Vertical Handoff in Future Heterogenous 4G Network

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Abstract
Next, the fourth generation of mobile communication will have the capability to support the mobile users either they belong to any wireless network. In fourth generation integration of network technologies for better services to mobile users is done .For example, Universal Mobile Telecommunication System (UMTS) which provides a large coverage area with low bandwidth, while Wireless LAN (IEEE 802.11) provides a low coverage area with large bandwidth. So, by the combination of these two technologies, the mobile user can benefit from the best features of both technologies by roaming seamlessly and transparently between them. Switching among these different wireless technologies is known as handover and it is a very important and burning issue. Every user wants to stay connected anywhere and anytime through whatever technology is available at the time. Providing connectivity by using integrated technologies is a difficult issue because every network has its own features and characteristics, such as data rate, geographical coverage area, latency, frequency and bandwidth.

Index Terms:
4G, Mobile Node, Radio network controller, seamless handoff, SGSN, UMTS, WLAN

1. Introduction

Wireless networking is becoming an increasingly important and popular way to provide global information access to users on the move. Current technologies vary widely in their bandwidths, latencies, frequencies, and media access methods. Most existing wireless network technologies can be divided into two categories: those that provide a low-bandwidth service over a wide geographic area and those that provide a high bandwidth service over a narrow geographic area. Unfortunately, there is no single network technology simultaneously provides a low-latency, high-bandwidth, wide-area connection to a large number of users simultaneous. In this paper we have the solution to the global information access problem to use a combination of these wireless networks to provide the best possible coverage and bandwidth over a variety of geographic ranges. A mobile device with multiple wireless network interfaces has many ways of accessing the wired infrastructure through alternative wireless subnets. 4G is one of the upcoming technologies which will support heterogeneous network, were many network will be integrated to provide seamless service for wide area to end users. Future 4G technology aims to provide seamless service across all the networks around the world, support high-speed multimedia services and access to high volume of information including data, pictures, and video. Some of challenges in 4G networks we will face are as listed below:

All-in-one: All-in-one solution means 4G should support any combination of radio access networks. The next generation mobile systems are expected to have wireless Local area networks, Wireless metropolitan area networks, Wireless personal area networks and various air interfaces like 3G, 3.5G and 4G air interfaces.

Seamless handoff procedures: Seamless procedures occur in such a way that the user does not recognize the quality change during and after the handoff, so 4G should support the seamless handoff procedures between same or different network technologies and between different administrative domain or within the same domain.

Quality of Service requirement: Quality of Service requirement within 4G services should be distributed through the most suitable radio access network.

Mobility Management: Mobility management is the major challenge for the telecommunication networks; need to draw some mechanisms to reduce the effects due to the movement of the object around the networks. The key purpose of mobile communication system is to give the user the liberty of selection to choose its appropriate communication service at any time.

Multimedia Service Support for 4G systems: Multimedia Service Support for 4G systems required to support not only services for telecommunication but also multimedia and data services as well. For this commitment high data rate services will be present with good system consistency and low per bit cost for communication.

2. Related WORK

Several proposals and approaches considering the vertical handoff schemes and decision algorithms were proposed in the literature. In [1], vertical handoff is done by T-DVHD scheme, which provides trusted and seamless vertical handover for the 4G. T-DVHD distributes the decision task among networks in order to decrease the processing delay caused by exchanging information messages between mobile node and neighbor networks. [3] Vertical handoff scheme is characterized by its adaptability to different QoS requirements by manipulating a threshold on the expected handoff instant. [4] The performance of vertical handover in terms of received signal strength measurement with

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suitable propagation model in heterogeneous network for hotspot communication and an efficient vertical handoff decision is taken between cellular and WLAN/HIPERLAN network based on RSS measurement.

