ISSN: 2278 - 1323
International Journal of Advanced Research in Computer Engineering and Technology (IJARCET)
Volume 2, Issue 6, June 2013

Decision Strategies during vertical handover in heterogeneous networks

Sandeep Chouhan Department of Electronics & Communication Ujjain Engineering College, Ujjain M.P. (INDIA)

Mr.R.B.Gaikwad Department of Electronics & Communication Ujjain Engineering College, Ujjain M.P. (INDIA)

Abstract – The next generation (4G) wireless networks is envisioned as a union of different access technologies, using terminals with multiple access interfaces and non-real-time or real-time services. Providing the user with the best anywhere anytime connection and improving the system resource utilization. The integration of Wireless Local Area Network (WLAN) hotspots and third generation (3G) cellular network has recently received much attention. While the 3G-network will provide global coverage with low data-rate service, the WLAN will provide high data-rate service within the hotspots. Although increasing the underlie network utilization is expected to increase the user available bandwidth, it may infringe the Quality-of-service (QoS) requirements of the active real-time applications. Hence achieving seamless handoff between different wireless technologies, known as vertical handoff (VHO), is a major challenge for 4G-system implementation. The most important subject in such situation is the Always Best Connected (ABC) concept allowing the best connectivity to applications anywhere at anytime. To answer ABC requirement, various vertical handover decision strategies have been proposed recently, using advanced tools and proven concepts. In this paper, we give a summary of the most interesting and recent strategies in order to introduce our vertical handover decision approach.

Keywords- Vertical handover, Heterogeneous wireless networks, Handover decision, Strategy.

1. INTRODUCTION

Wireless technology provides different alternatives for its users that vary in terms of coverage, bandwidths, delays, security, and cost of both implementation and service. The next generation wireless networking (4G) is envisioned as a convergence of different wireless access technologies keeping the user connected to the best available access network. Moreover, this convergence is expected to improve the pre-installed infrastructure utilization. In the wireless network hierarchy, overlay networks usually provide low data-rate expensive global services, while underlay networks provide cheaper high data-rate services within hotspots. Hence, overlay networks are preferable for high-mobility users with moderate or low traffic demand, while the underlay networks are recommended for larger users densities with higher traffic demands. In this logic, wireless access technologies are paired.

The integration of wireless local area networks (WLAN) and third generation (3G) cellular networks has been recently a topic of great interest. On one hand, 3G networks will provide global coverage at limited data rates. On the other hand, WLANs will provide higher data rates within hotspots. The integration process is propelled by the interest in bandwidth consuming applications and the clustered nature of traffic due to its concentration in public areas such as hotels, cafe-shops, and airports. Therefore, 3G cellular service providers will be able to relieve of such heavy traffic to WLANs, saving the 3G-network precious wireless resource for users located outside WLAN coverage. As a outcome, wireless Internet service providers will have a new revenue source and will improve the utilization of their pre-installed infrastructure. For the moment, network subscribers will enjoy the best features of both technologies including universal coverage, larger bandwidth, and lower cost of combined services on one bill.

Handover management issues include mobility scenarios, metrics, decision algorithms and procedures. Mobility scenarios can be classified into horizontal (between different cells of same network) and vertical (between different types of networks). In homogeneous networks, the needs for horizontal handovers are typically required when the serving access router becomes unavailable due to Mobile Terminal's (MTs) movement. In heterogeneous networks, the need for vertical handovers can be initiated for convenience rather than connectivity reasons (according to user choice for a particular service). Two of the major challenges in vertical handover management are seamlessness and automation aspects in network switching. These particular requirements can refer to the Always Best

Connected concept, of being connected in the best possible way in an environment of multiple access technologies, according to policies (i.e. network condition parameters or user preferences). A handover management technique must choose the appropriate time to initiate the handover and the most suitable access network for a specific service among those available, and must maintain service continuity. Fig 1 shows the handover types in 4G model.

