

# Device-to-Device Communication Initiation Model Using a Decision Making Procedure in the LTE-Advanced Networks

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## Abstract

Recently, interest in communication between devices is increasing steadily. So in this paper, we introduce a new concept; Device-to-Device (D2D) communication, which means direct communication between devices underlay to LTE-Advanced Networks. And we propose a D2D communication initiation model using a decision making procedure. This proposed model will be able to help D2D communication in the LTE-Advanced networks. A decision making procedure determines which communication is better, D2D or cellular communications. Also, through the simulation result, we show that D2D communication is better than cellular communication for short distances.

## I. INTRODUCTION

Currently, Human-to-Human (H2H) communication market is already saturated in advanced countries. Thus standardization organization is trying to create a new market for future businesses. In case of Third Generation Partnership Project (3GPP), they are studying about, means of communication between device and server, Machine-Type Communication (MTC) [1]. Moreover, further enhancement is possible if the telecommunication companies go beyond H2H communications exploiting Machine-to-Machine (M2M) communication, Human-to-Machine (H2M) communication, etc. So in this paper, we introduce a direct communication between devices in the LTE-Advanced networks beyond MTC technology.

## II. D2D COMMUNICATION IN THE LTE-ADVANCED NETWORKS

D2D communication in the LTE-Advanced networks means direct communication between devices underlay to LTE-Advanced Networks. The D2D communication enables new service opportunities and reduces the eNB load for short range data intensive peer-to-peer communication [2]. The concept of D2D communication in the LTE-advanced networks is showed in Figure 1. In the D2D communication, Cellular and D2D communications share same frequency resources. The User Equipment (UE) in D2D connections remains controlled by the eNBs and continues cellular operation.

The eNBs can set constraints on the transmit power of D2D transmitters to limit the interference experienced at the cellular receivers and resources can also be assigned to D2D links in the case of a dense LTE-Advanced network with high network load, where a cognitive radio with a cellular network as primary service would not be able to detect locally unused spectrum [3].