[5], Quality function includes essential VHO parameters which can be used to get quality of network , By means of elimination procedure sensitivity of proposed method to type of requested service is eliminated and also active set of available services is prepared in real time, a new framework for velocity and average received power estimation is proposed by means of incorporation of information of user's velocity, more efficient resource management is achieved.[7], Smart Decision Model to smartly perform vertical handoff among available network interfaces. Using a well-defined score function, the proposed model can properly handoff to the "best" network interface at the "best" moment according to the properties of available network interfaces, system configurations/information, and user preferences.[11], several optimizations are proposed for the execution of vertical handoff decision algorithms, with the goal of maximizing the quality of service experienced by each user. The concept of policy-based handoffs is discussed. Then, a multiservice vertical handoff decision algorithm (MUSE-VDA) and cost function are introduced to judge target networks based on a variety of user- and network-valued metrics and performance analysis. [14], vertical handoff between UMTS and WLAN is considered. Mobile IP is a method for network-layer mobility management designed. They have surveyed the handoff latency by using Mobile IP in a heterogeneous network. [17], The self-similarity based vertical handoff algorithm for wireless heterogeneous network. In addition, the pre-decision mechanism is added. [22], New vertical handoff method in which the number of signaling and registration processes is lowered as a result of reduced utilization of home agent and correspondent nodes while users are mobile. Throughput performance of the integrated network is improved by reducing handoff delays and packet losses. Special conditions such as boundary condition also considered.

3. UMTS and WLAN Integrated Network Architecture

UMTS and WLAN can be integrated in two different ways such as tight coupled and loosely coupled architecture. In loosely coupling of UMTS and WLAN network coupling is done directly to internet which uses the same database for authorization, accounting, and authentication with rapid movement of mobile node in integrated architecture and in tight coupling, UMTS and WLAN network are connected to each other by special interface. Rapid movement of mobile nodes from one network to other is possible.

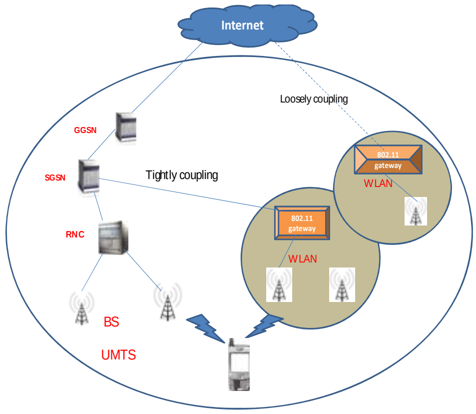


Fig 1 UMTS and WLAN Integrated Architecture

The Wireless LAN Access Point is an integral part of the UMTS network, directly connected to the Serving GPRS Support Node (SGSN) and thus represents an alternative radio access network to the existing cellular one. The mobile node (MN) itself is equipped with two interfaces, a Wireless LAN interface and a UMTS interface. Whenever the MN moves out of the coverage area of a Wireless LAN cell, it indicates measurement reports to the SGSN, and initiates the vertical handover, The Radio Network Controller (RNC) responsible for controlling the base stations which are connected to the controller. The RNC carries out radio resource management. The Serving GPRS Support Node (SGSN) is a main component of the GPRS network, which handles all packet switched data within the network, such as the mobility management and authentication of the users. The Gateway GPRS Support Node (GGSN) is a main component of the GPRS network which is responsible for the interworking between the GPRS network and external packet switched networks like the Internet and X.25 networks.

4. Proposed UMTS and WLAN Integrated Network Architecture

In this paper, we have integrated tightly coupled UMTS-WLAN network in which we have special database at UMTS network which is dynamically updated by the network information such as available bandwidth, battery life, network load etc. In UMTS network this database is connected to 3GPPserver. When mobile node(MN) served at WLAN needs to switch to UMTS network it send request message to SGSN of UMTS through WAG.SGSN checks all RNC available and sends back the network details updated in database dynamically connected by requesting for network condition to 3GPP and it send it to MN. After receiving this network information MN makes vertical handoff decision and executes it. When MN served at

UMTS needs to switch to WLAN, it sends request message to SGSN which will checks for network condition from database connected to 3GPP server and sends back the network detail to MN. When MN receives network detail it makes vertical handoff decision and execution.

