ISSN: 2395-2946

Multi-Cell Device To Device Communication Using Proximity in 5G Cellular Network

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Abstract -Direct device-to-device (D2D) communications is generally a best technology to provide low-power gain , high-data frequency rate and low-latency devices between end to end users in the future 5G networks. However, it may not always be capable to provide low-latency easy communication between end to end users due to the character of mobility. For instance, the latency could be increased when various controlling nodes have to convert D2D related information among each other. Moreover, the particular signaling overhead due to D2D communication need to be decreased. Therefore, in this paper, we propose several mobility management results with their technical challenges and expected gains under the creation of 5G small cell networks.

Keywords - D2D Communication, 5G Network, Mobility, Small cells, Proximity Servers, Heterogeneous Network.

1. INTRODUCTION

Now a days the world becomes connected, the more effective wireless devices appear in our proximity server. Due to the rapid increase in the various connected devices and traffic volumes, and the fifth generation (5G) networks are expected to be much unique and easily deployed than today's networks as depicted in Figure 1. In addition to the current cellular network, wireless devices in the future are to be constantly interacting with each other and also with their environment (e.g., data communications for wireless sensors to device and vice versa). Besides the human-controlled device-to-device (D2D) communications, one most important case for D2D is generally vehicle-to-vehicle (V2V) communications where the mobility plays a important role.

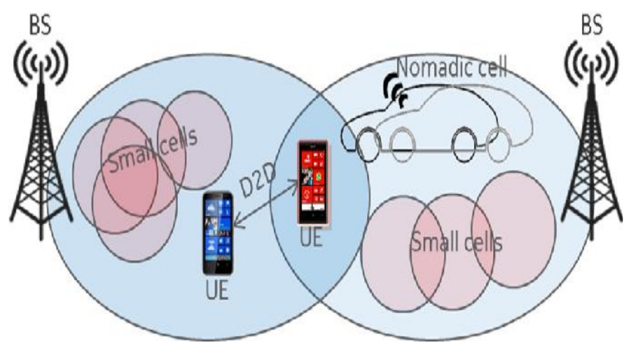

Fig. 1. 5G communications formulation where small cells,

nomadic cells and D2D are expected to be important technical method for increasing capacity and traffic offloading in the future networking category.

D2D communications has already been a function of wireless communications community for many years . Now a days more and more people used that D2D communications will be most important in the future 5G networks. For starting, the third generation of partnership project i.e (3GPP) agreed that device-to-device (D2D) creation and communication is one of the new features to be studied during 3GPP Rel-12 or -13 timeframes under the LTE Proximity Services (ProSe). In 3GPP, two different types of ProSe communication scenarios are defined :

(1) direct data path here two devices are exchage packet data without appearing of any network element in the data plane;

(2)Secondly, locally data path are routed where D2D user equipment (UE) follows the locally data path by relaying through the controlling node without the participation of core network elements. However, due to the small-time frame, the outcome of 3GPP work on D2D will be decreased at least in Rel-12 time frame. Now a days standardization there has not been much formed on the commercial use purpose which are generally considered for the future 5G communication scenarios .

To fullfill the requirements of 2020 wireless communications society, 5G communication system has to be effectively more effective and formulate in terms of energy, cost and spectral efficiency. Efficiency and scalability will be equal in order to reach the particular targets, i.e., 1000 times higher mobile data capacity per area, 10 to 100 times greater number of connected devices and 5 times decreased end-to-end latency as described in EU FP7 METIS project . In addition, next generation networks have to form a significant diversity of all cases, such as the various requirements of communication in mobility management. They are generally apply to D2D communications ranging from discovery of device to interference management. In this paper we concentrate on the need of decreased control signaling and describe end-to-end (E2E) latency in network based D2D communications by describing two smart mobility management solutions as the support for ultra-reliable communication and low power latency operations in future ultra-dense networks is allowed to be realized over 2020 (5G) communication systems.

2. SYSTEM MODEL

Mobility Management For D2d Communications System

In our solutions we assume that the D2D resource usage and management are under the network's control. This is due to the fact that band D2D operation, as describe for cellular communications, are generally requires the network's control on D2D radio function in order to set optimized utilization, for decreasing interference among D2D links and from D2D links to cellular network, as well as more robust mobility.

Decreasing very low latency data communications between end to end users is one of the main advantages expected from D2D communications. However, when various base stations (BSs), that are generally connected to each other a non-ideal backhaul, are involved in the D2D radio management control, the quality of performance requirement in terms of latency should not be fulfill due to large delay.