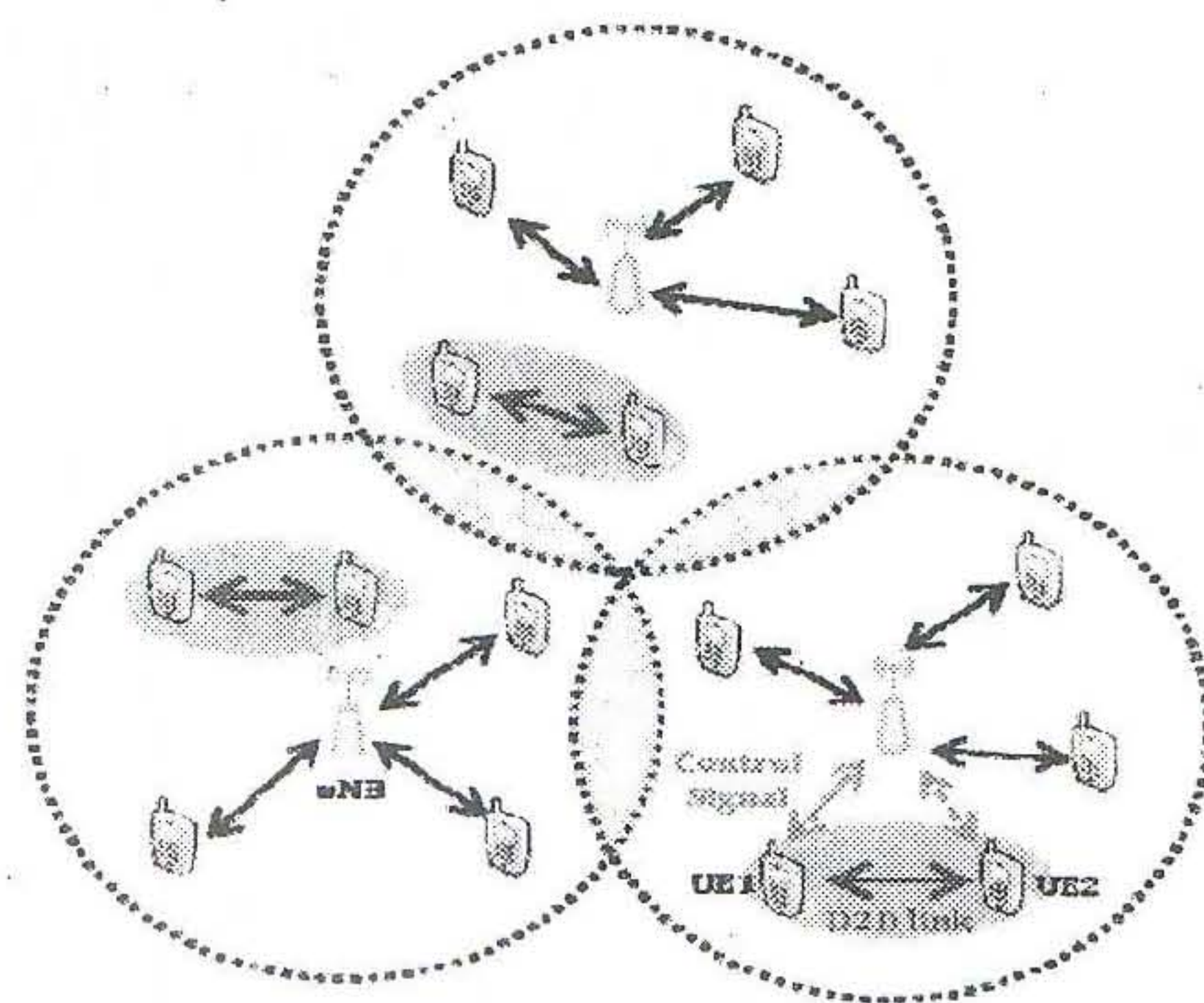


Figure 1. Concept of D2D communication in the LTE-Advanced networks

By using D2D communication in a conventional cellular network, performance improvements such as increased data rate, reduced transmission power, enhanced network capacity, better load balancing, and extended coverage area have been demonstrated [4]. While following problems are expected, when D2D communication is used in the LTE-Advanced Networks; how and when use D2D communication, mitigating interference because of frequency reuse, error monitoring and recovery, policy management for service charge, addressing and identification, security and authentication and so on.

## III. D2D COMMUNICATION INITIATION MODEL

We illustrate how D2D communication can be initiated in the LTE-Advanced networks. Proposed D2D communication initiation model has following assumptions; UE1 wants to connect UE2, user doesn't need to know communication status whether D2D communication or cellular communication is used, eNB makes a decision which communications are better D2D or cellular communications, and D2D communication overhead should be measured.

Also eNB should have an eNB ID table. This table, including adjacent eNB ID, lets eNB know information

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about adjacent eNBs. Figure 2 shows a flow of D2D communication initiation based assumptions mentioned above.

