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Vertical Handover Decision (VHD) Algorithm for Optimizing the Performance in Fourth Generation Heterogeneous Networks

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Abstract: *This paper presents a networks selection algorithm in fourth generation heterogeneous network. Radio network selection is the mechanism which makes a decision how to select the most suitable RAT based at the found accesses, QoS constraints, operator policies, consumer choices and available system capacity and usage. In such networks of heterogeneous nature, roaming users will revel in frequent handovers across network limitations and also the person who wants to request for offerings. Therefore, optimizing the selection procedure is a crucial issue of research to select the quality network, make sure seamless roaming and efficient useful resource usage over assorted networks, so wise algorithms want to be used considerably. This paper gives a vertical handover decision (VHD) scheme for optimizing the performance of vertical handover techniques within the Fourth generation (4G) heterogeneous wireless networks which increases the throughput, data rate for the users and decreases Handover Failure probability for the networks.*

Keyword: *Handoff; Vertical handoff; Heterogeneous wireless networks; Vertical handoff decision algorithm.*

1. INTRODUCTION

Recently the technology world became different and developed quickly so the next generation of the wireless telecommunication systems will involve the integration, diverse and complementary cellular and wireless technologies. These networks called heterogeneous networks (HetNet) [1]. Heterogeneous networks defined as a combination of large and small cells with different radio technologies (GSM, 3G, 4G, WiMAX) all working together to provide the best coverage and optimal capacity [2]. Heterogeneous networks pose many challenges in several areas. At the lowest levels, many new access technologies for example 3G, WiMAX and LTE will be supported on HetNet devices.

When there are many networks operating in a particular coverage area it will be difficult for users to select the suitable network to connect and how to authenticate with. So there is a need to have mechanisms for users to dedicate the suitable network to connect to.

"Handover" is defined as a capability for managing the mobility for a mobile terminal or a moving network in active state. Handovers are a core element in planning cellular networks. It allows users to generate data sessions or connect phone calls on the move. This method keeps the calls and data sessions connected even if a user moves from one cell site to another [3].

The important issue in handover is the need to decide when handover is necessary, and to which cell. In addition when the handoff occurs it is needed to redirect the call to the appropriate base station along with changing the communication between the mobile and the base station to a new channel. All of these need to be undertaken without any noticeable interruption to the call Handover in a heterogeneous network environment is different from that in a homogeneous wireless access system where it occurs only when a user moves from one base station to another. Handover within a homogeneous system is defined as horizontal handover, but handover between different access technologies is defined as vertical handover.

In 4G, there are a large range of heterogeneous networks. The users for diversity of applications would like to use heterogeneous networks on the based on their preferences such as real time, high availability and high bandwidth. When links have to switch in between heterogeneous networks for per-

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formance and high availability reasons, seamless vertical handover is needed.

The requirements are like ability of the network, network bandwidth, and network cost, network conditions, and power consumption and users preferences must be taken into consideration during vertical handoff [4, 5, 6].

The figure below shows the horizontal handover versus the vertical handover.

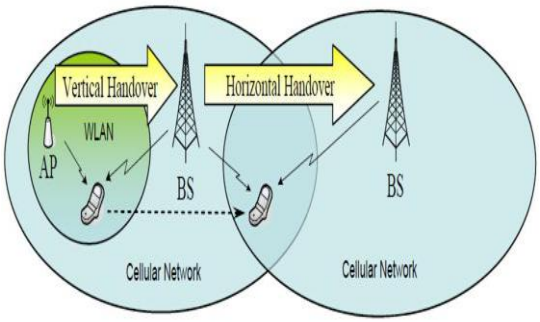

Figure 1 Vertical Handover & Horizontal Handover [6]

This paper proposes an algorithm for network selection in a heterogeneous network. The proposed algorithm has been implemented in Matlab and its performance has been evaluated by simulations. There are many algorithms for selecting in heterogeneous networks, most of them depend on one parameter like the type of service, bandwidth or received signal strength, but in this research, the proposed algorithm includes an extended set of selection parameters that refer to key performance indicators to improve the selection criteria and satisfy the user's needs.

2. SCENARIO OF PROPOSED ALGORITHM

Future wireless networks must be able to coordinate services within a diverse networks spot. One of the most challenging problems for coordination is how to select a suitable network. There are two cases for selection, when a user requests for a new service or when there is a handover request. In this paper the handover case is simulated (vertical handoff), which is the choice for a mobile station to handover between different types of networks. While the traditional handover is based on received signal strength which is not sufficient to make a vertical handover decision, as they do not take into account the various attachment options for the mobile user.

