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Original Research Article

VERTICAL HANDOVER IN HETEROGENEOUS NETWORK

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Abstract- The need of always being connected to network with multiple wireless technologies calls for seamless connectivity in high dynamic scenarios. An intelligent handover decision policy able to classify the candidate's point of attachment based on their provided context and the required mobile user context is required to ensure seamlessness. The decision policy is realized with an algorithm which will choose the appropriate context to be used for making decision for mobility management and handover process. In this paper, three radio access technologies, Wi-Fi, 3G and GPRS (mobile networks), are considered for implementation. An optimistic approach for an intelligent handoverin order to achieve the best available network is discussed.

Keywords: Vertical Handover (VHO), Point Of Attachment (POA),Multiple Attribute Decision MakingMADM, Context Aware (CA), Analytic Hierarchy Process (AHP) Encryption Standard (AES)

Introduction

Mobile network is made up of cells, each served by at least one fixed location transceiver called as base station. In a cellular system as distributed mobile transceivers move from cell to cell during an ongoing continuous communication mobile unit automatically switches from current channel to new channel and communication continues.With diverse wireless technologies there has been an evolution of wireless network towards heterogeneous infrastructure; users thus demand for the freedom to roam globally among multitude POA of different access networks as per service requirements. Such heterogeneity calls for a middleware to adapt to

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different execution conditions at different contexts, hide the heterogeneity from application and transparently and dynamically switch between network technologies. Heterogeneous wireless networks incorporate different radio access technologies. The challenge in internetworking of these heterogeneous networks is to provide high performance by achieving high data rate with high QoS levels.

Wireless access networks vary greatly by nature, for example, with regard to data rate, coverage, supported mobile velocity, anti-interference, and suitable transmitting environment. Usually networks with bigger coverage are of lower data rate, and vice versa. It has been well recognized that no single access technique can fulfill all the requirements. Moreover, the QoS parameters of each single wireless network vary dynamically over time as well, in terms of reliability and availability, bandwidth, delay, jitter, response time, and packet-loss rate. Finally, user mobility leads to continuous changing of location and environment, network operator and service provider, and access networks. These highly dynamic factors in mobile devices, wireless networks, and end users have led to the demand for adaptive seamless connectivity management, so that diverse networking resources can be optimally utilized in a simultaneous, collaborative, and complementary way. Thus principle objective of this work is to design a model which involves simple mathematical calculations and yet selects the optimum resources considering multiple criteria maintaining seamlessness.
This article is organized as follows: In section II we present concepts of handover. In section III, we describe our handover decision scheme. Later,context and context management in vertical handoveris presented in section IV.

Handover
Handover is the action of moving a mobile terminal from one wireless cell/technology to another. When such an action takes place between different cells, it is called, horizontal handover (HHO). Similar action between access technologies with different capabilities and characteristics, it is termed as vertical handover (VHO). This is divided in two categories: upward VHO is a handover to wireless overlay with a larger cell size(but lower bandwidth per unit area) and downward VHO is a handover to a wireless overlay with a smaller sized cell(high bandwidth per unit area). Handover activity requires a connection scheme called soft handover and hard handover. Soft handover, makes connection and then breaks the previous, whereas, hard handover breaks the connection before making one. Hard handover is observed in vertical handover.When heterogeneity of a wireless environment comes into picture it reflects issues namely, mobility, resource allocation, high QoS support, seamless handover.

Seamless handover is a major issue which requires mobility decisions and mobility protocols.

Handover Stages

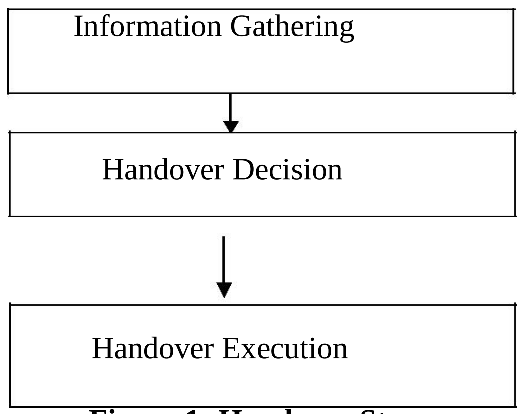

Figure 1: Handover Stages

Information gathering or the system discovery, is the initial phase. The handover information gathering phase collects not only network information, but also information such as network properties, mobile devices, access points, and user preferences. Second, handover decision, decides which algorithm to be executed, based on the information gathered. This directly affects transmission performance and QoS level. Third, is execution stage, this is where actual switching operation from one wireless access technology to another is performed.

