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Cognitive Radio Network Device-to-Device Communication Multihop -Based Protocol

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Abstract

The underutilised section of the wireless spectrum needs to be used effectively due to the anticipated exponential growth in traffic volume in 5G-based networks. Due to the popularity of numerous smartphone applications, cellular networks have seen a huge increase in data traffic in recent years. Therefore, expanding the network's capacity is essential to support new applications and services. However, when cooperative relays are used, multihop D2D communication necessitates the use of extra nodes for data forwarding. We must address the issues of transmission scheduling, routing, and channel allocation in order to establish effective multi-hop D2D cooperative communication. In order to deal with network dynamics, the suggested system architecture additionally emphasises online algorithms.

Keywords-*Cognitive Radio Network, Device-to-Device Communication, Multihop-Based Protocol.*

INTRODUCTION

Driven by the ever-increasing popularity of smartphones and tablets in recent years, wireless cellular networks have become one of the major systems accessing to the Internet with a huge number of customers due to their pervasive availability. Various mobile applications on such portable devices have generated a large amount of data traffic. For example, mobile data produced in North America was 222 PB per month in 2012. It will continually grow in the foreseeable future, as forecasted by Cisco that global mobile data traffic will increase 13-fold between 2012 and 2017. To accommodate such huge traffic demands, wireless cellular networks have been evolving to provide higher network capacity by integrating many new technologies. This evolution started from the second generation (2G) standard in early 1990s, as the first digital cellular system supporting voice services and low-speed data transmission. We are now in the fourth generation (4G) era with two candidates being actively developed today: 3GPP LTE-Advanced and IEEE 802.16m. As an enhanced version of LTE (Long Term Evolution), LTE-Advanced will meet or exceed the requirements of the 4G standard with 100 MHz bandwidth and 1Gbps peak data rate.

To achieve these objectives, it integrates the emerging technologies that can be classified into two categories: one is aiming to provide higher channel capacity, e.g., the multi-antennas technique and carrier aggregation, and the other focusing on developing new communication models, e.g., network traffic offloading. Many efforts focus on improving wireless channel capacity by exploring new coding schemes or advantages of multiple antennas. For example, turbo coding/processing is proposed to approach the Shannon limit on channel capacity, while space-time coding increases the possible channel capacity by exploiting the rich multipath nature of fading wireless environments. However, they are far from solving the network capacity enhancement problem because: (1) wireless channel capacity has physical limit and cannot be increased infinitely, (2) equipping multiple antennas incurs additional hardware cost, and is not adopted by most of mobile devices, and (3) traffic growth is faster than the progress of communication technologies.

Cellular network traffic offloading provides a new communication model to the network capacity enhancement problem. It can be classified into two categories: micro/pico/femto cells, and device-to-device communication. By deploying multiple cost-efficient access points at locations where large amounts of data are generated, cellular network capacity can be significantly increased by offloading the network traffic via the traditional cellular base stations to local low-power access points with reduced interference ranges. These access points may use different wireless technologies, such as WiFi and WiMAX, forming heterogeneous networks (HetNets) for mobile users. As shown in Fig. 1, traditionally, all network traffic needs to

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go through the base station that forms the bottleneck of the whole network. When multiple local access points are deployed, some mobile users can communicate via the local cells such that the traffic load on the macro base station can be reduced. Although traffic offloading to micro/pico/femto cells shows great advantages in increasing cellular network traffic, additional investment in network infrastructure, e.g., micro/pico/femto access points, is needed. Moreover, once these access points are deployed, they cannot be easily relocated. Since network traffic from mobile users is dynamic, i.e., traffic generation of different regions changes over time, fixed deployment would lead to low offloading performance. As an alternative, Device-to-Device (D2D) communication enables flexible traffic offloading without the support of any network infrastructure. It lets two devices in proximity of each other establish a direct local link for data transmission. After offloading some data traffic to D2D links, multiple users can transmit simultaneously in a single-collision domain. An example of D2D communication is shown in Fig. 1. Under cellular mode, users A and B communicate over an uplink and a downlink while all other nodes (e.g., user C) in the same cell should keep silence. When D2D communication is enabled, user A can send data to its destination B over a direct link if the link quality is good enough. Meanwhile, user C can access the network if they cause no interference to that D2D pair. The D2D communications can happen not only between a pair of nodes within a single cell, which is referred to as an intra-cell D2D pair, but also between those located in difference cells. Usually, D2D communication is managed by base stations, i.e., base stations determine whether a pair of users communicate under cellular modem or D2D mode.

