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A Robust Handoff Approach for 4G Cellular Networks using MATLAB

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***Abstract*-In Wireless Mobile Cellular Networks, users usually move between heterogeneous networks. In this type of environment, handoff procedure algorithm, handoff decision and its management is very important issue. Wireless Mobile Cellular Network supports the handoff process for users between various wireless technologies such as WLAN, CDMA and modern 3G networks. Heterogeneous networks are integrated in 4G wireless. To have seamless communication and mobility between these heterogeneous wireless access networks, support of vertical handoff (EVH) is required. Vertical handover is the convergence of heterogeneous networks for e.g.:- handover process between wireless cellular networks and WLAN. In this paper one of the handoff algorithms is discussed for different path loss models. Actually, the requirement to initiate handoff arises when the Received Signal Strength of the current base station falls below the threshold value. It adaptively controls the handoff according to the requirements of cells [13] and [14]. In this paper a simple and robust EVH algorithm for handoff procedure is discussed. The algorithm considers the parameters for all the networks under evaluation and then decides about the handoff by comparing the minimum threshold parameters with the values of current network as well as next all possible networks. This algorithm supports better service quality for all kind of networks with almost zero Call Blocking Probability.**

***Index Terms* -Cellular Network, Heterogeneous Network, Handoff, BS (Base Station), Received Signal Strength, Network Capacity, CDMA Networks and Call Blocking Probability.**

I. INTRODUCTION

In a cellular communication system, mobiles move in the service area and require communication services in the form of a wireless connection. In this system, total area is divided into smaller parts called cells to allow frequency reuse concept to increase the number of users in the network (Network Capacity). Large capacity with good service quality and minimum noise is always advantageous and also desirable.

[1] Frequencies used in one wireless service cell of the cluster can be reused in other distant cells. Every cell is controlled by its own transmitter and receiver to serve the mobile customers within its range. Calls can be handed off from one cell to another cell to maintain good quality phone service as the mobile moves between cells. A group of mobile customers having mobiles with a large range of mobility can access around in the overall network generating heavy flow of mobile traffic [11] and [12]. When the traffic load is concentrated in a cell, this cell becomes the hotspot cell. Therefore, the need arises for a proper traffic driven handoff management scheme [2]-[4]; so that mobile users will automatically move from congested cell to allow the network to balance itself dynamically in this situation.

II. HETEROGENEOUS NETWORK

These Heterogeneous Networks [4], [12] and [17] are the network used to connect computers and other devices with different operating systems and/or protocols. Example: A LAN connecting Microsoft Windows and Linux based PCs with Apple Macintosh Computers forms a heterogeneous network.

It also incorporates different technologies. Example: A wireless network which provides a service through a wireless LAN. This is able to provide and continue the service, when switching to a mobile network. This N/W is called, "**Heterogeneous Network**".

III. HANDOFF

In a wireless mobile cellular network handoff is the transition for any given user of signal transmission from one BS to an adjacent BS as the mobile user moves around [1]. In ideal cellular telephone network, each end user's mobile or modem (hardware of the subscriber) is always within the range of a BS. The area covered by each BS is called "Cell" [1]. The size and shape of cell depends upon the nature of the terrain. The cells in the network can overlap. For some time the hardware of subscriber may be in the range of two cells. The network decides which BS to handle the signal from the subscriber. Each time a mobile passes from one cell to another, the network automatically switches the responsibility of coverage from one BS to other. It is called, "**Hand OFF**" [8].

IV. PURPOSE

- To provide reliable wireless connectivity during the movement of mobiles between two cells.
- In non CDMA communication networks when the channel used by the mobile customer becomes interfered by other mobile user using the same channel in some other cell, the call is transferred to a different channel in the same cell or to a different channel in another cell in order to avoid the interference [1] [16] .
- Again in non CDMA networks, when the behavior of user changes. Example: Traffic based, when a fast traveling user connected to a large umbrella cell stops, then the call may be transferred to a smaller macro cell or even to a microcell in order to free capacity on the umbrella cell for other fast travelling users. Additional purpose of handoff is also to decrease the possible interference with other cells or users. This works in reverse also [1][15] and [16].
- When the capacity of connecting new calls for the given cell is used up. An ongoing call located in an area overlapped by some other cell is transferred to that cell to free some capacities [4].
- In CDMA networks a soft handoff may be induced in order to reduce the interference to a smaller neighboring cell due to the "**Near Far Effect**", even when the mobile customer still has an excellent connection in its current cell [1].
- When a user is detected moving faster than a particular threshold, the cellular call can be transferred to a larger umbrella cell in order to reduce the frequency of the handovers due to the movement [1].

