading ratio is increased because of the consideration of both file cache and location cache in a single unit. The advantage of joint caching is it matches with real time data sets as showed in simulation results. In the joint caching algorithm, it shows as the user mobility is high or low it caches most popular files, the user with medium mobility caches minimum popular files in order to get rid of duplication.

I. INTRODUCTION:

Smart mobiles got much popularity, because of its applications. The usage of those devices rose anonymously. The reason to prone so is sharing of audio, video, image and documents... Etc. It might be for personal use or commercial use thereby the traffic of data is rising recently. In next to no time it catches the capacity limit of the present Cellular Networks (CNTs), which are using 4G Technology. The spectrum requirement is high there by DT is growing; thereby mobile user's faces difficulties in getting channel for communication. To congregate the intense demand, network bulkiness is the common method for the raise in spectrum capacity, which should rose high by 1000 times for now to meet the desire. If the access points increased, according to requirement of DT, the usage of BLs raises which is not required. The Backhaul Links (BLs) are the interpretation between Base Stations (BSs) and Core Network (CN). The technique to decrease the overload on the BL is to cache the most known data file near the BSs and User devices. In this technique, BL usage will diminish as local links are used the most compared to previous. IN this technique not only decreasing burden on BLs but also increasing the Energy Efficiency (EE) and minimizing download delay.

Fixed topologies were installed earlier on CNTs as hybrid topologies which includes so many other topologies but in this caching technique user moves randomly from one area to another area thereby topology can't be fixed. The attribute user mobility is dragged into consideration which decides the percentage of communication through caching at devices and BSs as claimed to the speed of mobile user and mobile helper. There are many problems in WT the simple solution to it is mobility aware caching. By way of illustration, it helps in two instances one is improving capacity in ad-hoc networks and second one is minimizing the failed file possibility in Femto Caching Networks (FCN). In this regard, proposing the effectual0 mobility-aware caching approach in Device-to-Device Caching Networks (D2DCN) to offload traffic upon CN.

Nowadays the advancement in cellular communication has brought variety of paths for communication by its usage. The Spectrum Bandwidth (SB) in cellular system is very less at majority times. Rapid increase in use of multimedia, because of launching of high data rate supporting devices, due to increase in demand spectrum is not enough with what present have. Thereby the common challenges like power management, track of location also included with spectrum usage because of increased user demand. The Quality of service (QoS) is linked with the real time analyses also with no disturbance in communication.

1.1 Process of Communication in D2D:

D2D is advancement in CNTs which has opened door for many applications through caching. This caching attribute of CNTs is advantage over previous CNTs reason is it might use for distribution of information and location also brings into consideration as it is an application. It also has advantages in spectral efficiency along with optimal communication lag. Although it has so many advantages, little disadvantages also there, one is control in interference and one more is opened protocol research. As telecom industry is suffering from extra requirement of data from users as the usage of applications are increased rapidly, such as online games, TV on mobile etc. because mobile user who uses data is everywhere of the world. Even though 4G technologies has efficient Physical and MAC layers due to heavy exploration from user the present No.of access points aren't enough, if additional amount of access points increased burden on BLs increases which reduces the overall network performance. D2D is the advancement to the 4G technologies which overcomes the above mentioned problems and also it goes implemented in upcoming projects which are 5G technology.

Communication in D2D of mobile network is user device requested information is received from nearby helper device rather than receiving from BSs and CN. In CNT sharing of information is very transparent here coming to Devise-to-Devise Communication (D2DC) the sharing of information is invisible to cellular network. The communication in D2D has both chances to use spectrum one is called Inband which is of cellular spectrum and one more is Outband unlicensed spectrum. In conventional cellular network even supposing the communication has done in the distance of D2D the communication is very transparent.

In earlier CNTs data rate is very slow because it is only confined for voice call and text message but in present scenario the situation has changed the high data rate services are introduced as video chatting, online games etc with these high data rate devices can be direct communication range. Thereby problem of frequent request of data is solved by D2DC which improves spectral efficiency but its not ended with that D2D can also bring betterment in throughput, energy efficiency, lag and quality of information. D2DC able to value itself by being multi hop relays in CNT. The test of D2DC was initiated by Qualcomm’s FlashLinQ. Qualcomm’s FlashLinQ is PHY/MAC network architecture. This uses Orthogonal Frequency Division Multiplexing (OFDM) technology along with distributed schedule technology for use of efficient span synchronization, peering and link management. Along with Academia, 3GPP also doing research on public safety network for one point to many point communication. According the literature, they suggest D2DC to use the within the conventional cellular spectrum. Thereby D2DCs, cellular communications uses UI D2D. The UI D2D is implemented to examine the minimization of interference of D2D along with cellular communication. Solution to problem of interference is overlay Inband D2D. In this specific spectrum is allotted to D2DC so that cellular spectrum gets not affected.

