Interference Alleviation in Small Cell Networks

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The main use of Heterogeneous or a diverse network is when the users uses data excessively and when their requirements are very high and therefore HCSNet (Heterogeneous Cloud small cell network) play an important role in combining the cloud computing and small cell networks. The two major problems of this feature occurring due to excessive laying of small cells are interference and handover. In this regard, we discuss an architecture of small cells with radio access networks. In order to reduce interference which occurs due to co-channel, a clustering scheme is introduced. This scheme mixes with multipoint coordinates and propagation affinity to decrease the interference. But the handover mechanism is presented with a low complexity.

I. INTRODUCTION

In this HCSNet the coverage, capacity and hotspot of cell-edge users is improvised with the help of femto cell and pico cells by utilizing the spectral reuse concept [1]. Compared to macro cells, small cells can discharge volatile growth of data rate. For example, consider an environment of femto cells and macro cells and Wi-Fi [2]. In this the Wi-Fi and femto cells discharge data rate from macro cells. In case of mobile operators, small cells such as femtocells can decrease the capital expenditure (CAPEX) and operating expenditure (OPEX) due to installation of the self-installing and self-operating attributes of femto base stations. To reduce installation and operation cost like CAPEX Capital Expenses and OPEX Operating Expenses, femto base stations can be used.

In [5], in order to improve the efficiency, the architecture if the HSCNet and their behavior were considered. In order to ease the interference to the cell-edge users, coordinated multi-point (CoMP) transmission/reception is used in a setup called C-RAN. To implement CoMP C-RAN architecture setup the energy resource optimization is studied in [6]. In [7], the authors have studied CoMP performance of CoMP along with the heterogeneous network OF Advanced LTE in different sizes of cluster. To reduce the interference of HSCNet, CoMP is widely used. In spite of HSCNet having more advantages like efficient C-RAN and processing of data, still a complexed clustering setup is needed. Hence, clustering setup is a vital factor regarding the CoMP performance. This clustering setup for interference is not investigated well. One more challenge for HCSNet is continuous mobility handover for users. When we analyze the handoff management, we see that it depends only on the reference receiving signal. All the handover methods in HCSNet are different from traditional small cell networks [4]. In [8], the mobility handover control in a C-RAN wireless networks states that mobility scheme is an in-built feature.

The interference reduction is focused on CoMP and its handover management in HCSNet. In Section II the network architecture along with C-RAN is discussed. In section III the clustering setup of CoMP by which the interference is reduced considerably is studied in detail along with affinity propagation. However, handover setup and conclusion are dealt in section IV and V respectively.

II. HCSNET ARCHITECTURE

From [3][5], the following architecture is developed which consists of both small cells and macro cells together. The CoMP is positioned such that both macro cells and small cells base stations are reduced to MRRH and SRRH respectively.

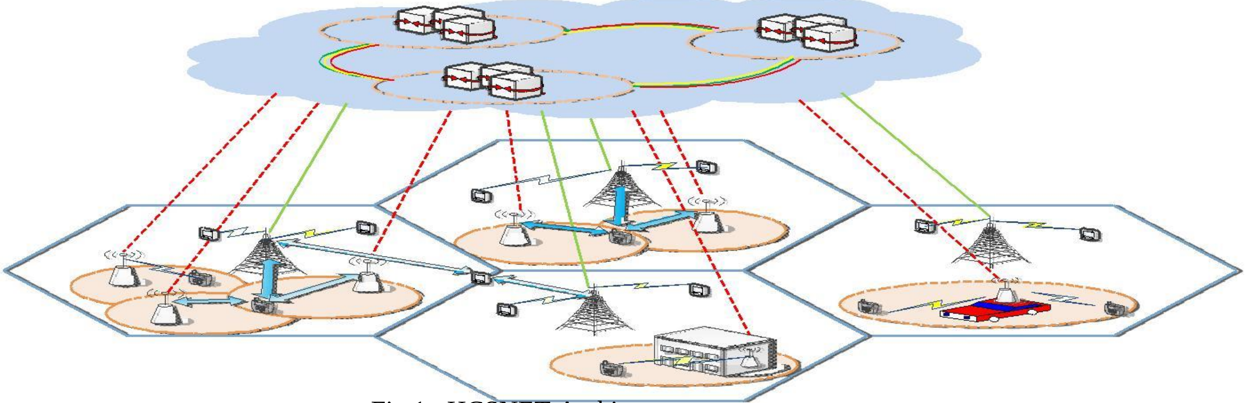


Fig 1 : HCSNET Architecture

Both the cells are placed next to each other and are managed in the BBU pool which controls all the resources of control and management features. This BBU pool consists of processors which performs baseband processing. They are connected by interfaces of X2. RRHs are placed in multiple areas in order to provide signal coverage to all the equipment of user (UE). RRHs are placed on floors of an apartment or an office in order to provide improved area coverage and efficiency. RRHs are positioned in a hotspot scenario, e.g., ground. But as, the interference is very high, interference management can be perfectly laid in a HCSNet architecture. It generally supports 100 MRRHs large sized network for an area of 5x5 km and 1000 MRRHs for an area of 15x15 km [4] which is of a medium size. The SRRHs is more than MRRHs to the same size stated above and it depends on definite scenarios.

