International Journal of Future Generation Communication and Networking
Vol. 10, No. 2 (2017), pp. 65-74
http://dx.doi.org/10.14257/ijfgcn.2017.10.2.07

Enhancement of Spectrum Detection in 5G Heterogeneous Network

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Abstract

Modern advancement of Long Term Evolution Advanced (LTE-A) in wireless communication industry is revolutionary to fulfill the high order expectations through extending the high system throughput and capacity. This is mainly due to the effects of the Orthogonal Frequency Division Multiplexing (OFDM), where both frequency and time division are employed in order to exploit the system capacity. However, in LTE-A Heterogeneous Network (HetNet), femtocells (HeNBs) are optimal choice to extend the coverage in indoor environment, whereas the deployment of such base station creates cross-tier and co-tier interferences with the macrocell users (MUE) becomes critical challenge. Therefore, the unutilized/idle spectrums reallocation is one of the solution to mitigate such challenges. However, the Enhanced Spectrum Detection (ESD) in such typical network is challenging. Trendy DSS networks, licensed secondary users (SUs) be able to gain assigned licensed spectrum band without any interference with primary users (PUs). This paper enhances the spectrum detection in LTE-A based Heterogeneous Networks (HetNets) using ESD mechanism. In ESD false alarms and missed detections are considered the performance metric. The result suggests that the performance of the spectrum detected is enhanced over existing method.

Keywords*: Spectrum Detection, Power allocation, OFDMA, HeNB*

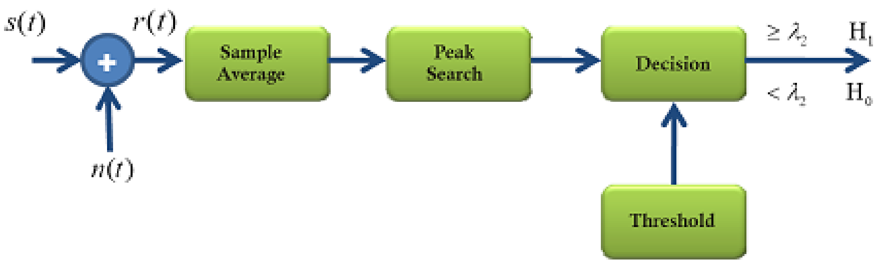
1. Introduction

In Heterogeneous Network, two tiers are considered *i.e.* HeNB with MeNB are confronting two classes of interference which are co-channel interference (CTI) and cross-channel interference (CSI). The CTI is the interference happened concerning the HeNBs, and the CSI is the interference among HeNBs and MeNB [1]. The conspicuous answer for relieving the cross-level is to partition the accessible range into two bits: one for HeNBs and the other for MeNBs [1]. Be that as it may, this is very wasteful to the extent the range effectiveness is concerned in light of the fact that the HeNBs are plug and-play gadgets, and it might bring about underutilization of the resources in OFMDA.

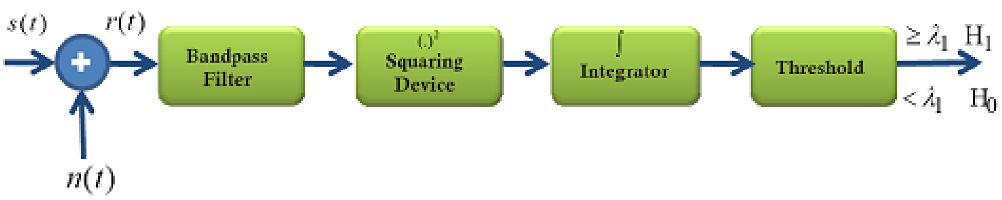
A monstrous conservative of power distribution polices and interference control approaches have been proposed for OFDMA resource sharing CRs [2]. For example, the ideal power control plans to boost the limit of the optional client with a compelling assurance of the PU for range sharing CRs. Wavelet entropy based OFDMA resource detecting scheme was proposed to detect the resource within the sight of PU by

ISSN: 2233-7857 IJFGCN

contrasting signs with an edge [3]. In any case, in this calculation, detecting postponement is watched which is not relevant in the HetNets. To detect the range in CR, SNR based adaptive resource detecting model was proposed which were the both systems of energy identifier and cyclostationary detection. The scheme demonstrates that it is acting as like OR capacity with these two identifications [4]. In any case, it can be seen that because of the lower SNR rate, this method is not appropriate for HetNets. Figure 1 demonstrates the square outline of energy identifier and cyclostationary location show.



