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TOPSIS METHOD FOR HANDOVER DECISION IN NEXT GENERATION NETWORKS

P. Ravi Kiran[#1] and Y. K. Sundara Krishna[#2]

[#]*Dept. of Computer Science, Krishna University, Machilipatnam – Andhra Pradesh, INDIA*

[1]camravikiran@gmail.com

[2]yksk2010@gmail.com

Abstract— Next Generation Networks have a major impact on existing communication technology. The main goal of Next Generation Networks is to give a greater flexibility to the users to access the desired services from the available heterogeneous networks at anytime, anywhere vigorously with the concept of generalized mobility. Seamless mobility is one of the major characteristics of next generation heterogeneous networks. NGN user may be interested to change or may be forced to change the access network technology to achieve Quality of Service (QoS) in seamless mobility. The way of changing the mobile between dissimilar access network technologies can be treated as vertical handover, a critical handover issue. This paper aims to develop an approach using TOPSIS method for vertical handover decisions amongst different access networks of NGN by considering QoS parameters.

Index Terms— Next Generation Networks, Seamless mobility, vertical handover, NGN services, access network parameters, TOPSIS method.

I. INTRODUCTION

In the recent years, wireless networks such as UMTS, Wi-Fi, WiMAX and WCDMA/HSPA has encouraged the emergency of many services such as VOIP, FTP, video on demand, web applications etc. that takes the advantages of the mobility. However, a single technology can hardly satisfy all the services expectations. Therefore the integration of different wireless technologies in a heterogeneous environment offers best opportunity

for services to be well served. NGN is urbanized to integrate heterogeneous wireless technologies that aim to provide guaranteed QoS. Seamless transfer of user's service from existing network to the new network with dissimilar radio access technology is called Vertical handover. As vertical handover is a critical problem, its issues need to be addressed. Handover decision is one of the major issues of vertical handover. Different approaches have been developed to address the handover decision issue of vertical handover. These approaches have to be developed that takes handover decision efficiently.

The rest of the paper is organized as follows. In section II we describe access networks and its technologies with data rates and frequency bands. Section III elucidates the access network parameters for different access network that are helpful in developing vertical handover decision approaches to achieve QoS. Categorizing NGN services and its applications are clearly explained in section IV. Section V describes the proposed vertical handover decision approach using TOPSIS method that selects suitable access networks to handle ongoing services while handover. Finally, section VI concludes that the proposed vertical handover decision approach is based on the context of the services employed by NGN users.

II. ACCESS NETWORKS & ITS TECHNOLOGIES

A typical NGN environment consists of Core Network (CN) and Access Networks (ANs) that are interconnected to achieve generalized mobility. The Core of NGN is essentially the IP based backbone network and uses digital technology to connect telephone calls and other network traffic more efficiently than traditional networks. Access Network is a network that is characterized by a specific wired/wireless access technology. A Radio Access Technology is the underlying physical connection method for a radio based communication network. Table I shows different RATs under different access. networks of NGN [1]. Figure 1 shows the NGN environment with CN and interconnected ANs.

This section briefs different Radio Access Technologies their standards and other specifications.

A. EDGE

Enhanced Data rates for GSM Evolution (EDGE) is an enhancement of GSM towards UMTS which uses enhanced modulation schemes that allows improved transmission rates up to 384Kbits/s. EDGE is a part of ITU's 3G definition.

TABLE I

RADIO ACCESS TECHNOLOGIES CATEGORIZED UNDER EACH ACCESS NETWORK

Access Network	Radio Access Technology
Cellular 2G	EDGE
Cellular 3G	UMTS, UMTS+HSPA, CDMA 2000
Cellular 4G	LTE
WMAN	WiMAX
WLAN	Wi-Fi

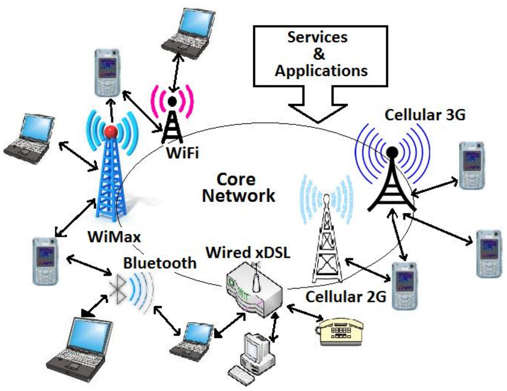

Fig. 1: NGN Environment

In addition to Gaussian minimum-shift keying (GMSK), EDGE uses higher-order PSK/8 phase shift keying (8PSK) for the upper five of its nine modulation and coding schemes [2].

