Bulletin de la Société Royale des Sciences de Liège, Vol. 85, 2016, *p.* 340 - 347

A New Scheme for Resource Allocation in Heterogeneous Wireless Networks based on Big Data

Morteza BARARI[1], Houman ZARRABI[2], Abbas Mirzaei SOMARIN*[1]

[1] Faculty of Information, Communications and Security Technology, Malek Ashtar University of Technology, Tehran, Iran

[2] Integrated Network Management Group, ICT Research Institute (ITRC) Tehran, Iran

Abstract

Joint Radio Resource Management (JRRM) has been used for an effective use of radio resources in heterogeneous networks. The efficiency and function of this method of management will be better than radio independent resources management in any radio access technology. In this paper, we introduce new management which its function is based on data analysis on the basis of Big Data technology. In our proposed scheme, we choose the most appropriate RAT considering various parameters including service type, the information relevant to the user's location, the user's type of movement and service costs and also by considering few statistical indices. It is predicted that aside from the increase in the decision-making's correctness in choosing RAT and the ideal distribution of network load, the proposed method provides fewer service for the operators. This issue can be considered a lot in implementing wireless heterogeneous networks.

Keywords: Heterogeneous Network, Roaming, Multi Technology, JRRM

1. Introduction

Next-generation wireless networks will be created from the gathering of many heterogeneous radio access technologies with each of them having their own special capabilities, abilities and limitations [1]. In these networks, providing multi-media services with a guarantee of the service quality is a necessary thing. The general aim of heterogeneous wireless access networks is realizing the concept of "Always Best Connected" so that the user can connect to the most appropriate and the best network at anytime, anywhere and anyway according to his/her own service needs [2-5].

In this paper, we will deal with the issue of load allocation in combination of mobile networks and WLAN based on logic methods for data analysis such as the Big Data method and handover between mobile networks through WLAN [6]. Our proposed scheme is allocation of the load to 2 groups partly between the Macrocells and Femtocells and partly handover from the mobile network to the WLAN [7,8]. The actual problem in this paper is allocating the power to the users of Femtocell and handover from the mobile network to the WLAN. Thus it is supposed to be in a way that first the user's equipments are connected to the mobile networks and in case the mobile network wasn't able to provide the intended service for the user's equipments due to any possible reasons, the process of handover to the WLAN happens [12]. On the one hand, whenever the number of subscribers in that place increases due to any reasons such as the incidence of an event and regarding the Big Data Technology which is intelligent in respect to network resources and all the events that are in the occurrence stage, the handover management from one network to the other gets done. In this scheme, the handover from the cell phone to the WLAN is done only in case of necessity. In other words, if it leads to an improvement in quality, the necessity is felt so ideally this act is better be done when we are sure about the improvement in quality. Usually the data rate of WLAN is many times the primitive networks based on packet delivery. However sometimes due to the high traffic, these two can possibly be comparable [9-11]. As a result, the lowering of the quality level due to the delay in case the available bandwidth of the WLAN is higher than NGMN3 in handover circumstances will be reparable. Of course this assumption is on provided that the user is present in WLAN at least to a clear extent so he/she can do the following:

- Reconfiguration, mobility management, security and accounting processes.
- Receiving and transferring packets that couldn't be done due to the interval in the handover.
- The recovery of high-level protocols as well as post-handover applications (i.e. the terminal must be adapted to the new data-rate and reach to a constant quality level).

One of the main concepts in HWN networks is how to optimally use different radio resources. Although there are many approaches to separately manage radio resources in the network, these approaches are not appropriate for the heterogeneous wireless networks. Therefore a new concept of Joint Radio Resource Management (JRRM) has been developed. JRRM refers to a set of functions which deal with an effective and coordinate usage of the available resources in heterogeneous networks.

RAT selection methods comprise of RAT selection algorithms in the time of session beginning as well as RAT selection in the time of running communications transfer from one RAT to the other (vertical handoff). The main element is the radio resources management methods in heterogeneous wireless networks. Until now, various methods have been presented for selecting RAT with each aiming at exploration of different criteria. In some papers, the issue of load distribution and network resistibility has been investigated [35-37]. In some others, the decisions have been made only on the basis of the requested service type. Yet in some others, function-based methods and mathematics-based methods in which the decisions are made based on many criteria, the goal is the network's high efficiency and increasing user's satisfaction.