III. COOPERATIVE INTERFERENCE MITIGATION USING COMP IN HCSNET

In HCSNet, a cluster of small cells results in interference due to co-channel. Therefore, interference management is necessary in HCSNet. The BBU pool does the work of signal processing and therefore the interference reduction is improved leading to facilitation of CoMP.

A. Cloud CoMP Architecture for Interference Mitigation

The four CoMP techniques are: joint transmission, selection, blanking, and coordinated beamforming [9]. Here we focus on joint transmission in which the RRHs form a cluster to serve the UE (see Fig. 2).

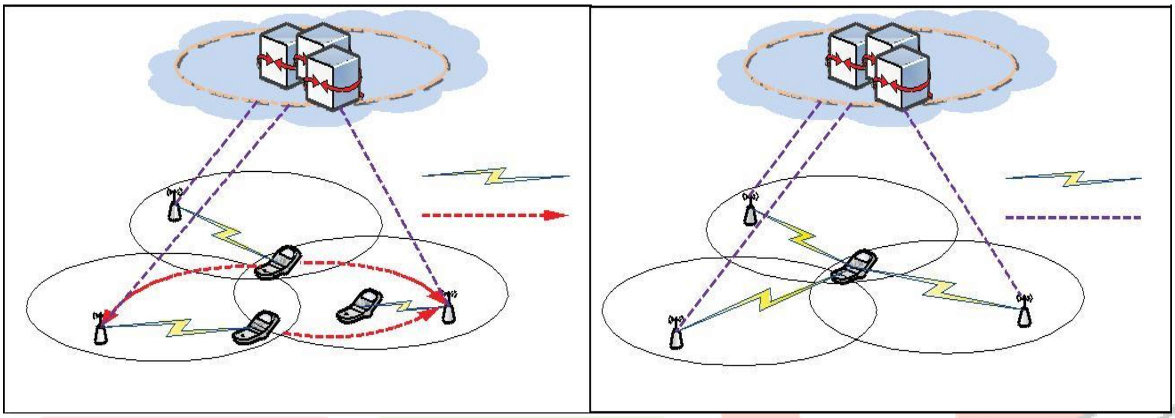


Fig 2 – Non CoMP and CoMP

In order to reduce the front haul overhead, three clustering techniques for RRH cluster are proposed here. They are static, semi dynamic and full dynamic clustering. [9]

a) Responsibilities b) Availabilities

Fig 3 – Framework and diagram of Responsibility

The static scheme, is a very simple process but gives incomplete gain in throughput [12]. The measurement RRH cluster is totally different from coordinated RRH cluster in the static process whereas the measurement cluster is a subset of coordinated cluster in both the dynamic schemes.

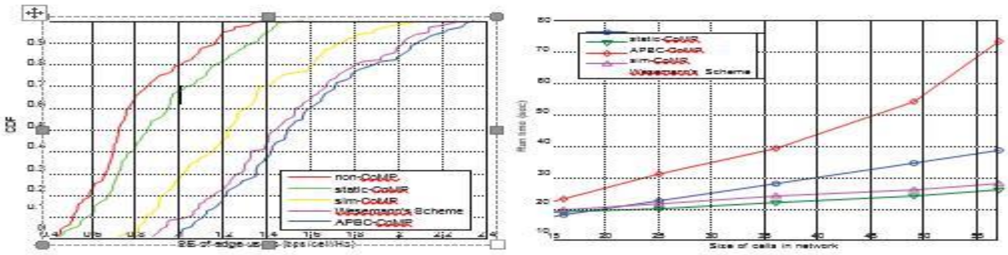
B) Analysis of the Cluster based CoMP in HCSNET

When we consider a relation between performance and complexity semi dynamic clustering is the best as it consists of both online and offline phases. This increases the efficiency of the spectrum and its throughput in a CoMP network. The measurement is done in both offline phase and online phase. In offline phase, we consider a location with the received signal and reference signal , whereas in online phase we define a algorithm for a cluster to choose the RRH which is coordinated [9]. As shown in Fig. 3(a), we segregate the semi-dynamic clustering schemes into online and offline phases.