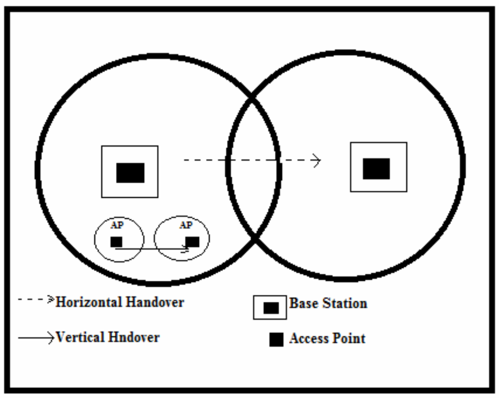

Fig.1 Handover types in 4G Model

2.0 Handover management in heterogeneous wireless networks

Handover management is the key aspect in the development of solutions supporting mobility scenarios. It is the process by which mobile terminals MT maintains its connection active while one point of attachment to another (base station or access router) to another. In this section, we describe the handover process features and we provide the motivation for analyzing the vertical handover decision problem in heterogeneous networks.

2.1 Handover management process

Many literatures describe the handover in three phases

- Handover Information Gathering: used to collect all the information required to identify the need for handover and can subsequently initiate it. It can be called also handover initiation phase or system discovery.
- Handover Decision: used to determine whether and how to perform the handover by selecting the most suitable access network (taking some criteria such as user preferences) and by giving instructions to the execution phase. It is also called network or system selection.
- Handover Execution: used to change channels conforming to the details resolved during the decision phase.

The handover procedure can be distinguished in various types. On one hand, the handover can be *hard* i.e. MT is connected to only one point of attachment at a time. It is referred to as a *break before make* handover. On the other hand, it can be *soft* i.e. MT is connected to two points of attachment at the same time and it is referred to *make before break* handover. For achieving *seamlessness* aspect in mobility scenarios, the handover has to be *seamless*. It means that the transition to the new network point of attachment is transparent to the user. So, it is the one that performs a *fast* handover (minimal handover latency) and a *smooth* handover (minimal packet loss).

Apart from handover types, the handover process control or the handover decision mechanism can be located in a network entity or in the MT itself. The handover decision usually involves some sort of measurements and information about when and where to perform handover and obtained from one entity or both. That's why, in Network Controlled Handover (NCHO), the network entity has the primary control over the handover. In Mobile Controlled Handover (MCHO), the MT must take its own measurement and make the handover decision on its own. In GSM, Mobile Assisted Handover (MAHO) and Network Assisted Handover (NAHO) MT and network collects the information that can be used in handover decisions respectively.

Among handover management solutions, one of the most popular schemes is Mobile IP, an IP layer mobility management protocol. This protocol is in charge of redirecting packets sent by a CN (Correspondent Node) to the MT or MN (Mobile Node) to its current location. It introduces mobility agents: a HA (Home Agent) and a FA (Foreign Agent). In Mobile IP, the handover procedure is carried out by these principles.

- MN detects whether it has moved to a new access network by receiving or sending messages from or to mobility agents. This step is known as *agent discovery*.
- MN obtains a new temporary address, CoA (care-of-address) when its Home Agent, which sets up a new tunnel up to the end point of the new CoA and removes the tunnel to the old CoA. This step is known as registration.
- Once the new tunnel is set up, the HA tunnel packets destined to the MN using the MN's new CoA. This step is known as routing and tunnelling.

In each type of wireless access network, we can find most of these handover process features.

3. Vertical handover decision

This section will give the characteristics needed in vertical handover decision strategy. It could be fascinating to introduce a more general classification according to initiation reasons for a vertical handover decision.

- Imperative or forced handover: triggered by physical events regarding network interfaces availability.
- Alternative or user handover: triggered by user policies and preferences.

While, rules have to be fixed for how and when to trigger the handover. These rules design a handover decision policy and use policy parameters, called metrics or decision criteria i.e. cost, QoS, power requirements, etc. As a result, a vertical handover decision strategy should decide, when to trigger the handover procedure, select and switch seamlessly to the most optimal access network from those available.

