A STUDY OF MULTIPLE HIGH SPEED DATA NETWORKS AND SEAMLESS VERTICAL HANDOFF FOR UNINTERUPPTED INTERNET ACCESS TO A HYBRID NETWORK

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Declaration

We hereby declare that this thesis is based on the results found by study. Materials of work found by other researchers are mentioned by reference.

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Signature of the Supervisor

Date:

Acknowledgement

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ABSTRACT

WiMAX is a wireless technology that provides broadband service to the residence or office organizations in economical manner by using many protocols, such as, OLSR, DSDV and DSR. WiFi is wireless network technology that provides internet access by covering a limited range of area using Media Access Control Protocol named CSMA/CA. 3G and WLAN are the integrated access that provides users with benefits and more flexibility.

Handoff is a networking system that automatically shifts or changes active connection from one to another while user is in motion. Handoffs are known as horizontal or vertical (VHO) in homogeneous or heterogeneous Wireless Networks. In traditional handovers, algorithm depends on the quality of link and received signal strength. However, these factors are not enough for VHO because of the complexity of network configuration as it is applied in heterogeneous network. In addition, VHO depends on a policy based network structure where various factors are considered like types of services, Quality of service (QoS), security, etc.

A Hybrid network or Interworking Architecture is usually a network construction infrastructure that works together for multiple technologies such as WiMAX, WLAN, and 3G etc. which is motivated to approach smoother service to users with its enriched communication system. In our work we are going study multiple High speed data networks, individually and as a hybrid network and also compare different features to get the best performance for seamless Vertical Hand-Off.

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Chapter 1

Introduction

1.1 Introduction

In our daily busy life, internet plays a vital role that makes our lifestyle much easier. With the integrated growth of technology, internet has enriched to a higher limit which provides us with better speed, band width, coverage and many more services even from miles away from us. These enriched integrated establishment of internet broadband services became possible because of the innovation of cellular network, more in devious, the innovation of WiMAX system. Along with many other services and technologies, such as, 3G, WLAN, Wi-Fi, etc, WiMAX reduces our workloads; saves time with more adequate speed and life becomes easier for us. Hence, we no longer need to wait for hours for a file to transfer or depend on the internet service serving a limited area, but can easily access from far distance within a less span of time interval.

WiMAX communication system is designed to provide a high speed of data rate within a wide area network. Wimax system is becomes more popular day by day because some attractive features like no wired infrastructure , high data speed, better security system and large coverage area, economically reasonable. There are many WiMAX routing protocol like optimized Link State Routing (OLSR), Destination-Sequence Distance Vector Routing (DSDV), Dynamic Source Routing (DSR), Zone Routing Protocol (ZRP) etc.

OLSR is a routing protocol which can be used in any ad hoc network; it is also known as proactive. In OLSR protocol all the nodes are not broadcast the route packets, only neighboring node of the source are broadcast the packets which are known as Multipoint Relay (MPR). Every node has its own MPR nodes lists. The MPR nodes can be found by sending HELLO messages to a specified destination. As earlier mentioned in OLSR all the

nodes has its own MPR lists so its routing overhead is small then other protocol, so OLSR gives less route discover delay then others.

DSDV is a table driven routing system for ad hoc mobile networks which based on Bellman-Ford algorithm. In DSDV it can be assume that all the nodes are acts like a router and nodes have their individual table which contains the identifier and destination address with number of hops in network are stored. Every router is interconnects with sequence number and this sequence number make different between old and new path between the network. However, highest sequence is always used while route data so the loop functions can be avoided by DSDV. There are two types of packet for minimize traffic, they are full dump and incremental packet. Full dump packet is use to hold changed Information and incremental packets hold changed of the loops. In addition, DSDV has overall efficiency of the network but it requires normal update of routing table so it uses battery power when network is ideal. DSDV is not appropriate for highly dynamic network because if the network pattern is changed the sequence number is also need to re-write.

However, we focused on three different metrics that are quantitatively calculated, they are (a) Packet Delivery Ratio (PDR) means the total number of packet sent successfully to the end, (b) Throughput (TH) means number of packet effectively deliver in a network, its unit is bit/second or byte/second, (c) Average end to end delay refer average delay in the system. After analyzes the result in PDR DSDV is more accurate the OLSR. DSDV have PDR with 100% in nodes. Similarly for throughput it is found that maximum value is for DSDV protocol and for average end to end delay the average delay value is higher for OLSR. Hence all the metrics DSDV is better than OLSR so it can be said that DSDV is more actual then OLSR.

For improved inter-working service between WiMAX and WiFi it is highly need two major elements such as Multimode system and when users travel between the networks. However, Multimode subscribers' device which is permits operating on both WiMAX and WiFi networks. OFDM air interface is used in both Wi-Fi and WiMAX and to minimize the size and cost both use silicon blocks. Similarly both the networks use same antenna as well as

operating power system management can save consumption and gives top battery life. Lastly for a mobile user the network is generally execute though ASN-GW, common Authentication, Authorized, and Accounting. An inter ASN session is provides more faultless communication between the WiFi and WiMAX.

1.2 WiMAX

At present, WiMAX is a latest broadband wireless technology that is used in a long-ranged wireless networking, also replaces DSL and cable services by providing fast internet access. Like Wi-Fi, it has same operations but with greater speed by offering connectivity up to almost 20-30 miles of distance. It uses mobile and fixed station to provide accessibility to the users that can offer services to more number of users, in comparison to Wi-Fi connectivity via voice, video, internet data, etc.

The users are privileged with several benefits of WiMAX such as high flexibilities in low cost, accessibilities, applications, higher speed (up to 40Mbps), etc. Based on the configuration chosen, speed is applicable for both fixed and portable applications, along with internet connectivity to mobile devices.

The main features of IEEE 802.16 Standard / WiMAX technology are following:

- Carrier frequency should be less than 11 GHz. currently we use 2.5 GHz, 3.5 GHz and 5.7GHz.
- Orthogonal Frequency Division Multiplexing (OFDM) transmission technique is used.
- High Data rate about 10 Mb/s even 70 Mb/s. this data rate depends on very good state of radio channel for a small cell.
- Some extra QoS (Quality of service) and VoIP application is add.
- Adaptive Antenna System and MIMO technology.

In addition WiMAX has a scalable physical-layer architecture that allows for the data rate to scale easily with available bandwidth and this scale ability is offered by OFDM mode.

Fast Fourier Transform (FFT) scaled by the available channel bandwidth. WiMAX supports a number of modulating and forward error corrections (FEC) coding schemes and allows the scheme to be change based on per user, per frame on channel conditions. It also provide the automatic retransmission request (ARQ) at data link layer. According to IEEE 802.16-2004 and IEEE 802.16e-2005 it support both TDD and FDD which is Time Division Duplexing and Frequency Division Duplexing. As well as a half-duplex FDD which allows for a low cost system Implementation and TDD allows several advantages like flexibility in choosing uplink and downlink data rate, less complex transceiver design etc. Security is handled by a privacy sub layer within the WiMAX MAC layer where user data is encrypted using cryptographic scheme both AES (Advanced Encryption Standard) and 3DES (Triple Data Encryption Standard) are supported. Secondly it prevents unauthorized use by using username/password, digital certificates and smart card etc.