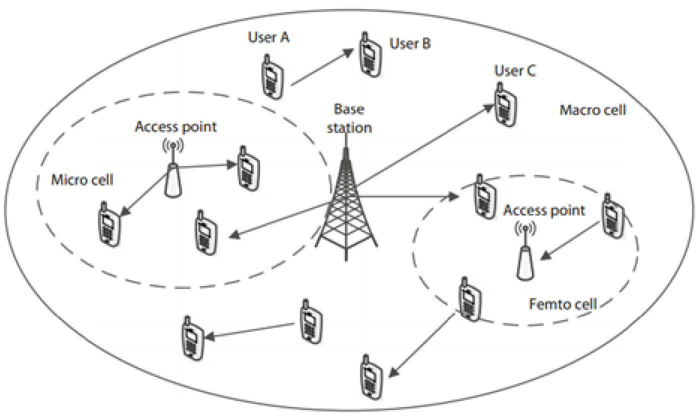

Figure 1. Traffic offloading in cellular networks

LITERATURE REVIEW

In the past a few years, there has been lots of research on network traffic offloading that focuses on offloading cellular traffic to WiFi or other networks to save bandwidth or energy. A quantitative survey of mobile data traffic surge and a strategic solution to traffic offloading has been presented in. Korhonen et al. have discussed existing traffic offloading solutions, and presented and evaluated three different IP traffic offloading solutions that aim to work on the internet layer and rely only on the standard IETF2 defined TCP/IP protocol suite, not requiring any access technology-specific knowledge. Lee et al. have presented a quantitative study on the performance of 3G mobile data offloading through WiFi networks.

Their trace driven simulation using the acquired whole-day traces indicates that WiFi already offloads about 65 % of the total mobile data traffic and saves 55 % of battery power without using any delayed transmission. Rstanovic et al. have designed two algorithms for delay-tolerant offloading of bulky, socially recommended content from 3G networks. They find that both solutions succeed in offloading a significant amount of traffic with a positive impact on user battery lifetime. Device-to-device (D2D) communication becomes a hot research topic recently due to its benefits of offloading data traffic at base station in cellular networks. In their early work, Janis et al. propose to facilitate local peer-to-peer communication by a D2D radio that operates as an underlay network to an IMT-Advanced cellular network.

Later, they have studied D2D communication in three modes, i.e., reuse mode (D2D links share common channels with cellular links), dedicated mode (D2D links use dedicated channels), and cellular mode (all communication is relayed by base station), and designed mode selection algorithm for a three-user (one D2D pair and a cellular user) cellular network. Based on a similar network model, Yu et al. have investigated the throughput optimization problem over shared resources while fulfilling prioritized cellular service constraints. For more general models, D2D communications have been extensively investigated from aspects such as interference management, power control, spectrum sharing, and so on. For example, Janis et al. have proposed a practical and efficient scheme for generating local awareness of the interference between cellular and D2D users at the basestation, which then exploits the multiuser diversity inherent in the cellular network to minimize the interference. Kaufman et al. have developed a distributed dynamic spectrum protocol, in which ad-hoc D2D users opportunistically access the spectrum actively in use by cellular users. A new interference management scheme is proposed to improve the reliability of D2D communication in. They derive outage probability in close form and design a mode selection algorithm to minimize outage probability.

