

## QoS oriented vertical handoff scheme for interworking of WLAN and WiMAX

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### ABSTRACT

A Mobile Node (MN) continuously moves in heterogeneous networks. When connections need to migrate between heterogeneous networks for performance and high-availability reasons, seamless vertical handoff is necessary first step. Everyone around the world would like to be connected seamlessly anytime anywhere through the best network. When MN changes its point of access technology handoff occurs. In this paper, a vertical handover scheme is proposed for interworking of WLAN and WiMAX to improve QoS in terms of throughput. Available bandwidth and average end to end delay will be taken in to account for making handoff decisions. Vertical handoff between WLAN and WiMAX occurs by satisfying QoS parameters.

**Keywords-** MN, QoS, vertical handoff, WLAN, WiMAX.

### 1. INTRODUCTION

QoS, mobility and security are most important issues to be covered by mechanism and architecture for integrating different types of wireless networks. Many new architectures or schemes have been proposed for seamless integration of various wireless networks. These networks allow mobile users to stay connected as they move through different networks. The IEEE 802.11 wireless local area network(WLAN) have been deployed widely and 802.11 access point can cover area of few hundred meters ,making them suitable for enterprise networks and public hotspot networks. Recently 802.16 standards (WiMAX) can provide high data rate and wide area of coverage. Integration of these two technologies raises several challenges.

When MN changes its current point of access technology handoff occurs. There can be two different types of handoff: horizontal handoff and vertical handoff. Horizontal handoff refers to switching between point of attachment or base station that belongs to same network. Vertical handoff refers to switching between stations that belong to different networks. Process of vertical handoff can be divided into three steps, namely system discovery, handoff decision and handoff execution. During system discovery phase MN search networks and what are the available services

in each network. During handoff decision phase MN determines which network it should connect to. Handoff decision may depend on various parameters such as bandwidth, delay, access cost, and transmission power, current battery status of mobile node and user preferences. During handoff execution phase connections are transferred from existing network to new network in seamless manner. This involves authentication, authorization as well as transfer of user's context information.

The main aim of this paper is to design effective QoS oriented VHO scheme for wireless network consisting of WLAN and WiMAX The paper is organized as follows. Section 2 presents the WLAN and WiMAX architecture. Section 3 analyzes the different existing strategies and compares each one with others. Section 4 proposes our VHO scheme. Finally, section 5 concludes the proposed work.

### 2. WLAN AND WiMAX

Wireless communication is, by any measure, the fastest growing segment of the communication industry. It is based on radio technology. GSM (Global System for Mobile communications), GPRS (General Packet Radio Service), UMTS, WLAN and WiMAX are some examples of different technologies, each with their own characteristics. As already discussed, this paper will focus on WiMAX and WLAN. This section will contain a brief overview of WiMAX and WLAN.

#### 2.1 WLAN

WLAN is a very popular wireless communication technology for short/medium distances nowadays, mostly because it is convenient, easy to deploy, easy to manage and because of its low infrastructure costs.

The Wireless Local Area Network (WLAN) is an unlicensed band of 802.11 ISM frequency band. 802.11 is one of the recent communication technologies of IEEE standard. A typical WLAN network consists of Access Points (APs) and several wireless clients, called Stations (STAs).

Today, the standard 802.11g, generally referred to as Wi-Fi, has been implemented all over the world. Physical layer specifies the modulation scheme used and signaling characteristics for the transmission through the radio frequencies, whereas the MAC layer defines a way accessing the physical layer.

### 2.1.1 Architecture

As stated before, a typical WLAN network consists of two entities: APs and STAs. APs are the Base Stations for a wireless network. APs communicate with STAs by radio waves. STAs are wireless clients which connect to the APs in order to gain access to the network, e.g. the Internet.

Lightweight and Autonomous are two discrete architectures used in WLAN environment. Each of the architectures has wide impact on wired LAN architecture. The selection of WLAN architecture is based on the consideration of building, integrated wired and Wireless network to achieve a high return on investment. Both architectures are popular but Lightweight architecture has an advantage over the WLAN market.

