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Efficient Power Saving during Handovers in Heterogeneous Network Scenario

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Abstract

The Next Generation of wireless networks will provide ubiquitous computing by the seamless operation of heterogeneous wireless networks. It will integrate the current co-existing wireless networks to allow the users to connect to the network that best suits their needs. The next generation wireless networks are characterized by anywhere, anytime connectivity, enhanced data services and higher data rates to end-users. This infrastructure will also support efficient handovers. Heterogeneous networks aim to achieve this. To facilitate new services, and make them flexible and bandwidth efficient, vertical roaming of mobile nodes is a tempting possibility for operators. Our project deals with reduction of power consumption during handovers. If the user call is based on previous history, the handover takes place without calculations and we have achieved a power saving of 28.38%. Also our proposed algorithm tries to select an appropriate target network for handover which will support the battery power of MN with its ongoing application if the call is not regular.

Keywords: DSDV, heterogeneous networks, vertical handoff (VHO), VHDF, U.F.

Introduction

Heterogeneous wireless networks include coexistence of current wireless technologies such as 2G/3G cellular, satellite, Bluetooth, LTE, 802.11, 802.16, and 802.20. This environment raises a new challenge for the study of radio resource management.

Early mobile phones were limited to voice calls and SMS and packet based applications such as email. The higher data bandwidths support many more applications including video calls, audio streaming, and video streaming. The bottleneck to take care of in the design process of mobile systems is not only the wireless data rate, but even more the energy/power limitation as the customers ask for new energy-hungry services, e.g., requiring faster connections or even multiple air interfaces, and longer standby or operational times.

Excessive energy consumption is limiting the evolution of smart phones as the improvement of battery capacity is quite moderate compared to the increase of the complexity due to new hardware and services.

Problem Formulation

Problem Definition

Our project deals with reduction of power consumption during handover, Also it tries to select an appropriate target network for handover which will support the battery power of mobile node with its ongoing application.

Motivation for Work

Since heterogeneous network is integration of various networks Vertical handover to a high power consuming network is not desirable if the mobile terminals battery is nearly exhausted or the batteries life time is relatively short.

Excessive energy/power consumption is limiting the evolution of smart phones as the improvement of battery capacity is quite moderate compared to the increase of the complexity due to new hardware and services.

Network Scenario

Network Scenario

In generated network scenario VHO is needed for the ongoing of mobile communication when mobile node (MN) moves from one network to another network.

Project Diagram

The MN is assumed to be in home network i.e., GSM network and on a voice call also the user is moving in the direction as shown in the Fig 1.

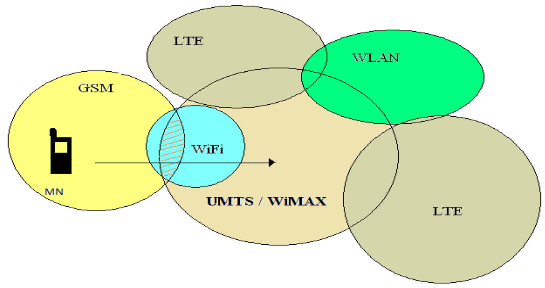

Fig. 1 Mobile Node moving through the Overlaying Heterogeneous network scenario.

The networks available in the direction of move of user are WiFi whose coverage is 10 m long also the WiMAX and UMTS network are overlapping WiFi having coverage area of 10 Km., further LTE network covers the area of 50 Km.

When the user makes a call MN checks the history of the call and if it discovers that the call is regular then handover takes place to the network based on previous history without calculations if network is available

But if the calls direction is not in the history of MN than the MN starts scanning the available networks and handover is done to the appropriate target network which also supports the mobile battery with its ongoing application.

This Vertical Handover considers power consumption as one of the main parameters for doing Handover.

Algorithm Designed

Parameters used for designing of Algorithm

The following aspects are considered important in relation to network discovery and selection

User Preferences: When the handover is needed, users have more options for heterogeneous networks according to their preferences and network performance parameters. The user preferences include user application requirements (real time, non-real time), service types (voice, data, video), Quality of service (technology to manage network traffic in cost effective manner

Cost of service (C): Cost of different services to user can be the major decisive factor in choice of network

Power Consumption (P): Vertical handover to a high power consuming network is not desirable if the mobile terminals battery is nearly exhausted or the batteries life time is relatively short.

Network Conditions (B): Available Bandwidth is used to indicate network conditions especially for voice and video traffic.

Calculations for selection of target network.

Calculations for following parameters are taken as input as well as MN previous history records are also taken as input. The calculation parameters are:

- Bandwidth.
- Cost.
- Power consumption of network.

The Utility Factor calculations are [7]:

$$U = X\left((B * WB) + \left(\frac{1}{C} * WC\right) + \left(\frac{1}{P} * WP\right)\right) \quad (1)$$

Where

$$X = SA * HLs \quad (2)$$

$$\theta = WB + WC + WP = 1 \quad (3)$$

Also

X- Exclusion factor.
SA – Service Available.
HLs – High Load signal.
B – Bandwidth available at network.
C – Cost of service.
P – Power consumed at network.