3.1 Handover decision criteria

Handover criteria are the qualities that are measured to give an signal of whether or not a handover is needed. Different criteria can be grouped as follows:

- Network-related: coverage, bandwidth, latency, link quality (Received Signal strength (RSS), Carrier-to-Interferences-Ratio (CIR), Signal-to-Interferences Ratio (SIR), Bit Error Rate (BER), etc), cost, security level etc.
- Terminal –related: velocity, battery power, location information, etc.
- User-related: user profile and preferences.
- Service –related: service capabilities, QoS, etc.

Above criteria can be classified into static and dynamic depending on the frequency and causes of changes. Classically static criteria are user profile and the cost of different access networks, whereas the MT's velocity and RSS are typically dynamic criteria.

3.2 Handover decision policy

Handover decision criteria help to establish which access network should be chosen and the handover decision policy represents the control of the network on when and where the handover occurs. The conventional handover decision policy is based only on RSS:

- RSS: choosing the new Base Station (BS_{new})
  If $RSS_{new} > RSS_{old.}$
- RSS with Threshold T: choosing the new Base Station (BS_{new})
  If $RSS_{new} > RSS_{old}$ and $RSS_{old} < T$.
- RSS with Hysteresis H: choosing the new Base Station (BS_{new})
  If $RSS_{new} > RSS_{old} + H$.
- RSS, Hysteresis and Threshold: choosing the new Base Station (BS_{new})
  If $RSS_{new} > RSS_{old} + H$ and $RSS_{old} <$ T.

4. Vertical handover decision strategies

In this section, we introduce a group of the most well designed vertical handover decision strategies proposed in the literature. We differentiate into five categories:

4.1 Decision function based strategies

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 sum of weighted functions of specific parameters. The general form of the cost function f_n of wireless network *n* is

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

$p^n_{s,i}$ the cost in the ith parameter to carry out services s on network n: $w_{s,i}$ the weight assigned to using the ith parameter to perform services.

The first policy-enabled handover strategy was proposed in 1999, which introduced the cost function to select the best available network in the decision making. The parameters used are bandwidth B_n that network n can offer, power consumption P_n of using the network device for n and cost C_n of n. The cost of using a network n at a certain time, with N(i) as the normalization function of parameter i is defined as:

$$f_n = w_b \cdot N(1/B_n) + w_p \cdot N(P_n) + w_c \cdot N(C_n)$$

The network that is consistently calculated to have the lowest cost is selected as the target network. Therefore, this cost function based policy model estimates dynamic network conditions and includes a stability period to ensure that a handover is valuable for each mobile.

The proposed policy-enabled handover system allows users to express policies on what is the best network and when to handover. The system operating environment is a Mobile IP infrastructure in which all the handover decisions and operations are done at the MT. In handover operation, the packets sent by CN to the MN go through it's HA. The HA routes the packets either to the multicast CoA of the MN. When MN is in WLANs, a reverse tunnelling is used where packets are routed to the HA first then to the CN. To achieve flexibility, the system separates the decision making scheme from the handover mechanism. To achieve seamlessness, the system considers user involvement with minimal user interaction.

4.2 User centric strategies

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. A model is proposed based on handover decision evaluated, from the user point of view, as the most convenient handover to his specific needs. Two handover decision policies between GPRS and Wi-Fi networks have been proposed.

1. The MT will never throw out GPRS connection without connection blackouts.
2. The algorithm searches for just Wi-Fi access points with connection blackouts.

The first one will satisfy that user who is willing to pay for having its connections as granted as possible. The second one will satisfy the user from the connection cost point of view but will upset with his expectation of QoS. Based on these policies, the performance of some applications running on the user terminal (FTP, HTTP, & TELNET) improves whereas others become worse. In order to find optimum handover decision policy maximizing the performance and defines a cost function as follows:

$$C = T_{WiFi} \cdot c_{WiFi}(H) + T_{GPRS} \cdot c_{GPRS}(h)$$

T_i –the time spent by the user in the *i*th access network; $c_i(h)$ the fee per unit of time (second) that operator of the *i*th access network charges to the user; C- the monetary cost faced by the user for a given communication session.