### 2.1.2 Lightweight model

Lightweight is the part of WLAN architecture. With most of wireless intelligence which residing at central controlling device, lightweight Wireless Access Point architecture have narrow functionality.

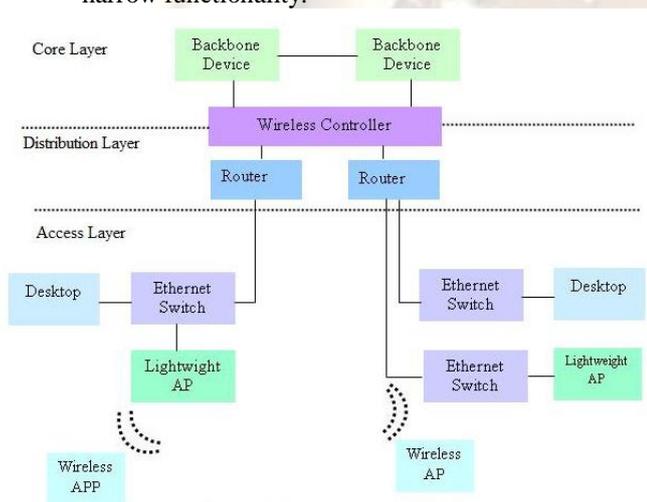


Fig 1: lightweight architecture model

Lightweight model is simple. The devices that provide the communication to the end user as Access Layer are identified by lightweight. Distribution layer provide the inter communication and the top layer (Core Layer) of Lightweight model is responsible fast and consistent data between networks.

Wireless Access Point (WAP) resides at the interface of access layer and provides the communication interface to end user. In lightweight architecture model, the management of operation is easy because it give the permission to WAP from single device, because the lightweight WAP have the knowledge of visibility and attentiveness of the neighbours WAPs. They can observe and if any one of their neighbours becomes the victim of fault, it notifies the wireless controller.

Lightweight WAP may be Self-healing because to pay compensation for unsuccessful counterpart, controller commands the neighbouring WAP to regulate their power level, where as in autonomous there is no concept of the visibility of its WAP neighbouring and in this case to perform self healing it cannot adjust the power level. If single WAP is busy or overloaded then in this situation wireless controller can relieve the wireless client to neighbouring WAP. In critical applications such as VoIP, self-healing and load balancing are important issues.

### 2.1.3 Autonomous model

In Autonomous Model WAP is not mandatory as shown in Figure 2. Autonomous Wireless Access Point sustains the switching and strong security as well as networking function that are indispensable to route the wireless traffic. As in autonomous system there is no concept of the visibility of WAP so it cannot make the load balancing.

Autonomous model cannot differentiate whether nearest WAP is part of WLAN infrastructure or illegal rouge WAP. The difference between the autonomous and lightweight is negligible. The difference is only that lightweight have one extra component (WLAN controller).

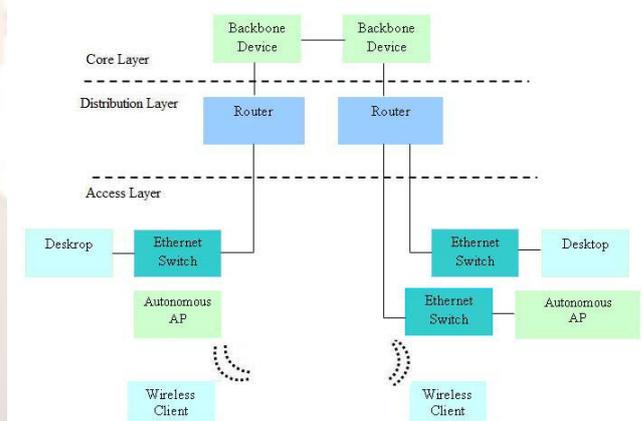


Fig 2: Autonomous architecture model

## 2.2 WiMAX

The fiber optic transport services providing the high bandwidth and data rates is replaced by WiMAX wireless technology all across the world. WiMAX is emerging technology to fulfill the high data rate and QoS requirements of the customers, also it is the cheap deployment of voice services with no need of line of sight wireless channel.