Lee et al. have proposed a two-stage semi-distributed resource management framework for the D2D communication. At the first stage of the framework, the base station (BS) allocates resource blocks (RBs) to BS-to-user device (B2D) links and D2D links, in a centralized manner. At the second stage, the BS schedules the transmission using the RBs allocated to B2D links, while the primary user device of each D2D link carries out link adaptation on the RBs allocated to the D2D link, in a distributed fashion. A two-tier 5G cellular network that involves a macrocell tier (i.e., BS-to-device communications) and a device tier (i.e., device-to-device communications) has been discussed in. Li et al. have investigated the fundamental problems of how D2D communication improves the system performance of cellular networks and what is the potential effect of D2D communication, with the aid of the optimal solutions for the system resource allocation and mode selection obtained under the realistic user and mobility conditions. Specifically, by formulating a max-flow optimization problem that maximizes the content downloading flows from all the cellular base stations to the content downloader's through any possible ways of transmission, they obtain the theoretical upper bound to system content-downloading performance.

The basic idea of CC is proposed in the pioneering paper. Later, Lane man et al. have studied the mutual information and outage probability between a pair of nodes using CC under both AF (amplify-and-forward) and DF (decode-and forward) mode. Based on their fundamental work, CC has been extensively studied from the perspectives of both physical layer and network layer. We summarize the most relevant work in the following categories: energy efficiency, relay assignment, and time-spectrum allocation in cooperative communications. In, Simic et al. compare the energy-efficiency of two major cooperative diversity schemes, virtual-MISO (multiple-input-single-output) and decode-and-forward, in wireless sensor networks. They show that decode-and-forward outperforms virtual-MISO since it avoids explicit local communication among cooperating nodes. The energy efficiency of CC in wireless body area networks is investigated in.

PORPOSED METHODOLOGY

Since of the restricted mobile device communication capacity they can only communicate in a narrow range. Through system may create a data path with other nodes at a distance, which results in more D2D communication opportunities by using multihop communication techniques. More nodes are used for data transfer, particularly when cooperative relays are adopted, for multihop D2D communication. We need to address the problems in the transmission cycle, routing and channel allocations to achieve successful multi-hop cooperative D2D communication. We also develop online algorithms to manage the complexity of the networks.

Mobile users enter or leave the network anytime in actual cellular networks, and because of customer choice, the efficiency of the wireless channels varies as well. Therefore online algorithms should be built to handle these complex network events. The theoretical limits for online cases and guideline for online algorithm design are these solutions found in this system. As online network topology is using I concentrate on Internet of Things for the design implementation.

Internet of Things (IOT)- IOT, A recent new market in the field of computer engineering has been the proliferation of devices which fit in the category of ”Internet of Things” (IoT). These often are embedded devices which can perform a small series of functions and can connect to the Internet and other devices nearby.

There are various radios on these devices such as Bluetooth and Wi-Fi that enable them to control each other or be controlled through a central interface. These embedded devices often run advanced operating systems such as Brillo, which is based on Android. This allows it to run Android apps, which are written in Java, using the same codebase as mobile phones or laptops. Android Things is the evolution of Brillo. This takes advantage of recent trends in the industry, notably the popularity of smartphones, cheaper technology costs, and the availability of Wi-Fi. Using a single app, or a voice-based assistant, one can control the lights, blinds, and other devices with a single command. There are currently an estimated 23 billion devices connected to the Internet, including mobile phones, tablets, and computers. This number is expected to double within the next few years. With so many devices connected to the Internet, they will be competing for bandwidth on underpowered routers, affecting their functionality and degrading performance for every user.

Cognitive Radio - Cognitive radio (CR) is a new technology which can dynamically allocate spectrum to each device to maximize the capability of each one in low-bandwidth areas. They take advantage of software- defined radios, devices which can change their frequency based through a program. Cognitive radio was introduced by Dr. Joe Mitola at the University of Stockholm in a research paper. The idea was to have handsets, mobile phones, and cell networks change how they communicated based on their environment. A diagram of the behavior is shown above in figure 2. Radio Knowledge Representation Language was defined as a way to provide ”a standard language within which such unanticipated data exchanges can be defined dynamically”.

This in turn, could be used in cognitive radios to improve performance and increase battery performance. Another feature is allowing the system to ”select the most appropriate network for the service requests of the user”. This component has recently been incorporated into mobile phones through Wi-Fi calling.