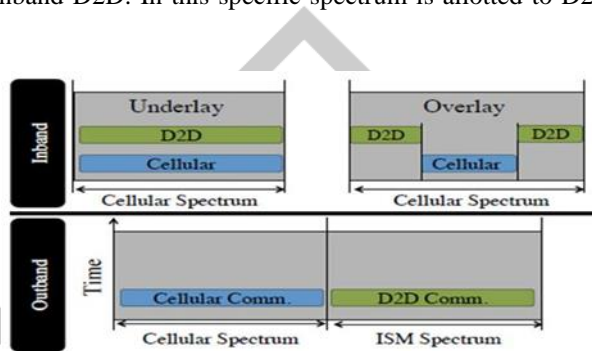


Figure 1.1: Schematic representations of overlay Inband, UI and Outband D2D.

D2DC along with conventional concept in CNs is a new and trending topic in present communication therefore much information about this isn’t obtainable as researches are still going on. Even though by looking at its architecture we can wrap that it is very familiar with Mobile Ad-hoc Networks (MANET) along with Cognitive Radio Networks (CRN). There is little difference between MANET and CRN. D2DC is seemed to be controlled or overseen by central network. D2DC services are used wherever the cellular spectrum is unavailable. The differentiation among D2D, MANET and CRN is the central control of infrastructure is done by cellular network.

The noticeable problems in MANET and CRN are white space detection, collision avoidance and time synchronization; these problems are corrected in D2DC by the concept of central entity. In D2DC about conventional CNs are utilizing the concept of single hop thereby multiple hop routing is not inherited as in MANET. Machine to Machine (MM) communication also benefited from the concepts of D2DC. M2M is defined in way the communication between machine-to-machine without human instruction. Although D2D and M2M operational commands are similar as .work between nodes, also their infrastructure is similar; here the thing is M2M doesn’t deal with distances. Thereby M2M is technology independent also with application oriented but D2D is different as it concerns on the connectivity it’s technology dependent as entire mobiles has to be installed with similar technology as such as 3G, 4G etc.

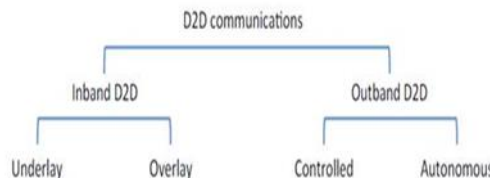


Figure 1.2: Device-to-Device Communication Classification.

1.1. a. Inband D2D Spectrum:

Inband category can be used together with D2DC as well as cellular communication of cellular spectrum. In Inband D2D spectrum, the spectrum of cellular is completely controlled by central network. Inband communication contains licensed and unlicensed spectrum. From licensed and unlicensed, unlicensed is uncontrollable over licensed spectrum. Inband D2DC is classification interested in two classes one is underlay and an additional one is overlay. Here Underlay D2DC allows the cellular communication and D2DC to divide and use of the radio resources. In overlay D2DC, D2D links are allotted specific cellular resources for

communication. Inband is inherited both underlay and overlay, where underlay let the spectrum be used for mutually to cellular and D2D links but where as in overlay it is not like that and the D2D connection directly from transmitter to receiver and vice versa. The disadvantage of Inband is interference by D2D links to the cellular links. This interference can eliminate by implementing complex resource allocation methods thereby increase in computational overhead either of the base station or else D2D users.

1.1.b Outband D2D Spectrum:

In Outband D2D spectrum, D2D links uses unlicensed spectrum. Outband D2D spectrum is developed to get rid of the interference problem as in Inband D2D spectrum. Unlicensed spectrum requires external interface which are generally Bluetooth, Wi-Fi direct and ZigBee. In Outband D2DC, the next interface is underneath the control of the conventional cellular network which acts as controlled. Others suggests to make control of cellular communications but to allocate D2DCs for users which is known to be self-directed. Here Outband D2D spectrum is always uncontrolled as it is of unlicensed spectrum. So the mobile user who wanted to use D2DC services must have the technology to interact with both interfaces. Those are LTE and Wi-Fi. Thereby mobile user can use D2DC and cellular communication simultaneously.

