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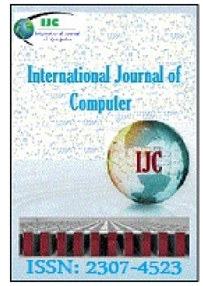

Wireless Heterogeneous Network

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Abstract

Heterogeneous network environment can be viewed as connecting computers and network devices such as switches, repeaters and routers with different protocols and different operating systems which varies in type, size, and topology; differences and how these networks can relate or interact with each other. Heterogeneous networks (HetNets) are an attractive means of expanding or increasing mobile network capacity thereby eradicating the problems to communicate between other networks when switching from one access technology to another. A heterogeneous network is typically composed of multiple radio access technologies, architectures, transmission solutions, and base stations of varying transmission power. Heterogeneous network integrate many up to date wireless technologies together to provide multimedia services by session initiation protocol (SIP) – based Internet protocol (IP) multimedia subsystems via mobile multiple mode devices.

Keywords*:* Heterogeneous network, WiMAX, IEEE, IP, Session Initiation Protocol (SIP)

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1. Introduction

It is a challenging feature for Heterogeneous networks to integrate several IP-based access technologies in a seamless way, the growth of the communication industry around the world is very high and tremendous [1]. There are different modes such as wired, wireless infrastructure based, ad-hoc network, mobile based network among others; supporting the growth of the communication industry but with all certain limits. Now, it is time to emerge into the world of mobility where the wireless communication plays a vital role, where it is necessary to satisfy the requirements of the modern world by providing high quality of service that can be accessible and acceptable anytime, anywhere and any day.

A large variety of applications such as environmental or habitat monitoring, emergency response, vehicular communication, to name a few, require that future Internet works be tolerant to frequent or long-lived connectivity disruptions. This connectivity disruption is the inherent property of Delay or Disruption Tolerant Networks (DTNs). Utilizing these networks will demand features such as real time, high availability across different access technologies in a seamless way, wide access wireless network have larger coverage and support better mobility but lower data rates and it requires high power consumption on mobile terminals When a user moves from one cell to another, the base station of the new cell must take the responsibility of handling all the previously established connections. A significant part of this responsibility involves allocating sufficient resources in the cell to maintain the quality of service (QoS) needs of the established connection(s). If sufficient resources are not allocated, the QoS needs may not be met, which in turn may result in premature termination of the connection. The network selection is made at the time of connection establishment by studying the nature of the network between the source and the destination, this research paper addresses the difficulty on connection thereby making it flawless connection anytime anywhere through the best network without delay.

1.1 *Statement of Problem*

In the last decade, being able to connect seamlessly anytime anywhere to the best network still remains an unfulfilled goal. Often, even determining the best network is a challenging task because of the widespread deployment of overlapping wireless networks and an expert manager is needed to handle the heterogeneous system and network that is hard to come by [2].

Various complementary access technologies namely WLAN, Bluetooth, GSM, WiMAX among others are developed with service intended to cater to different sections of mobile users. Each of these technologies has its own diverse set of standards, protocols and support homogeneous network mobility in their own way. For example, a mobile device can move between Access Points (AP) of a WLAN or WiMAX, handoff occurs when there is movement between cells of the same network type. With the current infrastructure and the increase in heterogeneous networks, it frequently possible to have wireless access of one type or another everywhere, yet there is not a single strong architecture, which embraces all these technologies and provides seamless interoperability between these disparate interfaces. Since these wireless infrastructures have developed independently of each other, we now have to integrate them in order to achieve seamless roaming [3].

1.2 Objectives of the Study

This study aims at achieving the following objectives:

Integrate all existing networks under a single environment with an understanding between the functional operations and also includes the ability to make use of multiple broadband transport technologies such as router for WIFI network, network base station for mobile phones and to support generalized seamless mobility in a heterogeneous network environment.

1.3 Significance of Study

To enhance better seamless communication between all heterogeneous networks.

This article is classified into the following stages apart from the introduction; section ii deals with literature review, section three handles research methodology, section iv talks about analysis and reports and finally section v which is on recommendations and conclusion.

2. Literature Review

2.2 Types of Heterogeneous Networks

2.2.1 Satellite (B-Gan)

According to the Harris manufacturing Co Ltd” the Harris RF-7800B-DU024 is a type of satellite communication device which is a Portable Broadband Global Area Network (BGAN) SATCOM terminal which provides tactical radio network capabilities. The RF-7800B-DU024 is a Class 2 BGAN Land Portable Terminal that provides data rates of up to 432 Kbps. The RF-7800B-DU024 BGAN terminal is mainly designed for operation in harsh environmental conditions like the TORNADO, FLOODING. E.T.C

This RF-7800B-DU024 terminal is a manually pointed antenna system which can be retracted and these systems is capable of rapid deployment for sending and receiving data once pointed at the satellite [4].