The decision method is included into a network selection process module. This module is in charge, on one hand, of retrieving constantly data from the network monitoring module i.e. actual network availability conditions and on the other hand, of getting user preferences specific through the user profile management module. The proposed user centric model integrates a Mobile IP-like distributed mobility protocol to support the roaming of MNs in the Wi-Fi and GPRS domain.

The described user centric functions propose handover decision policies and criteria mainly for user satisfaction and non-real time applications. Deciding for the most appropriate network that answers user satisfaction and network efficiency, more criteria to retrieve from the different available networks and more advanced techniques have to be considered.

4.3 Multiple attribute decision strategies (MAD)

Multiple attribute decision making (MADM) is the handover decision problem deals with making selection among limited number of candidate networks from various service providers and technologies with respect to different criteria. Term such as multiple objectives, multiple attribute and multiple criteria are often used interchangeably in the study of decision making. Distinctions can be made between the different concepts. Multiple Criteria Decision Making (MCDM) is sometimes applied to decisions involving multiple objectives or multiple attributes. But, generally when they both apply. Multiple Objective Decision Making (MODM) consists of a set of conflicting goals that cannot be achieved simultaneously. MADM deals with the problem of choosing an alternative from a set of alternatives which are characterized in terms of their attributes. The most popular classical MADM models are –

- Simple Additive Weighting (SAW): the overall score of a candidate network is determined by the weighted sum of all the attribute values.
- Technique for Order Preference by Similarity to Ideal Solution (TOPSIS): the chosen candidate network is the one which is the closest to ideal solution and the farthest from the worst case solution.
- Analytic Hierarchy Process (AHP): decompose the network selection problems into several sub—problems and assign a weight value for each sub-problem.
- Gray Relational Analysis (GRA): is then used to rank the candidate networks and selects the one with the highest ranking.

A comparison along with three of these models was established with attributes like Bandwidth, delay, jitter & BER. SAW and TOPSIS provide similar performance to the traffic classes used. GRA provides a slightly higher bandwidth and lower delay for interactive and background traffic classes. AHP is used to determine the weights of the three models requiring information about the relative importance of each attribute.

Multiple attribute is a difficult problem during vertical handover decision. AHP seems to be the most popular method to decompose it into a hierarchy of simple and more manageable sub-problems. These sub-problems can be decision factors or weights according to their relative dominances. AHP model has a three step process-

1) Decomposes the decision problem into different levels of the hierarchy.
2) Compare each factor to all the other factors within the same level through pairwise comparison matrix.
3) Calculates the sum of products of weights obtained from the different levels, and selecting the solution with the highest sum.

4.4 Fuzzy Logic and Neural-Networks based strategies

The concepts of Fuzzy logic (FL) and Neural network (NN) are applied to choose when and over which network to handover among different available networks. Both are combined with the multiple criteria or attribute concept in order to develop advanced decision algorithms for both non-real time and real time applications. MADM methods cannot efficiently handle a decision problem with imprecise data. That's why; FL concept provides a robust mathematical framework in which vertical handover decision can be formulated as a fuzzy MADM.

A neural network (NN) based vertical algorithm is proposed to satisfy user bandwidth requirements. It detects the RSS drop and makes handover decision. It is a three layer back propagation and used for further recognition. Many literatures showed that NN architecture performs better than conventional handover decision algorithms (RSS based or Hysteresis based) in terms of handover delay and number of unnecessary handovers. NN based strategy performs handover decision algorithm for choosing only the appropriate time to handover which is based on RSS. While, FL based strategy performs handover decision algorithm for choosing the appropriate time and the most suitable access network according to user preferences.

A solution incorporating fuzzy logic in which terrestrial (UMTS & GPRS) and satellite mobile networks operate together with each other. The handover decision algorithm aims at selecting a network for a particular service that can satisfy objectives based on some criteria such as low cost, good RSS, optimum bandwidth, low network latency, high reliability, & long life battery and taking into account the preferred access network. The handover decision algorithm can be defined as the MODM algorithm, which requires inputs from the system (i.e. link quality, network characteristics & user profile) and the user preferences application type etc. The selection of network has two stages.