1.3 Universal Mobile Telecommunication System (UMTS):

UMTS is a high speed (more than two megabytes) transmission system where packet and broadband based transmission is used to transmit text messages, multimedia messages, digital data etc. UMTS system provides portable end device facilities, which is not depend on any coverage area but the computer or mobile user can anywhere in the world. Universal Mobile Telecommunication System is also known as "Third Generation (3G)" system. Mobile and computer users will be able to connect at anytime and anywhere as they move out one area to another the rooming facilities would be same in UMTS system. Under UMTS system users are able to access a mixture of satellite and protective wireless transmission network. Global System for Mobile Communication (GSM) standards and the major standards bodies with manufacturer companies started implementation of UMTS from few years back. Until the full execution of UMTS system the mobile users needs to use multi-mode devices which can switch at present network (GSM 900 and GSM 1800) where UMTS is not presented.

A GSM network consists of different types of functions and layer or interfaces. Generally in GSM network there are three major part and they are Mobile Station or Mobile Equipment (ME/MS), the base station subsystem and network sub system. MS mixed up with mobile equipment terminal with a smart card called Subscriber Identity Module (SIM). This SIM supply the mobility and by set up SIM in GSM terminal user can receive calls at that particular terminal as well as user can make a call from same terminal. For security reasons Mobile equipment is exclusively recognize with International Mobile Equipment Identity (IMEI) number and the SIM card enclose with International Mobile Subscriber Identity (IMSI) number. This numbers are very important because to identify the subscriber of the system, secret key for authentication and other information we need to consider this IMEI and IMSI numbers. Second part of the GSM network is Base station subsystem; it consists with Base Transceiver Station (BTS) and Base Station Controller (BSC). The interfaces between MS and BTS are known as Um interface, Base Transceiver Station (BTS) maintain communication with MS by using a radio link. On the other hand Base station Controller manage communication with one or more BTS, which is responsible for changing the radio channel, frequency hopping and perform handoff or handovers. BSC connects MSC (Mobile Switching Center) with mobile stations. In addition another interface named A is between lies MSC and BSC.

Network subsystem is another important part in GSM network and main components of this subsystem is Mobile Service Switching Center (MSC). MSC operates as key nodes which connects PSTN (Public Switch Telephone Network) as well as maintain all process for initiate a call, authentication, registrations, transfer messages, perform handoff or handovers, location updates, routing updates, rooming subscriber etc. Home Location Register (HLR) and Visitors Location Register (VLR) worked together in MSC to update all latest call-routing and rooming. HLR manage all information about administrative for the registered user in corresponding GSM network but VLR manage only selective administrative information which is use for call control and other service option.

1.4 WLAN:

WLAN is an improved way for data connectivity in a location (such as building) without the expense of installing a structured cabling scheme in particular. Also, it gives flexibility in order of connection over the wired LAN connections by reducing problems like loose patch cords, broken connectors' live data outlet, etc.

Along with the benefits of WLAN, it has some difficulties also, such as, the security issues. Therefore, good wireless networking system is provided a range of different user's authentication along with the encoded data options in order to integrate the security for particular applications.

A wireless local area network (WLAN) is a wireless computer network that links two or more devices using a wireless distribution method within a limited area such as a home, school, computer laboratory, or office building. This gives users the ability to move around within a local coverage area and still be connected to the network, and can provide a connection to the wider Internet. WLAN standards define in IEEE 802.11 section. However, WLAN has two basic modes of operation: infrastructure and ad hoc mode. In ad hoc mode, mobile units transmit directly peer-to-peer. In infrastructure mode, mobile units communicate through an access point that serves as a bridge to other networks (such as Internet or LAN). Most Wi-Fi networks are deployed in infrastructure mode. In infrastructure mode, a base station acts as a wireless access point hub, and nodes communicate through the hub. The hub usually, but not always, has a wired or fiber network connection, and may have permanent wireless connections to other nodes. Wireless access points are usually fixed, and provide service to their client nodes within range. Wireless clients, such as laptops, smart phones etc. connect to the access point to join the network.

A Wi-Fi Direct network is another type of network where stations communicate peer to peer. In a Wi-Fi P2P group, the group owner operates as an access point and all other

devices are clients. There are two main methods to establish a group owner in the Wi-Fi Direct group. In one approach, the user sets up a P2P group owner manually. This method is also known as Autonomous Group Owner (autonomous GO). In the second method, also called negotiation-based group creation, two devices compete based on the group owner intent value. The device with higher intent value becomes a group owner and the second device becomes a client. Group owner intent value can depend on whether the wireless device performs a cross-connection between an infrastructure WLAN service and a P2P group, remaining power in the wireless device, whether the wireless device is already a group owner in another group and/or received signal strength of the first wireless device.A peer-to-peer network allows wireless devices to directly communicate with each other. Wireless devices within range of each other can discover and communicate directly without involving central access points. This method is typically used by two computers so that they can connect to each other to form a network. This can basically occur in devices within a closed range.

A bridge can be used to connect networks, typically of different types. A wireless Ethernet bridge allows the connection of devices on a wired Ethernet network to a wireless network. The bridge acts as the connection point to the Wireless LAN.

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There are two definitions for wireless LAN roaming and they are Internal Roaming and External Roaming. he Mobile Station (MS) moves from one access point (AP) to another AP within a home network because the signal strength is too weak. An authentication server (RADIUS) performs the re-authentication of MS. The billing of QoS is in the home network. A Mobile Station roaming from one access point to another often interrupts the flow of data among the Mobile Station and an application connected to the network. The Mobile Station, for instance, periodically monitors the presence of alternative access points (ones that will provide a better connection). At some point, based on proprietary mechanisms, the Mobile Station decides to re-associate with an access point having a stronger wireless signal. This scenario is known as Internal Roaming. Similarly, for external Roaming the MS (client) moves into a WLAN of another Wireless Internet Service Provider (WISP) and takes their services (Hotspot).

The user can independently of his home network use another foreign network, if this is open for visitors. There must be special authentication and billing systems for mobile services in a foreign network.Wireless LANs have a great deal of applications. Modern implementations of WLANs range from small in-home networks to large, campus-sized ones to completely mobile networks on airplanes and trains. Users can access the Internet from WLAN hotspots in restaurants, hotels, and now with portable devices that connect to 3G or 4G networks. Oftentimes these types of public access points require no registration or password to join the network. Others can be accessed once registration has occurred and/or a fee is paid.

