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Survey of Network Selection Approaches in Heterogeneous Wireless Network

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***Abstract*—In the near future, the HWN environment could contain multiple networks, such as universal mobile telecommunications system (UMTS), world-wide interoperability for microwave access (WiMAX), wireless local area network (WLAN). Selection of access network is main challenge in this scenario. To satisfy these requirements for seamless Vertical Handover (VHO) the Media Independent Handover IEEE 802.21 (MIH) which was delivered by IEEE group to give seamless VHO between the previously stated technologies. Various VHO approaches have been proposed in the literature and verified using empirical work in real environment, test-bed, simulation tools and analytical modelling. In this paper, we survey the VHO approaches proposed in the literature and classify them in 5 strategies which we compare their performances and characteristics.**

Keywords*—heterogeneous wireless network, vertical handover, media independent handover, network selection

I. INTRODUCTION

With the progression of wireless communication and mobile communication has been providing flexible, convenient and affordable network administrations than ever. Therefore, the quantity of clients of mobile communication systems has expanded quickly as a sample; it has been accounted for that today, there are billions of mobile telephone endorsers, near to five billion individuals with access to TV and a ten millions of new Internet clients each year and there is a developing demand for administrations over broadband wireless network because of assorted qualities of service which can't be given a solitary remote system anyplace whenever. This implies that heterogeneous environment of remote frameworks, for example, GSM (Global System for Mobile Communication), Wireless Fidelity (Wi-Fi), Overall Interoperability for Microwave Access (WiMAX)

and Universal Mobile Telecommunications System (UMTS) will exist together giving Mobile Users (MUs) with wandering ability crosswise over distinctive networks figure 1 shows the basic architecture of heterogeneous wireless network. One of the important issues in Next Generation Wireless Systems (NGWS) is accomplishing consistent Vertical Handover (VHO) while wandering between these technologies; therefore, telecom administrators will be obliged to build up a procedure for interchange ability of these distinctive sorts of existing systems to get the best association anyplace whenever without interruption to the continuous sessions. To fulfil these requirements for seamless VHO the Media Independent Handover IEEE 802.21 (MIH) mechanism was produced by IEEE group to provide seamless VHO between the different types of technologies (3GPP and non-3GPP). Since no handover decision is made within MIH [3], much research about the VHO decision under MIH has been done.

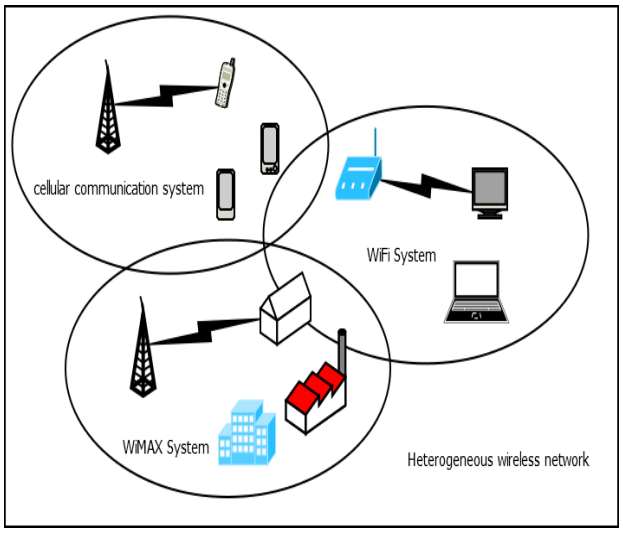

Fig-1 Heterogeneous wireless network

In homogeneous systems, horizontal handovers are regularly required when the serving access switch gets to be distracted because of MT's movement. In heterogeneous systems, the requirement for vertical handovers can be started for comfort as opposed to integration reasons (e.g., as indicated by client decision for a specific administration). Two of the real difficulties in vertical handover administration are seamless and automation of system exchanging. These specific necessities refer to the Always Best Connected idea, of being joined in the best conceivable way in a domain of different access technologies, as indicated by arrangements (expressed by rules based on parameters such as network conditions or user preferences). For that, a handover management technique choose the appropriate time to initiate the handover and the most suitable access network for a specific service among available, and maintain the continuity of the on-going session of user.