II.PROJECTED SOLUTION:

The solution for the difficulty in providing users wide band spectrums very complicated due to its increase in access points brings burden on BLs. So the alternate one is that D2DC, it is a caching based process thereby improves spectrum efficiency. In previous applications attribute mobility of user is ignored, where as in D2DC it plays a major role. Here the mobility attribute improves practical approach with the user. By considering mobility of a user Data off-loading (DOL) ratio is increasing, where DOL ratio defines the throughput via cellular links over D2DCal links. The computation of caching process is very complex, so it is solved through many methods. Initially it is a NP-hard CP problem, by solving through many methods such as. With Optimal Dynamic Programming (DP) Algorithm the performance reaches benchmark, unlike in exhaustive search its complexity is almost minimized. Solution generated is MS (MS) maximization, which is in the form of matroid constraint. The conventional solution for Monotone Submodular (MS) maximization over matroid constraint is Greedy Algorithm (GA). Using JC the data offloading ratio is increased because of the consideration of both file cache and location cache in a single unit. The advantage of Joint Caching (JC) is it matches with real time data sets as showed in simulation results. In the JC algorithm it shows as the user mobility is high or low it caches most popular files, the user with medium mobility caches minimum popular files in order to get rid of duplication.

III.PROPOSED METHOD

3.1 Model of the System for D2DC:

In model of the system, there are two categories which describe the model of the system those are caching scheme in addition to model of transmission of files.

3.2 Mobility of the User in D2DC:

The connecting path information of users in cellular network can obtained from inter-contact model based on its mobility pattern. This Inter-contact model describes the mobility patterns of users in defined regions. In inter-contact model, the statistics of mobility patterns are notified when the users contact in the allowed region of communication. In the range of transmission between two users transformation of files happens, the time required to transfer together with receiving is called as ‘contact-time’.

There is also another attribute called inter contact time, which is defined as the time delay between two successive contact time slots. Here a cellular network with users is considered, the index set is represented as $= \{1,2, \dots\}$. The sender user and receiver user s also represented with names I and j respectively. In the cellular network poison process along with its intensity is represented as λ . The oversimplification is preferred so the statistics for individual user is autonomous. λ also represents the contact-rate for each pair, it explains the number of times users are in contact per unit time.

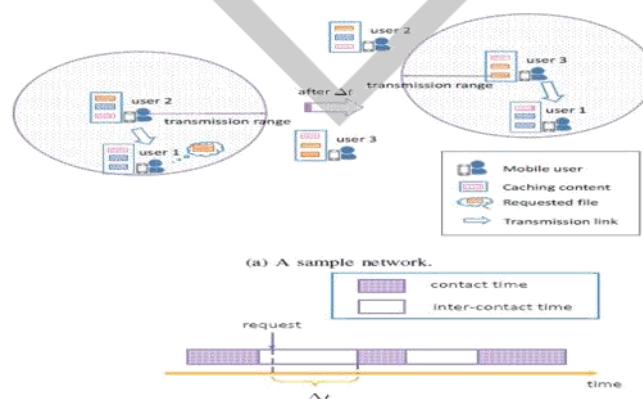


Figure 3.1: The timeline of user 1 and user 3

Here considering homogeneous cellular network thereby mobility patterns and contact patterns are familiar; by this calculation of aggregate of poisson process intensity is highest significant attribute. When practical cellular network is studied, the aggregate of poisson process intensity does not at all times gives raise the individual value of all independent users. Therefore, the results studied from the impractical results leads to wrong estimation. When the results taken at high number of users in the communication range the aggregate value of distribution becomes impractical so moderate number of user's gives fine value.

I.V RESULT ANALYSIS

Assessment of various caching strategies procedure:

Initially, in the process of estimation we produce the rate of contact for every device combination, λ_{ij} , for $i \in D$ and $j \in D$, in respect to a Gamma distribution as $\Gamma(4:43; 1=1088)$. The first step in statistical analysis is comparing three caching techniques those are JC, greedy caching and optimal caching. Here GA outperforms both Random caching and popular caching where as in JC also behaves the same the only difference is caching of files and placement process. The show of JC algorithm is very much close to GA.