To enjoy seamless communication with other networks you need to use with AN/PRC-117G(V)1(C) or the RF-7800M man pack radio, the terminal does provides a multi-mode system utilizing ad-hoc networking to automatically route or change between mobile wideband networked line-of-sight (LOS) nodes, adding global beyond-line-of-sight (BLOS) satellite connectivity. Such equipment is common with law enforcement agencies and homeland security.

2.2.2 Mobile Wireless

ZERO GENERATION TECHNOLOGY (pre call era)

Mobile Wireless telephone started from zero generation technology. It started at a point where we call the 0G. Mobile Telecommunication became available just after World War II. They are predecessors of the first generation of cellular telephones; these systems are called 0G (zero generation) systems. Technologies used in 0G systems are listed below

- PTT (Push to Talk),
- MTS (Mobile Telephone System),
- IMTS (Improved Mobile Telephone Service),
- AMTS (Advanced Mobile Telephone System),
- OLT (Norwegian for Offentlig Landmobil Telefoni, Public Land Mobile Telephony) [5].

First Generation Technology (1g)

1G stands for first generation, refers to the first generation of wireless telecommunication technology, these are popularly called cell phones, they were set of wireless standards developed in the 1980's, 1G technology replaced the 0G technology [5].

Its successor, 2G, which made use of digital signals, 1G wireless networks used analogue radio signals. Through 1G, a voice call gets modulated to a higher frequency of about 150MHz and up as it is transmitted between radio towers. This is done using a technique called Frequency-Division Multiple Access (FDMA).

Second Generation Technology (2g - 2.75g)

2G is short for second-generation wireless telephone technology. It cannot normally transfer data, such as electronic mail or software, other than the digital voice call itself, and other basic ancillary data such as time and date. Nevertheless, short message service (SMS) is also available as a form of data transmission for some standards. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja (now part of Elisa Oyj) in 1991. GSM Service is used by over 2 billion people across more than 212 countries and territories. The ubiquity of the GSM standard makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world [5].

2.5G – GPRS (General Packet Radio Service)

2.5G stands for second and a half generation, is a cellular wireless technology developed in between its predecessor, 2G, and its successor, 3G. The term second and a half generation is used to describe 2G-systems that have implemented a packet switched domain in addition to the circuit switched domain. 2.5G is an informal term, invented solely for marketing purposes, unlike 2G or 3G which are officially defined standards based on those defined by the International Telecommunication (ITU) [6]. GPRS could provide data rates from **56 kbit/s** up to**115 kbit/s**. It can be used for services such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS).

2.75G – EDGE (Enhanced Data rates for GSM Evolution)

EDGE (EGPRS) is an abbreviation for Enhanced Data rates for GSM Evolution, is a digital mobile phone technology which acts as a bolt-on enhancement to 2G and 2.5G General Packet Radio Service (GPRS) networks. This technology works in GSM networks. EDGE is a superset to GPRS and can function on any network with GPRS deployed on it, provided the carrier implements the necessary upgrades. EDGE technology is an extended version of GSM. It allows the clear and fast transmission of data and information. EDGE technology is preferred over GSM due to its flexibility to carry packet switch data and circuit switch data. GSM cannot carry packets [6].

Third Generation Technology (3g – 3.75g)

3G is the third generation of mobile phone standards and technology. It is based on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications programme, IMT-2000. 3G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. Services include wide area wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment. 3G (Third Generation Technology) technologies make use of value added services like mobile television, GPS (global positioning system) and video conferencing. The basic feature of 3G technology is fast data transfer rates. 3G technology is much flexible, because it is able to support the 5 major radio technologies. These radio technologies operate under CDMA, TDMA and FDMA.CDMA holds for IMT-DS (direct spread), IMT-MC (multi carrier). There are many 3G technologies as W-CDMA, GSM EDGE, UMTS, DECT, WiMAX and CDMA 2000. 3G has the following enhancements over 2.5G and previous networks: Enhanced audio and video streaming; several Times higher data speed; Video-conferencing support; Web and WAP browsing at higher speeds; IPTV (TV through the Internet) support [8].