WiMAX signals have the property to adopt the atmospheric conditions everywhere. WiMAX electromagnetic waves also offer the support of adoptive coding and different operation modes, so voice and data services can easily be transported by WIMAX network platform.

WiMAX is a wireless telecommunication technology based on the IEEE 802.16 standard [IEEE2]. It uses licensed spectrum to provide high speed wireless data transmissions over long distances in many different ways.

### 2.2.1 Architecture

The WiMAX Network Architecture defines a framework consisting of several functional entities and interconnections. Figure 3 shows this framework in simplified manner, followed by a description of each entity.

- NAP: Network Access Provider A business entity that provides WiMAX radio infrastructure.
- NSP: Network Service Provider Just like the NAP, the NSP is a business entity. It provides IP connectivity and WiMAX services. The level of services is legally binded through contractual agreements with one or more NAPs.

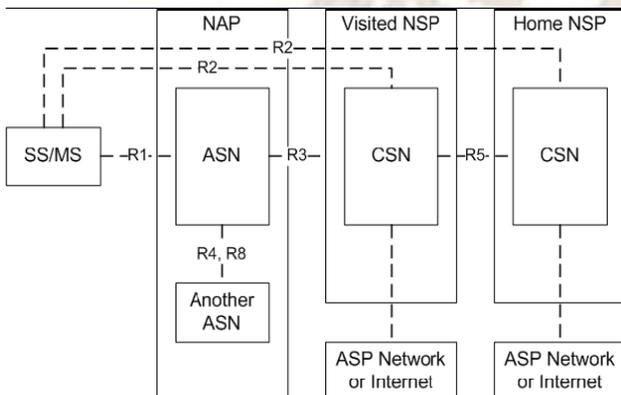


Fig 3: WiMAX network architecture

- SS/MS: Subscriber Station/Mobile Station Entity which wants to make a connection to the network.
- ASN: Access Service Network This is the point of entry for the SS/MS into the WiMAX network. This entity must support a complete set of functions required to connect a client to the network: authorization, authentication, session management, network discovery, IP-address allocation, QoS etc.
- CSN: Connectivity Service Network The CSN is the part of the network which provides IP connectivity services. It consists typically of routers, servers, proxies, and gateways etc. providing functions like Internet access and peer-to-peer services.

### 3. LITERATURE SURVEY

In order to understand scope and limitations of various vertical handover approaches, we need to study existing approaches. Various approaches have been proposed for vertical

handover decision which is based on various parameters.

The parameters which are evaluated to make effective handoff decision are described in [3]. Different authors have considered different parameters or combinations of these to make handoff decision. Dynamic decision module [4] select best network at best time by considering static and dynamic factors. Static factors include usage expense, link capacity and power consumption while dynamic factors include RSS (Received signal strength) and velocity of mobile node. This model was developed to reduce unnecessary handoffs. Dynamic decision process involves three phases: 1) Network discovery 2) Network analysis and 3) Network selection and execution. In Network discovery (priority phase) candidates networks (networks whose RSS is greater than threshold and velocity of mobile node is less than threshold value set for that network) are chosen and priority is assigned based on difference between RSS and its threshold value. Now process continues with second phase in which system status is collected and weight is assigned to each factor. Based on this static score is calculated. In third phase dynamic score is calculated by multiplying priority of each network with static score. Best network to handoff is selected which have highest value of dynamic score. Evaluating these many factors for making handoff decisions may incurs more handoff delay.

In [5] author proposed handoff decision making algorithms which takes wifi RSS and estimated end to end TCP handover latency. Main aim of this paper is that handover must be initiated well before it is required. As wifi RSS is measured every time both the interfaces are always on which consumes more power. In both these papers author have not given mathematical model to obtain these parameters.

In [6] only available bandwidth is taken into account for making handoff decision to provide QoS. Author proposed two bandwidth estimation algorithms to estimate available bandwidth of WLAN and WiMAX.