V. HARD HANDOFF

Hard Handoff [6], [9] and [10] is the process in which the channel in the current cell is released and only then the channel in the new cell is engaged. Thus the connection to the current cell is broken before the connection to the new cell is made. That's why these handovers are called as, "**Break before Make**". Hard handovers are intended to be instantaneous in order to minimize the disruption to the call / to reduce the possibility of ending of call / Call Blocking Probability. A hard handover is perceived by communication network engineers as an event during the call.

VI. SOFT HANDOFF

Soft Handoff [6], [9] and [10] is the process in which the channel of current cell is retained. It is used for some time in parallel with the channel in the new target cell. In this case the connection to the new target cell is established before the connection to the source cell (previous) is broken. So, this type of handoff is also called, "**Make before Break**". This time duration, during which both two channels are used in parallel, will be very brief. Due to this reason the soft handover is perceived by the communication network engineers as a state of call, rather than a brief event. Soft handover involves use of channels / connections of more than two cells. Example: Three, four or more cells can be maintained by one phone at the same time. When the call is in the state of soft handoffs, the signal of the best of all used channels can be used for the call at a given instant of time or all the signals can be combined to generate a clear copy of the signal.

The later is better choice. When such combinations are used, both in the down link and up link, the handover process is known as "Softer". Softer calls can be possible only when the cells involved in the handovers have a single cell site [15] and [16].

VII. HANDOFF IMPLEMENTATION

For realization of handoffs in a wireless cellular network practically, each cell is assigned with a list of potential new target cells. These cells can be used to hand over calls from the original source cells to them. These assigned target potential cells are called as "Neighbors" and the list is called"**Neighbor List**". Creation of these lists requires special computer tools. They are used to implement different algorithms. They may use input data obtained from field measurements or computer predictions of radio wave propagation in the regions covered by the cells [1], [8].

During a mobile call one or more parameters of the signal in the channel in the original source cell are monitored and assessed in order to decide when a handover is required. The handover may be requested by the user mobile or BTS of the current source cell. In some systems handover may be requested by the BTS of the neighbouring cell. The mobile user and the BTSs of the neighbouring cells monitor signals of each other. The best candidates are selected among the neighbouring cells. In CDMA, a target candidate may be selected among the cells which are not in the list of neighbour. This is done to reduce the probability of interference due to near far effect [15] [17] and [18].

VIII. MEASUREMENT AND PROCEDURE FOR A SIMPLE AND ROBUST VH ALGORITHM

Procedure of Handoff can be divided into three phases: measurement, decision and execution as illustrated in Figure 1. In the handoff measurement phase, the required information needed to make the handoff is calculated/ measured. Typical downlink measurements performed by the mobile are the E_c/ I_0 of the Common Pilot Channel (CPICH) of its current serving cell and surrounding cells. For certain types of handoff, other measurements are also required. In the decision phase of the handoff process, the calculated/ measured results are compared against the defined thresholds levels and then it is decided whether to start the handoff process or not. All handoff algorithms have different triggering requirements/ conditions. In the execution phase, the handoff process is done and the relative parameters are changed according to the different types of this handoff process. As an example, in the execution phase of the CDMA handoff, the mobile enters or leaves the soft handoff state, a new BS is added or released, and the active set is updated [15], [16], [17] and [18].

[5], [12]. An adaptive RSS threshold is recommended to use so that the mobile user has enough time to initiate the handoff process. Therefore, the threshold value to initiate handoff should be carefully selected in order not to degrade QoS of other users. In this algorithm handoff time is controlled. It is called adaptive RSS threshold (Thresmin).Thresmin value avoids too early or too late initiation of the handoff process. Handover is completed before the mobile user moves out of the coverage area of the serving network of the cell.

In this simple and robust EVH algorithm the same procedure is followed. The discussed algorithm considers the parameters for all the networks under evaluation such as: Current Available Bandwidth, Received Signal Strength, Estimated Time MS will be in present network, Power Dissipation in Network, Mean number of request arrivals per unit time, Mean number of calls serviced per unit time, Power Consumption and Network Conditions etc. then decides about the handoff by comparing the minimum threshold parameters such as Threshold Current Available Bandwidth, Threshold Received Signal Strength and Threshold Estimated Time MS will be in present network etc. with the values of current network as well as next all possible networks with almost zero Call Blocking Probability.