However, the additional control should be expected due to the exchange of important information between controlling nodes as shown in Figure 2. Therefore, we formed two mobility management solutions that can be used to minimize the negative creation in communication (e.g., larger latency and additional signaling overhead) of multi-function in radio resource control on D2D communications by setting the D2D handover and cell selection during the mobility of D2D UEs (DUEs):

- **D2D-aware handover formulation**,
- **D2D-triggered handover formulation.**

Here, it should be obtained that D2D control handover formulation and regular cellular handover could be created separately, such as in dual connectivity.

A. D2D communication Aware Handover Solution

D2D-aware handover solution is formed to minimize the E2E operation in D2D communications and minimize the network signaling overhead in situation of DUE mobility.

As shown in Figure 3a, a D2D communication is initially controlled by the same Base station. Figure 3b shows that one of the DUEs, UE1, generally move toward BS2 when fulfill the regular cellular network handover aware condition, such as event A3 in which the received signal strength of side cell becomes much better than primary cell, i.e., *RSRPtarget – RSRPsource > offset*.

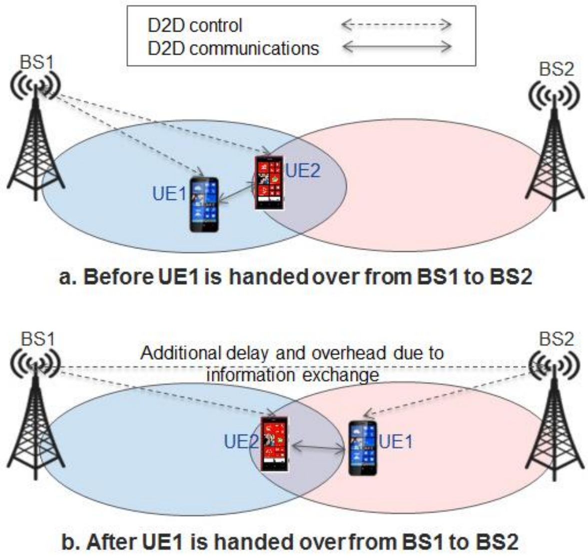

Fig. 2. D2D communications before and after a continous cellular communication handover execution.

However, to decrease the latency and signal overhead, it is beneficial to keep the D2D communication pair obtained by the same Base station. Otherwise, when the DUEs are generally control of different BSs, there can be potential performance degradation, due to formulation of asynchronous BSs. Using the regular handover condition for each DUE indisivually does not achieved guarantee this. Therefore, we form D2D-aware handover formulation which enables BS1 to cancelled the handover of at least the D2D control (or both D2D control and cellular network connectivity) to BS2 unless the signal quality of BS1 becomes worse than a already defined D2D control condition which is defined as the minimal calculation in terms of link management to maintain the D2D control. D2D control condition is generally set according to, for example, signal –interference of plus-noise-ratio (SINR) threshold (e.g., generally -6 dB in our performance evaluations). However, when the signal achieved of Base station2 is able to complete the D2D control condition for both UE1 and UE2, a connected handover to Base station 2, which provides the best SINR among all the candidate formed cells, is enabled by D2D communication aware handover solution as shown in Figure 3c.

B. D2D communication Triggered formulation of Handover Solution

With D2D-triggered handover solution, we obtained to cluster the members of a D2D group within a decreased number of cells or BSs in order to low the network communication signaling overhead obtained by the inter-BS information exchange, such as

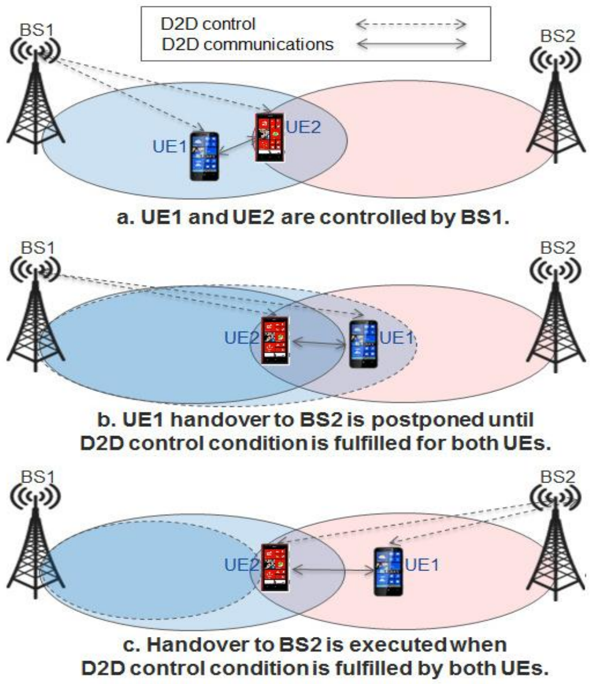

Fig. 3 D2D communication using Mobility between different sites

connected to D2D radio resource. The solution targets the scenarios where D2D groups are dynamically formed by greater than two DUEs. The solution can be apply when DUEs taking part in a D2D group are varying in time, for instance, due to the mobility.