1. The fuzzification and weighting procedures:

- The fuzzification evaluates and compares the available segments. Data from the system are connected into fuzzy sets in which each comparative criteria (such as cost) can be represented by an value between 0 & 1depending on a membership function (μ) for the fuzzy sets are obtained by mapping the measurements for a particular onto a membership function.
- The weighting evaluates the importance for each criteria based on instructions received from the network provider and the user. It uses AHP method influenced by user preferences as criteria.

2. The decision making: application of the weightings to each criterion according to the defined objectives in a decision function. The chosen segment is the segment with the highest membership values of the decision function.

The first stage can be done before the handover initiation. The second stage, generally used in any multi-criteria system. The proposed system uses Mobile IP infrastructure. System procedures are defined as registration, location management and handover management functionalities. A Handover management procedure retrieves the necessary information on the active segment i.e. link measurement, user profile & QoS information and tries to discuss the degradation or improvement in the QoS offered to the user (handover decision) and finally IP connectivity for Mobile IP registration i.e. handover execution.

4.5 Context – aware strategies (CA)

This handover concept is based on the knowledge of the context information of the mobile terminal and the network in order to take intelligent and better decisions. As a result, a context aware decision strategy manages this information and evaluates context changes to get decision on whether the handover is necessary and on the best target access network.

Context aware handover decision algorithm consists of two main components:

1. The context repository- which gathers, manages, and evaluates context information from different parts of the network.
2. The adaptability manager- it decides about adaptation to context changes and handover execution.

The context aware decision algorithm is processed for each service type currently running on the device. Primary objectives were defined in terms in terms of lowest cost, preferred interface, and best quality (i.e. maximizing throughput, minimizing delay, jitter and BER) this intelligent handover decision algorithm is based on the AHP including the session transfer (application management) which is considered as mobile initiated and controlled solution. This algorithm has five stages in which first two are pre-configuration stages, this stages as follows:

1. Taking user inputs: defining the relative priorities among the primary objectives, the available interfaces and three types of services (which are defined as real time, interactive and streaming) with fixing priority scores between 1 (for most preferred one) and 9 (for least preferred one).
2. Mapping limit values from discrete preferences:

expressing user QoS preferences as limits in order to provide better flexibility while comparing them with network QoS parameters. These limit values, which are related directly to the priority given to the objectives of *Best Quality* (i.e. BER, delay, jitter, and throughput), are mapped for each of the three services types. It is based on QoS requirements of specific service type and device capabilities.

Remaining three is known as real-time calculations, which performed for a particular type of running application as follows-

1. Assigning scores to available networks: comparing the capabilities of the reachable networks (i.e. interface, cost, and QoS) with the pre-configured user preferences (scores and limits based on primary objectives).
2. Calculating network ranking: based on AHP method through an objective pairwise comparison matrix at first level and network pairwise comparison matrix at the second level.
3. Employing a session transfer scheduling algorithm Managing the session: in order to switch applications to the selected network.

5. Proposed solution

A multi criteria solution is needed. Contextual information can be used as multiple criteria useful enough to avoid wrong handover decisions. Therefore we consider context aware vertical handover decision. Contextual information should know the MT's movements and it should take into account QoS requirements for the demanding service. The proposed intelligent vertical handover procedure using GRA (Grey Relational Analysis) and FLDA (Fuzzy Logic decision algorithm). Based on the sampled RSSs, GRA yields the predictive received signal strength (PRSS) that is used to decide whether to start a handover. After a handover is triggered, and there is available candidate networks will be fed into FLDA. Then QDV (quantitative decision values i.e. RSS, bandwidth, cost) of each candidate network can be achieved. By comparing the resulted QDVs, the candidate network with the largest QDV is selected, which is the target network to handoff.