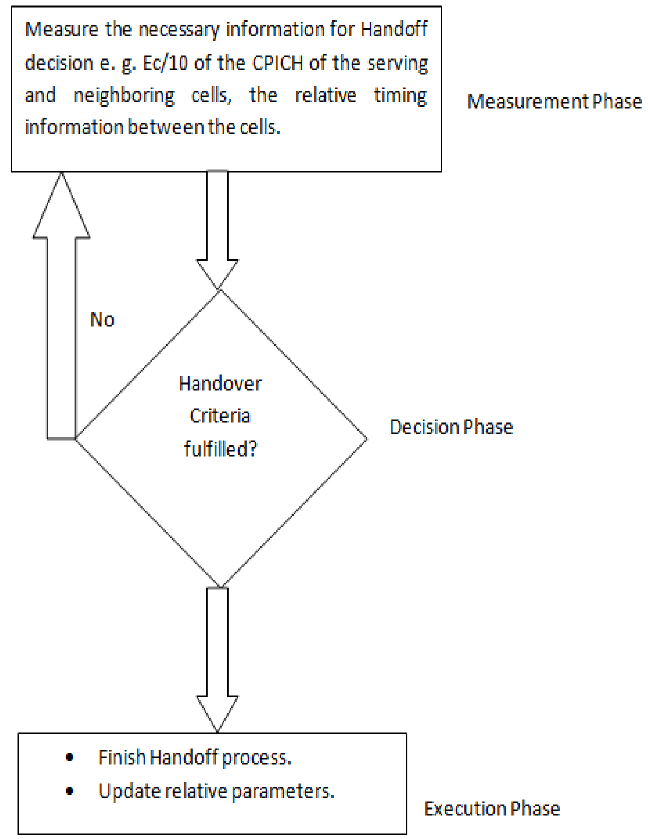

Figure 1. Handoff Procedure

IX. SIMULATION RESULTS

The simulations are performed in MATLAB, the assumptions made are:

(i) Wireless Radio model:Hata Okumura path loss model, Normal shadowing log spiral model and Free space path loss models etc.
(ii) Radius of cell: 1 km
(iii) Carrier Frequency 500 MHz to 1000 MHz
(iv) Antenna Heights 30m to 200 m.
(v) Mobile Station Height 1 m to 10m.
(vi) Distance between BS and MS 1km to 20 km.

Simulation is done for the following parameters in two example cases:

PARAMETERS USED & RESULT FOR CASE 1:

PARAMETERS:

The number of networks under evaluation N: = 2

Now enter the threshold values of all parameters when prompted:

Threshold Current Available Bandwidth: 30

Threshold Received Signal Strength: 40

Threshold Probable Time MS will be in present network: 10

Enter the values for the N/W 1 when prompted:

Enter the parameter values in currently connected network:

Current Available Bandwidth: 40

Received Signal Strength: 50

Probable Time MS will be in present network: 15

Power Dissipation in Network: 45

Mean number of service request arrivals in unit time: 15

Mean number of mobile calls serviced per unit time: 13

Enter the N/W Dependent Weights to the following:

Power Consumption: 10

Network Conditions: 15

Enter the values for the N/W 2 when prompted:

Current Available Bandwidth: 20

Received Signal Strength: 30

Probable Time MS will be in present network: 7

Power Dissipation in Network: 35

Mean number of service request arrivals in unit time: 30

Mean number of mobile calls serviced per unit time: 19

Enter the N/W Dependent Weights to the following:

Power Consumption: 10

Network Conditions: 15

RESULT:

No other network is having minimum service quality better than threshold. Stay in same network i.e. No handoff for these two networks under evaluation with above parameters. MATLAB result is shown in Figure 2.

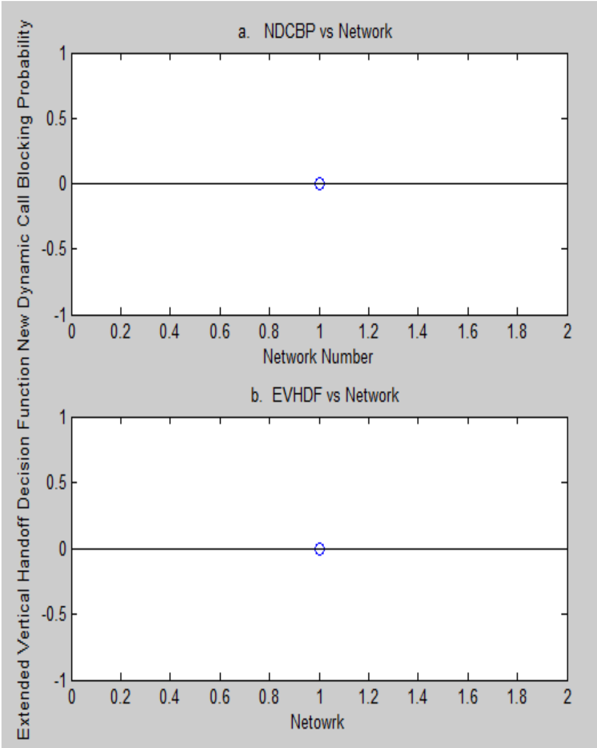

Figure 2. MATLAB result for case 1: The

graphs for New Dynamic Call Blocking Probability and Vertical Handoff Decision Function Vs Network.