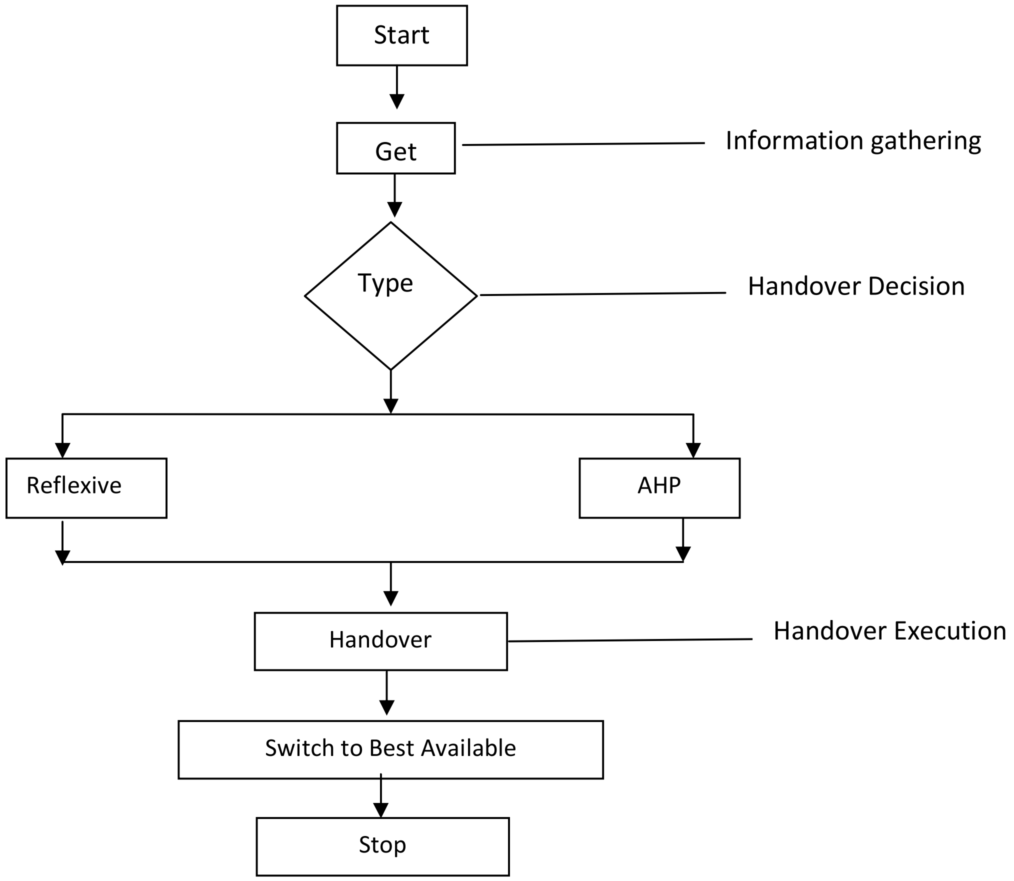

Figure 2 : Procedure for handover

A need for seamless connection is sensed whena user moves in different geographical areas, maintaining a continuous session during his movement without any disruption or loss of information. Tracking the location of the user and evaluating his movements is a major task.Mobility decisions are based on VHO decision criteria and algorithms aiming to ensure automated, rapid and right decision for suitable network selection.

A handover controlling scheme is based on who controls the handover decision, it is categorized as,

1. Mobile assistedhandover
2. Mobile controlledhandover
3. Network assistedhandover
4. Network controlledhandover

In network controlled handover, network decides whether handover should be taken or not depending upon networks parameter, not the mobile terminal. In mobile controlled handover, mobile decides whether handover should be taken or not depending upon mobile parameters, not the network. In Network assisted handover, the mobile terminal takes the decision about the handover considering network parameters. Mobile assisted handover, the network takes the decision about the handover considering the mobile parameters.

In this paper we will be implementing an algorithm considering the network, terminal parameters as per need for an application, based on, Network assisted handover.

Handover Decision Scheme

Multiple Attribute Decision Making (MADM) Strategy

After referring [2][3][6][7] we conclude that the decision making algorithm considers the QoS parameters required for the applications (e.g. the bandwidth required). Each candidate network is compared with the previous best network. The chosen network is the one which provides the best optimized results.

Context Aware :

Context-Aware strategy not only considers mobile terminal information, and network information, but also considers user preference, that is, the information about the application that is running. It supports multi criteria consideration, real time support and high user consideration. Medium implementation complexity, medium throughput and high delay are its short comings. [2][4][6] states the comparisons of various methodologies and algorithms.

In this experiment we implement Context Aware methodology through AHP and a reflexive algorithm, which is a RSS based algorithm as per the handover scenario for seamless connectivity.