Chapter 2

Interworking Architecture

2.1 Interworking Architechture

Basically interworking architecture is an architecture framework. This framework describes the interworking procedure of Worldwide Interoperability for Microwave Access (WiMAX),Wireless Local Area Network (WLAN) and UMTS network technologies. As time is passing through, our world is getting more and more used to internet. That's why the demand of mobile internet and wireless multimedia applications is going greater than ever. To fulfill this demand the interworking infrastructure is exceedingly motivated. The approach of this architecture framework promise to revolutionize the services offered as peer-to-peer entities, which facilitate sharing. The interworking architecture is designed as the enriched communication system. Here enriched communication means that it is designed to make available robust multimedia services diagonally roaming boundaries and over assorted access technologies. Using the design of WiMAXcpa networks, with the ability to become stationed with each certified along with unlicensed spectra. It supports different Radio Access Network topologies. The particular interworking platform is concerning to help self-sufficient JOGGED structures help seamless integration and also interworking having Wireless, 3GPP and also 3GPP2 systems and also recent IP agent key circle. WiMAX circle implement the relationship focused MAC though Wi-Fi goes on the particular CSMA/CA process, that is actually cellular in addition to strife dependent. The particular interworking cpa networks delivers world-wide walking around and cost effective broadband Wi-Fi access to the internet. This interworking of communities evolves into a new pattern with the extensive application associated with portable technological innovation within cellular transmission. WiMAX – WLAN interworking has been commonly deemed by means of cellular providers due to the advantages for both equally customers and also providers.

2.2 Differences of Interworking Architecture between different Network

The differences between UMTS-WLAN interworking and UMTS-WIMAX interworking. The WLAN in hot-spot areas forms the microcellswithin the UMTS macro-cells. The mobility between UMTS and WLANcan be referred to fully overlapping handover. Accordingly, the required timefor switching from UMTS to WLAN connection can be tolerantly long. Moreover,when the mobile is connected to WLAN, it can maintain simultaneouslythe Packet Data Protocol (PDP) context of UMTS so that it can reconnectimmediately to UMTS without need of PDP context re-activation. On the contrary,the mobility between UMTS and WIMAX is referred to partially overlappinghandover since the WIMAX coverage is in order of UMTS coverage area.Consequently, the handover should be done quickly to maintain the connectionparticularly when the speed of the mobile terminal is high.

Chapter 3

Vertical Handoff (VHO)

3.1 Vertical Handoff

Now a days there are a mixture set up of wireless network, such as wireless local area network (WLAN), wireless personal Area networks (PANs) etc. The interworking architecture provides a different kind of opportunity where multiple single networks are connected. Due to the huge demand of users in terms of coverage, bandwidth, latency, security and cost for setup and service wireless network gives them different option. In future internet protocol (IP) is used to launch multimedia Internet applications which can be use from anyplace at any time. However, rapid development for wireless service and mobile broadband wireless access (BWA) which gives a high speed data rate within its coverage area.

The future network configuration will carry different level of structure for higher load, strong security and ensure best quality of service as well as better subscriber density management which is able to provide verity of service. Interworking architecture is combine different type of network in a single network and act like heterogeneous network. In homogenous network we use similar configuration and protocol or single network architecture. The main problem in homogeneous network is a small error can affected common to all configuration in its components. Similarly, heterogeneous network connects various protocol and configuration.

A network with huge number of heterogeneous network element can serve a better as compare with homogenous network. However, handoff is networking system that automatically shifts or changing active configuration from one to another while user is in

motion within the same network. There are two types of handoff in wireless networking system for homogenous and heterogeneous network known as horizontal and vertical handoff (VHO) respectively. Generally handoff is known as handover. Furthermore, traditional handoff depends on the quality of link and average received signal strength. But for heterogeneous network this factor is not enough for a seamless connection handoff. Some extra function is needed because of the complexity of network configuration. In VHO we need to consider user velocity, network condition, user preferences etc, so more precious and accurate algorithm is needed.

3.2 Vertical Handoff in Physical and MAC Layer

Another reason for VHO algorithm is the PHY and MAC layer is different for different network, so single calculation is need for this layers. However, in VHO it is important to determine whether handoff is needed or not. In multi- layer environment it is quite difficult to measure but some factors is very important to take its decision. For example the type of service, network condition, security etc. for different user's data rate, bandwidth will be different, so the quality of service (QoS) will be different. By varying the QoS the cost of service is also changing. Another important factor is network conditioning which includes traffic, available bandwidth, latency, packet loss. In addition, mobile entity condition which includes the speed, location information and mobility model. In heterogeneous network travelling at a high speed is discourage and sometimes handing over in its cell within very shortly. Furthermore, channel quality where average receive power, receive signal(RS), inter channel interference(ISI), signal to noise ratio (SNR), bit error rate (BIR)is execute.

Similarly security is different for different network so it is very important factor for VHO decision making algorithm. Power requirement is another factor where low power consumption, the device power, battery power is calculated. The final stage of the decision algorithm is proactive handoff where the users are includes in VHO decision whether VHO is take place or not. So VHO decision is deal with too many individual

factors which have different parameters as well as it increase the complexity of the VHO process.

3.3 PHY and MAC layers of WiMAX and Wi-Fi

3.3.1 WiMAX MAC Layer:

The principal process from the WiMAX MAC stratum would be to offer software involving the greater transfer levels and the actual stratum.

This MAC stratum will take packets in the upper stratum, these kind of packets are usually named MAC services information items (MSDUs) and sets up these straight into MAC method information items (MPDUs) for sign within the atmosphere. Pertaining to gotten transmissions, the particular MAC stratums can the particular opposite.

3.3.2 WiMAX PHYSICAL Layer:

This WiMAX physical layer is founded on orthogonal regularity department multiplexing. OFDM is the indication scheme of preference allow high-speed information, online video, and multimedia systems devices and is also used by various business broadband systems, which includes DSL, Wi-Fi, Electronic Video clip Broadcast-Handheld (DVB-H), and MediaFLO, other than WiMAX.

This real covering involving WiMAX is quite accommodating; information rate performance varies good operating boundaries.

3.3.3 Wi-Fi MAC Layer:

Like a condition in order to being able to access the particular channel, the particular MAC Stratum inspections on-line regarding it's circle part vector, the industry counter-top person on every single section which presents the quantity of moment that the preceding frame should send out it's frame. The particular circle part vector must be absolutely no ahead of the section can certainly attempt to send out the frame. Prior to sending the frame, the section considers the quantity of moment needed to send out the particular frame in line with the frame's size and files price. The particular section spots the price symbolizing this time inside length area inside header with the frame. Whenever stations get the frame, they will analyze that length area price and apply it because the schedules with regard to placing their matching circle part vectors. This method reserves the particular channel for that transmitting section.

3.3.4 Wi-Fi PHYSICAL Layer:

The actual protocol architecture consists of Physical layer along with a couple of bass speaker cellular layers PLCP & PMD and Info Link Covering consists of MACINTOSH PERSONAL COMPUTER and LLC bass speaker stratum. The actual Wi-Fi system consists of Wi-Fi consumer, accessibility point and LAN. LAN may perhaps contain Ethernet Change, RADIUS Authentication Server and so forth. When it comes to the actual physical layer there are a lot regarding things to be looked at: tad development, rate of recurrence, state simply by state rules and the like.

