TELKOMNIKA, Vol.14, No.1, March 2016, pp. 86~90
ISSN: 1693-6930, accredited A by DIKTI, Decree No: 58/DIKTI/Kep/2013
DOI: 10.12928/TELKOMNIKA.v14i1.2358

Research on Load Balancing in C-RAN with Femtocells

Zhanjun Liu*[1], Xia Peng[2] ,Yujing He[2], Qichao Ma[2]
[1]College of Communication Engineering,Chongqing University,Chongqing 400030,China
[2]Chongqing Key Laboratory of Mobile Communications Technology,
Chongqing University of Posts and Telecommunication, Chongqing 400065, P. R. China
*Corresponding author, e-mail: liuzj@cqupt.edu.cn, 454660432@qq.com

Abstract

The traditional load balancing optimization scheme cannot guarantee the user's QoS in the C-RAN wireless communication networks when all the neighboring macrocells are under the situation of overload. In order to resolve this problem, we implement the femtocell to the macrocell network, which considers the advantages of femtocell, i.e., small coverage, low cost and better signal quality. Therefore, in this paper, the joint load balancing mechanism is proposed to achieve the joint optimization of femtocell and macrocell network by allowing the users of overloaded macrocell to handover to the femtocell. Finally, the simulation results show that the proposed mechanism greatly improves the user satisfaction as well as the resource utilization rate of the femtocell network while decreases the blocking rate and dropping rate.

***Keywords**: Femtocell, Load Balancing, Joint Optimization, Resource Utilization*

1. Introduction

To meet the growing capacity demands in wireless communication networks, Cloud Radio Access Network (C-RAN) has been proposed for the purpose of satisfying the capacity requirements and scalability problems [1-2]. C-RAN is composed of a BaseBand Unit (BBU) and a remote radio unit (RRU), and it also has better flexibility because it breaks the fixed connection relationship between BBU and RRU [3]. Moreover, some notable features are included in C-RAN, e.g., centralized processing, collaborative radio, real-time cloud computing infrastructure, and clean system [4].

Since the distribution and service requirement of the users are stochastic in C-RAN wireless access network [5-6], therefore, the load balancing techonology is inevitable in the case of solving the problem of unbalanced cell and improving the resource utilization. However, the traditional load balancing schemes only allow the users of overloaded macrocell to handover to the neighboring macrocells. Consequently, there will be no suitable neighboring cells to support the users' handover when the neighboring cells are also overload, and it also cannot alleviate the unbalanced problem [9-11].

With the increases of the data usage of wireless communication system occurs in indoor, the research of indoor service are becoming more and more important [12]. As the femtocell has the advantages of small coverage, low cost and better signal quality, therefore, it has been selected as the primary canditate technology to resolve the problem of indoor coverage in the future 5G wireless communiction. The Femtocell Access Point (FAP) of femtocell and existing networks as a backhaul connectivity can meet the upcoming demand of high data rate and extend the coverage area[13-15]. Moreover, the coexistence of macro cell and femtocell can also allow the users of overloaded macrocell to handover to the femtocell. Therefore, a joint optimization scheme of load balancing in C-RAN two tier networks is proposed

The remainder of this paper is organized as follows: In Section 2, we deccribe the system model. Section 3 analyzes the detailed procedure of the proposed Joint Optimization Load Blancing Based on The Coexistence of Femtocells (JOLB) mechnism. The simulation results are discussed in Section 4. We conclude the paper in Section 5.

2. System Model

In the C-RAN radio access network, when the cell is overload, the network tries to move the mobile users of the overloaded cell to the appropriate femtocell to achieve the load

Received July 25, 2015; Revised November 23, 2015; Accepted December 10, 2015

balancing while make reasonable use of femtocell resources. The system model is as shown in Figure 1.