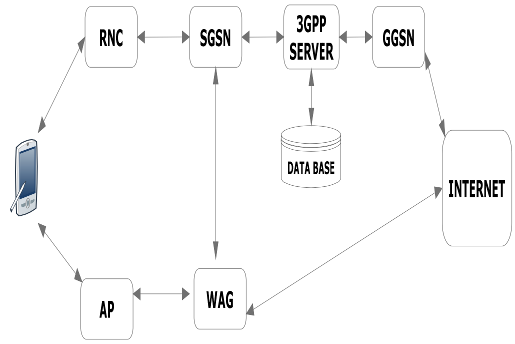


Fig 2 Proposed Architecture

5. Algorithms

In this section, we have discussed different Algorithms used for making handoff decision, when mobile node is on mobility in integrated UMTS-WLAN network.

A. Handoff when MN is connected to WLAN

If MN is receiving signal from base station of UMTS network during mobility, then we compare receiving signal strength of present MN connected access point and Base station of UMTS. If UMTS base station has better signal strength than connected WLAN access point then, we check for available bandwidth from dynamically updated database. If available bandwidth at base station of UMTS is greater than connected access point than, MN will switch to base station of UMTS network else remains in connected access point of WLAN.

Algorithm 1:
Begin
Step 1. If MN is receiving signal from base station of UMTS
network.
Step 2.Compare receiving signal strength of present MN connected access point and Base station of UMTS.
Step 3.If UMTS base station has better signal strength than presently connected WLAN access point than check for available bandwidth.
Step 4.If available bandwidth at base station of UMTS is greater than connected access point then, switch to base station of UMTS network else remain connected access point of WLAN.
End

B. Handoff when MN is connected to UMTS

If MN is receiving signal from access point of WLAN network then we compare receiving signal strength of present MN connected UMTS base station and signal receiving access point of WLAN. If access point of WLAN as better signal strength than connected base station of UMTS, then check for available bandwidth at that base station from dynamically updated database, if available bandwidth at access point of WLAN is greater than connected base station of UMTS then,

Switch MN to access point of WLAN else remain connected to UMTS base station.

Algorithm 2:
Begin

Step 1.If MN is receiving signal from access point of WLAN network.
Step 2.Compare receiving signal strength of present MN connected UMTS base station and access point of WLAN.
Step 3.If access point of WLAN as better signal strength than to connected base station of UMTS than check for available bandwidth.
Step 4.If available bandwidth at access point of WLAN is greater than presently connected base station of UMTS than, switch access point of WLAN else stay connected to presently UMTS base station
End

C. Handoff within a same network

If MN is receiving signal from more than one Base station/access point (AP) then, we compare receiving signal strength of present MN connected Base Station/AP and new Base station/AP from which we are receiving signal. And if new base/AP station has better signal strength comparing to present connected base station/AP then, we check for available bandwidth from dynamically updated database. If available bandwidth at new base station/AP is greater than presently connected base station/AP than, Switch MN to new base station/AP else stay connected to present base station/AP

Algorithm 3:
Begin
Step 1.If MN is receiving signal from more than one Base station/access point (AP)
Step 2.Compare receiving signal strength of present MN connected Base Station/AP and new Base station/AP

Step 3. If new base/AP station has better signal strength comparing to present connected base station/AP than check for available bandwidth.

Step 4. If available bandwidth at new base station/AP is greater than presently connected base station/AP than, Switch to new base station/AP else stay connected to present base station/AP

End

6. Sequence diagram for vertical handoff executions

In this section, we described the sequential steps involved in vertical handoff for our proposed architecture, when MN is connected to WLAN and UMTS networks.