B.UMTS+HSPA

The European proposal for IMT-2000 is Universal Mobile Telecommunication System (UMTS) which provides a range of broadband wireless and mobile communication services [3, 4]. The objective of UMTS is to build an all-IP network and uses complex technologies includes Wideband Code Division Multiple Access (W-CDMA), Asynchronous Transfer Mode (ATM), and Internet Protocol (IP) [5]. High Speed Downlink Packet Access is a modified interface version of UMTS in 3GPP. This interface provides both downlink and uplink data packet access with speed up to 14 Mbps per user [6, 7].

C. Wi-Fi

Wi-Fi is abbreviation of Wireless Fidelity is an IEEE 802.11 standard. It is a Wireless Local Area Network (WLAN) which allows direct adhoc or peer-to-peer access without Access Points. Wi-Fi uses unlicensed spectrum 2.4GHz. It is faster and more flexible in terms of connectivity and bandwidth [8].

D. WiMAX

WIMAX is Worldwide Interoperability for Microwave Access is an IEEE 802.16 standard. WIMAX provides portable mobile broadband connectivity across cities and countries. WiMAX network operators typically provide a WiMAX subscriber unit which connects to the metropolitan WiMAX network. The licenced spectrum allocated for WiMAX is 2.3GHz, 2.5GHz and 3.5GHz. WiMAX define peer-to-peer and adhoc networks with connection oriented MAC [9].

E. Wired LAN

Wired LAN is an IEEE 802.3 standard defines Medium Access Control (MAC) layer which is a sub layer for Physical and Data Link layer of wired Ethernet. Physical connections are made between nodes and/or infrastructure devices (hubs, switches, routers) by various types of copper / fibre cable.

Table II shows the data rates and frequency bands of different Radio Access Technologies with its wireless standards.

TABLE II

DATA RATES & FREQUENCY BANDS FOR RADIO ACCESS TECHNOLOGIES

Radio Access Technology	Wireless Standards	Data Rates	Frequency band
EDGE	--	2 Mbps	850/900/1800/1900/2100 MHz
UMTS+HSPA	--	7.2 Mbps	1.95 – 2.15 GHz
Wi-Fi	802.11g	54 Mbps	2.4 GHz
WiMAX	802.16a	75 Mbps	2 – 11 GHz
Wired LAN	802.3	100 Mbps	2.45GHz

III. ACCESS NETWORK PARAMETERS

To develop vertical handover decision approaches for NGN, access network parameters of different access networks are necessary.

These parameters are sometimes essential and sometimes non-essential depends on the type of services utilizing by the NGN users. This section describes access network parameters that are necessary for developing vertical handover approaches to achieve QoS [courtesy - 10], [11], [12], [13]:

A. Throughput

Bandwidth is the amount of data that passes through a network connection in wireless networks over time as measured in bits per second. Network throughput is the average rate of successful delivery over a communication channel. These data may be delivered over a physical or logical link, or pass through a certain network node. Throughput can be measured in data frames per second or data frames per time slot. Bandwidth can also be defined as the maximum throughput.

Throughput = Total bytes sent * 8

Last frame sent time – First frame sent time

B. Latency

Latency is defined as the time taken for a source to send a data frame to a receiver. Latency is typically measured in milliseconds. As the latency decreases the network performance increases.

Latency = Frame received time – Frame sent time at Server at Client.

C.End-to-End Delay

End-to-end delay indicates the length of time taken for a frame to travel from the CBR (Constant Bit Rate) 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.

Average Sum of transmission

End-to-End delay = delays of all received frames

Number of frames received

Where, transmission delay of a frame is nothing but the latency.