PARAMETERS USED & RESULT FOR CASE 2:

PARAMETERS:

The number of networks under evaluation N: = 2

Enter the threshold values of all parameters when prompted:

Threshold Current Available Bandwidth: 30

Threshold Received Signal Strength: 40

Threshold Probable Time MS will be in present network: 10

Enter the values for the N/W 1 when prompted.

Enter the parameter values in the currently connected network:

Current Available Bandwidth: 22

Received Signal Strength: 25

Probable Time MS will be in present network: 15

Power Dissipation in Network: 15

Mean number of service request arrivals in unit time: 20

Mean number of mobile calls serviced per unit time: 15

Enter the N/W Dependent Weights to the following:

Power Consumption: 20

Network Conditions: 15

Enter the values for the network number 2 when prompted:

Current Available Bandwidth: 42

Received Signal Strength: 45

Probable Time MS will be in present network: 14

Power Dissipation in Network: 12

Mean number of service request arrivals in unit time: 20

Mean number of calls serviced per unit time: 18

Enter the N/W Dependent Weights to the following:

Power Consumption: 18

Network Conditions: 15

RESULT:

Handoff to new network with Network ID 2 i.e. Handoff is required and now the mobile should move to network 2 for these two networks under evaluation with above parameters. MATLAB result is shown in Figure 3.

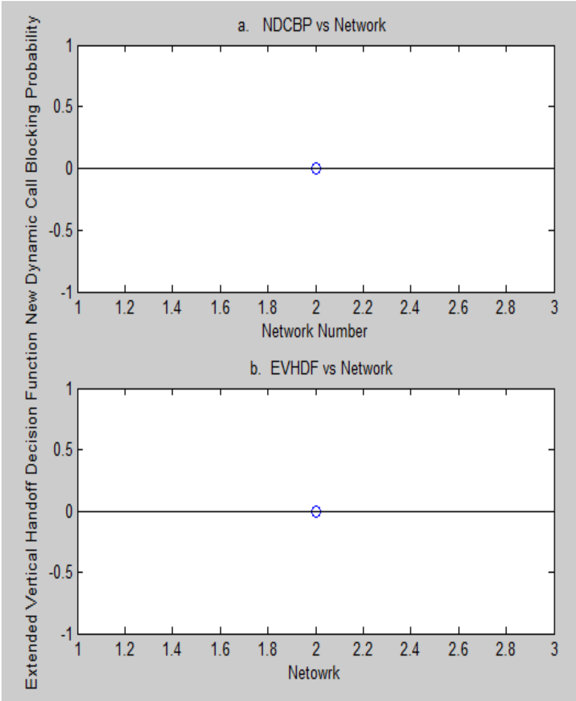

Figure 3. MATLAB result for case 2: The graphs for New Dynamic Call Blocking

Probability and Vertical Handoff Decision Function Vs Network.

CONCLUSION

A vertical handoff management algorithm scheme is presented in this paper for heterogeneous wireless cellular networks. The Dynamic Call Blocking Probability and Vertical Handoff Decision Function have been studied for all networks under evaluation with the decided parameters of algorithm have been simulated in the MATLAB. During simulation this algorithm evaluates all the networks with all possible handoff steps with the decided parameters and takes the decision regarding handoff based on the values of network available for the particular network. Here we simulated the results for Call Blocking Probability and Handoff Decision Function, results show that in case 2, handoff will occur in network 2 and handoff is not required for case 1. In case 2, handoff occurs in network ID 2 with zero call blocking probability. The algorithms is good for cases of handoff between WLAN and advanced and fast networks such as 3G as it decides handoff with zero call blocking probability and evaluates the network for a large number of parameters before making handoff decision so this algorithm also avoids the unnecessary handoffs. In future this algorithm can be compared with other algorithms with decides for handoff adaptively by considering other parameters such traffic load, RSS, hysteresis and fading conditions etc.

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