A. Vertical handoff from WLAN to UMTS

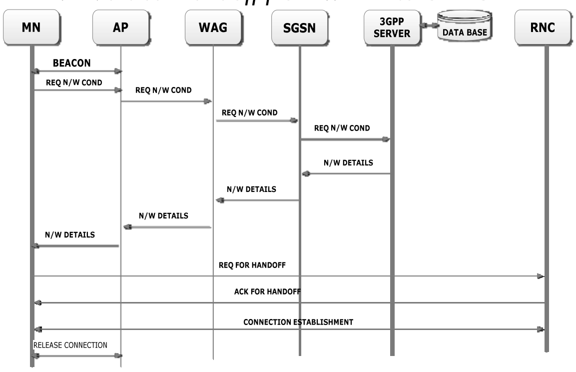


Fig 3 Sequence diagram Vertical handoff from WLAN to UMTS

When MN is receiving signal from UMTS base station. It sends request message for network condition to SGSN which in turn collect the network information from 3GPP server connected database and sends backs the network details to MN. When MN receives network condition it makes vertical handoff decision and sends the handoff request message to RNC. After receiving handoff request, RNC sends the handoff acknowledgment message to MN then finally, connection is established for MN to RNC and earlier connection is released.

When MN is receiving signal from access point of WLAN, it will send request message for network condition to SGSN. Then SGSN will collect the network condition information from dynamically updated database connected to 3GPP server and send back the network details to MN. When MN receives network condition information from SGSN vertical handoff decision is done and vertical handoff request if sent to access point. When access point receives handoff request its sends back the handoff acknowledgment to MN, after receiving handoff acknowledgment MN establishes connection with access point and releases UMTS base station connection.

B. Vertical handoff from UMTS to WLAN

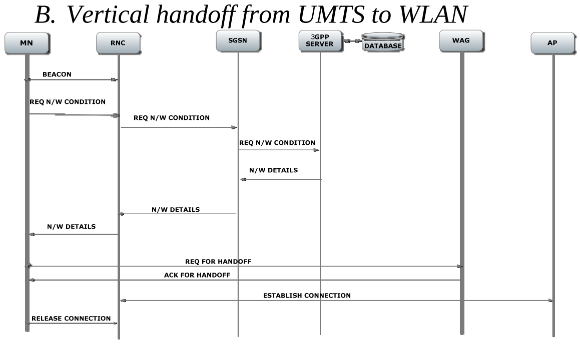


Fig 4 Sequence diagram Vertical handoff from UMTS to WLAN

7. Simulation and Results

In this section we will discuss the simulation and results analysis of our work. We have used Omnet ++ version 3.4 simulator. In our simulation, we have considered proposed integrated UMTS-WLAN overlaid network

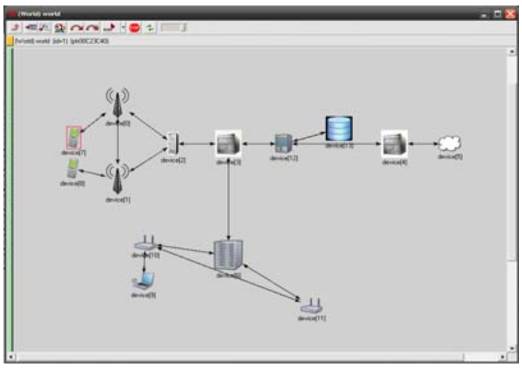


Fig 5 Network topology

Results:

The tracing of user distribution for different simulation periods is done and graph is plotted for our proposed work and existing RSS method. In the existing RSS method handoff were done based on RSS factor were as in our proposed method handoff decision is done based on both RSS and available bandwidth detail which is collected in database. We have compared RSS method and proposed method for different parameters such has packet delivery ratio (PDR), number of handoff, handoff delay, number of packet drop, and channel utilization as shown in below graphs.

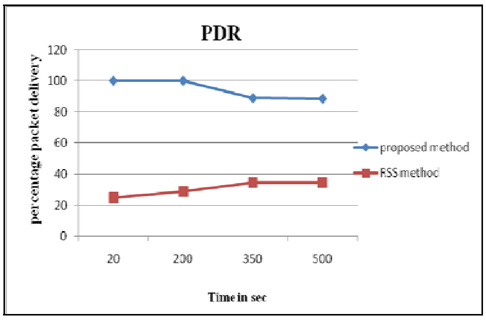


Fig 6 packet delivery ratio

Performance of our proposed work gave better packet delivery ratio when compared to RSS method because in our method handoff is done only if available bandwidth is better which results in greater number of packet delivery as we can see in above graph fig 6.