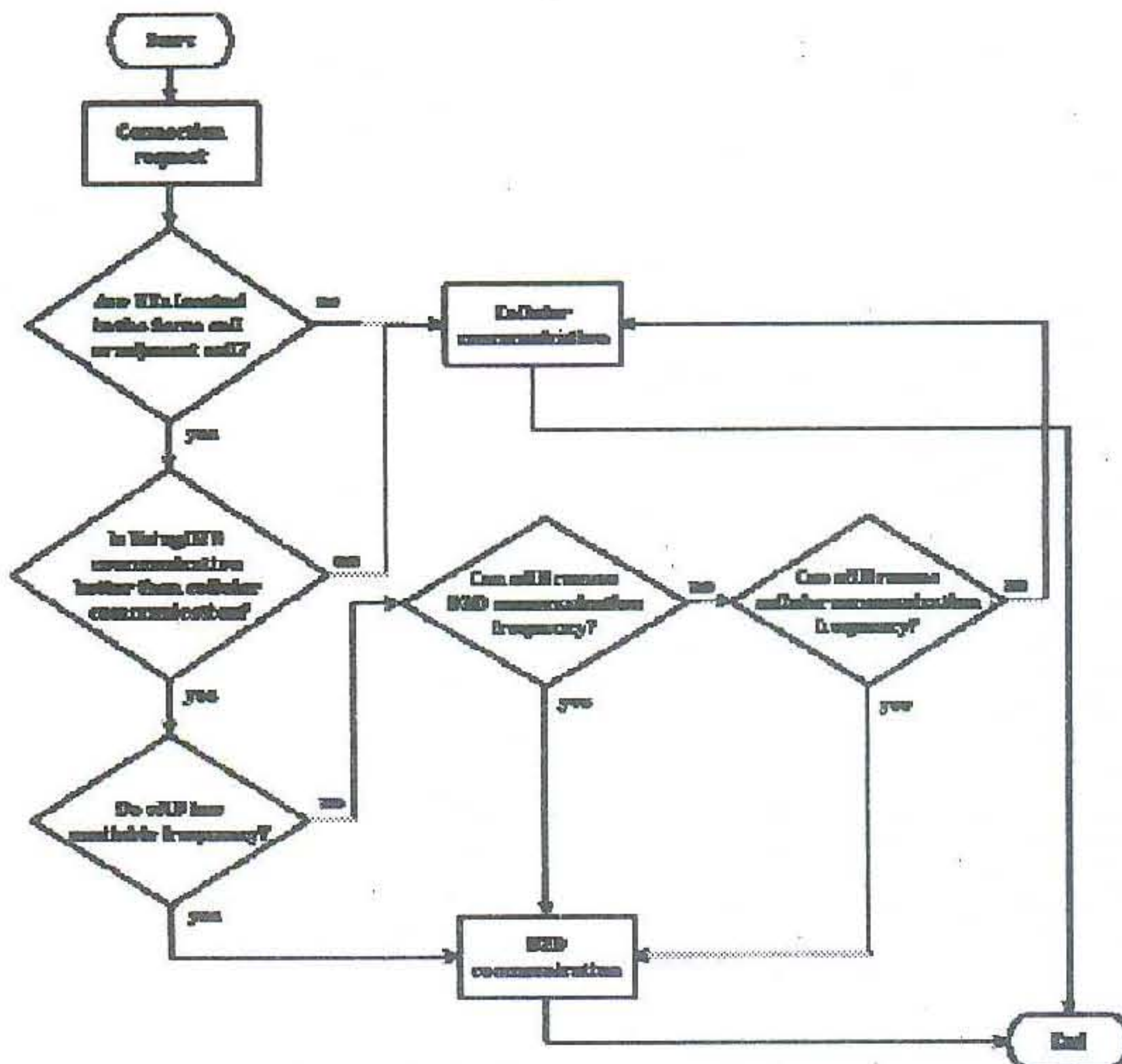


Figure 2. D2D communication flow chart

Figure 3 shows D2D receiver's eNB search procedure. Whenever possible, this procedure attempts to replicate LTE-Advanced connection procedure as it is. First UE1 sends a request to eNB1. Then eNB1 sends a request message including eNB1's own ID to evolved packet core (EPC). And then eNB2 receives a request message from EPC. For eNB2 checks UE2's location, eNB2 should know eNB ID of eNB2 and adjacent eNBs. In case UE2 is located in UE1's cell, eNB2 equals to eNB1.