(a)



(b):

Figure 1. Block Diagram of (a) Energy Detector,(b) Cyclostationary Detector [1]

A power controlled based range detecting systems was proposed [2] utilizing interference level limit to manage the interference in OFDMA based HetNets. The method could tie as far as possible. The figured likelihood thickness of whole cell throughput for closed and open access at a home domain considers an expansive organization of HeNBs and MeNB [3]. Thus the basic interference delivered by HeNB to clients which are into the MeNB scope. It was found that open get to execution is more palatable than shut get to. The shut get to procedure is slanted to have the entire cell throughput to 15% lower than open get to strategy. In half and half get to, the availability of HeNB can be exact and it can be built to guarantee the minimum presentation. Also, the designation of HeNB assets amongst endorsers and non-supporters ought to be exceedingly tuned. The hybrid access gets the strategy which obliges change in accordance with the HeNB course of action improvements.

2. Enhanced Spectrum Detection Mechanisms

To mitigate both of CTI and CSI, enhanced resource detection is essential. As a result, inaccuracies in correctly detecting the PU signal surges the interference to MeNB network. To regulate the interference of MeNB system, the revealing probability P_D for the OFDMA resources is essentials to be figured. Furthermore, the total probability of mis-detection of MeNB signal at wideband is correlated to P_D. The norm of this detection system model is to exploit licensed channels of MeNB applying CR mechanisms. Therefore, the main of this paper is to enhance the Spectrum

Detection (SD) model through cluster mechanism at MeNB (Primary Transmitter *i.e.* PT) and Primary Users can be stated as MUE. The SD mechanism allows them to decide the presence of a PU. The Enhanced Spectrum Detection (ESD) system model for resource execution mainly based on cluster formation and unexploited resources in OFDMA to assign to its users. To discover the vacant spectrum hole, SS is one of the best techniques which can be applied through CR. The ESD model is classified in to three sections such as, cluster formation and thereby spectrum sensing using cluster. The system model diagram is represented in Figure 2. The general architecture is directed in Figure 3, where MeNB is considered as PU and HeNBs are considered as SU.