We analyze the Signal to Noise Interference ratio(SINR) while we measure the RRHs. This makes the system of communication less expensive. In an online phase, it receives SINR of the referenced signal and therefore if there is a low SINR, there is a lot of interference in CoMP.

The APBC has both input and information variables. The input variable is called as similarity and the information variables are availability and responsibility. The output variable is called exemplar. This similarity is given by s(i,k). The master RRH is denoted as the output variable. The s(I,k) denotes a RRH k variable which is proportionate to the output variable. Therefore a particular s(I,k) is called as preference variable. The gain is given by $pcg = SINRCoMP(k,i)/SINRnon{-}CoMP(k,i)$.
As shown in Fig. 3(b), the *responsibility variable r* (i,k) is sent from RRH *i to output variable.*

The spectrum efficiency cumulative distribution function (CDF) curves of edge UEs are plotted in Fig. 4(a). Which can be observed that the four well studied CoMP schemes that is used to achieve higher spectrum efficiency than non-CoMP scheme;



(a) Spectrum efficiency CDF of edge users. (b) Comparison of run time.

Fig 4 – Existing Scheme of Overhead

IV. HANDOVER MANAGEMENT IN HCSNET

Handover management is one of the very important technique to satisfy the users' quality of service (QoS) requirement in mobile communications. However, handover management in HCSNet did not received required attention in the current literature. In [5], the authors examined a survey for HCSNet and conferred how high-mobility UEs must served by macrocells with reliable connections and the low mobility UEs must served by SRRHs. In a densely positioned HCSNet, handovers occur recurrently, that causes heavy burden to front haul and core networks. Besides, mobility handover can be related to radio link failure (RLF) and unnecessary handover (e.g., ping-pong handover) may happen due to the small size of SRRH's coverage and severe co-channel interference. In C-RAN enabled HCSNet, interpose time and delay of handover can be decreased due to handover can be able within the BBU pool.

A. Handover methods in HCSNet

The management of handover in the HCSNet architecture is totally different from the usual EUTRAN and current network architecture. Since the macro cells are of different sizes, the handover of MRRH-SRRH is much more complicated than SRRH-SRRH. By introducing C-RAN in this architecture , the management functions of radio functions move to BBU group.

B. Unusual Handover Identification in HCSNet

The unwanted handovers due to RLFs in the heavily crowded small cells. The different type of handovers can be explained as follows. They are wrong handover, early handover, late handover, continuous handover and ping-pong handover. Wrong handover refers to a RLF which occurs after a handover is given to a target RRH and therefore the UE connects again to another RRH. In early handover, it refers to a RLF which occurs after a proper handover to the destination in which the UE connects once again to the main serving RRH. In late handover, the RLF occurs during the handover process. Continuous handover is the handover to the adjacent RRH. Ping Pong handover occurs when the handover reaches again to the starting cell from the destination RRH.

C Less Complex Handover Technique in HCSNet

There are two types of macrocells UE. They are high speed UE macrocells and low speed UE macrocells. Normally , in a handover, the scheme allows the high speed UE to handover to small cell UE. But in this process the user faces twice handover which is time consuming. Thus with less complexity , a handover scheme is introduced to enhance the system performance. It is given as follows. Generally a high speed UE macrocell doesn't handover to SRRH, but a medium speed UE cell handover to small cells.

The performance of the handover management techniques are proved by comparing with the normal handover technique.

Figure 6(a) shows a graph between holding time and the delay of processing of a signal. The mobility state of users is α and is set to 0.When the overhead of signal increases, the holding time also increases. Figure 6(b) this shows the graph of of the signaling and users mobility proportion. When α *increases* , in the normal handover scheme the handovers and overhead increases, but in the proposes technique ,the overhead of signal decreases. Here we allow high speed handover from MRRH to SRRH but for low speed handover is prevented.

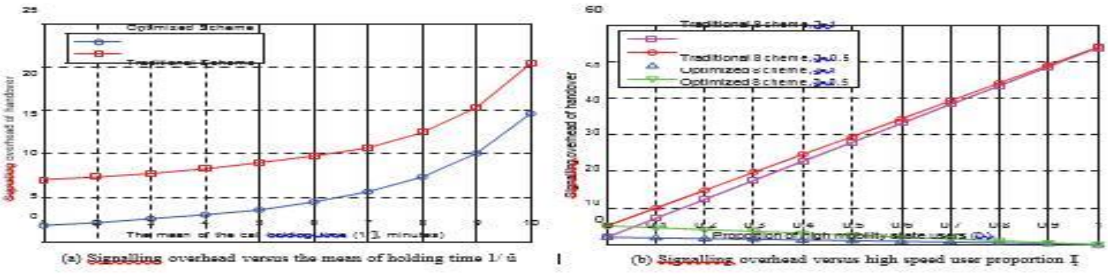


Fig 5. Signaling overhead of optimized scheme compared with existing scheme.