3. SIMULATION SCENARIO AND POSSIBILITIES

Simulation scenario generally gives the ultra-dense deployment of 5G networks, i.e., more than 10 times more densely deployed than today's networks. In the network layout, there are 60 randomly situated small cells under the coverage of a three-sector macro cell of BS. Under each macro sector, small cells are effectively and uniformly situated in the minimum distance of 45 m among each other as depicted in Figure 4. Macro and small cell are generally allocated with different carrier frequencies.

In the simulation scenario which are commonly assumed that there are generally eight terminals per small cell on average. At starting, some UEs are randomly and uniformly dropped throughout the macro geographical area range. But other UEs are dropped uniquely and uniformly within the radius of 10 or 50 m from the starting dropped UEs. D2D groups are formed with two and four UEs in each other's proximity. The mobility is modeled such that a DUEs group moves straight to the same direction, which is uniquely chosen, with 3 km/h velocity. The UE direction is forrned at the layout border.

The main simulation possibilities follow the simulation guidelines follows by 3GPP [9, 10] and Table 1.

Table 1. Main simulation assumptions

Simulation time	10-15 drops at 1000 s each cell
Network layout	1macro cells, 5 small cells
Number of UEs	969 (8 per small cell)
UE velocity	3 km/h
Carrier frequency	2 GHz
Downlink frequency tx power	Macro BS: 48 dBm, Small BS: 35 dBm
BS antenna height	Macro BS: 28 m, Small BS: 15 m
UE antenna height	1.5 m
Pathloss model	ITU Urban Macro NLOS and Micro NLOS
Fading model	Shadow fading deviation: {6, 4} dB
{Macro BS, Small BS}	Correlation distance: {45, 15} m
A3 margin & TTT [8]	3 dB & 100 ms
D2D control thr.	-7 dB (SINR)

The smart handover solutions is in this paper aim at maximizing the single small cell control on D2D communications by which DUEs can efficiently be offloaded to the small cell layer; E2E latency can be fixed in minimal; and the network signaling overhead is decreased. Inter-frequency deployment, where macro cells and small cells layers are allocated with non-overlapping codes of the radio spectrum, is of our interest in this given paper. In this given scenario if D2D communication control is given to a macro cell, advantage of the small cell offloading should not be maximized due to the lack of communication control of the macro layer on small cell.

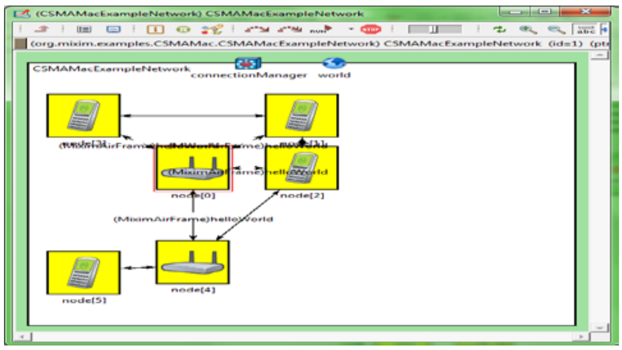

Fig 4. Simulation flow diagram modeling devise to devise communication selects the target cell for handing over D2D control of a new device to involve in D2D group communications.

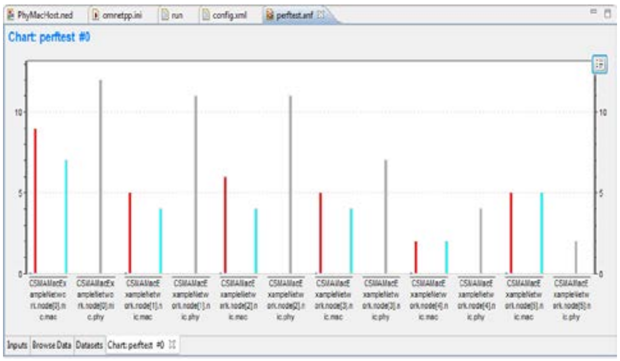

Fig 5. Statistics (of the nodes of the continuous D2D communication service time created under the same small cell. A3 HO and D-A HO denote A3 triggered event handover and D2D-aware handover, respectively.

As shown in Figure 31, D2D-aware handover (D-A HO) improves the mean continuous time period of the D2D device control under the equal small cell by 237% and 67% for the maximal D2D pair distances of 20 m and 100 m, respectively.