Fourth Generation Technology

4G refers to the fourth generation of cellular wireless standards. It is a successor to 3G and 2G families of standards. The nomenclature of the generations generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology and new frequency bands. The first was the move from 1981 analogue (1G) to digital (2G) transmission in 1992. This was followed, in 2002, by 3G multi-media support, spread spectrum transmission and at least 200 kbit/s, soon expected to be followed by 4G, which refers to all-IP packet-switched networks, mobile ultra-broadband access and multi-carrier transmission [8].

Table 1. Comparing the generation of wireless technologies

GENERATION	**YEAR**	**TECHNOLOGY**	**DATA**
1G	Early 1980s	TACS,AMPS	Analog Voice
2G	Early 1990s	D-AMPS,GSM,CDMA	Digital Voice
2.5G	1996	GPRS, EDGE, EVDO, EVDV	Digital Voice + Data
3G	2000	WCDMA, CDMA2000	Digital Voice + High Speed Data + Video
4G	2012	Not finalised	Digital Voice, High Speed Data, Multimedia, Security

Source: Research work, 2013

2.3 Related works

Recently, many optimization approaches have been proposed to enhance smooth output or the performance of handoff in these present generation heterogeneous networks and even the future heterogeneous networks. Although there has been lots of previous work done which concentrated on the architectures and the mechanisms to support roaming and vertical handoff.

Seamless handoff in mobility support has become a great issue in heterogeneous wireless networks (HWN). These issues are categorized into

- Architectural: They have their issues and there issues are related to handoff control, Methodology and protocols re-routing the connection
- Decision Algorithm: issues are the handoff decision algorithm and the metrics exploited by the algorithm to decide on the handoff.

Research according to [8] proposed session initiated protocol (SIP) based procedure for congestion aware handover in heterogeneous networks. With newly defined SIP messages, the handover decision is based not only on the signal strength, but also on the target network status. According to a research carried out by [7], the handoff process can be divided into three stages: initiation, decision and execution. Handoff initiation is responsible for triggering the handoff according to specific conditions such as, radio bearer deterioration or network congestion. In the handover decision stage, (AP) / Base station (BS) decisions are taken in appropriate time. At this stage, several parameters such as the signal strength of neighbouring APs and available radio resources are considered before a final decision is reached. The required signalling exchange for communication re-establishment and data re-routing through the new path is made in the last and final stage. On the same note, [9] and [10] suggested three main alternatives for handover decision depending on the way the network and the MT contribute to it: network-controlled handover, mobile-assisted handover and mobile controlled handover. While [6] and [8] opined a different moves for triggers and optimization and they are summarized as follows:

1. Received Signal Strength (RSS) or SNR (for example, user uses the network with the best available signal).
2. QoS parameters in the network (for example, some applications require a high level of QoS support).
3. Bandwidth of the target network (for example, user uses the network with the broadest bandwidth).
4. Power consumption (for example, some network interfaces require higher power, which can lead to greater battery consumption).
5. Economic price (for example, user prefers the use of cheapest network).
6. Preferred network operator (for example, user prefers to use particular operator).
7. Combinations of the above triggers.

3. Research Methodology

Vertical Handoff

This helps to keep continuous user communications when a mobile terminal changes or switches it access point. i.e. when switching from access technology A (GSM) to access technology B (WIFI)

Vertical Handoff Process

The vertical handoff processes are divided into three phases: network discovery, handoff decision, and handoff execution.

A. Network discovery

This is when a mobile terminal looks out for reachable wireless networks during the network discovery process. The Mobile Terminal must know which wireless networks are reachable. A multimode mobile terminal must activate the interfaces to receive service advertisements broadcasted by different wireless technologies. A wireless network is reachable if its service advertisements can be heard by the mobile terminal. The easiest way to discover reachable wireless networks is to ensure that all interfaces are kept on. It is critical to avoid keeping the idle interface always on since keeping the interface active all the time consumes the battery power even without receiving or sending any packets

B. Handoff decision

Handoff decision can be refer to as the ability to decide when to perform the vertical handoff and determine the best handoff candidate access network. This phase compares the neighbour network QOS and the mobile users QOS with this QOS decision maker makes the decision to which network the mobile user has to direct the connection.

C. Handoff execution

The connections should be transferred in a seamless manner from the existing network to the new network.