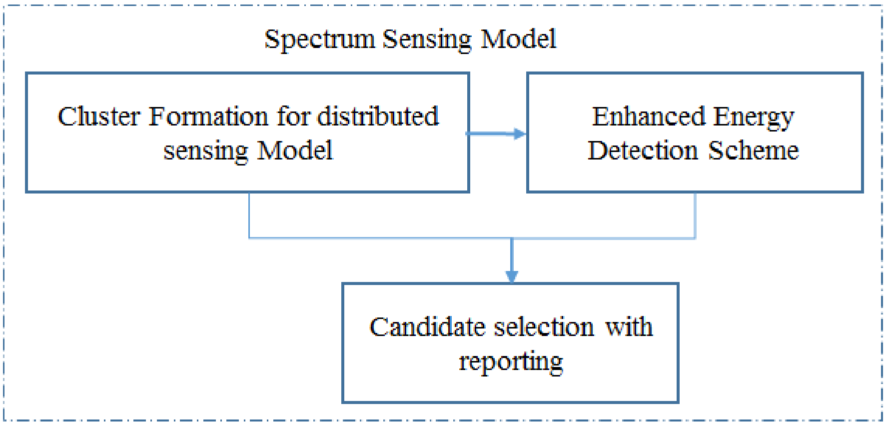


Figure 2. Proposed Procedure

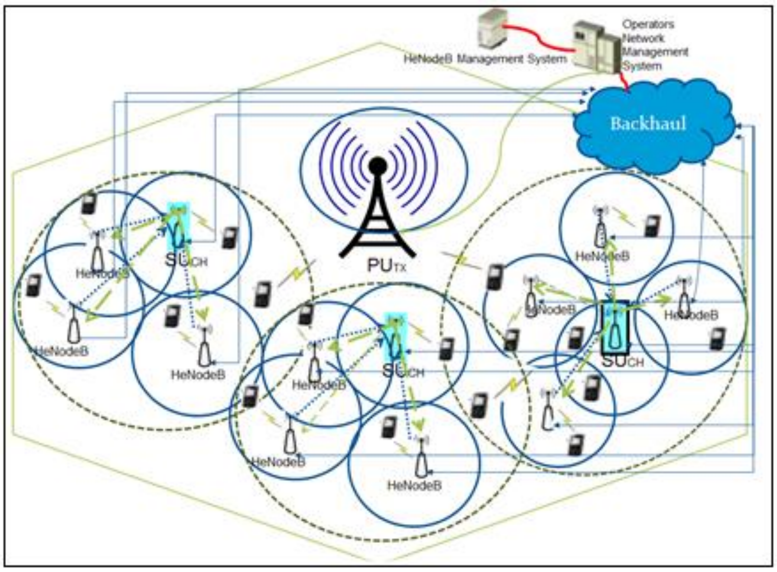


Figure 3. Proposed System Cluster-based Architecture

Within the clusters a signaling node (SN) is selected by CH and rest of all will play as cluster-member (CM). In HetNet, the extended base stations which are HeNBs are contemplated for the cluster formation. The CH and CM selection is shown in Figure 4, and SN is shown in Figure 5.