Besides the creation of the continuous time period of the D2D system control under the same small cell, D2D system handover solution is able to constant the mobility robust because it does not cause a notable change in either the number of (potential) D2D system failures, i.e., generally *SINR < D2D control thr.*; or the number of D2D control handovers, where a D2D group comprises 4 DUEs, are describes that generally a D2D-triggered handover (D-T HO) off the majority of the DUEs to be kept under a particular small cell for longer mean continuous time period by 414% and 63% for the maximum D2D link distances of 20 m and 100 m, respectively. Here, the main advantage of the solution is expected to be decreased in the network signaling overhead, whereas D2D communication aware handover solution aims at minimizing the E2E latency primarily.

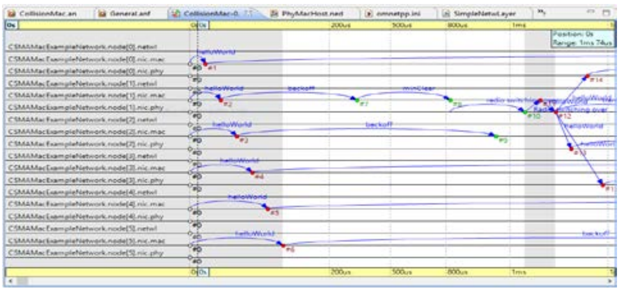

Fig 6. Mobality index in terms of D2D communication indicators. Number of events is given per UE per simulation drop (1000 s). node0 to node5 denote event on triggered in handover and D2D communication aware handover, respectively.

Signal-to-Interference-plus-Noise Ratio and Calculation of Throughput Performance

We calculate the performance of heterogeneous network for communication by which simulating the coverage probability that gives a probability, that a any random user achieves a SINR with all cumulative distribution function that is averaged all the visible base stations. We simulate every coverage probability is completely depends on the SINR value for different cases: that are on single tier form , multiple tier communication and D2D heterogeneous networks. For our simulation we use following parameters which are as follows:

- Poisson parameter for the macro Base stations on spatial location – 10;
- Poisson parameter for the pico-cell Base station on spatial location – 50;
- Poisson parameter for the femtocell Base station on spatial location – 100;
- Poisson parameter for the UEs location – 1000;
- transmission power of macro cell Base station – 45 dBm;
- transmission power of pico cell Base station – 30 dBm;
- transmission power of femto cell Base station – 20 dBm;
- receiver floor level management– -90 dBm;
- propagation model – COST-232.

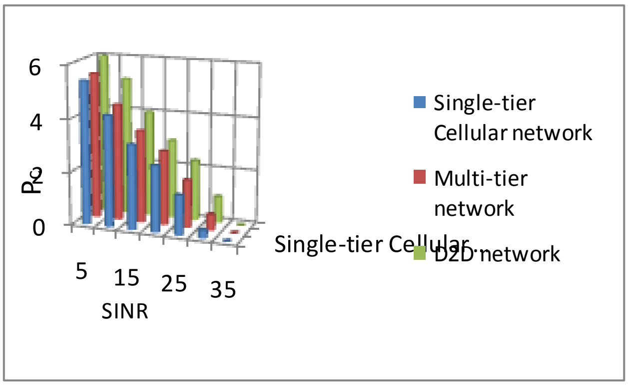

Fig 7. Coverage Probability versus SINR for different HetNet Senerios

Although, increasing of all the cells density executes the interference gives, simulation results show that single tier network topology gives the worst coverage area probability comparing to all HetNet scenarios. It is obtained due to high propagation loss in the path between macro cell Base station and Use equipment. Thus, influence of additive noise is much higher and greater for the SINR values. The

SINR distribution for HetNet is more uniform, because of all the small cells transmits that are located closer to the UE. Simulation results shows that D2D communication by HetNet shows best performance due to the efficient transmitter selection according to the better SINR conditions. Therefore, D2D HetNets provides more effective SINR distribution. We also simulate throughput values distribution of all the coverage area. To evaluate throughput , we set the following parameters:

- bandwidth criteria – 20 MHz;
- modulation index – 64 QAM;
- antenna configuration: omnidirectional antenna
- D2D link transmission – 5 Mbit/s.

4. CONCLUSIONS

As we can see in the simulation results, the proposed smart mobility solutions can reduce the network signaling and improve the D2D and E2E latency by maximizing the time period when the DUEs are under the control of the small cell.

By this level of improvements in the system, we are now able to support more reliable communications, for instance, V2V communications and low level latency services in future ultra-dense networks, as required for beyond-2020 (5G) communication systems.

Future work will be consider different mobility scenarios in cellular radio networks, for many purpose for example, vehicular communications.

5. FUTURE SCOPES

Future work may consider different mobility scenarios in cellular radio network for many purpose. It is possible that 5G network will relay on a number of different frequency bands that carry information at different rates and have widely different propagation characteristics. These devices will have the ability to decide when and how to send the data most efficiently.

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