D. Average Jitter

Jitter is a variation in frame transit delay caused by queuing, contention and serialization effects on the path through the network. In general, higher levels of jitter are more likely to occur on either slow or heavily congested links. The usual causes include connection timeouts, connection time lags, data traffic congestion, and interference. Simply put, jitter is an undesirable output of system flaws and interruptions. Thus when jitters occur, computer monitors and computer processors may malfunction, files may get lost, downloaded audio files may acquire noise, Internet phone calls may get interrupted, suffer time lags or get disconnected. Jitter can be calculated only if at least two packets have been received.

Average Jitter = Sum of Jitter for all received frames

Number of frames received – 1

Where, Jitter = Transmission delay of current frame – Transmission delay of previous frame.

E. Bit Error Rate (BER)

Bit error occurs when one or more bits of data travelling across a network fail to reach their destination. Finite number of bits collectively forms a packet. Data loss can be caused by a number of factors, including signal degradation over the network medium due to multipath fading, packet drop because of channel congestion, corrupted data packets rejected in transit, faulty networking hardware, faulty network drivers or normal routing routines. In addition to this, Bit Error Probability is also affected by Signal-to-Noise Ratio and distance between the transmitter and receiver.

BER= Packet transmitted –Packet received

Session Time * 100

F. Signal to Noise Ratio (SNR)

Signal-to-noise ratio is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal).

SNR= [Psignal/Pnoise] Where, P is average power.

Both signal and noise power must be measured at the same and equivalent points in a system, and within the same system bandwidth. If the signal and the noise are measured across the same impedance, then the SNR can be obtained by calculating the square of the amplitude ratio.

SNR= [Psignal/Pnoise] = (Asignal/ Anoise)2Where, A is root mean square (RMS) amplitude (for example, RMS voltage).

Because many signals have a very wide dynamic range.

SNRs are often expressed using the logarithmic decibel scale. In decibels, the SNR is defined as

SNRdB = 10 log 10 (Psignal/Pnoise) = 20 log10 (Asignal/ Anoise)

G.Modulation Scheme

Modulation is the process of conveying a message signal, by transferring a digital bit stream over an analog band pass channel. This modulation is called digital modulation. Based on the type of digital modulation technique the data throughput can vary. Modulation schemes for different radio access technologies are shown in Table III.

TABLE III MODULATION SCHEMES FOR RADIO ACCESS TECHNOLOGIES

Radio Access Technology	**Modulation Scheme**
EDGE	GMSK+8PSK
CDMA2000	CDMA
UMTS	QPASK
UMTS+HSPA	QPSK
Wi-Fi	OFDM (for >20Mbps), DSSS with CCK (for <20Mbps)
WiMAX	OFDM
Wired LAN	PAM

IV. NGN SERVICES

NGN is a packet-based network that handles multiple types of traffic. In NGN, users can have unfettered access to different type of networks or type of services on their choice. NGN Services can be classified into four categories according to the class of services: 1) Conversational services 2) Streaming services 3) Interactive services and 4) Background services [14, 15].

A. Conversational Services

Conversational services provide typical applications like VoIP and video conferencing. These types of applications always perform Real-time conversation between peers of live endusers. The QoS characteristics for these services are estimated based on human perception.

B. Streaming Services

Streaming services are one-way transport services in which the user is listening to audio or looking at real-time video. This type of services always needs a real-time data flow aiming at live destination. The best examples for streaming services are CBR applications.

C. Interactive Services

In interactive services, the end user is retrieving data from remote devices by consistently interacting with them. Examples for human interaction with the remote equipment's are Database retrieval, web browsing, remote server access etc.

D. Background Services

Sending and receiving of data files in the background by the end user from any remote source is called background traffic. Applications that provide these kinds of services are categorized as background services. E-mails, SMS, download of databases, updates for antivirus/ software and other FTP applications are examples for background services.