So vertical handover should evaluate additional factors, such as bandwidth availability, signal to noise ratio, offered services, network conditions, and user preferences. Therefore in this thesis a new algorithm is proposed for the execution of vertical handover decision algorithms, with the goal of maximizing the data rate and the throughput.

The RSS based VHD algorithm is used for handover between two networks LTE and WiMAX, by adding the bandwidth and signal to noise ratio for the algorithm to increase the throughput and data rate. The above scenario is simulated in Matlab to show how the algorithm works better when adding additional parameters to the main selection parameter (RSS).

Later we would show the result figures which we would show the differences between the proposed Algorithm and when using only RSS.

3. PROPOSED VHD ALGORITHM

There are many proposed algorithms for network selection in Heterogeneous Network, these algorithms don't guarantee the required QoS for all calls have limitations and don't provide a complete solution for network selection problems. So there is a need for an intelligent approach to select the radio access technology. The proposed solution is to create an enhanced algorithm for network discovery and selection in Heterogeneous Network according to a set of parameters. The algorithm will be evaluated through simulation results for a reference scenario including several radio access networks. The simulation results will show how the considered shall influence the network discovery and selection mechanism, increase the throughput and data rate.

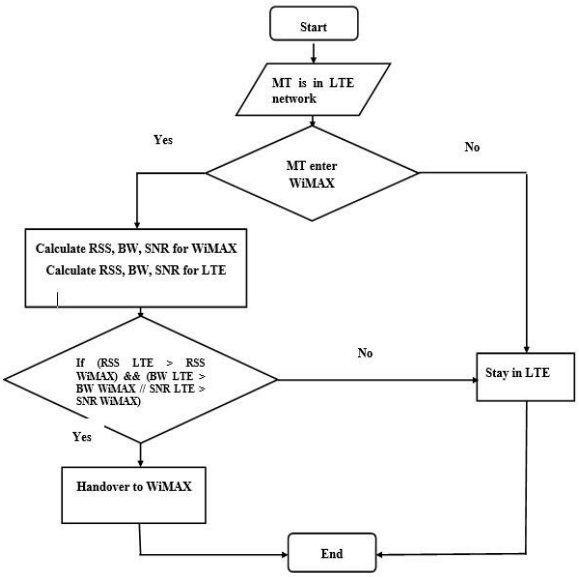

Figure 2 Flowchart of proposed VHD model

Consider that the MT moves between LTE and WiMAX. First the MT is tested, if it is in LTE or WiMAX network, if it is in the two networks at the same time, it compares the RSS for the two networks (LTE & WiMAX), then it measures the network performance for the two networks (bandwidth & SNR), the network with the best performance and higher RSS will be candidate.

If the LTE network is the candidate one, the MT will stay in it or either handoff to WiMAX network.

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The same procedures will consider if the MT is in WiMAX network. The flowchart in figure 2 shows this proposed VHD algorithm.

4. SIMULATION AND RESULTS

In this section, the results are obtained from the mathematical analysis which is presented in the previous sections using Matlab simulation. These results are obtained for different modulation schemes i.e. QPSK, 16-QAM and 64-QAM.

4.1 Environment and Parameters Assumptions

Table 1 gives a list of main simulation parameters used through the simulation performances. These parameters are widely used to simulate the wireless cellular networks.

TABLE 1 LIST OF MAIN SIMULATION PARAMETERS

Parameters	Values
LTE frequency	2.3 GHz
WiMAX frequency	2.5 GHz
LTE transmit power	33 dBm
WiMAX transmit power	26 dBm
LTE bandwidth range	3.5 -20 MHz
WiMAX bandwidth range	1.25 -10 MHz
Mobile station speed	10 m/s
LTE point	0
WiMAX point	600
Mobile station point	100

4.2 Simulation and Analysis

In this phase, the system performance has been compared between the two algorithms, when using only RSS and when adding the bandwidth and SNR to the selection criteria.

At the beginning, the MT will be in the LTE network and moving toward WiMAX which is a microcell inside LTE network. When the MS is in LTE network, it will remain in it until it reaches the boundary of WiMAX, firstly in the algorithm which is depending on RSS only, the mobile compares the RSS for the LTE and WiMAX networks and selects the network with the highest RSS but in the algorithm where additional parameters added to the RSS (bandwidth and SNR), it will give higher data rate and throughput as shown in the results.