Analytic Hierarchy Process (AHP) - A Context Aware methodology:

In AHP, list of threshold values and a list for the set of attributes attained from various contexts as per an application. A comparison list is generated that represents the pair-wise comparison between both the lists. AHP avoids the process of fuzzification and defuzzification; it involves user consideration and has medium implementation complexity. It decomposes the network selection problem into sub problems. The candidate networks are then ranked and the best one is selected.

Reflexive – A RSS based methodology:

A scenario where users within vehicular networks demand to access content from the Internet at high speeds while travelling, that is, switching among multiple access points with heterogeneous coverage areas, as well as with different Quality of Service (QoS) levels.[1] To maintain connectivity seamlessly and conveniently in such dynamic conditions, a rapid vertical handover technique is required. Reflexive methodology, a vertical handover decision algorithm designed for dynamic environments where RSS and available bandwidth are compared to their threshold values and a rapid decision is taken in a dynamic situation. Vehicular environments, latency issues are a critical challenge in this algorithm.

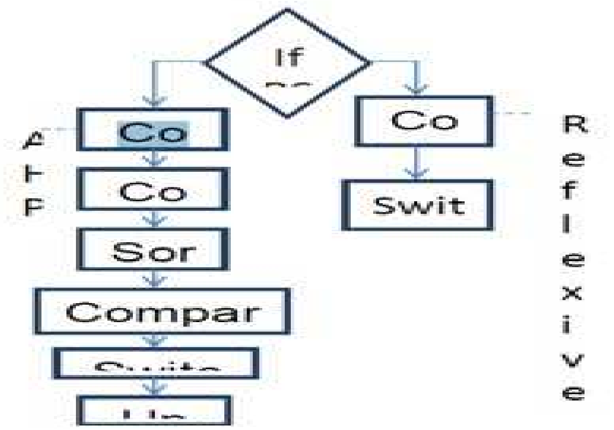

Figure 3: Handover

Context Aware Vertical Handover

Context means data collected through monitoring and measurement,required to identify the need for handover for handover and to apply handover decision.This information is monitored periodically and updated accordingly.[5]It is characterized by a high degree of complexity due to challenges,

1)Decisions may be made quickly

2)Situations and devices evolve dynamically overtime.

Context awareness demands systems to obtain real-time information using available resources in a way, i.e., useful for the applications at hand.[9] The derived context can either be immediately used for triggering actions or perform further computations required to relate the contexts to the situations, leading to what is termed as, situation awareness.

Network QoS Parameters

1) Received Signal Strength (RSS): RSS depicts the power present in a received signal.

2) Available bandwidth:Available bandwidth refers to the width of a range of frequencies in the available network. It measures, how much data can be sent over a specific connection in a given amount of time.

3) Latency:It is the time that elapses during handover stages.

It can be formulated as follows :

Total latency = latency for information gathering + handover decision latency + handover execution latency.

4) Throughput:Throughput refers to the average data rate, successfully delivered over a specific communication link.

5) Packet Loss:Packet loss is measured as packets of data travelling across a computer network, which fail to reach their destination.

6) Jitter: Jitter refers to variation in delay time in the arrival of packets.

7) Round Trip Time (RTT):RTT refers to time taken for a packet to travel from a specific source to a specific destination and back again.

Table I: Priority for network parameters

Sr. No.	Profile	Parameters	Priority
1.	User Profile	1.1 User location	**Low**
		1.2 User mobility	**High**
		1.3 Application type	**High**
2.	Terminal Profile	2.1 Battery Life	**Medium**
		2.2 Power Consumption	**Medium**
3.	Handover Profile	3.1 Number of VHO events successful	**Medium**
		3.2 VHO latency	**High**
4.	Network Profile	4.1 Received Signal Strength (RSS)	**High**
		4.2 Bandwidth	**High**
		4.3 Latency	**High**
		4.4 Throughput	**Medium**
		4.5 Packet Loss	**Medium**
		4.6 Jitter	**Medium**
		4.7 Round Trip Delay (RTT)	**Medium**

Table II: Application specific network parameters[8]

Sr. No.	Application	Parameters	Threshold value
1.	Web Browsing	RSS	Less than -95 dBm
		Available bandwidth	< 30.5 Kbps
		Delay	< 400 ms
		Response time	2-5 sec
2.	Video Streaming	RSS	Less than -95 dBm
		Delay	< 150 ms
		Jitter	< 100 ms
		Available bandwidth	28.8- 500 Kbps
3.	Email	RSS	Less than -95 dBm
		Delay	10 Kbps
		Data rate	< 10Kbps
		Available bandwidth	< 10 Kbps

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