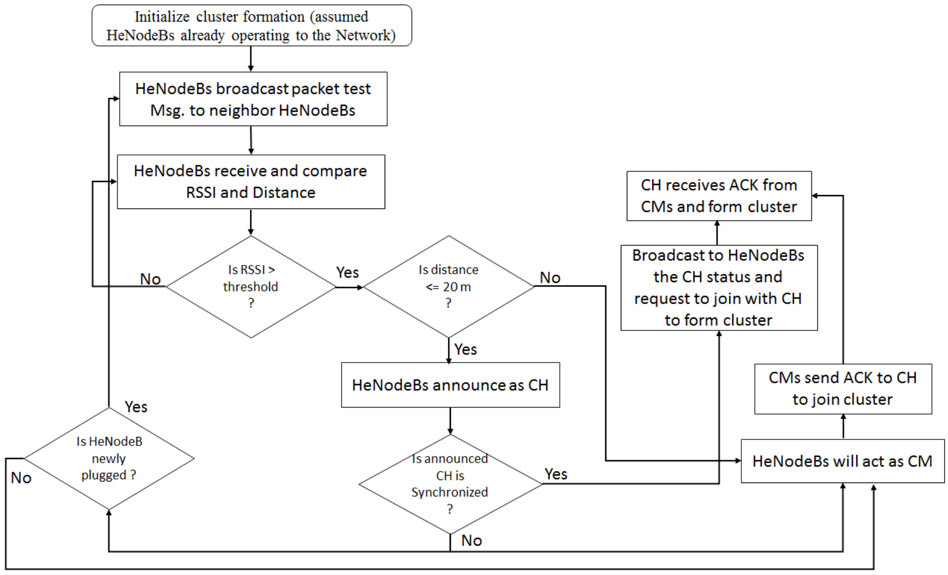


Figure 4. CH and CM Selection Flowchart

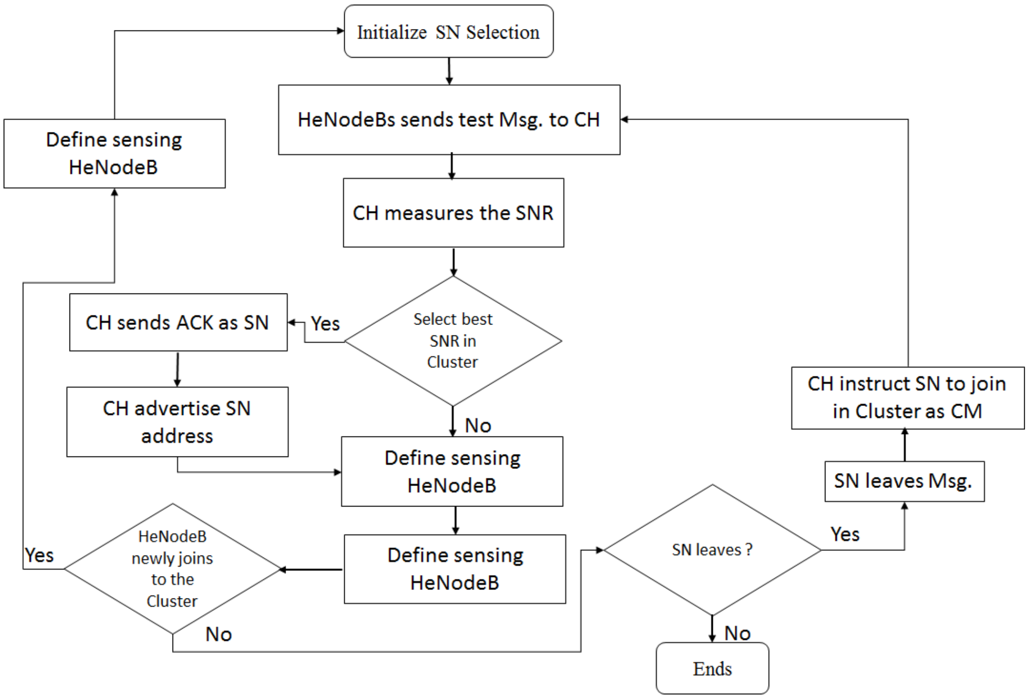


Figure 5. Signaling Node (SN) Selection

The main functionality for sensing is to utilizing the empty spectrums. The SD is applying the CH and SN detection using ED detection. All CM's are acquired the signal from the MeNB, then SN applies the ED mechanism to detect unused resources from LTE-A based OFDMA resources in both time domain and frequency domain[2]. Here, the main focus is on carrier frequency of fc thru a given bandwidth as well as acknowledged signals are experimented at the f_s. The SD can be represented in Eqn. (1) [2, 3], [10-11].

$$H_{SN}(n) = \begin{cases} \Theta_i(n) & \text{inactive of PU;} \quad P_0 \\ U_i S_i(n) + \Theta_i(n) & \text{active of PU;} \quad P_1 \end{cases} \qquad (1)$$

where, $H_{SN}(t)$ symbolizes the perceived signal from MeNB transmitter, U_i denoted as Rayleigh fading channel gain, $\Theta_i(n)$ signified the AWGN which is independent and prospective spreading random procedure through mean zero as well as variance as $\varepsilon\,[|\Theta_i(n)|^2] = \sigma_\Theta^2$. At the occurrence of MeNB signals$\big(S_i(n)\big)$ are independent of $\big(\Theta_i(n)\big)$in the assumption of P_1, then AWGN variance of $\varepsilon\,[|S_i(n)|^2] = \sigma_S^2$. Therefore using ED the output assessment matric can be conveyed as in Eqn. (2) [2, 4, 5][10-11].

$$V_k = \frac{1}{A_k\,B_k\sigma_{\Theta,k}^2}\sum_{n=1}^{N}\|\mathrm{H}(n)\|^2 + \mathrm{O}_{SN} \tag{2}$$

where, *B* is the size of observation of the assessed information of the resource occupancy of a band can be obtained by comparing V with a fixed threshold λ which the ED can be self-possessed at frequency sphere. If the received information statistics exceeded the threshold (η), then report statistics with reporting decision O_{SN} and without decision $\tilde{\tilde{\mathrm{O}}}$ is expressed in Eqn. (3)[2-5]. Where, *b* is the average reporting bits. Therefore, in the independent channel of $\mathrm{A_k}$ for $\mathrm{A_k B_k}$ can be stated with the $\mathrm{O_k}$ in Eqn. (4), where, Φis the SNR of the k[th] HeNB. Taking consideration of Neyman-Pearson theorem [6] established, $\mathrm{Z_f}$ and $\mathrm{Z_d}$ can be illustrate the proposed schemes test hypothesis with reporting is expressed in Eqn. (5) test statistics, Eqn. (6) for $\mathrm{Z_f}$ as well as Eqn. (7) for $\mathrm{Z_d}$ [2-5]. The ESD model for $\mathrm{Z_{f,ESD}}$ can be find out through Eqn. (6) under fading channel, and $\mathrm{Z_{d,ESD}}$ is assessed by using Eqn. (7) [2-5].