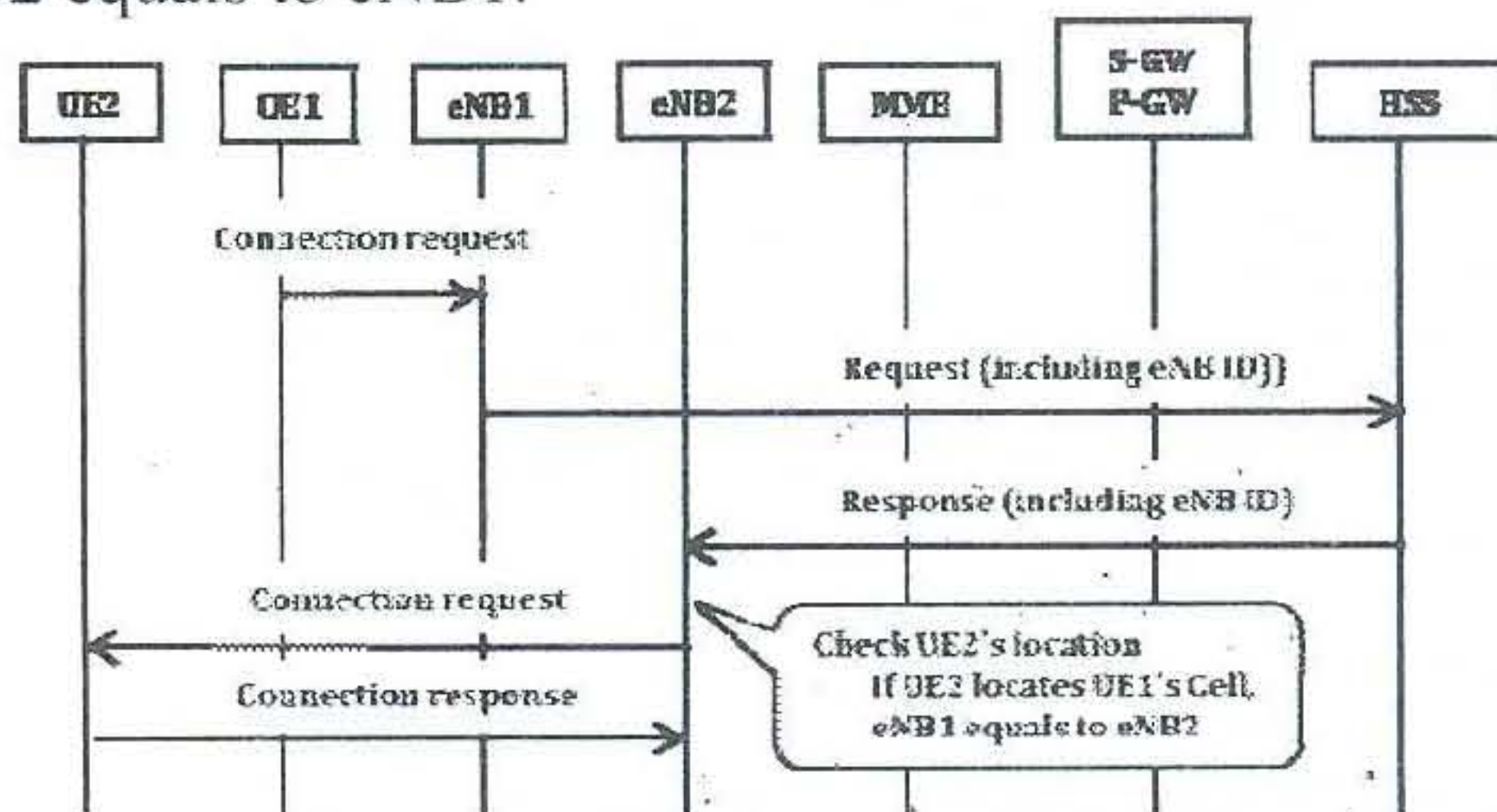


Figure 3. D2D receiver's eNB search procedure

If UE2 located same cell or adjacent cell, eNBs (or eNB) perform a D2D decision making procedure. Figure 4 shows D2D decision making procedure, in case UE2 is located in UE1's adjacent cell. In case UE2 is located in UE1's cell, communication between eNB1 and eNB2 doesn't exist. eNB2, has received connection response from UE2, sends a D2D connection request to eNB1. Communication between eNB1 and eNB2 uses X2 interface. After receiving response, eNBs send information request to UEs. Then UEs, have received information request, send information response to eNBs. And then eNB1 performs a decision making process. In order to make a decision at eNB1, eNB2 sends a UE2's information to eNB1. Through a decision making process, eNB1 knows which communication is better, D2D or cellular communications.