All of the results in this phase are demonstrated against time because most of the wireless channel parameters have random values which are changed with time so if one value is chosen it will not give the right evaluation of the system that is why different values at different time are taken to measure the performance of the system.

Figure 3 illustrates the different RSS values for the LTE and WiMAX network switch the time. In the figure the LTE RSS decreases with time as the MT moves away from the antenna and the WiMAX RSS decreases in the boundary of the cell and increases when the MS is closer to the antenna of WiMAX BS.

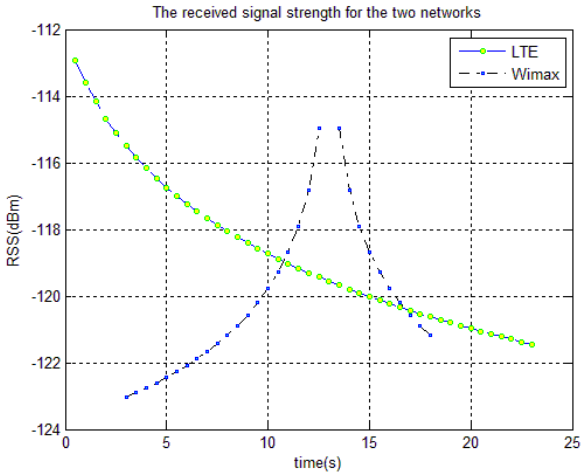

Figure 3 The received signal strength for the LTE and WiMAX networks

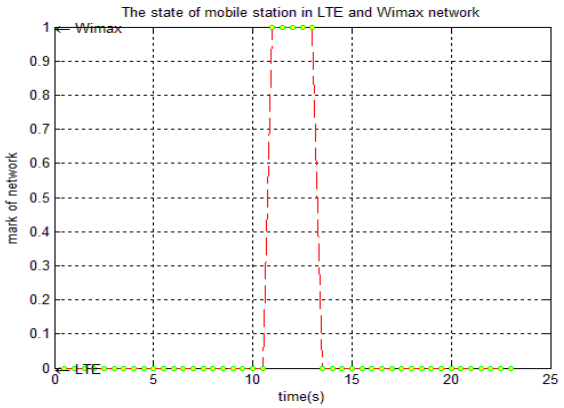

Figure 4 The state of the MS in the LTE and WiMax networks (Existing algorithm)

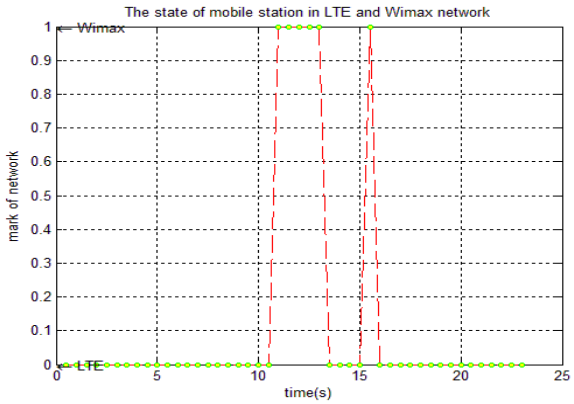

Figure 5 The state of the MT in LTE and WiMax networks (the proposed algorithm)

Figure 4 explains the handover scenario in terms of RSS only. As the figure explains MS will remain in the LTE network while it is in WiMAX network, it

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handover only when the RSS for WiMAX became greater than RSS for LTE. (Existing algorithm)

Figure 5 even though the RSS of the WiMax is higher, the handover didn't occur because of the bandwidth and SNR. Handover may only occurs with respect of SNR and highest bandwidth.

Figure 6 shows the handover failure probability which is very with the velocity, it has shown that over handover probability of existing algorithm is high all the time user starts moving.

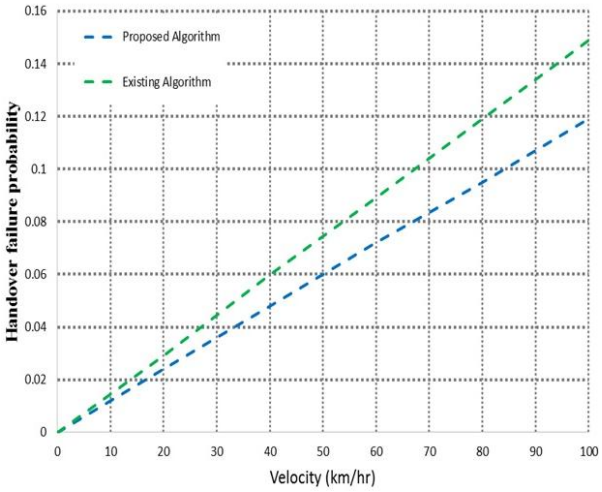


Figure 6 Handover Failure Probability

Figure 7 show the handover successful rate which has shown that proposing algorithm has better handover successful rate.