According to the data link layer this framework has three basic points:

- This is a checklist of all of the box forms.
- This is a practice of which describes instead apparent precisely what your packets tend to be supposed to accomplish.
- This is a display that creates a long list of quite box forms.

Chapter 4

IP Multimedia Subsystem (IMS)

4.1 IP Multimedia Subsystem (IMS)

IP Multimedia Subsystem (IMS) is Internet Protocol based telephony and multimedia service which is used over third generation networks.IMS introduced for 3GPP but now it extended with different broadband wireless technologies, 3GPP, 3GPP2, WLAN, UMTS etc. IMS is mixture of three layer architecture with Transport layer, control layer, service layer. Transport layers manage all units for supported access network, core of the IMS is located in Control layer and service layer includes the application of server hosting the IMS service. Home Subscriber Server (HSS) and Subscriber Location Function (SLF) is the key thing for IMS core user database in IMS reference architecture. Additionally Call Session Control Function (CSCF) is SIP server, Media Resource Function (MRF),Application Servers (AS), Breakout Gateway Control Function (BGCF) an Public Switch Telephone Network (PSTN) is also important factors in IMS architecture. In a home network there can be multiple HSS and HSS store profile of a specific users. For entering IMS subsystem Proxy- Call Session Control Function (P-CSCF) is the primary position to contact with ME. The administrative functional domain of the IMS is SIP proxy in Interrogating-CSCF server. The correction between UEs SIP address and the session control is powered by Serving-CSCF server.

Chapter 5

Entry Process

5.1 Entry Process (During Vertical Handoff)

During vertical handoff entry process of WiMAX, UMTS and WLAN usually happen via GSM network and IP Multimedia Subsystem (IMS).

5.1.1 UMTS Entry Process:

In UMTS entry process Mobile Station (MS) create GMM Attach Request when the terminal switch is on. SGSN of the current network received this GMM Attach Request and add the old TMSI (Temporary Mobile Subscriber Id) number, the mobile network identity, the location areaas well as routing area.

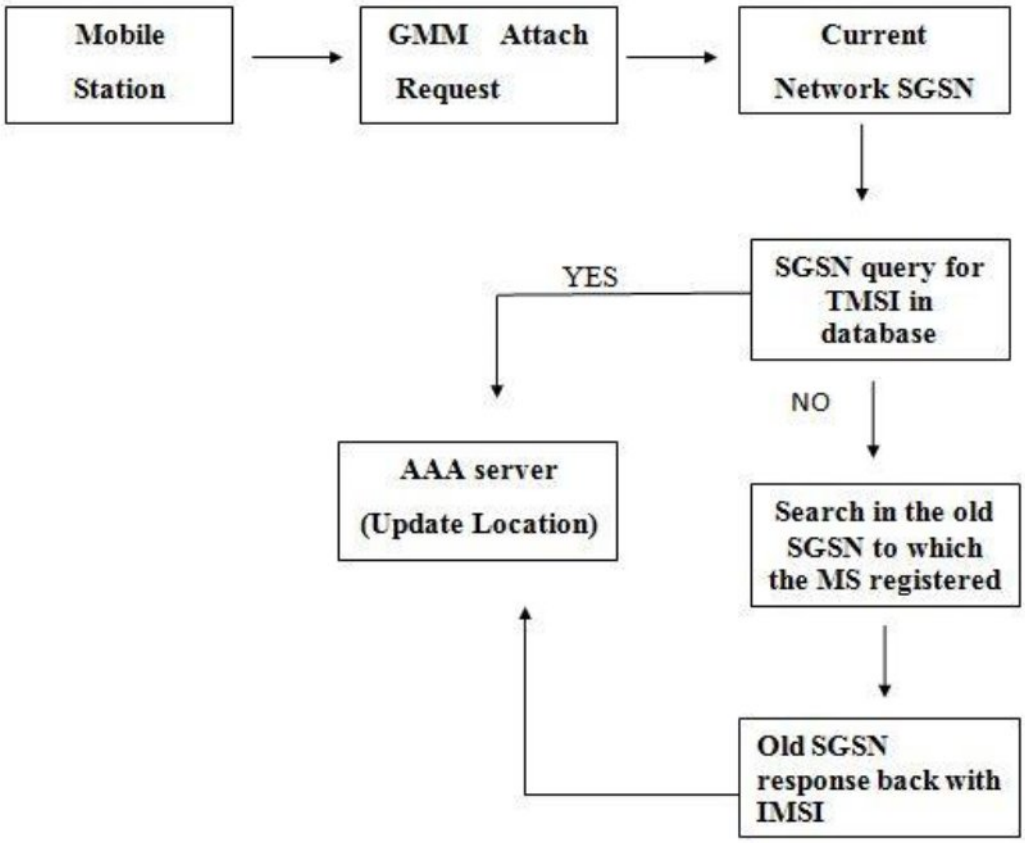

Fig.5.1 Block Diagram for UMTS Entry Process

Once the network SGSN receive GMM attach with TMSI then its starts query for the specified TMSI in its database. If SGSN does not find any information in its database it starts search for Identity Request TMSI of in the old SGSN database. The old SGSN replies back to the new SGSN with (Identity Response IMSI) IMSI (International Mobile Subscriber Identity) of the MS. Before SGSN registered the MS in its database few packet transferred between MS and SGSN for authentication purpose.

However, SGSN send a identity request to the mobile station when the MS requesting itself. Then MS response to the SGSN and SGSN sends authentication request and mobile SIM card or MS operate some particular algorithm for RAND

value and the secrete key (Ki), which produce session key (Kc) and the secret response (SRES). SRES value is replied to the SGSN, when the identity check is done by the SGSN, MS identity has been obtained. Thus SGSN inform AAA server and AAA server updates the SGSN with all users or MS,

Then the SGSN commence a message for MS with GMM attach Accept and the MS response back with the packet GMM Attach Complete as well as close the procedure with its final response to SGSN.

5.1.1.1 PDP Activation:

Mobile station starts the PDP for an IP address reservation. Service provider define APN (Access point Name) which generates activate PDP context message. The SGSN query for the DNS server and DNS responses with DNS response packet. From the DNS server SGSN get IP of the GGSN. After acquiring the GGSN IP, SGSN forward the "Activate PDP Context" to the GGSN, which carry APN via "Create PDP Context Request" packet. The SGSN receive "Radius authentication request" to registration of the users. A DHCP server (DHCP Address request) allocates a dynamic IP for the uses on MS of the request IP address reserved. After that GGSN response back SGSN and SGSN response back MS with its IP and MS finalizing the whole process.