The surplus consumer scheme is designed for non-immediate applications and is not appropriate for immediate traffic which has more limitations not only in terms of time [13]. The scheme presents a user-oriented solution which isn't possibly appropriate for load balance in the whole network and whenever a user considers only his own criteria and not the network's load distribution, congestion in the network is resulted. Freeing the bandwidth allocated to low-priority traffics and allocating that to high-priority traffics such as multi-media traffic is a desirable strategy for the service providers. Declining-benefit function is designed for this purpose and the balance among the desirable number of declined connections and the new connections are studies in that respect. Moreover, all of the above-mentioned methods are only appropriate when a Service Level Agreement between the users and the service-providers is available so as to specify the tasks of each one of them.

Since each one of the aforementioned methods has assessed different criteria according to the goals they have, they are not comparable with each other. For example, the method that has applied target function with the aim of appropriate allocation of bandwidth has shown the results in terms the network load amount, number of execution times and the quality of handoff service. Aside from the system's handoff status, the utility function method explains the results in terms of blockage rate and connections losing rate which are important criteria from the viewpoint of user's satisfaction. In the declining-benefit method, it has been shown that the declination rate for low-priority users is less than the declination rate for low-priority users. Ultimately, the results have been shown with the aim of reduced costs in terms of the obtained profit amount (According to Cent) per running time. The capabilities of the proposed algorithm is dependent on the location of user's terminal which can both be in the hot-spot area covered by the networks and outside the hot-spot area which is only under the coverage of one network which in this case, the proposed algorithm only monitors the available sessions in this area and manages the available resources in that RAN [14]. When a user is in a hot-spot environment, Joint Radio Resource Management (JRRM) does the RAT selection procedure and then informs the selected RAN to execute the necessary operations for the request acceptance. Module Admission Control (AC) will accept the request in the selected RAN.

The proposed JRRM method consists of two algorithms:

1) RAT selection algorithm for the new calls

2) VHO algorithm for the users who are in movement in between the RANs and are involved in one call. The goal of both algorithms is considered to be guaranteeing a persistent connection and a reduction in the service costs in HWN.

2. RAT Selection Algorithm Based on Location and User Mobility

In this JRRM algorithm, the necessary decisions for selecting an appropriate RAT are made according to the information it has gathered. RAT selection algorithm consists of 3 stages.

JRRM entity receives the request for a new call.

JRRM requests for the location-related information and user mobility from the units of location register and location predictor of the user. According to the gathered information by the JRRM unit and the rules that come in the following, the most appropriate RAT for the session will be selected.

- If the user is outside the hot-spot area, resource management will be done in LTE by the available radio resource management unit.
- Otherwise, for an automotive user that is in the hot-spot area, LTE will be selected for different resource management so that the repetitive VHO which may happen due to the frequent automotive user mobility is prevented from.
- The RAT service type will be selected for a non-automotive user that is in the hot-spot area.

If the condition (service type=non-immediate service) is on, IEEE 802.11 will be selected for the user due to the high-bandwidth and low-service cost. Otherwise, if the condition (service type=immediate service) is on, an appropriate RAT will be selected according to the relevant information in regards to user location prediction.

As in case it is predicted that the user has left the hot-spot area, IEEE 802.11 will be selected for him/her (so that service resistibility is guaranteed) otherwise LTE will be an appropriate option for the user so as to prevent from an unnecessary VHO.