Classification of Vertical Handoff

Vertical Handoff can be classified into four types based up on its direction, process, control and decision:

i) Upward and Downward Handoffs:

In Vertical Handoff, if the mobile node switches from the network with a small coverage to a network of larger coverage, it is termed as upward handoff. On the other hand, a downward handoff occurs in the reverse direction, i.e. from a network of larger coverage to a network of smaller coverage.

ii) Hard and Soft handoffs:

When the mobile node switches to the target network only after the disconnection from current network is called as hard handoff or break before make. On the other hand, in soft handover a mobile node maintains the connection with the previous base station till its association with the new base station is completed.

iii) Imperative and Alternative handoffs:

When there is loss of signal strength an imperative handoff occurs. For imperative handoff the RSS is sufficient to be considered. On the other hand, an alternative vertical handoff is initiated to provide the user with better performance. For alternative handoffs several other network parameters such as available bandwidth, supported velocity and cost of the network are to be considered in addition to the device parameters such as quality of service demanded by the application and user preference.

iv) Mobile Controlled and Network Controlled Handoffs:

Vertical handoffs can further be classified based on who controls the handoff decision. If mobile node controls the handoff decision, it is termed as Mobile controlled handoff (MCHO). In Network controlled Handoff (NCHO) networks control the handoff decision. The handoff decision control is shared between the network and mobile in case of Mobile controlled Network Assisted (MCNA) and Network Controlled Mobile Assisted handoffs (NCMA). MCNA handoffs are more suitable because only mobile nodes have the knowledge about the network interfaces they are equipped with and user preferences can be taken into consideration [10].

4. Reports and Analysis

Vertical Algorithms

COMPLEX PARAMETER CONSIDERATION

This will let the system consider complex conditions for handoffs to be possible.

Handoff Decision algorithms

1. Start
2. Scan for the various Network types available
3. Determine their Order of preference
4 Continue the ordering
5 If a new highest ordered discovered
6 Select the newly highest ordered
7 Execute Handoff
8 Else continue scanning
9 End

For velocity

1. Scan for available networks
2. Check the velocity of each network found
3. Make a list of networks found with their velocity
4. Loop through the list and search for the best velocity using this sample iteration
5. Declare network velocity array [number of networks]= [network Name , Velocity, network velocity Rank];
6. Assign the value for the first network as network velocity[] = [network1name, 1];

```
For(x=0; x= total networks; x++)

If(network velocity [x]. Velocity > minimum)

{

Network velocity [x]. Rank =n;

For((y=x+1; y=total marks; y++)

{

If(network velocity [y]. velocity >network velocity (x). velocity)

{

Network velocity[y] =[network (y)name, network (y) velocity, rank(minimum-1) ];

Minimum -=1;

}

}
```

Received Signal Strength (RSS)

```
For(x=0; x= total networks; x++)

If(network rss[x]. rss > minimum)
```

```
{
Network rss [x]. Rank =n;
For((y=x+1; y=total marks; y++)
{
If(network rss [y]. velocity >network rss (x). rss)
{
Network rss[y] =[network (y)name, network (y) rss, rank(minimum-1) ];
Minimum -=1;
}
}
```

Bandwidth

```
For(x=0; x= total networks; x++)
If(network bandwidth [x].bandwidth > minimum)
{
Network bandwidth [x]. Rank =n;
For((y=x+1; y=total marks; y++)
{
If(network bandwidth [y]. velocity >network bandwidth (x). velocity)
{
Network bandwidth[y] =[network (y)name, network (y) velocity, rank(minimum-1) ];
Minimum -=1;
}
}
```

TAKING THE HANDOFF DECISION

To choose the best network, the system must compute the following for the average.

We will calculate the average rank for every network and then determine the network with the highest average rank

FOR AVERAGE RANK (AR)

```
For(x=0; x= total networks; x++)

If(ar [x].ar > minimum)

{

ar [x]. Rank = (network velocity [y]. velocity +network rss [y]. rss + network bandwidth [y].bandwidth)/3

For((y=x+1; y=total marks; y++)

{

If(ar [y]. ar >ar (x). ar)

}

For((x=1 ; x=nos of network; x++)

{

If (network(x).rank<minimum)

{

New best rank=network(x)

}

Best rank network=new best rank

}
```

5. Recommendations

Though the integration of seamless network communication across wireless heterogeneous network was a success, various modifications and enhancements can still be done to improve its integration. Further research can still be made into how to combine various vertical handoff parameters so as to ensure minimal handoff.

Conclusion

This article basically shows the integration of seamless network communication across wireless heterogeneous network and if this concept is implemented, handoff would be eliminated to the minimum which would be easier for users to move around with their various access technology devices in heterogeneous wireless environment without any service disruption as well as without notifying the user whenever the devices are switching from one access technology to another service continuity is always ensured. In our article, we have compared the evaluation parameters of vertical handoff decision in the heterogeneous wireless networks. The main observation of the evaluation parameters is to reduce the handoff processing delay time and a trust vertical handoff decision algorithm is done in our research to show for this. Also due to lack of infrastructure, this algorithm cannot be implemented in real life.

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