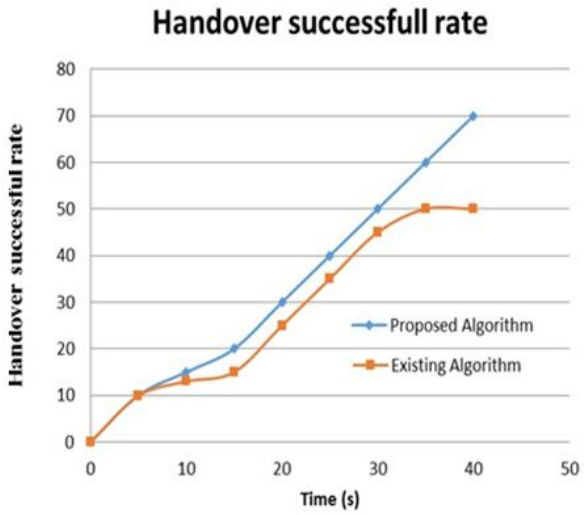


Figure 7 Handover Successful rate

In the figure 8: comparison has been made, which compares the signal to noise ratio of both existing and proposed algorithm and it clearly indicates that the proposing algorithm has better SNR in the time between 10-16 which is time that handover decision occurred.

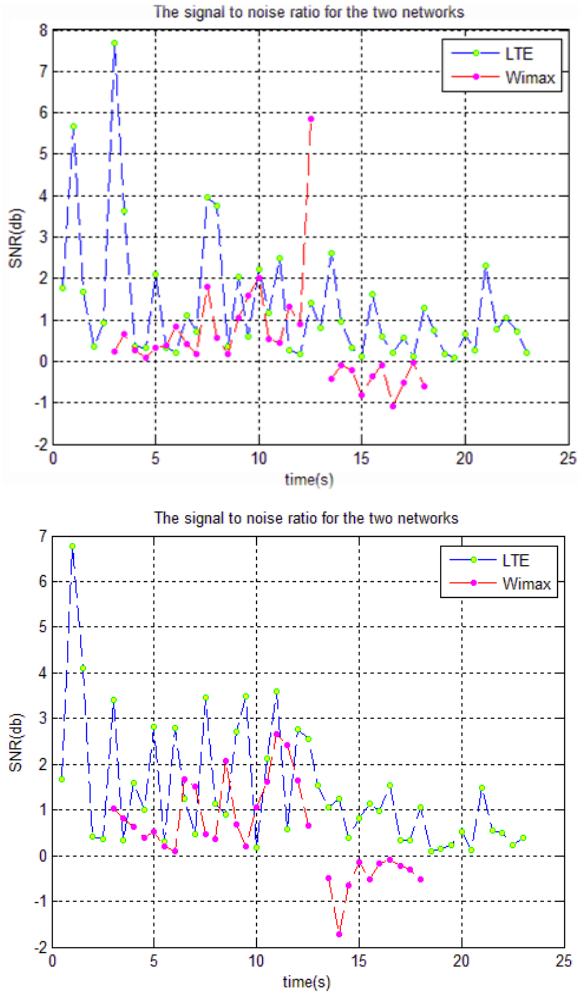
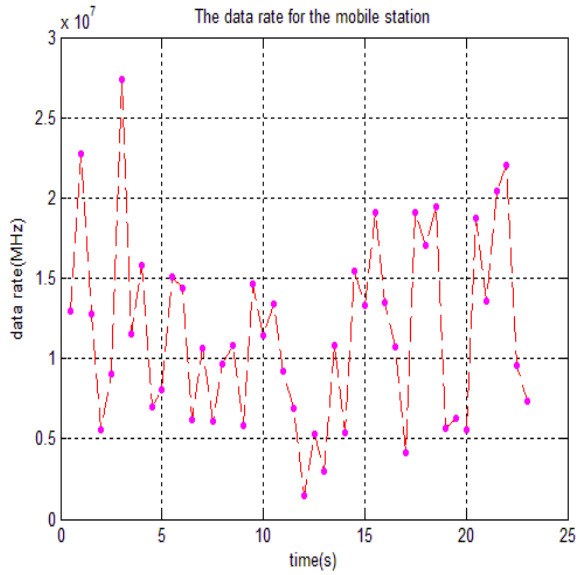