V. TOPSIS METHOD FOR VERTICAL HANDOVER DECISION

Handover refers to the process of transferring an ongoing service from one channel connected to the core network of another in NGN. Handovers can be classified as two types: 1) Horizontal handover and 2) Vertical handover. Horizontal handover referred to as the handover of an ongoing service within the same access technology, whereas vertical handover referred to as handover of the services between different access network technologies [16, 17]. Vertical handover is a critical problem and involves changing the access network to handle the ongoing services. An efficient approach that selects the suitable access network from the available access networks is mandatory to provide seamless services. An approach has been developed to address the issues of vertical handover from the data link layer. Apply TOPSIS method to generate ranks to the available access networks and selects the best suited access network to continue the ongoing services without interruption [18, 19].

In this approach, TOPSIS method is used to select the best access network from the available access networks to continue the ongoing service. TOPSIS is an acronym for Technique of Order Preference by Similarity to Ideal Solution [19]. This method is based on the concept that the chosen alternative should have the shortest geometric distance from the ideal solution and the longest geometric distance from the negative ideal solution.

This approach can be realized by considering set of available access networks with their access network parameter values. TOPSIS is a method of compensatory aggregation that compares a set of available access networks by identifying weights for each parameter of the available access networks. As the access network parameter values are often of incongruous dimensions, normalize the values for each parameter of the available access networks. Calculate the separation measures for each access network parameter value from ideal access network parameter value and negative ideal access network parameter value respectively. An ideal access network parameter value or negative ideal access network parameter value is maximally/minimally suitable value purely depends on the impact of the access network parameter in continuing the ongoing services. Generate a vector of relative closeness to the ideal solution for all the available access networks and rank them. Select the best ranked access network to continue the ongoing services without interruption.

Steps for TOPSIS [courtesy – 19]:

Step 1: Construct a decision matrix m□n, m available access networks and n access network parameter values. is the jth access network parameter value with respect to ith access network.

Step 2: Construct normalized decision matrix.

For i = 1, 2 … m and j= 1, 2 … n

Step 3: Assume we have a set of weights for each access network parameter for j = 1, 2…n.

Construct the weighted normalized decision matrix.

Step 4: Determine the ideal and negative ideal solutions.

Ideal solution:

Where Based on the jth access network parameter value

Negative ideal solution:

Where Based on the jth access network parameter value

Step 5: Calculate the separation measures for each access network.

The separation from the ideal access network is: i = 1, 2…m

Similarly, the separation from the negative ideal access network is: i = 1, 2…m

Step 6: Calculate the vector of relative closeness to the ideal solution i = 1, 2…m.

After calculating the vector of relative closeness to the ideal solution for n access networks by using TOPSIS method, generate ranks for all the available access networks. The best ranked access network is suitable to continue the ongoing service. Such access network is selected for handover the ongoing service. If the best ranked access network is not available, chose the access network with the next best rank

VI. CONCLUSIONS

To deal with vertical handover issues of NGN, the approaches that need to develop for vertical handover decisions are based on the context of the services employed by NGN users. Context based vertical handover decision approaches are essential to achieve QoS in seamless mobility. The strategy developed in the proposed vertical handover decision approach is based on the access network parameters. Essentiality of access network parameters depends on the context of the services employed. The proposed vertical handover decision approach is purely based on the context of the services employed by NGN users

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BIOGRAPHIES

P. Ravi Kiran received the B. Tech degree from Srikalahasteeswara Institute of technology, Srikalahasti and M.E degree from Sathyabama University in 2011. He is a research scholar from Krishna University, Machilipatnam and his areas of interests are Mobile Computing, Service Oriented Architecture, Wireless Networks and Information Security. He has presented number of papers in national and international conferences, seminars.

Y. K. Sundara Krishna qualified in Ph.D. in Computer Science & Engineering from Osmania University, Hyderabad. Now, he is working as Professor in the Department of Computer Science, Krishna University, and Machilipatnam. His research interests are Mobile Computing, Service Oriented Architecture and Geographical Information Systems and having practical work experience in the areas of Computing Systems including Developing of Simulators for Distributed Dynamic Cellular Computing Systems, Applications of Embedded & Win32 clients, Maintenance of Multi-user System Software. Also he is working with International Telecommunications Union (ITU): Y. 2018 recommendation series Y: Global Information Infrastructure, Internet Protocol aspects and NGN.