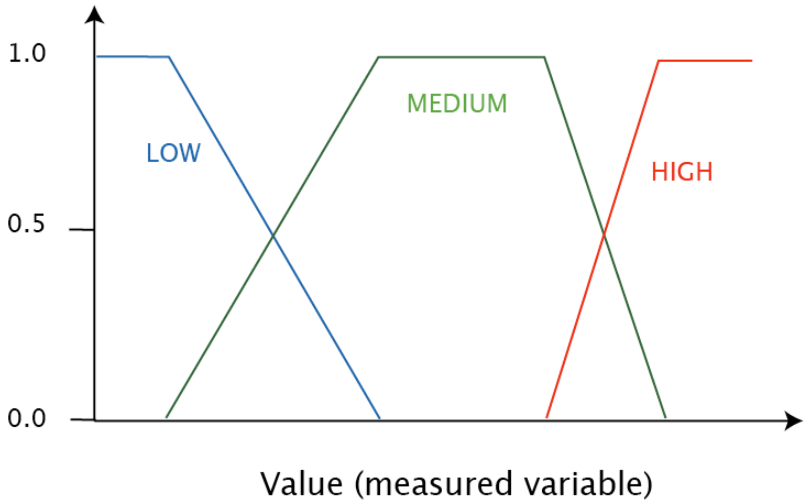
Continuing the explanation of this flowchart, in case the WLAN network finally is considered as the target network, the capacity of this network must be considered. In case the capacity of this network isn’t providing our needs for the entrance of new users and using the WLAN network resources, we should inevitably select the cellular network as our target network.

Multi-Dimensional Decision-Making

The proposed pattern that was presented in this paper is based on a set of multi-dimensional decision-making procedures. In this pattern, one of the packets of the network is used based on 3 basic parameters of the service type provided, the expense of service provision as well as user mobility type and of course in the assumed decision-makings, the number of vertical inter-systemic handovers are supposed to decline.

Each one of the aforementioned indices can to different efficacy coefficients have the required effects directly on the decision-making related to the selection of handover.

As it was suggested, in the assessment of the functional pattern of the proposed scheme, using the concepts of Big Data is proposed as our leading approach toward achieving optimization in the network. The effect of some of the intended parameters is emerged as the determination of a threshold limit in the network. Also the effect of some of these parameters can be analyzed in a Fuzzy way.



This decision-making pattern (NFDE) for the selection of an optimal network is a multi-dimensional, approximate and indefinite logic problem which is an appropriate candidate to be solved based on Fuzzy Nervous method. NFDE is expanded exactly based on Adaptive Fuzzy Logic System (AFLS). AFLS is a type of Fuzzy Logic System (FLS) that has fuzzifying and defuzzifying units. Its structure is similar to the traditional FLS but its rules are derived and extracted from a known educative data. In other words, its parameters can be educated just like in a nervous network method but along with its structure in a Fuzzy Logic System Structure.

Central defuzzifier is a very famous method for defuzzification but can't be used in NFDE by its calculated expense and prevents from using back-propagation education algorithm. The proposed AFLs include an alternative defuzzification method based on the FALCON model shown by Altug. NFDE feed-forward structure based on FALCON model is shown in figure 4. NFDE is created when 1) the mobile host identifies and then specifies a new radio link, 2) the priority of the user changes, 3) a request for a new service is made and 4) there is a declination in the new signal or a complete signal loss from the current radio link.

Definition of membership functions: in choosing the best network in a change of vertical signal transfer, applying an appropriate parameter from different layers both on the user-side and on the system-side is required. The used features for NFDE includes financial costs(C), network bandwidth(B), RSS(R), user priority(U) and network delay(D). As a result, the revelation of a better control is possible by increasing the number if Fuzzy sets but this issue will reinforce the complexity of NFDE. Membership functions must be adaptable toward environment change in order to maintain its usefulness. The system behavior is relied on Fuzzy rules and membership functions significantly so as to describe decision-making rules. NFDE features are defined as the following:

3. Results

We have had an experimental investigation about the differences WLAN and UMTS based on their functionality per predefined constant values for some effective parameters in which, Cost, Bandwidth, Transmission Rate and Delay have an impressive role in this scenario.

As it can be seen in the result, the differences will be deeply dependent to the coefficient of these parameters.

	C(Cent/Kb)	**B (Mbit/s)**	**R (dBm)**	**D (ms)**
WLAN	0.001	11	+38	**1.25**
UMTS	0.220	0.5	-100	**18.54**

By doing repetitive simulation, below vector has been achieved as coefficient which can be used in next simulations.

$$W = [0.0652, \quad 0.0791, \quad 0.0211, \quad 0.0981, \; 0.4991]$$

By considering the achieved coefficient for various parameters which are used in simulation, we arranged a wide evaluation for these two networks in which the combination of these two networks considered as a heterogeneous network. As the table shown, the functionality of the provided network has been related to the kind of service and the application type.