Figure 8 The differences in SNR of the two algorithms



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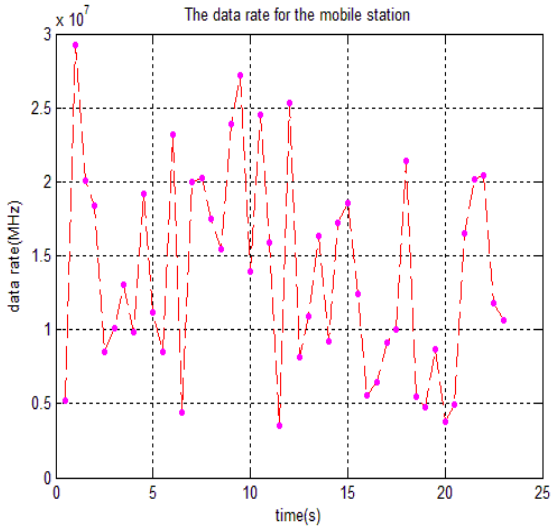
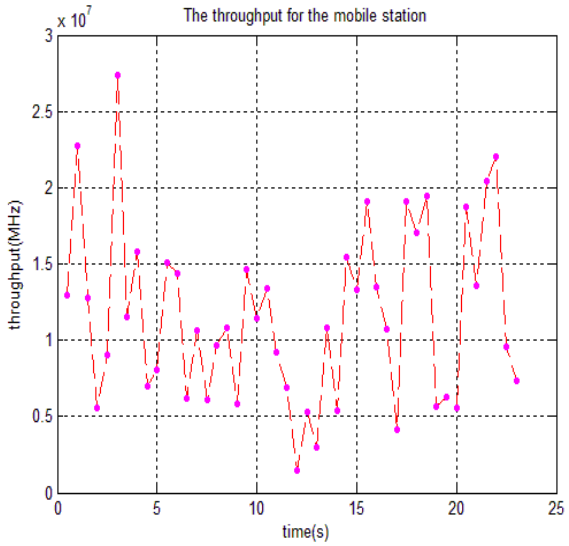


Figure 9 Data rate of the Existing vs. Proposed algorithm



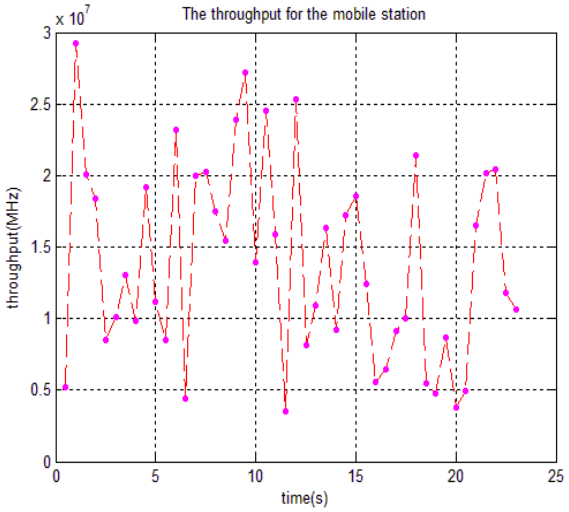
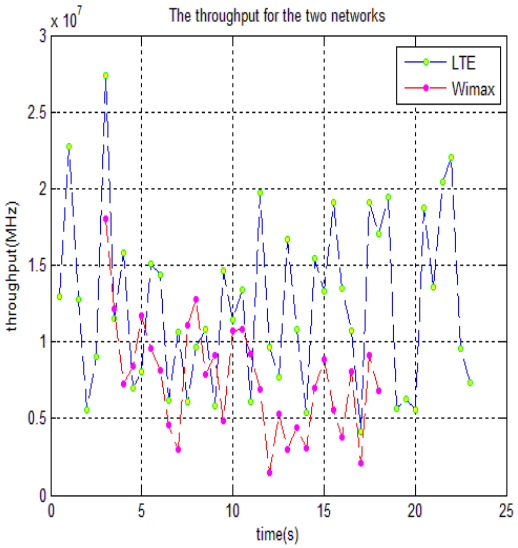