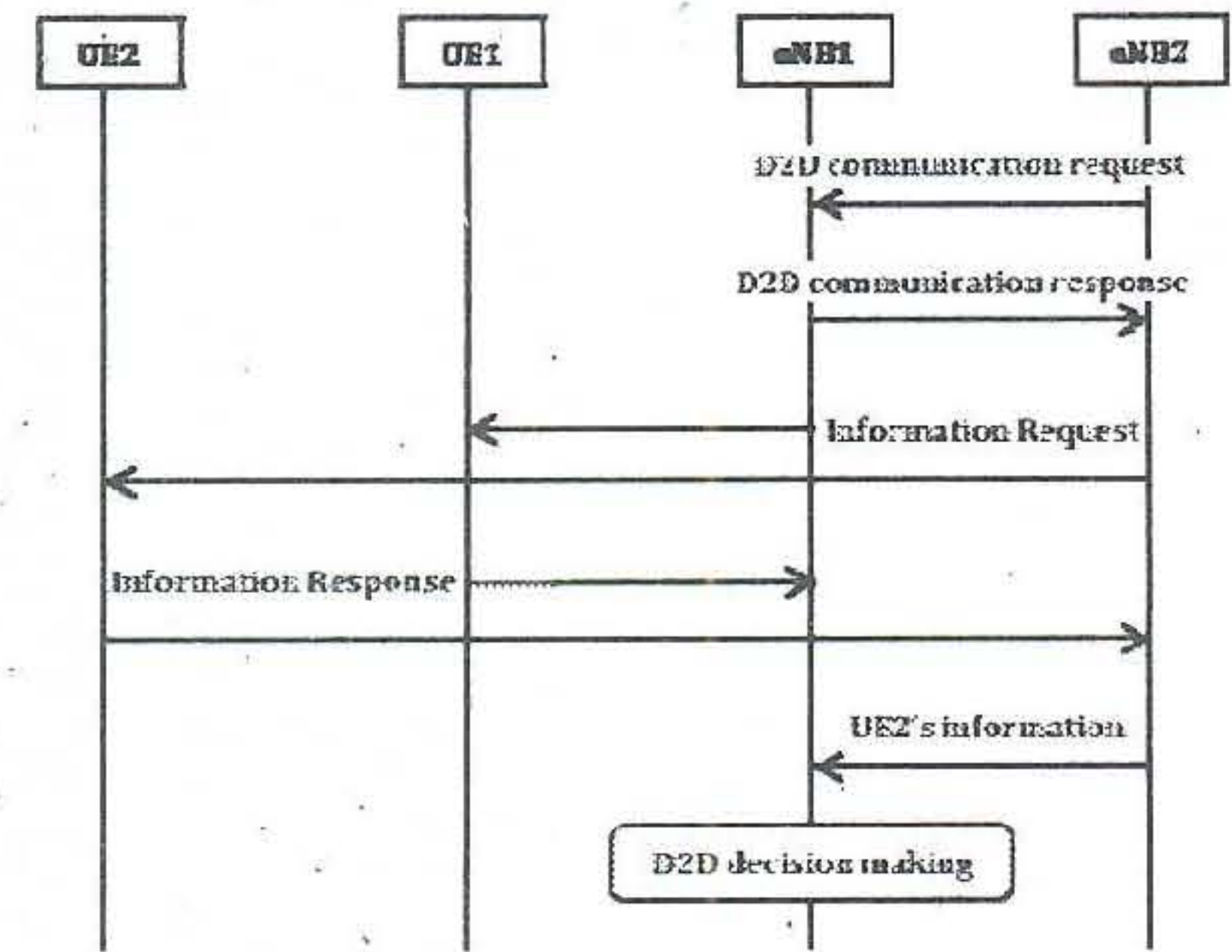


Figure 4. D2D decision making procedure, in case UE2 is located in UE1's adjacent cell

Connection between UE1 and UE2 is established through a D2D decision making procedure, After D2D connection, D2D link is managed by control signal.

#### IV. PERFORMANCE EVALUATION

We simulate average throughput of D2D communication in the LTE-Advanced networks. Figure 5 shows the result of simulation that compares D2D and cellular communications throughput. This result shows the D2D communication throughput is better than cellular communication throughput within the range of distance less than 70m.