Network	Application Type	Service 1	Service 2
WLAN	Min	0.775	**0.011**
	Max	3.675	**0.055**
	Ave	1.470	**0.029**
UMTS	Min	6.944	**0.900**
	Max	68.690	**1.699**
	Ave	19.721	**1.191**

4. Conclusion

In this paper, a new method of Joint Radio Resource Management was proposed which aside from providing a desirable service quality, decreases the vertical handover rate and service cost. In the considered scenario, both the immediate and non-immediate services are considered. In this paper, we tried to deal with optimization of traffic distribution in heterogeneous networks on two levels. On the first level, this issue will be done by selecting an appropriate RAT and on the second level, by establishing the user connection to the specified Femtocell's cells during the process of optimization. Using Big Data technique will have tremendous effects on prediction feasibility and better future decision-making about network load distribution which this decision-making will be done during user-level and network-level processing.

5. References

[1] L. Giupponi, R. Agusti, J. Perez-Romero and O. Sallent. “Joint Radio Resource Management Algorithm for Multi-RAT Networks,” IEEE Global Telecommunications Conference, GLOBECOM '05, pp. 3850-3855, Dec. 2005

[2] 3GPP, “Improvement of RRM across RNS and RNS/BSS (post rel-5) (release 6),” TR 25.891 v0.3.0, 3rd Generation Partnership Project (3GPP), 2003.

[3] D. Niyato and E. Hossain. “Wlc04-5: Bandwidth allocation in 4g heterogeneous wireless access networks: A noncooperative game theoretical approach,” IEEE Global Telecommunications Conference, GLOBECOM ’06, pp. 1–5, Nov. 2006.

[4] A. Tolli, P. Hakalin, “Adaptive load balancing between multiple cell layers,” VTC 2002-Fall. 2002 IEEE 56th Vol. 3, pp. 1691–1695, Sept. 2002.

[5] K. Murray, R. Mathur, D. Pesch, “Network access and handover control in heterogeneous wireless networks for smart space environments, ” in: First International Workshop on Management of Ubiquitous Communications and Services, MUCS, Waterford, Ireland, Dec. 2003.

[6] W. Zhang, “Performance of real-time and data traffic in heterogeneous overlay wireless networks, ” in: Proceedings of the 19th International Teletraffic Congress (ITC 19), Beijing, 2005.

[7] E. Vanem, S. Svaet and F. Paint. “Effects of multiple access alternatives in heterogeneous wireless networks,” in Proc. IEEE WCNC, pp. 1696–1700, 2003.

[8] J. P. Romero, O. Sallent, R. Agusti, and M. A. Diaz-Guerra, Radio Resource Management Strategies in UMTS: John Wiley & Sons, 2005.

[9] Xu Yang, J. Bigham, and L. Cuthbert. “Resource management for service providers in heterogeneous wireless networks,” Wireless Communications and Networking Conference, IEEE, Vol. 3, pp. 1305–1310, Mar. 2005.

[10] F. IdrisKhan and E. Huh. “An adaptive resource management for mobile terminals on vertical handoff,” Annals of Telecommunications, pp. 435-447, May. 2008.

[11] K. Piamrat, C.Viho, A. Ksentini and J.M. Bonnin. “Resource Management in Mobile Heterogeneous Networks: State of the Art and Challenges,” inria-00258507, v 4-3, Mar. 2008.

[12] G. Koundourakis, D.I. Axiotis, and M. Theologou. “Network-based access selection in composite radio environments,” Wireless Communications and Networking Conference, 2007.WCNC 2007. IEEE, pp 3877–3883, Mar. 2007.

[13] O. Ormond, P. Perry, and J. Murphy. “Network selection decision in wireless heterogeneous networks,” Personal, Indoor and Mobile Radio Commu- nications, 2005. PIMRC 2005. IEEE 16th International Symposium on, Vol. 4, pp. 2680–2684, Sept. 2005.

[14] Xiaoshan Liu, Victor O. K. Li, and Ping Zhang. “NXG04-4: Joint radio resource management through vertical handoffs in 4g networks,” IEEE Global Telecommunications Conference, 2006. GLOBECOM ’06, pp. 1–5, Nov. 2006.