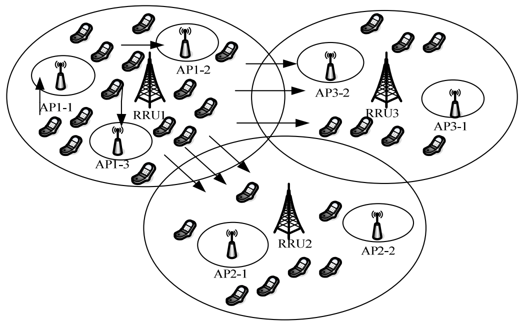

Figure 1. System model

As we can see form Figure 1, there are three macrocells *RRU1*, *RRU2* and *RRU3* in the C-RAN wireless access network. *RRU1* is overloaded, *RRU2* and *RRU3* are the two neighboring macrocells with different load levels. *APi-j* denotes the *i-th* femtocell in the *j-th* macrocell. If the *RRU2* and *RRU3* are all under the situation of heavy overload, the users of *RRU1* are not allowed to handover to the *RRU2* and *RRU3*, and then the users of *RRU1* will be handovered to the femtocell. For example, the users of RRU1 will be handovered to the femtocells such as *AP1-1*, *AP1-2* and *AP1-3* for the purpose of reaching the load balancing.

3. Joint Optimization Load Blancing Based on The Coexistence of Femtocells(JOLB)

The detaied procedure of JOLB algorithm is as follows:

Step1: Compare the cell load with the predefined overload threshold. If the load value is greater than the threshold value, it will be treated as the overloaded cell. Then, to identify the neighboring cells whose load is smaller than the threshold, and generate a target cell list cell_list.

Step2: Analyze the load state of neighbor cells in the cell_list, and then arrange the cell_list in ascending order according to the load state.

Step3: Get the ue_list in descending order based on the signal strength of users .

Step4: If the cell_list is not empty, handover the first user of the ue_list to the first cell of the cell_list, and update the ue_list and cell_list based on the signal strength of users and load state of cells, separately. If the cell_list is empty, handover the first user of the ue_list to the adjacent femtocell, and update the ue_list based on the signal strength of users .

Step5: Check if the cell is still overload. If the cell is overload, repeat **Step2-4**, otherwise go to **Step6**;

Step6: Terminate the load balancing and then wait for the next load balancing period.

3. Simulation Results and Analysis

In this section, we describe the simulation environment and results of the performance of the proposed scheme. We assume that 37 RRUs are located in the network, and the number of cells is 37. Morever, each RRU covers one cell, and the users are randomly distributed in each cell. The system model is as shown in Figure 1, which indicates the distribution of the users and base stations, and the simulation parameters are listed in Table 1.

The simulation results mainly focus on the resources utilization, the number of the unsatisfied user, blocking rate and call dropping rate of the JOLB algorithm. The compared algorithms include No Load Balancing (NLB), Load Balancing only with macrocells (LB), and Joint Otimization Load Blancing based on the coexistence of femtocell (JOLB).

Table 1. Simulation parameters

Parameter	Value
RRU distance	500m
RRU transmit power	46dBm
Mobility mode	velocity：5km/h,30km/h,60km/h direction：（0,360）
Load balancing period	200ms
The pass-loss model	L=32.44+20lgd(km)+ 20lgf(Mhz)

In Figure 2, we can see that with the increases of the user arrival rate, the average resources utilization of JOLB is larger than the NLB and LB schemes. This is because when the neighboring macrocells are in heavy loads, the LB can only transfer a small amount of users to the macrocells until it is in overload. However, the JOLB can shift the user of the overloaded cell to femtocell when the neighboring macrocells are in overload. Therefore, the JOLB scheme can improve the resource utilization of both macrocells and femtocells

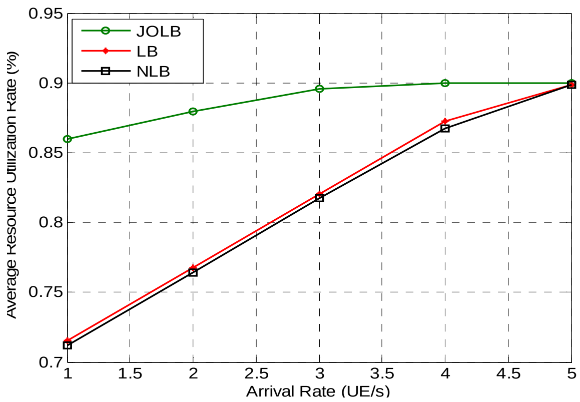

Figure 2. Average resource utilization rate

In Figure 3, we can see that with the increases of the user arrival rate, the number of unsatisfied user of JOLB is smaller than the NLB and LB schemes. This is because when the neighboring cells are in overload, the LB and NLB schemes cannot transfer the users to the neighboring cells, whereas the JOLB scheme can transfer the users of the overloaded cell to femtocell, which ensures the user's quality of service (QoS).