In above utility factor calculation Wb,Wc,Wp are the weights assigned by user to bandwidth, cost, and power consumption respectively. The utility factor takes into account the bandwidth, cost of service, and power consumption of network. User preferences are also involved in the utility function by allowing them to assign weights to these parameters. The sum of weights will always be equal to one. Through an interface on the MS, the user can assign weights according to his/her requirements. For ex., for non real time data a user may prefer cost over bandwidth, but for smooth running of real time data, he may prefer bandwidth over cost.

The utility function also includes exclusion factor(X) i.e., if the MS receives high load signal from a network, the value of HLs will be set to zero. As a result, the utility of that network will become zero. This indicates the network is congested and does not provide the resources required by the application.

Thus exclusion factor is used to exclude a network from the set of candidate networks. All the networks are evaluated and a set of candidate networks is made. Among the candidate networks, the network with highest value of utility function is selected for handover.

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Flowchart

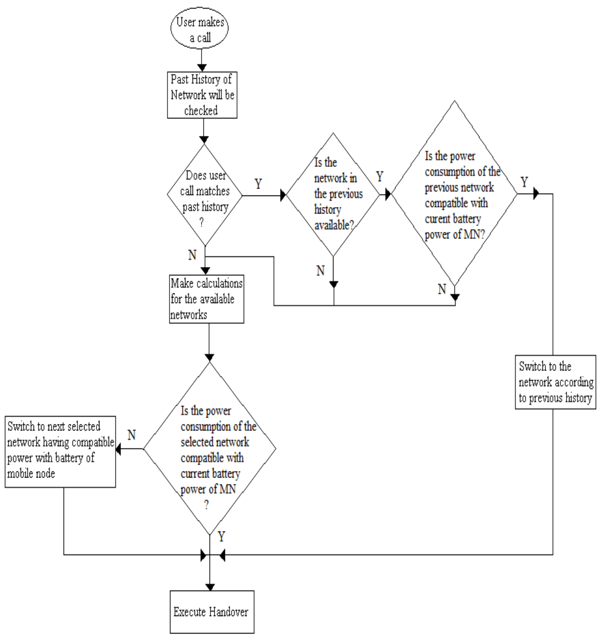

Fig. 2 Flowchart for optimisation of vertical handover

Implementation of this algorithm is simulated using NS2.

Simulation of Designed Work

Simulation Setup

Fig. 3 demonstrates the experimental setup for evaluating the performance of power consumed during vertical handovers. It consists of MN equipped with interfaces of various wireless networks. WiFi, WiMAX,UMTS are assumed to offer overlapping .UMTS offers uninterrupted

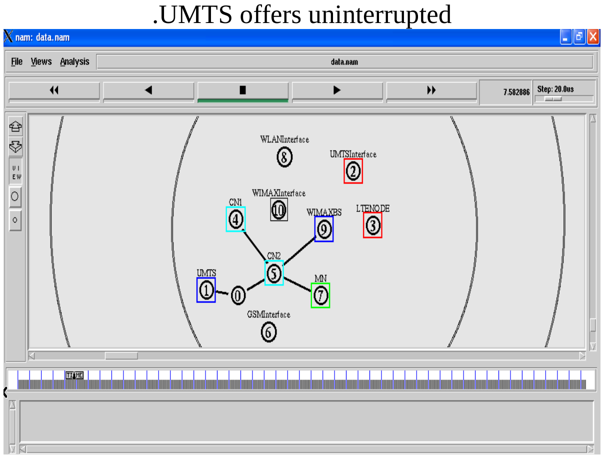

Fig 3 Simulation setup.

uniform coverage .The MN moves out of the GSM coverage while simultaneously carrying out the transfer of different types of traffic streams, thus exposing itself to vertical handovers.

Network Model.

The network model was chosen so as to simulate roaming between heterogeneous networks. Figure 3 illustrates the network area used for the movement of MNs. GSM, WiFi(WLAN), WiMAX, UMTS, LTE are configured where each network has shown having a interface and a node.

For WLAN the frequency of operation is assumed to be in between 200-900 MHz, and bandwidth of 11.6Kbps with an area of coverage of 50 m^2.

For WiFi the frequency of operation is assumed to be in between 1800-1900 MHz, and bandwidth of 4.8Kbps with an area of coverage of 50 m^2.

For GSM the frequency of operation is assumed to be in between 933-960 MHz, and bandwidth of 29Kbps with an area of coverage of 100 m^2.

For UMTS the frequency of operation is assumed to be 2 GHz, and bandwidth of 3Mbps with an area of coverage of 5000 m^2.

For WiMAX the frequency of operation is assumed to be 2.3 GHz, and bandwidth of 16.5Mbps with an area of coverage of 1000 m^2.

For LTE the frequency of operation is assumed to be 1.8 GHz, and bandwidth of 3Mbps with an area of coverage of 500 m^2.

Processing of Handover

1. When the call is based on previous history.

When the call is regular the handover takes place without handover and the power saving achieved is 232.08mW

2. If call is not regular

MN checks for the history of the call and handover takes place to a network either based on history or to the target network which supports the mobile battery with its ongoing application. As here MAHO is used, MN in its process of scanning has the available networks.