Figure 10 The throughput of MS existing vs. proposed algorithm



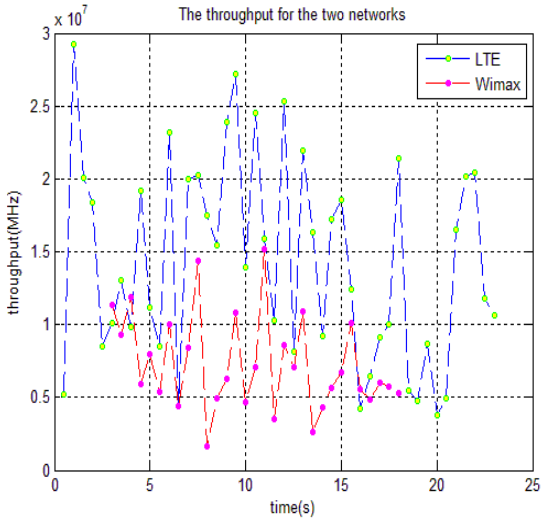


Figure 11 the throughput of the two networks existing vs. proposing algorithm

In the figures 9, shows that the data rate in the time between 10 - 16 s of the proposed algorithm has higher than the existing algorithm in same time. This time where the handover occurs in the two cases, so adding additional parameters to the RSS gains data rate with 160% higher than using only RSS which is existing algorithm.

In the figure 10.compares the throughput scenario of existing algorithm and proposed in the time between 10- 16 s which is the time that handover occurs in the two cases, and it is clear that the throughput of proposed algorithm higher when adding two parameters SNR and Bandwidth to the RSS in the scenario.

Figure 11 compares the throughput of the two networks using both algorithms existing algorithm and proposed algorithm which clearly indicates that time between 10-15 s throughputs is high when using proposed algorithm. This case it can clearly say that the proposing handover decision algorithm has more data

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rate then using RSS based handover decision algorithm, because in proposing algorithm has to look which network has better SNR and higher bandwidth the decision cannot be talking after evaluating single parameter but have to check these additional parameters which will cost the network to have better quality of service and to be optimized.

TABLE 2 FINDINGS OF EXISTING ALGORITHM

Parameter	Time (s)	LTE	WiMAX
Receive signal strength (RSS)	5-15 s	-114dB up to -120	-125dB up to -112 dB
Signal to noise ratio	5-15 s	2 dB up to 1.5 dB	0 dB up to 2 dB
Bandwidth	5-15 s	1.2 MHz up to 600KHz	800KHz up to 1MHz
Data rate	5-15 s	2 Mbps up to 1 Mbps	1Mbps up to 800 Kbps
Throughput	5-15 s	2 Mbps up to 1.5 Mbps	
Handover success rate of existing algorithm	5-15 s	56%	

TABLE 3 FINDINGS OF PROPOSING ALGORITHM

Parameter	Time (s)	LTE	WiMAX
Receive signal strength (RSS)	5-15 s	-114dB up to -120	-125dB up to -112 dB
Signal to noise ratio	5-15 s	3dB up to 5 dB	2 dB up to 2.75 dB
Bandwidth	5-15 s	8 MHz up to 10MHz	5MHz up to 6MHz
Data rate	5-15 s	7 Mbps up to 3 Mbps	4Mbps up to 3Mbps
Throughput	5-15 s	5 Mbps up to 3Mbps	3Mbps up to 2Mbps
Handover success rate of existing algorithm	5-15 s	75%	

4.3 Findings

After optimizing the performance of the network, big difference found, which has seen the tables below; the proposing algorithms is much better for performance and have good quality of service. The tables (table 2and table 3) below summarize overall finding analysis in existing algorithm;

5. CONCLUSION

Seamless vertical handover between different access networks in the 4G heterogeneous wireless networks remains a challenging problem. In order to provide QoS inside the integrated network environment, the vertical handover algorithm needs to be QoS aware, which cannot be achieved by RSS based handover criteria. The new vertical handover algorithm has been proposed in this thesis using bandwidth and SNR with RSS from WiMAX and LTE networks as the handover criteria. Here we considered two 4G networks (LTE and WiMAX) and perform a handover between them using Matlab. We compare between two types of algorithms for handover, the first one depends on RSS only and the second one depends on additional parameters with RSS (bandwidth and SNR). The MS will be in LTE moving toward WiMAX. When it arrives the boundary of WiMAX, the algorithms are worked because the MS detects two networks and it will try to select one of them according to the parameters. Analysis results show that the performance of the second handover algorithm is able to consistently offer the end user with maximum available throughput during vertical handover. Simulation results also confirm that the new algorithm provides higher overall system throughput and data rate comparing with the RSS based vertical handover algorithm.

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