5.1.1.2 Registration process:

Registration processes contain total 36 messages and it is the standard 3GPP SIP registration method. MS creates the SIP REGISTER to the P-CSCF. As the P-CSCF cannot connect with MS home network so P-SCSF needs to use its traffic and forward the packet I-CSCF. I-CSCF identify whatever S-CSCF is allocated to particular MS, then I-CSCF sends UAR packet to HSS and HSS replied back UAA messages. Hence S-CSCF is register with I-CSCF. Then an invitation

message (401 UNAUTHORIZED) is send by I-CSCF to the MS responder with SIP REGISTER. After that I-CSCF response with UAR and HSS repeat with UAA hence MS complete its registration and S-CSCF informs HSS of the MSs successful registration and retrieves its profile. Finally S-CSCF informs to the MS for the successful completion process and finishes the procedure.

5.1.2 WiMAX Entry Process

WiMAX entry process for the users is not so uncomplicated as UMTS process. It is involve for the WiMAX entry process method which MS will be informed for require IP address (PDG, P-CSCF) and user authentication mode has to be achieve. Firstly, MS call for its registration to the network, ASN gateway is referred for validation as it manage user authentication derived from recover information from AAA Relay and in WiMAX CSN DHCP server is situated as well as dependable for the "Addressing Requirements ". the entry process of WiMAX contain total 48 messages. This packet is not only transferred between MS to BS but also travel different unit of network.

Firstly MS sends "SBC-Request" to the BS and BS response back with "SBC-Response". Meanwhile Base Station sends MS-Preattachment-request to the ASN gateway Authenticator and it replies back with MS-preattachment-response. After receiving MS-preattachment-response Base station informs MS with SBC-Response. Secondly, Mobile Station starts EAP-AKA process which involves authorization stage from MS to BS. In addition This EAP acts between the AAA proxy and an SA-TEK in MS and BS. Mobile station creates MS-preattachment-Ack to ASN gateway authenticator and the ASN response with EAP-Identity-request. Then based on the EAP identity information MS identify CSN AAA Proxy and send EAP-over-radius packet again AAA server replies with EAP-response (Acknowledgement) and MS responds with validity of authenticator. Once the process is done successfully authenticator informs both MS and BS. Then BS sends new keys for session establishment and a three way handshake process established for a secure connection between MS and BS. This handshake is used for encryption data during session and base station response with key response message.

The main entry process is started from MS to BS with REG-REQ (Registration Request) and BS sends MS-attachment-request to the ASN gateway authenticators which replied with ms-attachment-response and send it back to the MS with REQ-RES (Request Response) and MS again informs ASN with acknowledgement packet. Up to this part registration processes is complete and start establishing for IP connectivity. For IP connectivity MS sends DHCP Discover to the DHCP server and DHCP response with DHCP Offer, then MS sends Request for a IP and DHCP server response with an IP as well as its validity and a session. The final process of DHCP is MS response with DHCP acknowledgement. This IP addressing can be done in both versions IPv6 and IPv4. MS should have two IP for home and foreign and MIP used for mobility support. DHCP reserves IP address and can be use for different MSs Allocation and DHCP is good for its ability to send network configuration to MSs.

IP connectivity is established by sending Time of the Day request from MS to BS and BS responses with Time of day Response to MS. For a good quality of service (QoS) service flow creation is execute by DSA REQ and DSA RESP between MS and BS, the acknowledgement is used for Service flow creation is DSA ACK from MS to BS.

To entire the process MS has to perform SIP register o the IMS core. It is depends on PDG and P-CSCF, there are two option to execute this process. Firstly, we can use a second DHCP procedure recover these IP address, but it will increase the number of control messages for MS registration. Secondly, use OPTION field in DHCP message, DHCP OPTION means use an unused code of DHCP and pass these address to the MS during the DHCP messages exchanges.

5.1.3 WLAN Entry Process

The WLAN entry process consists of 17 messages. Firstly, MS open EAPOW-start to AP for authentication process. Then AP response back with EAP-request/identity. Then MS sends RADIUS message for entrance in WAG via ARG, WAG sends authentication information to AAA server and AAA server acknowledge the MS with RADIUS access-

challenge again MS replied back EAP-SRES (response) and the authentication algorithm saves in SIM card, EAP SRES pass to WAG and WAG to MS EAP-success message exchange, it occurs when the AP sends EAPOW-key (WEP/WPA/WPA2) packet.

For the IMS registration the number of total messages is 32. Similarly MS creates REGISTER packet to I-CSCF. I-CSCF cannot access the MS home network it is important to find a path for entering in MS home network. However I-CSCF use its traffic and DNS actions are operate to pass the packet in HSS, so HSS connects with S-CSCF and S-CSCF forward a 401 message (Unauthorized) to MS via WAG and ARG, then ARG pass the 401 message to Mobile Station and again MS response with Register, HSS and I-CSCF exchange few packet between them UAR is send by I-CSCF to the HSS and HSS response with Diameter UAA. However, I-CSCF again send a packet SAR to the S-CSCF and it replied with SAA and HSS finally confirmation with S-CSCF. Hence the SIP is register with MS and the completion process in acknowledge to S-CSCF from MS.

Chapter 6

Network to Network Assembly Procedure

6.1 Network to Network Assembly Procedure

6.1.1 WiMAX-UMTS Assembly Procedure:

The INVITE message that arrives at P-CSCF 1 is then verified properly of the Route Header field. Next, its Session Description Protocol (SDP) validity is verified with the values of QoS used in the home network and then forwarded to the S-CSCF 1 for the registration purposes if all the things are verified properly.

Next, when the S-CSCF 1 receives the INVITE message, it recognizes the respective caller's identity from the Header field and routes the SIP network. This SIP request tries to route mainly based on the designated user in the Request-URL.

In the mean time, DNS tries to set a SIP server (I-CSCF in actual case) in the activated network and tries to forward the INVITE message. The INVITE message is then received by the I-CSCF and forwarded to the S-CSCF 2, associated to the caller. The I-CSCF has to find out from HSS by mean of Diameter LIR request in order to find out the address of S-CSCF 2 on account to pass the message. The HSS searches for the data associated with user including Public-Identity AVP Header field after receiving the Diameter request. The data associated with the user includes the S-CSCF 2 address that inserts into a Server –Name AVP in a Diameter-Location-Information-Answer (LIA) message.

Next, the I-CSCF receives the LIA and then it routes the INVITE request and the message then reaches the terminal of awaited user2. Now at the user2 side, it responds with assembly process known as “183 message” to the SDP offer and gets started with its resource reservation on association of all the required parameters. The user1 starts the verification closely of the SDP answer that carries the IP address of the caller. The media streams are included with the IP address. User1 then answers with a PRACK that contains a new SDP offer due to the change in the previous SDP negotiation. In the end, the resource reservation of user1 initiates.