II. VERTICAL HANDOVER PROCEDURE

When mobile node moves from same radio access technology to maintain the on-going session that handover procedure is horizontal handover procedure, while when handover is carried out when traveling from one access technology to another radio access technology to continue the on-going session is called as vertical handover.

Vertical handover procedure is divided into three phases:

I. Handover information gathering
II. Handover decision making
III. Handover execution

a) Handover information gathering

In this phase, all required information for VHO decision is gathered, some related to the user preferences (e.g. cost, security), network (e.g. latency, coverage) and terminal (e.g. battery, velocity).

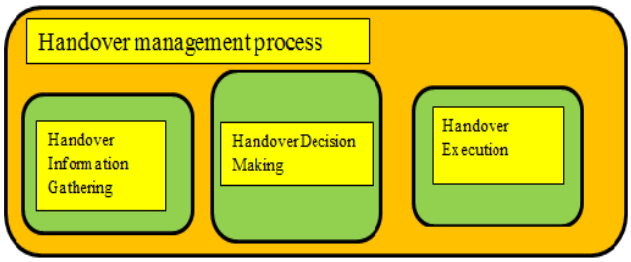

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Fig-2 Handover management process

b) Handover decision making

In this phase, the best RAT based on aforementioned information is selected and the handover execution phase is informed about that.

c) Handover execution

In this phase, the active session for the MU will be maintained and continued on the new RAT; after that, the resources of the old RAT are eventually released.

Figure-2 shows vertical handover management processformat"

III. NETWORK SELECTION APPROACHES

pa" There are various network selection strategies reviewed in literature. Fussy logic based (FL) and neural network (NN) based, multi attribute decision making method (MADM), user centric strategies (UC), context-aware strategies (CA) and decision function based (DF), network selection.

I. Multi attribute decision making method (MADM)

In order to always select a reasonable network, it is necessary to take a large number of factors into consideration simultaneously. Among all the factors, network attributes compose a large category, which are generally used as decision criteria to characterize different aspects of a network's capabilities. Since these criteria have different measurement units, utilities and inexactness, their values need to be adjusted before combining together. [3report stg1] Multiple attribute decision making (MADM) is sometimes applied to decisions involving multiple objectives or multiple attributes. [2]

II. FUSSY LOGIC BASED (FL)

Fuzzy Logic (FL) and Neural Networks (NN) ideas are Applied to pick when and over which organize to hand over among distinctive accessible access systems. These are consolidated with the multiple criteria so as to create advanced choice calculations for both non-real and real time applications. [2]

Network selection using fuzzy logic has two stages

a) Fuzzification and weighing procedure

Fuzzy sets of criteria are created and weighting is applied to get important criteria.

b) Decision making

To choose target network weights of criteria are provided to decision function.

III. User centric strategies

User-centric functions propose handover decision policies and criteria mainly for user satisfaction and non-real-time applications. Deciding the most appropriate network that answers user satisfaction, network efficiency and more criteria, retrieved from the different available networks and more advanced techniques have to be considered. Among the different criteria that a vertical handover decision takes into account, user preferences, in terms of cost and QoS, is the most interesting policy parameter for a user-centric strategy.

IV. Decision function based

Vertical handover decision cost function is a measurement of the benefit obtained by handing over to a particular network. It is evaluated for each network n that covers the service area of a user. It is a sum of weighted functions of specific parameters.[2]

The general form of the cost function f_n of wireless network n is:

$$f_n = \sum_s \sum_i w_{s,i}\, p^{n_{s,i}}$$

Where;

$p^{n_{s,i}}$: The cost in the ith parameter to carry out service on network n,

$w_{s,i}$: the weight (importance) assigned to using the ith parameter to perform service.