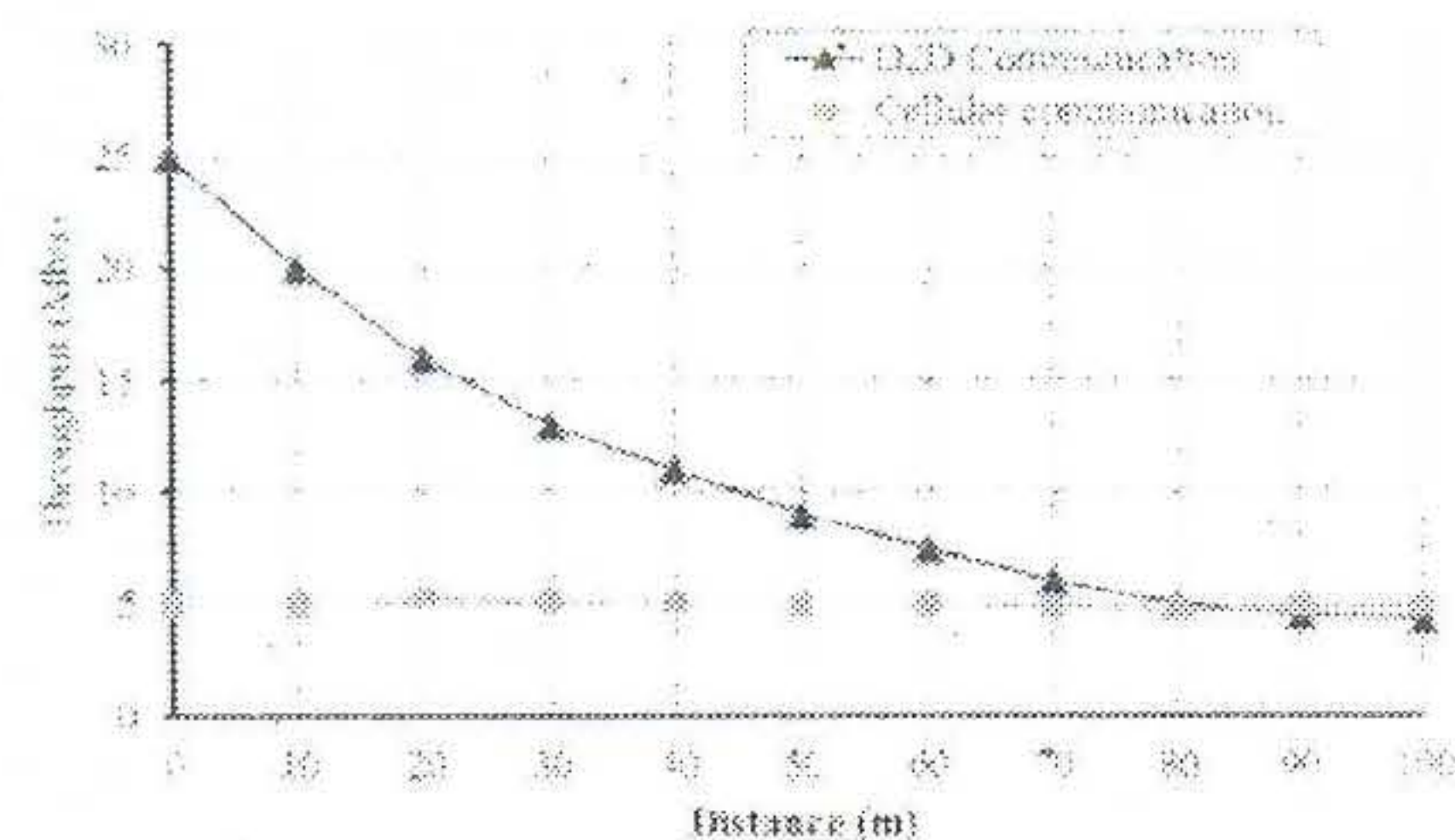


Figure 5. Average throughput of D2D and Cellular communications

#### V. CONCLUSION

In this paper, we described the concept of D2D communication in the LTE-Advanced networks and proposed a D2D communication initiation model using a decision making procedure. And we evaluated throughput of D2D and cellular communications. This evaluation indicated D2D communication throughput is better than cellular communication throughput for short distance.

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