On the other hand, user2 responses to the PRACK with a term known as “200 ok” and initiates the resource reservation. There’s a notification of SDP field that gets carried within the message “200 ok”, that lets the caller’s terminal know that the termination did not complete yet at the caller’s. Then, user1 sends an UPDATE request that contains SDP offer generated, that shows the reserve resources at the user’s local segment. Then, IMS terminal of the caller’s sends a reply using 200 ok message according to the SDP offer. The user2 terminal might end up with its resource reservation within the span of time required and the IMS terminal then makes a ring by generating a 180 ringing response that travels a long distance to a caller terminal. The IMS of user1 receives the ringing response; it then generates a ring-back tone as an opposite response along with a PRACK message. The user2’s IMS terminal then responds with a 200 ok message and completes the INVITE cycle/transaction. Next, user1’s terminal (IMS) sends and ACK request for confirmation that 200 ok is received and starts the media-plane traffic generation across the user2 terminal.

6.1.2 WiMAX-WiMAX Assembly Procedure:

The WiMAX-WiMAX assembly system is quite similar to the WiMAX-UMTS assembly system but the only difference is of different nodes present at the network of termination. The procedures are all small in any kinds of assembly system.

6.1.3 WiMAX-WLAN Assembly Procedure

Like WiMAX-WiMAX assembly system, it also has similarly equivalent steps and procedures to WiMAX-UMTS assembly system but with only differences of several nodes at the network of termination and origination.

6.1.4 UMTS-WLAN Assembly Procedure

The main order of sequence flow for every assembly system is equivalent to each other and follows the exact same sequence. Similarly, UMTS-WLAN assembly also have an equivalent signaling sequence as WiMAX-UMTS assembly system discussed at first but with only difference of different nodes at the originating and terminating network.

6.1.5 UMTS-UMTS Assembly Procedure

Like WiMAX-WLAN, WiMAX-UMTS and other respective assembly systems, UMTS-UMTS assembly system has also similar signaling sequence but different nodes at the originating and terminating network.

6.1.6 WLAN-WLAN Assembly Procedure

Like any other assembly system sequence, WLAN-WLAN assembly system also follows similar signaling sequence with difference of different nodes at the respective network of termination and origination.

Chapter 7

Vertical Handover decision making Algorithm

7.1 The Performance Evaluation of Vertical Handover decision making algorithm:

Vertical handover decision making process is basically based on the core concept on a policy based network system structure. In this case, policy database helps to store data information related to the parameters that are considered for VHO. The respective parameters are then measured by considering the necessity of VHO like should it be suitable to use or not. This creates a big challenge in the multi-network environments and not very much easily achievable. It is not that easy because the factors of respective VHO do not have the liberty to give away information about when to use handoff and when not to. Hence, the criteria of VHO are introduced that are necessary when VHO is in need.

Along with the necessity of signal strength, the respective criteria of VHO are:

1. Type of service.
2. Quality of service.
3. Security
4. Power requirements and consumption.
5. Proactive handoff.

7.1.1 Types of Service:

As we know the services change with the change in network setups and structures, so, considering this fact, the above criteria deals with the different types of services that require different ranges of band width (bit rate), reliability, latency, etc. The more big the network structure, the more differently the types of services operates.

7.1.2 Quality of service:

One of the most renowned criteria is quality of service that gives consistency, predictable data delivery service which also deals with the providence of real-time as well as, non-real-time services. Mostly, it is the real-time that acts more dominant than that of the non-real-time service for QoS prospective.
It falls under into three categories. They are network conditions, mobile entity conditions and channel quality. The parameter like availability of band width, packet loss, latency, traffic, etc. falls under the part of network condition. Along with the above factor, geographical location information, speed, mobility, etc. are also considered where the speed factor along with distance is very important and has big effect on the handoff decision making algorithm.

The high-speed travelling of handoff from one network to another is said to be not eligible because the heterogeneous network structure is more of a spreading network. If it is made eligible then the handoff would have come back shortly to the original network by leaving its operation incomplete. That's how mobile entity of QoS performs.

On the other hand, the channel quality deals with the signals that have been received, average of received power, interference between inter-channels, Signal-to-Noise Ratio, Bit-Error Rates, etc.

7.1.3 Security:

This is one of the most important criteria of vertical handover decision making algorithm because different networks support of prefer different formats and level of security. As we know, an encrypted network is always secured to operate because lesser the risk of data to be lost or violated, the more the efficiency and effectiveness of the operation of the respective network, so do the same in the case of decision making algorithm of vertical handover.

7.1.4 Power requirements and consumption:

Like security, this factor is also important because wireless devices have a limited range of battery power. Therefore, more power is consumed with the usage of the device for several applications like handover and other. So, low power consumption device can last for longer period of time if the handoff is subjected to low power consuming network, which will also increase the usage time period of the network itself.

7.2 Proactive Handoff

This part of criteria of vertical handover deals with the users' involvement to the vertical handover decision making algorithm and hence, make a final decision whether to use handoff or not, depending on the network condition. Mainly, it gathers the interests of the users' and takes decision whether handoff is appropriate to use to fulfill those respective interests.

The above criteria of vertical handover decision making algorithm make it full of complexities. But, hopefully these complexities can be reduced and can be speeded up by implementing quality function of vertical handover algorithm.