When α increases to 1, the signaling cost is zero. From Fig. 6, when the holding time increases, the cost of signaling in both normal algorithm and proposed algorithm increases.

V. CONCLUSION

This article has discussed handover and interference in a cloud network mixed with small cells. To reduce the interference clustering scheme of CoMP was presented which has propagation toward higher affinity. The handover management was analyzed by different procedures of handover and the output was studied. All the results have proved that HCSNet capacity can be increased thereby maintaining the users QoS. For further research , interference reduction, time delay and clustering for management of handover will be considered.If HCSNet can be organized as a self , it can be used for future research.

REFERENCES

[1] T. Q. S. Quek, G. de la Roche, I. Guvenc, and M. Kountouris, “Small cell networks: deployment, PHY techniques, and resource allocation,” Cambridge University Press, May 2013.

[2] M. Peng, X. Xie, Q. Hu, J. Zhang, and H. V. Poor, “Contract-based interference coordination in heterogeneous cloud radio access networks,” IEEE J. Sel. Areas in Commun., to appear in the second Quarter, 2015.

[3] M. Peng, Y. Li, Z. Zhao, and C. Wang, “System architecture and key technologies for 5G heterogeneous cloud radio access networks,” IEEE Netw., vol. 29, no. 2, pp. 6–14, Mar. 2015.

[4] A. Checko, H.L. Christiansen, Y. Yan, L. Scolari, G. Kardaras, M.S. Berger, and L. Dittmann, “Cloud RAN for mobile networks - a technology overview,” IEEE Commun. Surv. Tut., to appear.

[5] M. Peng, Y. Li, J. Jiang, J. Li, and C. Wang “Heterogeneous cloud radio access networks: a new perspective for enhancing spectral and energy efficiencies,” IEEE Wireless Commun., vol. 21, no. 6, pp. 126–135, Dec. 2014.

[6] M. Peng, K. Zhang, J. Jiang, J. Wang, and W. Wang, “Energy-efficient resource assignment and power allocation in heterogeneous cloud radio access networks,” IEEE Trans. Veh. Technol., to appear.

[7] A. Davydov, G. Morozov, I. Bolotin, and A. Papathanassiou, “Evaluation of joint transmission CoMP in C-RAN based LTE-A HetNets with large coordination areas,” 2013 IEEE Globecom Workshops, pp. 801–806, Dec. 2013.

[8] S. Chen, Y. Shi, B. Hu, and M. Ai, “Mobility-driven networks (MDN): from evolution to visions of mobility management,”IEEE Netw., vol. 28, no. 4, pp. 66–73, July 2014.

[9] H. Zhang, H. Liu, C. Jiang, X. Chu, A. Nallanathan, and X. Wen, “A practical semi-dynamic clustering scheme using affinity propagation in cooperative picocells,” IEEE Trans. Veh. Technol., to appear.

[10] B. J. Frey and D. Dueck, “Clustering by passing messages between data points,” Science, vol. 315, no. 5814, pp. 972–976,2007

[11] S. Wesemann, and G. Fettweis, “Decentralized formation of uplink CoMP clusters based on affinity propagation,” 2012 International Symposium on Wireless Communication Systems (ISWCS), Aug 2012, pp. 850–854.

[12] X. You, D. Wang, B. Sheng, X. Gao, X. Zhao, and M. Chen. “Cooperative distributed antenna systems for mobile communications,” IEEE Wireless Commun., vol. 17, no. 3, pp. 35–43, June 2010.

[13] W. Zheng, H. Zhang, X. Chu, and X. Wen, "Mobility robustness optimization in self-organizing LTE femtocell networks," EURASIP J. Wirel. Comm., vol. 27, Feb. 2013.

[14] H. Zhang, W. Ma, W. Li, W. Zheng, X. Wen, and C. Jiang, "Signalling Cost Evaluation of Handover Management Schemes in LTE-Advanced Femtocell," 2011 IEEE 73rd Vehicular Technology Conference (VTC Spring), pp. 1–5, May 2011.

[15] L. Song, M. Peng, B. Lv, M. Wang, and H. Jiang, "Speed estimation in uplink frequency domain for mobile OFDM systems," 2014 IEEE/CIC International Conference on Communications in China (ICCC), pp. 458–462, Oct. 2014.