Device-to-Device Communication in 5G Cellular Network: Challenges, Solutions, and Future Directions

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Abstract - *Traditional cellular network, devices are not permitted to directly communicate with each other in the approved cellular bandwidth and all communications take place via the base stations. In this article, we foresee a two-tier cellular network that includes a macrocell tier (i.e., BS-to-system communications) and a system tier (i.e., node-to-device communications A).System terminal relaying makes it possible for devices in a network to act as transmission relays for each other and realize a huge ad hoc mesh network. It is clearly a radical break from the traditional cellular architecture and presents particular technological challenges.In such a two-tier cellular system, since the user data is routed through other users' devices, security must be maintained for privacy. To ensure mini- mal impact on the performance of existing macrocell BSs, the two-tier network needs to be designed with smart interference management strategies and appropriate resource allocation schemes.Furthermore, novel pricing models should be designed to tempt devices to partici-pate in this type of communication. Our article provides an overview of these major challenges in two-tier networks and proposes some pricing schemes for different types of device relaying.*

1.INTRODUCTION

With the launch of a plethora of smart hand- held apps, consumer demands for mobile wide- band are experiencing an exponential increase. The dramatic growth of bandwidth-hungry applications such as video streaming and multimedia file sharing are already stretching the limits of existing cellular networks. In the next decade, imagined media-rich smartphone applications such as tele-pres- ence and 3D holography would require data rates simply not feasible with fourth generation (4 G) networks.

The ever rising demand for higher data rates and capability need innovative think- ing for the fifth generation (5 G) cellular networks. Cooperative communications has such promise!Cooperative communications are a new class of wireless communication techniques in which network nodes help each other to relay information in order to achieve spatial diversity on an advanced stage. This new transmission paradigm promises significant performance gains in terms of connectivity reliability, spectral efficiency, system capacity, and transmission range.Cooperative communi- cation has been extensively studied in litera-ture and fixed terminal relaying (which includes the installation of low-power base stations to enable contact between the source and the destination) has also been included in the 4 G Long Term Evolution (LTE) – Advanced Standard[1]. Fixed terminal relaying brings changes in cellular networks, but the full potential of coop- eration can be realized only through the imple- mentation of interface relaying. The word computer here refers to a mobile phone or some other portable wireless device with cellular connectivity (tablet , laptop, etc) a consumer owns.Device relaying makes it possible for devices in a network to function as transmission relays for each other and realize a massive ad hoc mesh network. This, of course, is possible with device-to - device (D2D) communi- cation functionality, which allows two nearby devices to communicate with each other in the licensed cellular bandwidth without a base sta- tion (BS) involved or with limited BS involvement.For the first four generations of mobile work, D2D communication functionality has not been considered. This is because it is seen primarily as a tool to reduce the cost of providing local service, which has been common in the past in terms of mobile operator market statistics. Operator performance in D2D performance has changed recently due to several styles in the wireless market [2]. For example, the amount of resources and understanding used in context is growing very rapidly. These applications require location acquisition and contact with neighboring devices, and the availability of such activity may reduce communication costs between devices. D2D performance can also play an important role in cloud computing and participate in the effective sharing of resources (spectrum, computing power, applications, social media, etc.) for close users. Service providers can also use D2D functionality to take over some network load in your area such as a stadium or supermarket by allowing direct transmission between mobile phones and other devices. In addition, D2D interactions can be very effective in natural disasters. In an earthquake or hurricane, an emergency communication network can be set up using D2D functionality in a short period of time, replacing damaged communications and Internet infrastructure. In today's market, technologies such as Wi-Fi or Bluetooth offer the functionality of some D2D applications. However, these things work with an unwritten band, and the disruption is undeniable. In addition, they will not be able to provide security and quality of service (QoS) as do mobile networks. Seeking to lose the emerging D2D market, mobile operators and retailers are looking for ways to introduce D2D communication capabilities to mobile services, which has aroused interest in this topic. Other recent D2D activities in mobile systems have reported implications for issues of management disruption and distribution of radio resources [4 - 6] as well as communication session planning and management processes [3]. In this article, we first provide the

D2D communication category based on the level of mobile service involvement. We then summarize some of the major challenges that need to be addressed before the implementation of D2D can be implemented. In particular, we briefly discuss safety, disruption management, and resource sharing issues, and identify specific indicators for future research. Throughout the article, we focus on pricing, another major challenge to D2D performance in practice, and propose some experimental programs for both users and operators.

1.1 ALLOWANCE D2D DEPARTMENT COMMUNICATION SYSTEMS AND TECHNICAL CHALLENGES

In this article, we look at the two 5G cellular network with macrocell and device tiers. The macrocell tier includes a base station (BS) - in the device connection as in a standard mobile system. Device tutorial includes D2D communication connection. When the device connects to a mobile network via BS, this device is said to be running on a macrocell tier. If the device connects directly to another device or detects transmissions with the help of other devices, these devices are listed in the device list. In such a system, BS will continue to use the devices as usual. However, at the edge of the cell or in the connected areas, the devices will be allowed to communicate with each other, creating an ad hoc mesh network.