In this paper QoS oriented vertical handoff scheme is proposed for interworking of WLAN and WiMAX. Best network can be chosen at best time by taking handoff decision based on available bandwidth and average end to end delay.

### 4. PROPOSED MODEL

To provide QoS oriented vertical handoff between WLAN and WiMAX VHO (vertical handoff) scheme is proposed as shown in Fig. 4 Traffic measurement module measures traffic at station i.e. throughout of network and gives input to HDM(handoff decision module).NCDM detects available network and estimate values of parameters and provide this to HDM. Based on information provided by NCDM and handoff policy, it decides

need to launch handoff. CTM transfer all connections of station to new network.

#### 4.1. Bandwidth Estimation

Available bandwidth is calculated as difference between total capacity and aggregated utilized bandwidth.

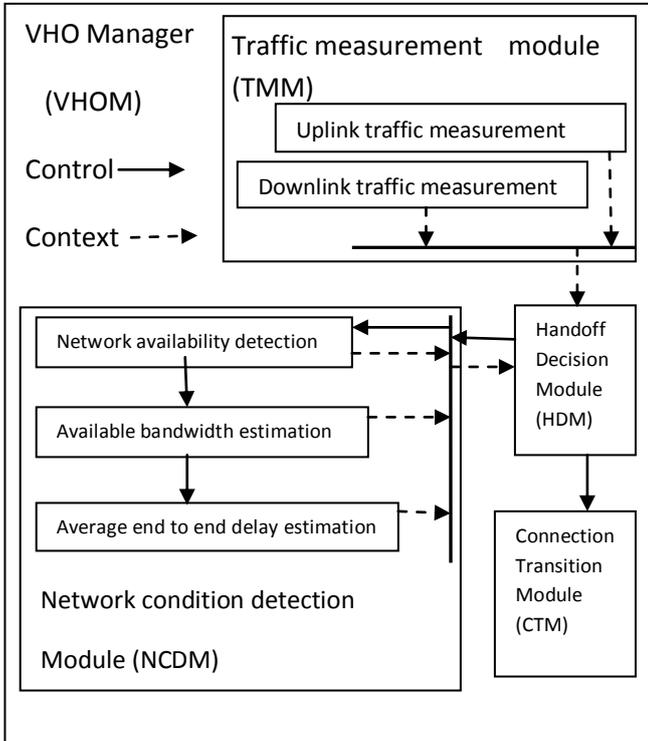


Fig. 4 overview of vhom.

#### 4.1.1. Bandwidth estimation in WLAN

In IEEE 802.11 medium is shared in contention manner by stations [6]. It is assumed estimation period  $\tau$ . During this period data transmission can be expressed as:

$$T_{data}(t - \tau, t) = \sum_{t-\tau}^t T_{data\_NAV} + \sum_{t-\tau}^t T_{data\_trans} \quad (1)$$

Where  $T_{data\_NAV}$  denote data transmission time in NAV interval. NAV is network allocation vector which is set when station listens RTS/CTS message from other stations.  $T_{data\_trans}$  is data transmission time in transmission opportunity obtained by desired station. Then average utilization of medium can be expressed as:

$$u(t - \tau, t) = \frac{T_{data}(t - \tau, t)}{\tau} \quad (2)$$

Proportion of reserved resource that can be used purely for data transmission is:

$$Y(t) = \frac{\mu_{data}}{\mu_{data} + \mu_{R/C/A} + (3T_{SIFS} + T_{DIFS} + T_{backoff}(t))c(t)/8} \quad (3)$$

Where  $\mu_{data}$  is mean data packet size in bytes of desired station,  $\mu_{R/C}$  is sum of RTS/CTS frame size,

$T_{SIFS}$  and  $T_{DIFS}$  are time duration of SIFS and DIFS.  $T_{backoff}(t)$  Denote random back off time and  $c(t)$  is data rate at time  $t$ . Available bandwidth can be calculated as :

$$BW_{available}(t) = (Y(t) - u(t - \tau, t))c(t) \quad (4)$$

#### 4.1.2. Bandwidth estimation in WiMAX

In IEEE802.16 bandwidth resource is allocated in the form of number of physical slots used. In IEEE 802.16 transmission occurs in the form of uplink sub frame and downlink sub frame. BS determines bandwidth station can obtain for receiving downlink and uplink data.