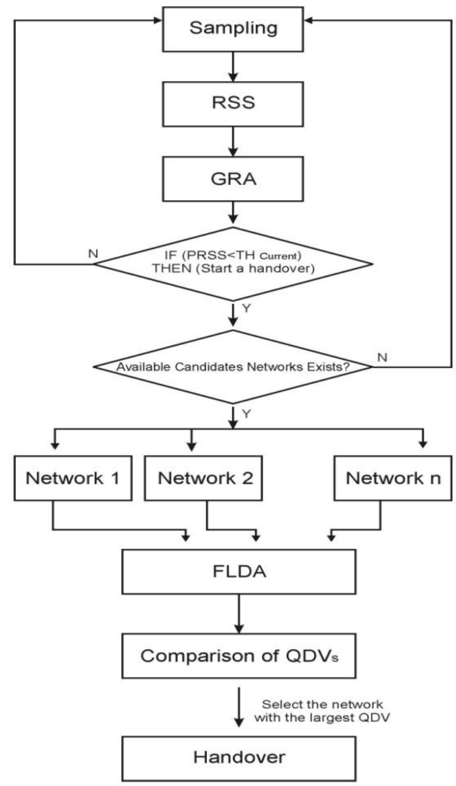

Fig. 2. The proposed intelligent vertical handover procedure

Conclusion

The convergence of wireless access technologies towards 4G wireless networks should overcome several challenges before practical implementation. One of the major challenges is user mobility handling between different accesses technologies in order to keep the user connected to the best available network. This network is usually the underlay network that can provide better service at lower cost to the user as well as improve the overall system resource utilization. However, achieving both goals requires a well designed handover algorithms that can compromise the exchange between efficient resource utilization and user perceived QoS. In this paper, we present the advanced evaluation functions and optimized architectures which are needed to perform better handover decision making for user satisfaction as well as for the efficient use of the network resource. We also study the vertical handover decision process with a classification of the different existing vertical handover decision strategies. Therefore, the goal of handover decision process consists of findings the appropriate time to perform handover and the most optimum access network according to the user demands, network resources and terminal capabilities. Regarding the entire handover management additional considerations are taken into account in most of the proposed strategies: Mobile IP like infrastructure and the types of access network such as WLAN and cellular networks.

References

1. J. McNair, F. Zhu, -Vertical handover is fourth-generation multinetwork environment, IEEE Wireless Communication 11 (3) (2004) 8-15.

2. I. Akyildiz, J. Xie, S. Mohanty, A survey of mobility management in next-generation all-IP-based wireless systems, IEEE Wireless Communications 111 (4) (2004) 16-28.

3. E. Gustafsson, A. Jonsson, Always best connected, IEEE Wireless Communications 10 (1) (2003) 49-55.

4. K. Pahlavan, P. Krishnamurthy, A. Htami, M. Ylianttila, J. Makela, R. Pichna, J. Vallstron, Handover in hybrid mobile data networks, IEEE Personal Communication 7 (2) (2000) 34-47.

5. P. Chan, R. Sheriff, Y. Hu, P. Conforto, C. Tocci, Mobility management incorporating fuzzy logic for a heterogeneous IP environment, IEEE Communication Magazine 39 (12) (2001) 42-51.

6. E. Stevens-Navvaro, V. Wong, Comparison between vertical handover decision algorithms for heterogeneous wireless networks, in: Proceduings of IEEE Vehicular Technology Conference (VTC-Spring), vol.2, 2006, pp. 947-951.

7. F. Zdarsky, J. Schmitt, and Handover in mobile communication networks: who is in control anyway? In: Proceedings of the 30th Euromicro Conference, 2004, pp. 205-212.

8. C.E. Perkins, Mobile IP, IEEE Communications Magazine 40 (2002) 66-82.

9. M. Bernaschi, F. Cacace, A. Pescape, S. Za, analysis and experimentation over heterogeneous wireless networks, in: First International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities, 2005 (Tridentcom 2005), pp. 182-191.