V. CONTEXT-AWARE STRATEGIES

The context-aware handover concept is based on the knowledge of the context information of the mobile terminal and the networks in order to take intelligent and better decisions. Thus, a context-aware decision strategy manages this information to evaluate context changes to get decisions on whether the handover is necessary.

It is the framework with an analytical context categorization and a detailed handover decision algorithm. It consists of two main components:

a) the context repository
b) the adaptability manager.

The context repository gathers, manages, and evaluates context information from different parts of the network. The adaptability manager decides about adaptation to context changes and handover execution. It is in charge of the vertical handover decision process. It is a rule-based process deciding when to invoke the handover operation (by evaluating terminal's location changes) and to which network.

Handovers are more efficient when context information is considered. Moreover, it seems to be flexible in a way that it ensures the possibility to use different protocols in exchanging different types of context information and to use different context aware decision algorithms on mobile terminals. fic decision algorithms can be used, context matrix evaluation as a simple linear calculation or a rule-based logic algorithm.

IV. COMPARISON OF NETWORK SELECTION APPROACHES

In this section we have discussed network selection strategies found in the literature [3,4,5,6] and classified them into two categories multi-attribute decision making, fuzzy logic based decision making approaches. In order to provide comparison of the categories, we summarize their features on eight aspects: objective, decision criteria, composition of HWN, complexity and evaluation method, traffic used.

In literature [3] author explained multi attribute decision making (MADM) for network selection in heterogeneous wireless network. Author simulated selection scenario on simulator for SAW and WPM for low-speed and high-speed mobile terminal, and compared the obtained results. Criteria's used are delay, bandwidth, cost, and jitter for HWN consists of wLAN, GPRS, WiMAX, used analytic method for comparison. In [4] author classified the handover metrics based on traffic classes for criteria are bit error rate, delay, jitter, bandwidth. Used simulation for of HWN composed of UTMS, GPRS, wLAN. Both [3-4] used MADM approach for network selection in HWN.

In [5] author simulated test bed consists of GPRS, UMTS, Satellite networks for criteria bandwidth, cost, reliability, and battery status. In [6] author used simulation for network selection for networks WLAN, WiMAX considering criteria's cost, bandwidth, power consumption, security level, bit error rate, jittert.

CONCLUSION

In this paper, we have surveyed Network selection approaches proposed in the literature. We have classified the approaches into two categories multi-attribute decision making based and fuzzy logic based network selection approach for which we have presented their performances and characteristics. In order to provide comparison of the two categories, we have summarized their features on four aspects: VHO decision criteria, Heterogeneous network composition, complexity, evaluation method and traffic. The fuzzy logic based category is used in conjunction other network selection and the majority of its evaluation reside in the theoretical analysis stage which need testing or still too complex for implementation. This category has been mostly and implemented through test bed to get optimal results. Whereas multi-attribute decision making category is usually based on multiple parameters, it has mostly used between three RATs. It's also less complex.

Therefore, we can say that in the near future, providing service continuity through multi-attribute decision making under MIH will allow the operators to diversify their access networks.

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Category	Approach Found in Literature	Applicable Area	Decision Criteria	Complexity	Evaluation Method
Multi-Attribute Decision making (MADM) selection approach	[3]	Delay, bandwidth, cost, jitter	WLAN, GPRS, WiMAX	Complex	Analytic
	[4]	Bit error rate, delay, jitter	UMTS, GPRS, WLAN	Complex	Simulation
	[6]	Cost, bandwidth, power consumption, security, traffic load, signal strength	WLAN, WiMAX	Very complex	Simulation
Fuzzy Logic based network selection approach	[5]	Bandwidth, cost, reliability, battery status.	GPRS, UMTS, Satellite	Highly complex	Test bed

Table 1 Comparison of criteria's