Number of frames during  $\tau$  can be expressed as:

$$n = \frac{\tau}{T_{frame}} \quad (5)$$

Number of unused physical slots of this period is equal to:

$$S_{UL-free}(t - \tau, t) = nS_{UL-total} - \sum_{i=1}^n S_{UL-used} \quad (6)$$

$$S_{DL-free}(t - \tau, t) = nS_{DL-total} - \sum_{i=1}^n S_{DL-used} \quad (7)$$

$S_{UL-used}(i)$  And  $S_{DL-used}(i)$  denote utilized PSs in its uplink and downlink sub frame. Available bandwidth based on above results can be expressed as:

$$BW_{DL-available}(t) = \frac{1}{\tau} S_{DL-free}(t - \tau, t) c_{DL-slot}(t) \quad (8)$$

$$BW_{UL-available}(t) = \frac{1}{\tau} S_{UL-free}(t - \tau, t) c_{UL-slot}(t) \quad (9)$$

#### 4.1.3. End to End delay estimation

End-to-end delay indicates the length of time taken for a packet to travel from the source to the destination. It represents the average data delay an application or a user experiences when transmitting data. The delay is usually measured in seconds. When available bandwidth of target network satisfies quality of service, end to end delay with respect to that network can be calculated as:

Let,  
 $\eta$ =Average end to end delay,  
 $\delta$ =Total transmission delay of all received packets,  
 $\Omega$ =Number of packets received.  
 $\eta = \delta/\Omega$  (10)

If Average end to end delay is less than threshold value then handoff to that network takes place.

## 5. CONCLUSION

When connections need to migrate between heterogeneous networks for performance and high-availability reasons, seamless vertical handoff is necessary. Handoff occurs when mobile node

changes its point of access technology. In this paper various vertical handover schemes between WLAN and WiMAX are described. Vertical handover decision is based on various parameters to provide always best connected service to mobile users.

In this paper the VHO scheme is proposed for inter- working of WLAN and WiMAX to improve QoS in terms of throughput. When mobile node moves out of coverage area of one network, the proposed scheme provides always best connected service and QoS can be improved. Available bandwidth and average end to end delay are taken into account for handoff decision.

#### REFERENCES

- [1] R. O'Hara and T.L.Cole, Local and metropolitan area networks specific requirements, *IEEE Std 802.11-2007*.
- [2] R.B. Marks and J.Puthenkulam, Local and metropolitan area networks-part 16: Air interface for broadband wireless access systems, *IEEE Computer Society .IEEE Std 802.16-2009*.
- [3] Mandeep Kaur Gondaral and Dr.Sanjay kadam, Requirements of vertical handoff mechanism in 4G Wireless networks, *international journal of wireless and mobile networks (IJWMN) vol. 3,no.2, April 2011*.
- [4] Pramod Goyal and S.K.Saxena, "a Dynamic decision model for vertical handoff across heterogeneous wireless networks, 677? 2008 WASET.ORG, *World academy of science, engineering and technology, issue 41, pp 676-682*.
- [5] Bushra Naeem, Able Nyampfene, Seamless vertical handover in wifi and WiMAX networks using RSS and motion detection, *Pacific journal of science and technology vol 12 May 2011*.
- [6] D Ma and M Ma, A QoS based vertical handoff scheme for interworking of WLAN and WiMAX, *Proc.IEEE global telecomm. Conf,PP.2260-2265,Nov./Dec.,2009*.
- [7] R.Prasad,C.Dovrolis,M.Murray,And K.Claffy, Bandwidth estimation metrics ,measurement techniques and tools, *IEEE network vol.17,No.6,PP.27-35,Nov-Dec.2003*.
- [8] Rajendra Kumar and Brahmjit Singh, Comparison of vertical handover mechanisms using generic QoS trigger for next generation network, *International journal of next generation networks (IJNGN) Vol.2, No.3, Sept.2010*.