7.3 Proposed Handoff Mechanism:

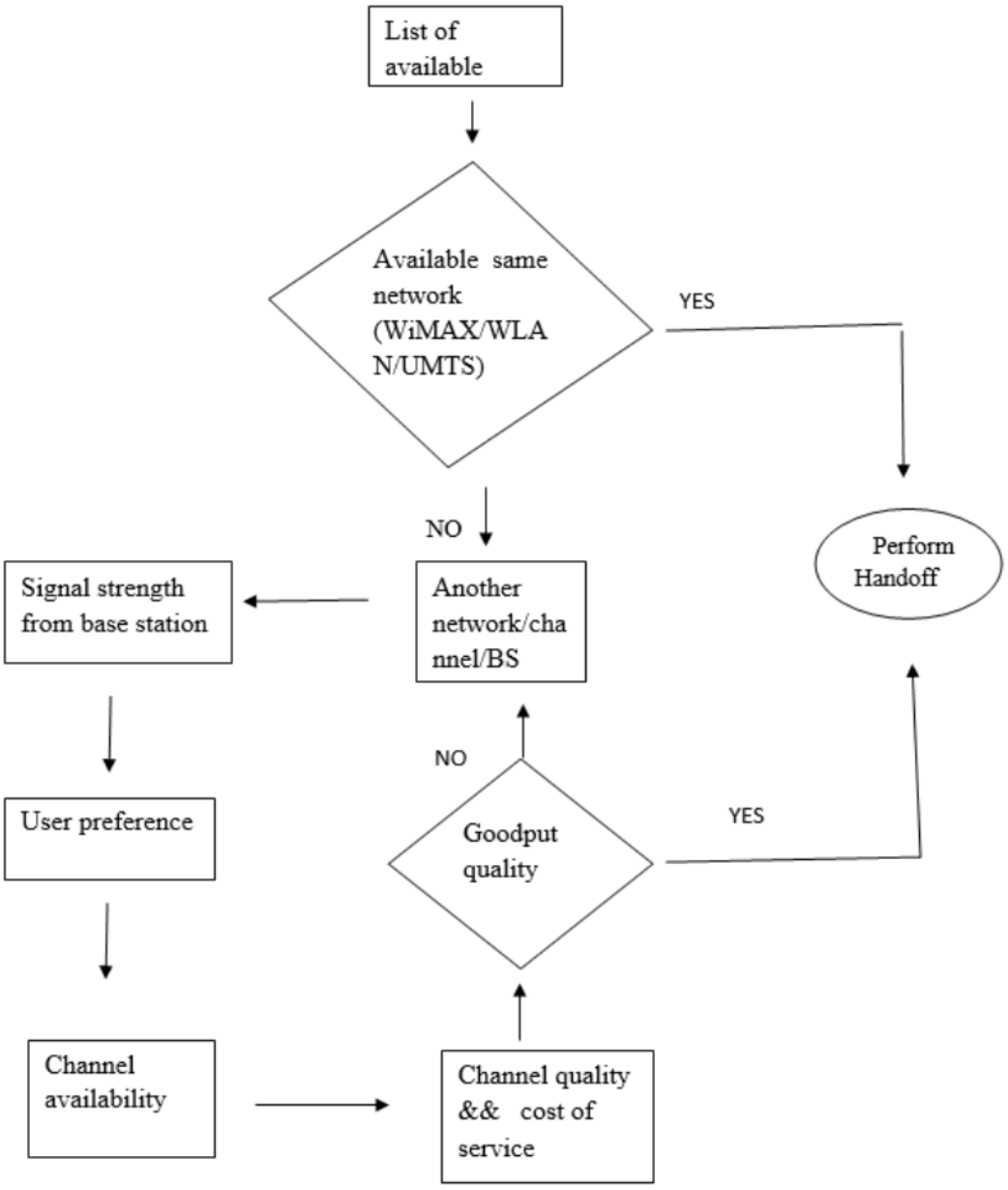

Fig.7.1 Handoff (VHO) process

If a user is moving one to another area handoff or handover is very important for seamless connection between user MS and Base station. As we know there are two types of handoff vertical and horizontal, vertical handoff is take place in where more than one

network is combining together. In another word vertical handoff is perform in heterogeneous network. Similarly horizontal handoff takes place in homogeneous network. Traditionally handoff decision depends on some fixed criteria which are discussed earlier. In this section we propose a policy base handoff method where some fixed criteria are execute for handoff perform.

First of all when a user or carrier is moving one to another cell and current base station signal strength is getting poor then BS initiate handoff method. Current base stations check nearby available network for transfer the active session. In this check list if there is any similar network found then current base station transfer the session into new base station under the same network. On the other hand if there is no available same network found then current base station take random selection for new base station. However new base station measure the signal strength, if the signal strength is good enough then it proceed on next step which is user preferance. Then current BS check the user partiality, partiality means BS determines which service is desire for this user. User preference could depends upon the type of application (real-time, non-real time), service type (voice, data, video), quality of service etc. once base station select preference service its check the availability of the channel in new base station. Channel availability is important because of network balancing, load balancing is require to avoid overloading in particular network so it must be paid attention. If base station found any match then it jump into next step which is cost of service, where function cost is calculated from the rate of new call arrival and handoff call arrival in a particular BS. However, then BS check the goodput quality or throughput quality. Traditionally, network throughput refers average data rate of successful data or message send over a specific link. Network throughput is measured in bits per second (bps). If the throughput ensure a reasonable value then final handoff process is execute and old base station pass the session into new base station. If any of the steps has a poor response then the whole handoff process is started from the beginning. After performing a successful handoff, handoff process should be stop until the next handoff scenario is coming.

Chapter 8

Comparison among Routing Protocols

8.1 Comparison among Routing Protocols

If a comparison get create based on the performance evaluation of commonly used routing protocols then a best protocol may come out. There are different types of routing protocol are used in wireless network system and the most well-known protocols are Optimized Link State Routing (OLSR), Destination-Sequenced Distance Vector routing (DSDV), Ad-hoc On-demand distance vector (AODV), dynamic Source Routing (DSR), ZRP etc. This protocol has different type of effects on transmission of data packets while they routing which is depends on protocols criteria. For AODV protocol packet functional delay (PDF) is very poor compare with DSDV, but almost same with DSR. Similarly, the average time delay is high in DSDV compared to both DSR and AODV for first few seconds. However goodput is a term which can be define by the number of data packets successfully sent and received by the whole network with a certain time which is proportional to PDF. So, we prefer DSDV because it has the best goodput and outputs then other protocols. In addition DSDV shows the best overall performance as we compare with OLSR in the basis of Packet delivery Ratio and the number of nodes. The performance of routing protocol in terms of normalized routing load can be define by which is the best number of routing packets transmitted per data packet delivered to the destination. Similarly, overhead is known as the total number of routing packets

transmitted during a period of time. However, Bandwidth is an important parameter for managing normalizes routing load and overhead; if the overhead or load size is increase a lot our packets occupy more bandwidth in transmission medium. For a large distance path probability of packet drop is high because in large distance more packet need to send and there is a chance to collision over transmission medium and as a result packet loss is increase. Similarly, the packet loss is so small or negligible for a short distance data transmission. The normalized routing load for DSDV is very high compared with AODV and DSR. Again in overhead criteria DSDV is much much higher than other two prptocols. For this reasons in DSDV packets exhibits more delay and it also increase the probability of collision. As we know DSDV has a good performance in PDF and goodput criteria compare with AODV and DSR. So if we can reduce DSDVs overhead problem and normalize routing load problem then DSDV will be best routing protocol.

Comparison can be cleared with the given information of the following table:

Routing Protocols	Performance Evaluation				
	PDF	Average End-to-End Delay	Good put	Normalized Routing Load	Routing Overhead
1. AODV	Poor at initial, but rate increases time after time	Very Poor, Up and Down happens time after time	Poor, but rate increases time after time	Poor, Up and Down occurs but time after time rate laid down	Poor, rate remains almost same
2. DSR	Very Poor at initial, rate increases time after time, after some time became similar to AODV	Poor, Up and Down happens time after time	Very Poor, but rate increases time after time	Very Poor, and rate laid down in high range	Very Poor, rate remains same
3. ZRP	Rate is not so High but also not so poor	Average			Average
4. OLSR	Average, rate increases time after time	Average, Up and Down happens time after time	Average, rate remains almost same	Average, rate laid down time after time	Average, rate remains same
5. TORA			High and remains same		Average
6. GRP	High		Average		
7. DSDV	High, almost 75% packets delivered	High in 1st 30 seconds, then almost similar to other protocols	High, rate increases time after time	High, but rate decreases time after time	High in rate, but laid down a little bit after some time