10. W. Zhang, J. Jaechnert, K. Dolzer, Design and evaluation of a handover decision strategy for 4th generation mobile networks, in: The 57th IEEE Semiannual Vehicular Technology Conference, 2003 (VTC 2003-Spring), vol. 3, 2003, pp. 1969-1973.

11. F. Pollini, Trends in handover design, IEEE Communications Magazine 34 (3) (1996) 82-90.

12. H. Wang, R. Katz, J. Giese, Policy-enabled handover across heterogeneous wireless networks, Second IEEE Workshop on Mobile Computing Systems and Applications, 1999 (Proceedings WMCSA'99), 1999, pp. 51-60.

13. W. Chen, J. Liu, H. Huang, An adaptive scheme for vertical handover in wireless overlay networks, in: Proceedings on the 10th International Conference on Parallel and Distributed Systems, 2004 (ICPADS 2004), 2004, pp. 541-548.

14. F. Zhu, J. McNair, Optimizations for vertical handover decision algorithms, in: IEEE Wireless Communications and Networking Conference, 2004 (WCNC 2004), vol. 2, h 2004, pp. 867-872.

15. A. Calvagna, G. Di Modica, A User-centric analysis of vertical handovers, in: Proceedings of the Second ACM International Workshop on Wireless Mobile Applications and Services on WLAN Hotspots, 2004, pp. 137-146.

16. O. Ormond, J. Murphy, G. Muntean, Utility-based intelligent network selection in beyond 3G systems, in: IEEE International Conference on Communication (ICC

2006), vol. 4, 2006 pp. 1831-1836.

17. R. Ribeiro, Fuzzy multiple attribute decision making: a review and new preference elicitation techniques, Fuzzy Sets and Systems 78 (2) (1996) 455-181.

18. S. Quiqyang, A. Jamalipour, A network selection mechanism for next generation networks, in: International Conference of Commnications, 2005 (ICC 2005), vol. 2, 2005, pp. 1418-1422.

19. T. Saaty, How to make a decision: the analytic hierarchy process, European Journal of Operational Research 48 (1) (1990) 9-26.

20. J. Makela, M. Ylianttila, K. Pahlavan, Handoff decision in multiservice networks, in: The 11th IEEE International Symposium on Porsonal, Indoor and Mobile Radio Communication, 2000 (PIMRC 2000), vol. 1, 2000, pp. 655-659.

21. P. Chan, Y. Hu, R. Sheriff, Implenmentation of fuzzy multiple objective decision making algorithm in aheterogeneous mobile environment, in: IEEE Wereless Communications and Networking Conference, 2002 (WCNC 2002), vol. 1, 2002, pp. 332-336.

22. Q. Guo , J. Zhu, X. Xu, An adaptive multi-criteria vertical handover decision algorithm for radio heterogeneous network, in: IEEE International Conference on Communications, 2005 (ICC 2005), vol. 4, 2005, pp. 2763-2773.

23. Q. Wej, K. Farkas, C. Prehofer, P. Mendes, B. Plattner, Context-aware handover using active network technology, Computer Networks 50 (15) (2006) 2855-2873.

24. S. Balasubramaniam, J. Indulska, Vertical handover supporting pervasive copmputing in future wireless networks, Computer Communications 27 (8) (2004) 708-719.

25. T. Ahmed, K. Kyamkya, M. Ludwing, A context-aware vertical handover decision algorithms for mobile terminals and its performance, in: Proceedings of the IEEE/ACM Euro American Conference on Telematics and Informatics Systems (EATIS 2006), 2006, pp. 19-28

Sandeep chouhan has received B.E. in Electronics & Communication from University Institute of Technology - RGTU, Bhopal and pursuing M.E. from Ujjain Engineering College, Ujjain. His research interest includes Mobile Communication and Digital Signal Processing.

Mr.R.B.Gaikwad has received B.E. in Electronics & Communication from Jabalpur Engineering College and M.E. from SGSITS, Indore. He possesses 20 years Experience and currently is an Associate Professor at Ujjain Engineering College, Ujjain, M.P., INDIA.