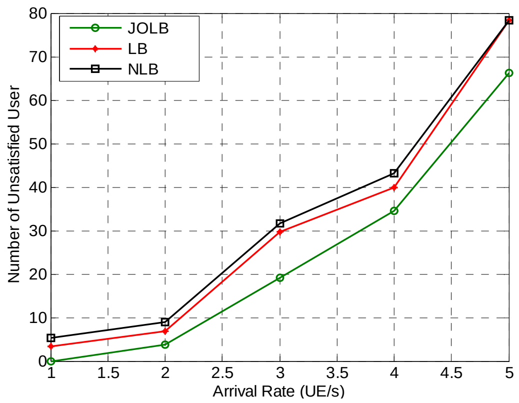

Figure 3. Number of unsatisfied users

Figure 4 is the blocking rate of the network by applying different mechanisms. From the Figure 4, we can see that with the increase of the user arrival rate, the JOLB scheme has the minimum blocking rate, which indicates that the JOLB can decrease the blocking rate of users to meet the access requirement of users.

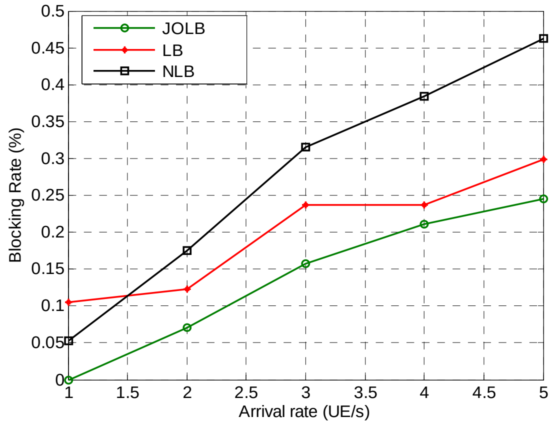

Figure 4. Blocking rate

In Figure 5, we can see that with the increase of the user arrival rate, the network call drop rate also increases. Under the same arrival rate, the call dropping rate of the JOLB is the least while that of NLB is the biggest. Furthermore, when the user arrival rate is 1, the call drop rate of JOLB is zero, which indicates that the handover requirements of all users are satisfied. When the arrival rate is 3, the call drop rate of JOLB drops by 15%, which means that the JOLB improves the handover success ratio.

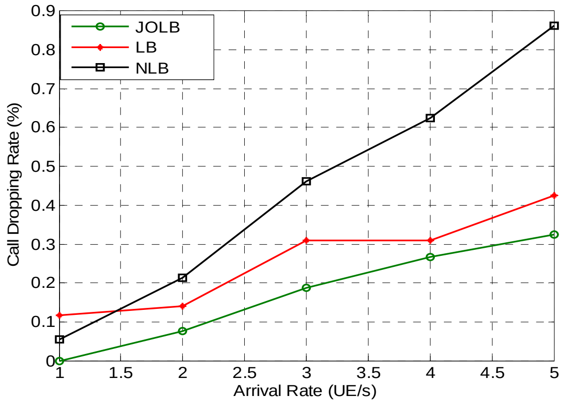

Figure 5. Call dropping rate

4. Conclusion

In the C-RAN wireless network, a joint optimization load balancing algorithm based on the coexistence of femtocells is proposed for the purpose of providing better user service when all the neighboring macrocells are overloaded. Our proposed algorothm can meet the increasing service demands and huge data exchange by introducing the C-RAN wireless access network. Moreover, the load balancing problem is inevitable in C-RAN due to the randomness of the user's location and service request. As the traditional load balancing mechanisms of C-RAN cannot work well when all the neighboring macrocells are overloaded. Therefore, in order to resolve that kind of handover problem, we take the femtocell as the target handover cell to allow the users of overloaded macrocell to handover to the femtocell. Simulation results show that the proposed mechanism compared with the LB and NLB schemes can reduce the number of unsatisfied users, lower the blocking rate and dropped call rate while improve the average network resource utilization.