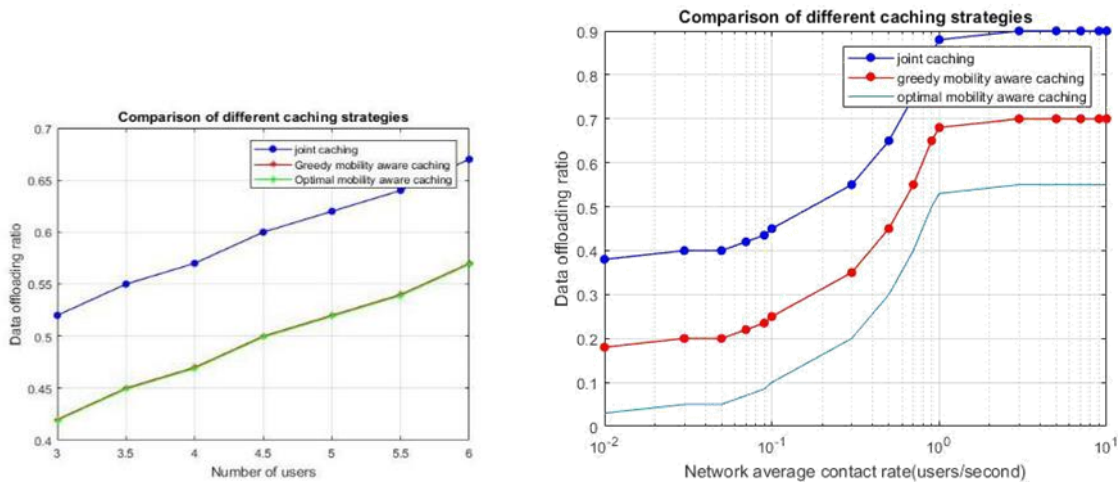


Figure 4.1: Comparison of different caching strategies for Number of users and DOL ratio

At length, the aforementioned observations don't modify for unique parameters of this document petition possibilities. Be aware that a huge significance of usually means the asks out of mobile end users tend to be somewhat more focused about the well-known data files.

Figure 4.1 demonstrates the consequence of the amount of end users (N_u). It's revealed that the suggested mobility-aware tactic consistently supplies a considerable performance advantage within the JC and best caching plans for distinct Caching abilities. Additionally, once the range of end users are really high, Caching the sections among their absolute most well-known records supplies a fantastic functionality.

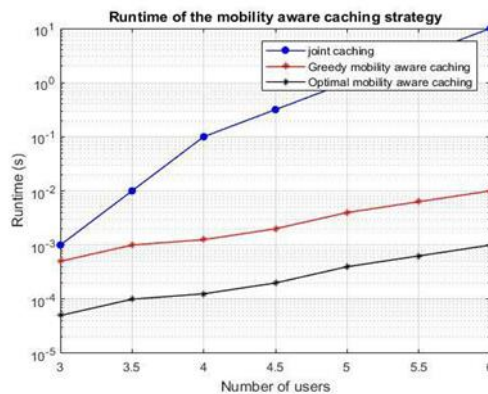


Figure 4.2: Runtime of the mobility aware caching strategy for Number of users and Runtime Moreover, the run time of this combined caching algorithm is far lower compared to GA, plus it may attain a close optimum functionality as exhibited amount as in Figure 4.2.

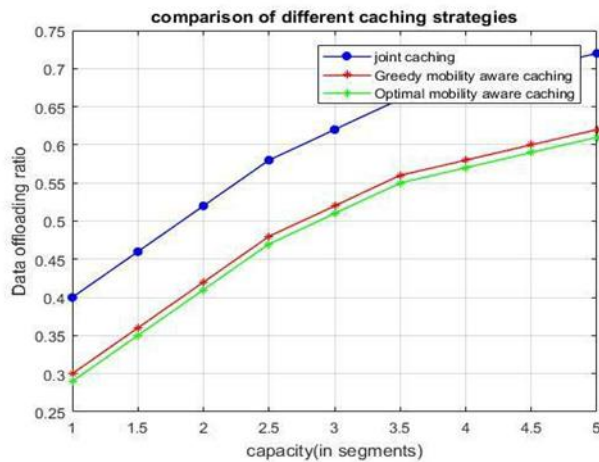


Figure 4.3: Comparison of different strategies for capacity and DOL ratio.

Whilst the storage boosts Caching capacity additionally rises but in concerted caching algorithm its own marginally higher in comparison to egotistical and best caching. Since it can certainly save both these features. Therefore DOL ratio is higher in JC rather than greedy caching.as shown in Figure 5.

CONCLUSION

In this project, we exploited user mobility to improve CP in D2D networks using a coded cache protocol. We took advantage of the inter-contact pattern of user mobility when formulating the CP problem. To assist the evaluation of the complicated objective function, we proposed a divide and conquer algorithm. A DP algorithm was then developed to find the optimal CP, which is much more efficient than exhaustive search using GA we are improvising the optimal CP by converting the NP-hard problem into monotone sub modular maximization. In JC algorithm both file cache and location cache are taken into computation at a single unit. The advantages of JC also taken into considerations. Comparisons are done between JC and GA results which shown more DOL ratio for JC over GA.

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