Table 8.1: Comparison among Routing Protocols

8.2 Architecture Model

Based on the Performance Evaluation of vertical handoff and the proposed Handoff mechanism an Interworking Architecture Model is designed:

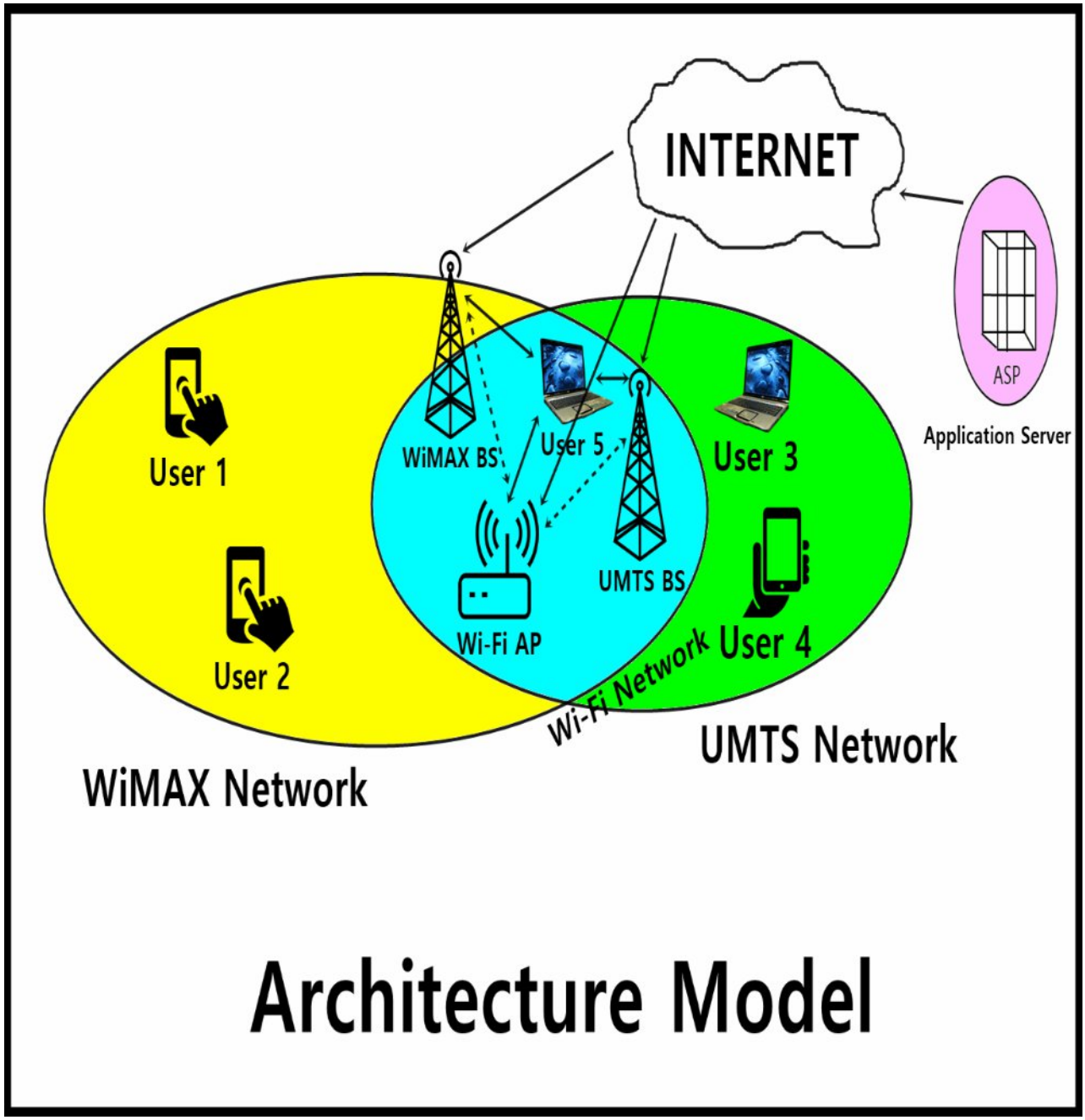

Fig.8.1 Architecture Model

Let consider a client is in the WiMAX Network zone. According to our proposed mechanism or algorithm of vertical handoff system it send the access request andit's access request traffic will look for the list of available nearby networks. It may find out different networks available near it. But according to the properties of vertical handoff we know that in case of transferring a data a network will prefer to communicate and connect via its own network than switching the network type. So in our proposed case if client's access request discovers a path in its same network system or same network type it will transfer its data and its request will discover an access point immediately. This case is about to connecting Wimax MS1 with WiMAX MS2 client where clients rogue AP will find out its specific legitimate AP and the process will come to an end.

If the client which is WiMAX MS1 wish to connect or send or request access point from any other device the whole explanation will be different. In this type of case at first it will check the signal strength from its base station. Base station should collect the required data from the Internet Cloud and that data can come to the cloud any application server system.

If from base station it gets a low signal response then it will be amplified using battery life. Then a question will occur according to the preference network of user or client. Like in our architecture model we can see that in UMTS Network space almost like every type of networks or devices are available. Then based on the client's preference available network may come out. After this the channel quality and cost of service will be checked. Like if the client of WiMAX MS1 go through the WiMAX base station, then it can found both WiMAX MS3 and Wi-Fi Station 1 both are suitable for its access request. WiMAX MS3 may provide a better channel quality where in other hand Wi-Fi Station 1 or Wi-Fi AP will offer a low channel quality which may also have some interference. And there is also a fact of cost analysis. But if the destination is designated like clients access traffic must have to connect with Wi-Fi AP or Wi-Fi Station 2or 3 which are in the Wi-Fi Network zone then there is like no way out and it must have to choose that path of access.

Then if a better goodput quality comes out, handoff will be performed and the process will come to an end. If there is no goodput quality comes out, it will look again for some nearby available network and the whole process will be recycled.

*** This explanation is based on our proposed Vertical Handoff Algorithm.

Chapter 9

Conclusion

9.1 Conclusion

The modernity of this present world requires a technological change in cellular network field, which will promise faster internet connectivity within less span of time, hence, delay can be overcome. The technology must provide minimum interference and be accessible from far distance with any change in data or loss of data. In this thesis paper, we tried to pursue the best possible ways in order to construct such network system with relative protocols and assemblies of applications, such as, DSDV, WLAN, WiMAX and WIFI protocols, UMTS, etc., along with some convenient layers, such as, physical layer, MAC layer, etc.

The mentioned procedures of rapid construction of Interworking Architecture with suggested assembly systems, entry processes, and every other criterion of VHO decision making algorithms hopefully will be helpful to construct a more improved integrated VHO network along with better enhancement of security and better implementation of routing protocols.

Our aim is to propose such a network system that can have the capability to captivate the evaluation of the better routing protocols and can select which protocols are essential for such betterment through decisions. Such VHO network implementation can hopefully provide a better internet access and can ensure an easier daily life for us.

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