Handover between Cellular Network to Wifi

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Abstract

Ensuring seamless and reliable switching across different constituent technologies is the basic requirement of heterogeneous wireless networks. IEEE 802.21 standard is recommended for 4G networks for coordinating among different mobile network for better services. This paper proposes an effective technique of vertical handover between cellular network and wifi. A network scenario is been design using network simulator 2. The results show that the packet loss during the whole path of movement is low and throughput is high as compared to other technique

Keywords
Heterogeneous Networks, Vertical Handover, Network Simulator, Packet Loss.

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Introduction

Cellular is very essential part of every human now. The cellular system is divided into different generations. The first generation cellular system does not support data transfer. The second generation cellular system has data rate 10 kb per second [1]. For transmitting multimedia services at high speed evolution of third generation has taken place. In 3G cellular systems there are two types of switching used one is circuit switching which is also used in 2G cellular systems and other is packet switching which is introduced into 3G cellular system [2]. As demand of higher data rate increases the evolution of next generation cellular system will require. Figure 1 shows the cell architecture

![Cellular Architecture](image.png)

Figure 1: Cellular Architecture

of the cellular network. For initializing calls in cellular network mobile station must start scanning all the available frequencies. It selects the channels which have strongest signal. There are some controlling signals which are controlling the calls in cellular network.

The movement of the 3G cellular system in to 4G cellular system is taking place because of the introduction of different type of new services like online TV in the cellular system. It is implemented by making the advancement in different technologies so that the quality of service may improve. The evolution is takes place in the field of the processor, size of memory and data rate, and power consumption. The advancement is also takes place in the field of the high resolution display and mega-pixel of the camera.

The next advancement in cellular system is the use of the IP based services in cellular system which can provide the quality of services to the people as broadband services at home [3]. Some of the services that are introduced into
the 4G cellular system are those which are already supported by 2.5G cellular system. But up to this time there is no standard architecture is design for the IP based services into LTE cellular system.

In recent years, the quality of service in wireless networks has been improved rapidly. Among so many wireless standards, WiFi technology becomes one of the most preferred technologies because of its lower construction and operating costs, higher data rate. Wi-Fi is widely applied in connection of home and small office network because of its flexibility and mobility. Now a day, the number of wireless access point (AP) of the WIFI is increased rapidly. This makes the applications of wireless network more convenient and efficient. The APs can be set in public areas. Wireless metropolitan area networks are used in foreign countries based on wireless network standard. There are so many domestic and foreign universities which are covered by the wireless local area networks (WLAN). This is the main reason behind the position of Wi-Fi in WLAN will become very strong. Wi-Fi is an effective way for broadband access. The radius of 802.11n standard is up to about 100m [4]. Its transmission speed is very fast. The speed can reach 600Mbps, which meets the personal and social needs [5]. In and above the second layer the Wi-Fi technology are fully consistent with the Ethernet. Any devices with a wireless network adapter can be easy to enter the network. That is the reason it is preferred for mobile requirement and has broad market. The actual transmission power of IEEE802.11 is only about 60-70 mW [6]. In contrast, the Transmission power of cell phone is about 200mW to 1W. The transmitter power of hand-held inter-phone is 5W [7]. Therefore, Wi-Fi technology is absolutely safe. Figure 2 shows the architecture of WiFi network. The base station which is serving situated in cell, provide services to all mobile stations up to end point of the cellular cell. When mobile station is moving from one base station to any other base station, services which are

![WiFi Architecture](image)

**Figure 2: WiFi Architecture**
provided by old base station are transfer to the new base station. The process of transferring the services from one base station to other base station is called handover. The transferring of services from one base station to other base station is takes place only when mobile station crosses the boundary of one base station. This happened so that the interruption of ongoing call does not take place and services to the mobile station remain unaffected. When handover takes place between same type of networks it is called horizontal handover. The handover between different types of networks like WIFI and cellular is called heterogeneous handover or vertical handoff [8]. In vertical handover transfer of calls takes place from one base station of a network to other base station or access point of different networks. These two networks can be any of two WIFI, WIMAX, cellular and WLAN.

In vertical handover mobility is takes place in between different type of the networks. It means that mobility of the network is takes place from one type of network to other type of the network.

**Dual Mode**

For supporting vertical handover, there should be a model which is dual mode. Dual mode is needed by mobile node for vertical handover. It is consisting of the model of both type of services which is supported by both type of network current network and target network. Actually here both type of architecture is included in one single block of the architecture. This unit of the block is attached at every base station and access point. Just like that here vertical handover between cellular and WIFI is considered. So the dual architecture will include the architecture of the cellular and WIFI both. This dual mode will be attached at the base station and access point. When mobile node moves from cellular to WIFI, the base station will on its services of the WIFI in to dual mode and mobile node will be connected with the access point of the WIFI [9].