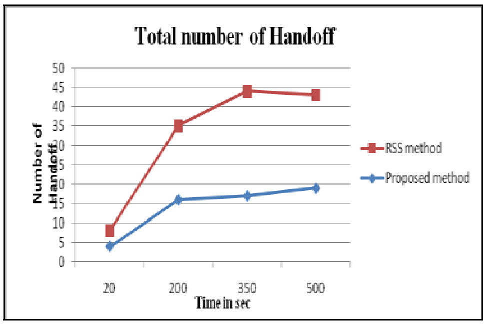


Fig 7 total number of handoff

Performance of network degrades has and when number of handoff increases .There is chance of unnecessary handoff even when mobile node is receiving better service which leads to unnecessary battery wastage of mobile node has execution of handoff consumes more battery and effect QOS of end users .Our proposed method has less number of handoff when compared to RSS method as shown in graph fig 7, since handoff is done if and only if maximum RSS and bandwidth is available.

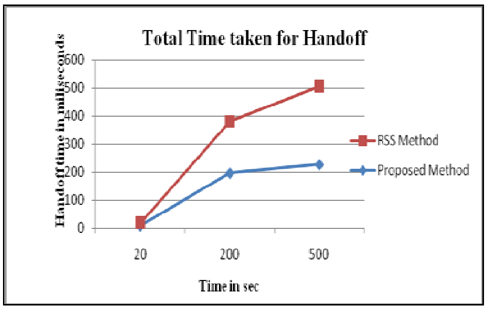


Fig 8 Total time taken for handoff

For better performance of network the handoff should be designed such a way that it should have lesser handoff delay, such that we can provide seamless mobility to end user. We have simulated both methods for different simulation time interval as shown in above graph fig 8.Our proposed work showed minimum handoff time when compared with RSS method.

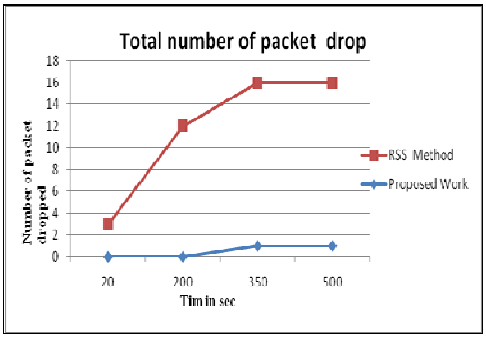
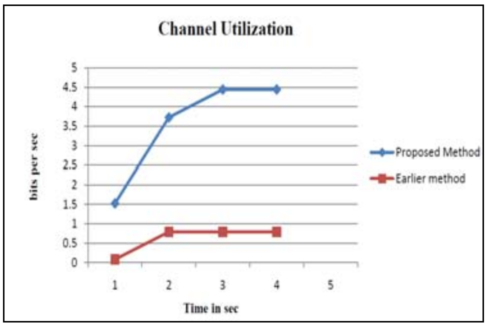


Fig 9 Total number of packet drop

Performance of network degrades has the number of packet drop increases. We have simulated proposed work and RSS method for different simulation time interval which showed. our proposed method has less number of packet drop when compared with RSS method as we can see in graph fig 9.



8. Conclusion

In this paper, We have proposed an UMTS-WLAN integrated architecture with dynamically updating database at UMTS network which keep track of network condition such available bandwidth and We have designed algorithm for handoff decision when MN need to switch to other network due to poor network service. Whenever MN needs to switch to other network it takes the network condition information from database and make decision of handoff. We have simulated our proposed scheme and compared with existing RSS based handoff scheme and .We came to conclusion that our proposed scheme give better performance in terms of PDR, total number of handoff, total time taken for handoff, total packet loss and channel utilization.

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