Acknowledgements

This work was supported by 863 project (2014AA01A701) and Program for Changjiang Scholars and Innovative Research Team in University (IRT1299).

References

[1] Liming Chen, Hu Jin, Haoming Li. *An Energy Efficient Implementation of C-RAN in HetNet*. IEEE Vehicular Technology Conference (VTC Fall). 2014: 1-5.
[2] Henrik Holm, Aleksandra Checko, Rami Al-obaidi. *Optimal Assignment of Cells in C-RAN Deployments with Multiple BBU Pools*. IEEE European Conference on Networks and Communications (EuCNC). 2015: 15-19.
[3] Zhanjun L, Zhichao Z, Shiyan Z. Cooperative RRU Selection Algorithm for Multicast Service in C-RAN Wireless Network. *Journal of XiDian University*. 2013; 40(6): 168-173.
[4] Li G, Zhang S, Yang X. *Architecture of GPP Based, Scalable, Large-scale C-RAN BBU Pool*. IEEE Globecom Workshops. 2012: 267-272.
[5] Xiaohu Ge, Tao Han, Yan Zhang, Guoqiang Mao. Spectrum and Energy Efficiency Evaluation of Two-Tier Femtocell Networks with Partially Open Channels. *IEEE Transactions on Vehicular Technology*. 2014; 63(3): 1306-1319.
[6] Huan D, Qianbin C, Xianwei C. A Power Control Selection Algorithm of Adaptive Service Environment in LTE SON. *Journal of Chongqing University of Posts and Telecommunications*. 2011; 23(6): 661-664.
[7] Andreas Lobinger, Szymon Stefanski. *Load Balancing in Downlink LTE Self-Optimizing Networks*. IEEE Vehicular Technology Conference. 2010: 1-5.
[8] Shiao-Li Tsao, Chen-Wei Wang, Yun-Ciou Lin. *A Dynamic Load-balancing Scheme for Heterogeneous Wireless Networks*. IEEE Wireless Communications and Networking Conference. 2014: 3070-3075.
[9] Dengyuan Xu, Shixun Wu, Benniu Zhang, Xiaoqin Qin. Power Balance AODV Algorithm of WSN in Agriculture Monitoring. *TELKOMNIKA*. 2013; 11(4): 811-818.
[10] XIN K, RUI Z. Price-based resource allocation for spectrum-sharing femtocell networks: a stackelberg game approach. *IEEE Journal on Selected Areas in Communications*. 2012; 30(3): 538-549.
[11] Zhanjun Liu, Qichao Ma, Cong Ren, Qianbin Chen. Load Balancing Based on the Specific Offset of Handover, *TELKOMNIKA Indonesian Journal of Electrical Engineering*. 2014; 12(8): 6281-6290.
[12] Chandrasekhar V, Andrews J, Gatherer A. Femtocell Networks: a Survey. *IEEE Communications Magazine*. 2008; 46(9): 59-67.
[13] Xiaohu Ge, Tao Han, Yan Zhang, Guoqiang Mao. Spectrum and Energy Efficiency Evaluation of Two-Tier Femtocell Networks with Partially Open Channels. *IEEE Transactions on Vehicular Technology*. 2014; 63(3): 1306-1319.
[14] Yidan Zhuang, Su Zhao, Xiaorong Zhu. *A new handover mechanism for femtocell-to-femtocell*. 2012 International Conference on Wireless Communications & Signal Processing (WCSP). 2012: 1-4.
[15] KUANG X, YANG Q, FU F. Resource allocation for femtocell networks with imperfect channel knowledge. *IEEE Signal Processing Communications and Computing*. 2011: 1-5.