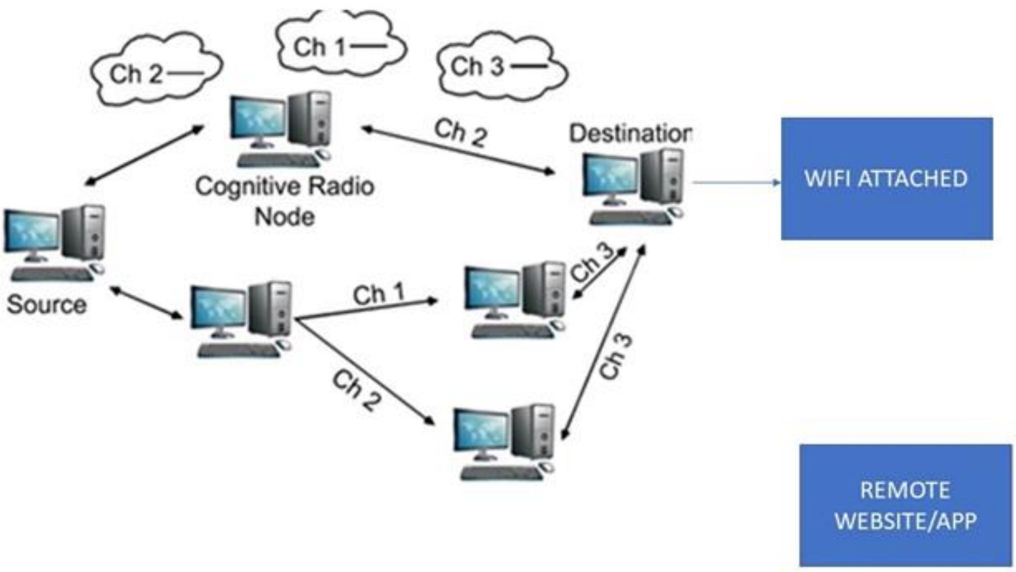

Figure 2 -Design of Proposed system

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RESULTS

It can be expressed in terms of how many MTS there are and how many parameters each MTS can have. For example, for MTS-1, we can say that there are N possible parameter sets, while for MTS-2 we can say that there are N possible parameter sets for MTS-1 and MTS-2. Consider the fairness of MTs when using the logarithmic utility function for throughput. When it comes to objective function, MTs with lower throughputs have larger gains compared to MTs with higher throughputs. Figure 3 shows Probability a D-beacon is received correctly by a UE varying the probability (p) a b-UE is active for a threshold and Figure 4 shows path loss exponent.