In the realization of device communication, operators may have different levels o control. Based on the business model, it uses full / partial management in the distribution of resources within the source, destination, and transfer devices, or prefers out of control. Therefore, we can describe the following four types of communication with the device-tier (Figs. 1 - 4):

Device connection and establishment of operator control link (DR-OC): A machine on the edge of a cell or in a poorly covered area can communicate with BS by transmitting its data to other devices. This allows the device to achieve higher QoS or more battery life. The operator communicates with the partial transmission devices partially or partially of the control link.

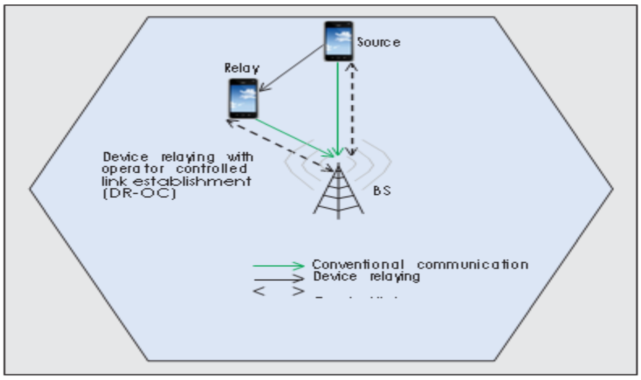
D2D direct communication through established operator domain (DC-OC): Source and input devices communicate and exchange data with each other without the need for BS, but are assisted by the network to establish a link.

Device connection via device-specified device device (DR-DC): The operator is not involved in the installation process. Therefore, the source and access point devices are responsible for connecting the communication using transmission between each other.

D2D direct communication via integrated device (DC-DC): Source and universal access devices have direct communication with each other without conflict. Therefore, source and destination devices must use the app in such a way that it ensures limited interference with other devices of the same tier as the macrocell tier.

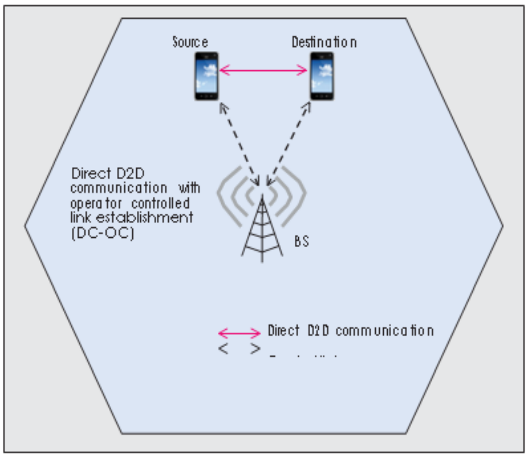
A dual-cell system, if done carefully, can bring about significant improvements in the design of a built-in cellular system. Prior to the launch of D2D, several technical challenges, particularly security

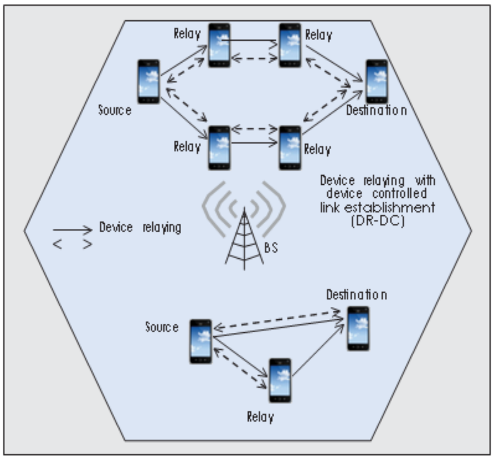
Issues of imperial rule and interference, must be overcome.



Since user data is transmitted by other users' devices, security must be kept private. One possible solution is to ensure secure access to devices that want to operate the tiger device. In offline access, the device has a list of "trusted" devices, and devices not listed will use a macrocell tier to share indicate with it. For example, users in a neighboring area or workplace who know each other, or users authorized by a group that are trusted as an organization, can communicate directly, satisfying the level of privacy. Devices in the group can place the appropriate encryption between each other to avoid sending their data to other devices. With open access, on the other hand, each device can function as a transfer of other devices without limitations. Since there is no form of surveillance, security in such a case is a major open source research problem. Security issues on D2D connections include the identification of potential attacks, threats, and system vulnerability. Previously working on cyber security issues [7 - 11] can be exploited to address security issues when accessing D2D is easily accessible. For example, work in [7] develops a credible environment for establishing trust relationships between M2M machines, while managing confidentiality in management [8]. Secure encryption, software-based cryptography, and detection of potential attacks are still being investigated in [9 - 11].