**IEEE**

IEEE provides a standard which is known as IEEE 802.21. It helps in to design the feature of vertical handover by using the cross layer services. This standard of handover is media independent handover [10].
Proposed Technique

There is so many drawback of earlier work just like unnecessary handover, handover latency. In this paper it has been proposed one algorithm which is used to reduce these types of problem. In this algorithm it has been consider the concept of media independent handover in which different parameter is used to take the decision of the handover that will also filter out unnecessary handover in between heterogeneous network like WIFI and cellular.

Figure 3 shows the connectivity model of media independent handover. When mobile node moves out of current access router (AR) MIIS of MIH function will scan other access router. Access router is consisting of the information about physical address, IP address of different base station (BS) and access point (AP). There is information server (IS) at the router at the access router which is consisting of the information about the available resources at the base station. So the time taken by MIIS for scanning will be reduced because MIIS will get the information about access point or base station at the access router from server.

As we know that the coverage area of the access point is very small near about 100 meter. If the value of velocity of mobile node is very high, it will cross the coverage area of access point very soon within few second which is less than the time taken by the mobile node in the handover process. The mobile node will return back in to the coverage area of cellular network and handover from WIFI to cellular takes place. So by assuming the threshold value of the velocity we are filtering the unnecessary handover. During this time QOS would be reduce for few second only that can be manageable by the users.
Some times when one user enter from one base station or access point in to other base station or access point by method of handover, if the value of the bandwidth at the base station or access point is less than the value of the bandwidth which is required by user, congestion will takes place at the target...
base station and contention window will be reduced. Due to which the value of the throughput will be reduced. So by considering bandwidth parameter at the base station or access point we can reduce the probability of the congestion and throughput will not be reduced.

The parameter for handover decision making is velocity and received signal strength where as available bandwidth and number of users are considered in selection of the target network for handover. In media independent handover there are some commands which are used for management of handover. When scanned signal strength is less than the threshold value of received signal strength and velocity of mobile node is less than the threshold value at that time link_going_down is triggered. Lower layers send commands to the upper layers. At that time MIIS of media independent handover get the information from information server. It will select the target base station which have better received signal strength and have sufficient amount of bandwidth which is needed for handover. For reducing the latency in the handover use of fast mobile IP has been considered. Fast MIPV6 provides fast handover which is based on lower layer or link layer triggers by using these mobile nodes can select new subnet or new base station quickly. Here a buffer is considering at every access router. When mobile node leaves the coverage area of current access router, from that time all packets are stored at the previous access router. When the connection at the new access router is established stored packet from previous access router is transferred to the new target access router and that packet will be delivered to the mobile node. Thus the packet loss will be reduced up to null and QOS will be better than earlier methods. There will be no packet loss but the latency due to handover is increased due to large number of signal which is transferred during the handover. The time taken in handover can be reduced by eliminating some of the signal which is transferred during the handover. There are so many base station, access point and access router which are static. These access routers, base station, access point have fixed addresses and this address is known by neighbouring access router. When scanned signal strength is less than the threshold value of received signal strength and velocity of mobile node is less than the threshold velocity mobile node at that time PAR will transmit a HI message to NAR. NAR will send HIACK to PAR. So authentication is over and now the packet which are buffered at the PAR that is transmitted at NAR. So these packets will be delivered at the mobile node through appropriate access point or base station. After that mobile nodes will send router advertisement to the home network. Thus the handover between WIFI and base station is performed. So here the latency as well as packet loss is reduced.
Simulation and Analysis

For development of this technique network simulator-2 (NS2) is used. NS2 documentation is maintained by using Ns2 API documentation and organises across different module.

Development Environment

In NS2 scripting is done in c++ or TCL. Many of the NS2 API exists in TCL but their models are written in C++. In NS2 c++ and object oriented concept are used. Generally the NS2 is working in Linux or Linux type environment. It is considered two access point, one base station and 13 mobile nodes in the scenario. The coverage area of WIFI is 60 meter. The scenario is developed with the help of the Network Simulator-2 (NS2). Data rate of the WIFI is considered as 11 mbps whereas data rate of cellular is considered 500 kbps. Node number 0 is working as the AP1 and node number 14 is working as the AP2 while node number 9 is the BS (base station) of the cellular network. All other nodes are considered as mobile node in this scenario. The scenario is shown in the figure 4.

As shown in figure 5 - Node number 7 which is currently connected with the base station of the cellular, attempts handover from the base station BS to the access point AP1. But the velocity of the mobile node 7 is very high which is 100 m/s considered here. That is why for the node number 7 execution of handover from the cellular to WIFI is not take place. During the movement of the mobile node 7 from cellular to WIFI coverage area the packet loss is increased. Due to the packet loss QOS of ongoing call is also affected.

In figure-5 it is shown that as the mobile node 7 go away from the coverage area of the cellular, the channel condition which is experienced by the mobile node 7 is worst and the packet drop is increased. The movement of the mobile node 7 is from cellular to WIFI coverage area. As mobile node moves from cellular to WIFI QOS is decreased.