Finally, after selecting a network with maximum returns the MN requests the selected network for handover. Basically soft handover is used. Before moving to handover, the MN checks the mobile battery power for the ongoing application. If the battery power is not sufficient it moves to the next network for handover. This process of verifying the mobile battery power and proceeding to the other network increases the chances of the confirmed continuation of the call.

Processing time required for simulation is 1.34ms.

Evaluation and Results

Evaluating the Parameters

For evaluating the UF parameters used are given weight factors by the user

Case Study

Here we have considered two applications: Audio, Video. In this section we will see UF calculations for network selection for these applications.

In this case study our system scenario consists of MN which is currently connected to GSM and it is moving towards an area where multiple networks are present These are WiFi (WLAN), WiMAX,UMTS, LTE.

Evaluation when the call is regular using data[1][2] power saving achieved by our algorithm is 28.34% of the actual power consumed by processor.

Table II

UF Calculations For Audio Call [1], [18] - [20],[24] - [27].

Sr.No.	Network	UF	Mobile Battery power consumed(mW) for 1 minute audio call
1	WiFi	12.782	1525mW
2	WiMAX	4.117	253.18mW
3	UMTS	1.7082	249.3mW
4	LTE	2.022	13720mW
5	GSM	Network not available further	________

Handover is done to WiMAX network.

Table III

UF calculations for video call[1], [18] - [20], [24] - [27].

Sr.No.	Network	UF	Mobile Battery power consumed (mW) for 1 minute audio call
1	WiFi	8.5735	1525mW
2	WiMAX	16.0625	2177.5mW
3	UMTS	Network not available	______
4	LTE	10.035	13720mW
5	GSM	Network does not support Video	________

Handover is done to WiMAX network.

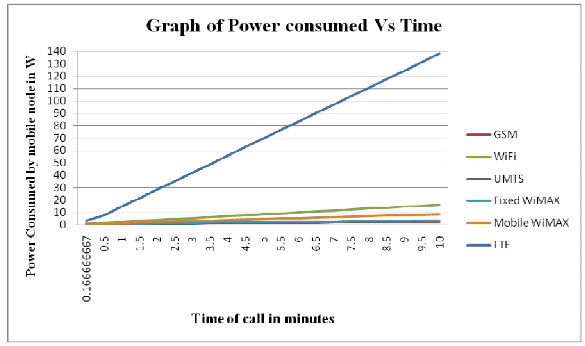

Fig 4. Graph of Power consumed Vs Time.

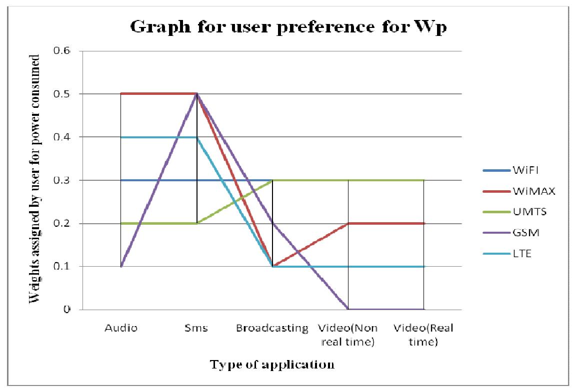

Fig 5. Graph of user preference for Wp.

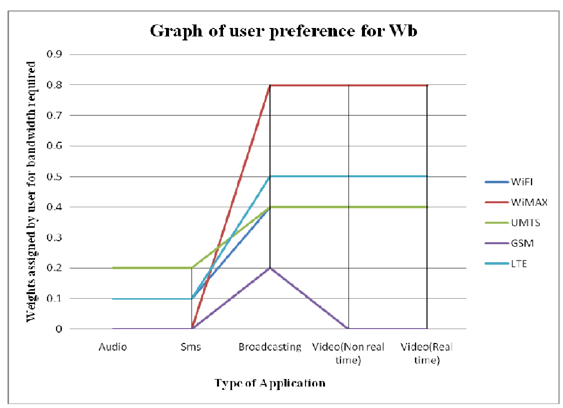

Fig 6. Graph of user preference for Wb.

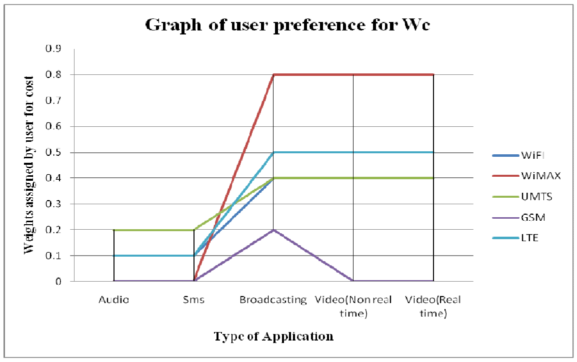

Fig 7. Graph of user preference for Wc.

Conclusions

The designed algorithm and its simulation give an indication that 28.34% of the total power consumed by 100% processing of processor for the algorithm when the call is regular. When the call is not regular (without history)this algorithm selects an appropriate target network for handover which supports the battery power of mobile with its ongoing application.

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