Another important concern in the two degree programs is the management of distractions. In DR-OC and DC-OC, resource allocation and call setup are done by BS. Therefore, BS can alleviate the problem of interference interventions to some extent using intermediate, well-established research areas for wireless communication. On the other hand, in DR-DC and DC-DC, there is no integrated business to oppose resource sharing between devices. Works with the same licensed band, the devices will adversely affect macrocell users. To ensure minimal impact on the performance of ancient macrocell BSs, a two-tier network needs to be built with smart disruption management strategies and appropriate resource allocation systems. In addition to the interference between macrocell and device devices, there is also transmission between users in the device group. Dealing with the allocation of resources through this type of communication, various approaches such as resource management [4], non-cooperative or negotiating game [12], consensus control and merger [6], segmentation, and transfer options [13] can be hired. In DR-OC, as shown in Fig.1, as BS is one of the communication associations, some of these predictive challenges can be addressed through BS control using existing methods [5]. BS can authenticate compatible devices and use appropriate encryption to maintain adequate device information privacy. BS can also manage interactions between passing devices to prevent interference from other devices. In DC-OC, shown in Fig.2, the devices communicate directly with each other through the establishment of an operator control link. Specifically, the operator deals with authentication login authentication, communication control, resource allocation, and financial interactions between devices. It has full control over D2D connectivity, including flight control functions (e.g., connection setup and maintenance), and data plane functions (e.g., resource allocation)

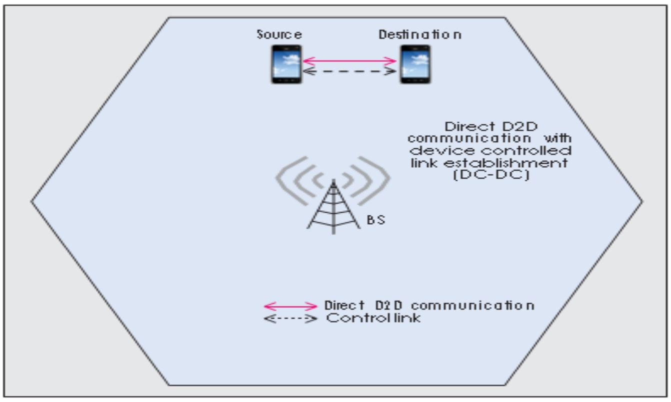




1.2 D2D connection

Share the cellular license band in the device range with a simple cellular connection in the macrocell tire. The network can allocate resources to each D2D connection in the same way as a normal cellular connection or provide a semi-statistically unique resource pool for all D2D connections.

In DR-DC and DC-DC, there is no BS or server to control communication between devices. As shown in fig. 3 and 4, many devices communicate with each other using cooperative or non-cooperative communication and one or more devices act as a relay for other devices. Due to the lack of centralized oversight of the relay, this type of community living is far more challenging than ever before. Connection setup, intervention management and resource allocation should therefore be addressed using distributed methods. Before the data transmission phase, the two devices must locate each other and adjacent relays (i.e., peer discovery and D2D connection setup). Devices can periodically spread identification information to notify the presence of other devices and to determine whether they can enable D2D direct or device relay communications [4]. In addition to the technical challenges summarized in the previous section, operators of ambiguity need to address how they control and charge D2D services. Some users, if charged for D2D services, may switch to traditional D2D technologies, which are free, but have lower speeds and less security. Therefore, operators must answer the question of "what to pay for" before developing controlled D2D technology, which requires extensive analysis of usage cases and business mode.From the operator's point of view, the operator benefits by providing devices that do not have coverage or by demanding higher than the data rates available on the macrolayer tire. Another incentive to transmit devices is that instead of discounting the bill of the month, the operator can offer some free services in lieu of the amount of data they relay. For example, suppose the following utility function is defined [12]:



Devices that act as relays for other users use Own resources such as battery, data store-edge and bandwidth. Therefore, pricing models should also be designed to entice devices for this type of communication. Furthermore, in direct D2D communication, devices need a secure environment to support the sale and purchase of resources among themselves. The operator can control and create this safe environment for such a process. Therefore, it is possible to expect security in D2D com-communicationS and some payment from devices for QoS. In the following, we will discuss pricing issues for each

D2D communication type and support some solutions using tools from Game Theo-Rye and Auction Theory.

1.3 Price for DR-OC

The main challenge in DR-OC is to provide souf-fuse incentives for relay equipment. Because they use their resources (e.g., battery, bandwidth) to transmit information to other sources, they need monetary or other incentives to engage in this type of communication. A possible alternative is that the operator can offer some discounts on monthly bills based on the amount of data transmitted through their devices.

CONCLUSION

In this article, we will look at a two-tier 5G cellular network called the macrocell and device arrays. In achieving device-level communication, the operator may have different levels of control depending on the bus-ness model. We have previously provided a range-level of D2D communication, taking into account the level of cellular operator involvement. We discuss some of the major technical challenges that need to be addressed for each type, such as security, intervention management, and resource allocation issues. In the rest of the article, we will focus on pricing issues and propose some pricing schemes for using a tool from Game Theory and for a two-tier network of Theo-Ray auctions. Our numerical results have proven that prudently designed value schemes for two-tier cellular networks bring significant benefits to operators and customers compared to traditional single-tier counters.

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