Figure 4: Deployment of the Scenario
As the node number 7 enters into the coverage area of WIFI due to worst channel condition some of the packet loss occurred. Due to this packet loss the QOS of the ongoing calls are affected. But this happened for few second because it will cross the coverage area of the WIFI within few second. That is why handover from the cellular to WIFI does not take place. The node number 7 enters in to the coverage area of the WIFI, First of all it check the MIH scan the velocity of the mobile node which is 100 m/s. Mobile node cross the coverage area of the WIFI within the few seconds that is why mobile node are connected to the base station instead of connecting with the access point AP1.

Finally the mobile node 7 crosses the coverage area of the WIFI, during this period mobile node is 7 connected with the base station. If mobile node 7 attempt handover from the cellular base station BS to the access point of WIFI AP1, it will cross the coverage area of the WIFI within few seconds and will return back in to the coverage area of the cellular. So it will attempt handover again from access point of the WIFI AP1 to the base station of the cellular BS. But it is unnecessary handover that is why the unnecessary handover attempts did not take place here. After some times the mobile nodes return back in to coverage area of the cellular. So after reaching in to the coverage area of the cellular the packet loss is decreased or tends to zero again.

After node 7 return to cellular network it is consider that the node number 11 attempts handover from the coverage area of the WIFI or from the access point AP2 to the base station of the cellular BS. Due to which some of the packet are dropped during the handover that is shown in to the scenario below. After the handover is completed from WIFI to the cellular the packet drops are minimised. Now another node number 5 attempts handover from the access point AP1 to the cellular’s base station. The node number 5 moves away from the coverage area of the access point AP1 to the coverage area of the cellular,
packet drops are increased.

Finally node number 5 reached in to the coverage area of the cellular or coverage area of the base station. So the packet loss after the handover is completed tends to the zero. The scenario below is after the completion of the handover. Node number 11 comes from the coverage area of the access point AP2 to the coverage area of the base station of the cellular. Node number 5 comes from the coverage area of the access point of the WIFI AP1 to the coverage area of the cellular’s base station BS.

As it is mentioned in Figure 6, final position of the node after the handover completion now the packet loss will be reduced to the zero. Now the node number -11 comes under the coverage area of the base station of the cellular BS. Node number 5 comes under the coverage area of the base station BS of the cellular from the coverage area of the access point AP1 of the WIFI.

![Figure 6: After handover](image)

**Results and Discussion**

As shown in the figure 7 during the time when node number 7 attempts handover from the base station BS to access point of WIFI AP1, the velocity of the node number 7 is very high. That is why the handover from the base station BS to access point AP1 is not take place. Due to the poor channel condition when it moves from the coverage area of the cellular to the coverage area of the WIFI, the packet drops is increased that is why at the time 20 seconds the packet drops is very high.
At the time 44 seconds node number 11 attempts to the handover from the WIFI to the cellular that is why in the graph at the 44 second the packet drops is increased but after the handover completion from access point AP2 to the base station BS the packet drops reduced to zero. But in this graph the packet loss is less than the packet loss of other techniques just like DVHDC.

At the time 86 seconds node number 5 attempts the handover from the access point AP1 of the WIFI to cellular. As node number 5 moves from the coverage area of the access point to the coverage area of the cellular, during the handover due to connectivity some of the packets are dropped. But after the completion of the handover from WIFI to cellular coverage area the packet drops reduce to zero. Here the packet drops are very low as compared to other techniques which is comes prior to this technique.

In the graph below figure 8 throughput variation along with time is shown. At the time 20s the throughput is minimum because of node number 7 did not execute the handover. It moves from the coverage area of the cellular to the coverage area of the WIFI and returns back in to coverage area of cellular. Due to not proper connectivity or due to bad channel condition packet drops is very high. Due to which the throughput at the time 20 second is very low. After returning to the proper position connectivity resumes and the throughput become good. During the time of the handover of the other nodes the throughput did not reduced too much. So as compared to the previous algorithms the throughput of this technique is not low. Node number 11 attempts the handover at the time 44 s and node number 5 attempts handover at the time 86 seconds. At these two times the throughput is not decreased too much.
As shown in the figure 9 the throughput of the proposed method is compared with the throughput of the DVHDC. At the time when node number 7 moves through the coverage area of the WIFI and return back in to the coverage area of the cellular without the handover take place from cellular to WIFI, throughput of the proposed method is less than the throughput of DVHDC. At other time the throughput of the proposed method is better than the throughput of the DHVDC [13].
Conclusion

A new technique is proposed for the vertical hand-off in heterogeneous wireless network. This technique insures the seamless mobility in the integration of WiFi hotspots and cellular networks in a better way as compared to other techniques like DVHDC. However further optimization should be done for better resource utilization, latency minimization.

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References


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References


[8] Sueng Jae Bae and Min Young Chung, Handover Triggering Mechanism Based on IEEE 802.21 in Heterogeneous Networks with LTE and WLAN, IEEE 2011.


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References


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