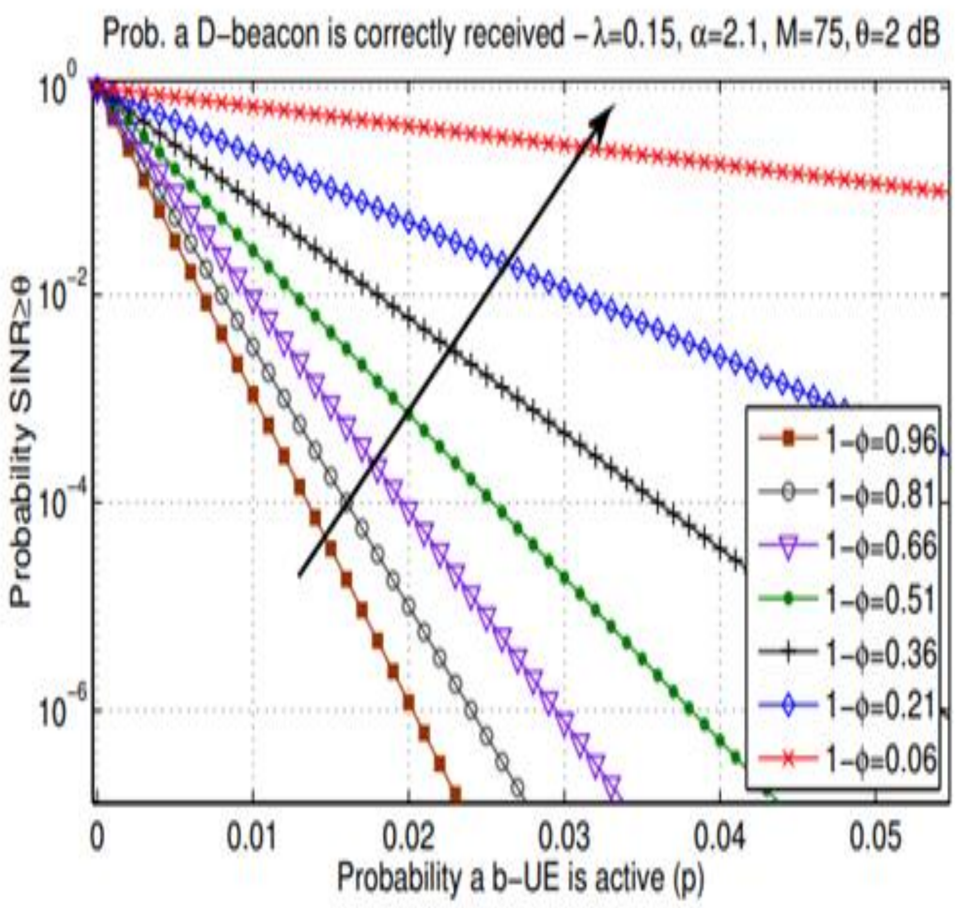

Figure 3- Probability A D-beacon is appropriately received by a UE by altering the likelihood (p) that a b-UE is active for a threshold period of time

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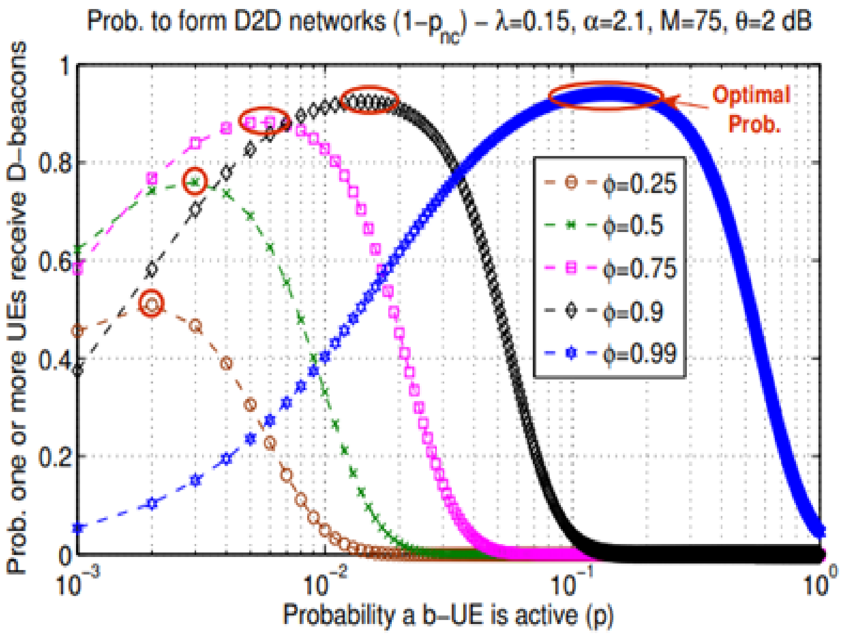

Figure 4- Path loss Exponent

CONCLUSION

In this paper, a novel cognitive dynamic network architecture (CDNA) for upcoming 5G wireless networks is presented. In order to provide Internet access anywhere, this design makes use of the density and heterogeneity of wireless devices. Increased energy and spectrum efficiency, support for heterogeneous connectivity requirements, dynamic reconfigurability, and new commercial opportunities are all advantages of this design. To properly exploit its potential, a distributed matching approach has been developed for resource allocation. Users can self-organize into a stable matching using this technique, which makes trading data and spectrum more productive.

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