$$\mathrm{O}_{SN} = \begin{cases} O_k < \eta & \tilde{\tilde{O}} \qquad\qquad b = 0 \\ O_k \geq \eta & \tilde{O}_{SN} \quad 1 \leq b \leq V_k \end{cases} \tag{3}$$

$$O_k \sim \begin{cases} \xi\left(1, \dfrac{1}{A_k B_k} + \sigma_{\Theta,k}^2\right), & P_0 \\ \xi\left(\Phi + 1, \dfrac{1}{A_k B_k} + \sigma_{\Theta,k}^2\right), & P_1 \end{cases} \tag{4}$$

$$V_{ESD} = \sum_{k=1}^{K}\frac{\Phi_k\,A_k B_k\left(1 - A_k B_k\sigma_{\Theta,k}^2\right)}{\left(1 + A_k B_k\sigma_{\Theta,k}^2\right)\left(1 + 2\Phi_k + \Phi_k\right)} \tag{5}$$

$$Z_{f,ESD} = 1 - \prod_{k=1}^{K}\left(1 - Q\left(\frac{\eta - 1}{\sqrt{A_k B_k + \sigma_{\Theta,k}^2}}\right)\right) \tag{6}$$

$$Z_{d,ESD} = 1 - \prod_{k=1}^{K}\left(1 - Q\left(\frac{\eta - 1 - \sigma_{\Theta,k}^2}{\sqrt{\dfrac{1 + 2\sigma_{\Theta,k}^2}{A_k B_k} + \sigma_{\Theta,k}^2}}\right)\right) \tag{7}$$

3. Result and Discussion

The simulation environment is considered for the HetNet using Monte Carlo simulation. The main considered cluster scenario is simulated using proposed cluster formation algorithm (as in flowchart) correspondingly using the correlation (¥) of HeNBs as following the condition as in Eqn. (8).

$$¥ = R/D \tag{8}$$

Where, *R* represents the radius of the HeNB coverage, as well as *D* indicates the distance among neighbor HeNBs. The simulation setup of the cluster formation is illustrated in Figure 6.

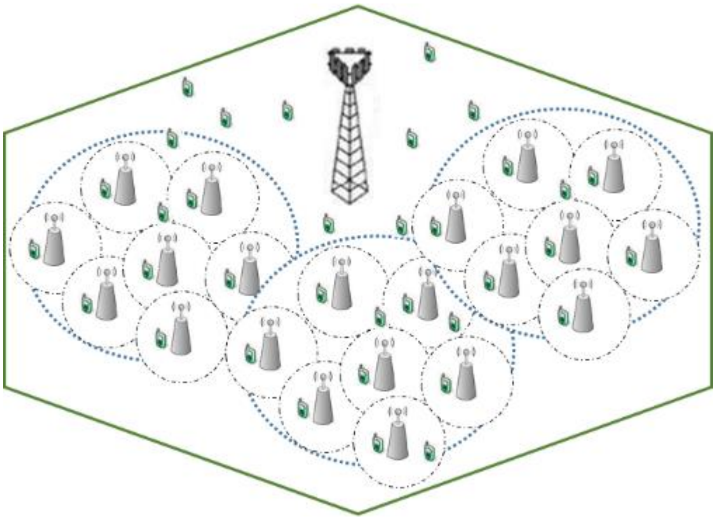


Figure 6. Cluster Simulation Scenario

In evaluating the proposed technique, the subchannel sensing is set at 5MHz sampling rate where the detection time is recorded to be 0.546723s during the simulation. The subchannel sensing performance is measured in terms of received signal statistics at CSN. This statistic is generated on the basis of multiple numbers of GMs. The numbers of HeNBs are randomly distributed; the area of the locations can be varied. The channel is well-thought-out with physical path loss model for indoor and outdoor conditions [2-5]. The multipath validated as a complex Gaussian random variable with Rayleigh fading and as well as AWGN noise for reporting errors. For the simulation 25 HeNBs are taken in a typical HetNet. To estimate the variance, the errors can be reported by the $A_k B_k \sigma_{\theta,k}^2$ factors. The parameters for the Matlab simulation are as in Table 1[7-11].

Table 1. Simulation Parameters [2-9]

Parameter description	Assessment
Modulation technique	BPSK
Number of users	25
Noise	AWGN
Channel SNR	0 dB to 20 dB
Number of samples	25
PU transmit power	46 dBm
Distance	30m
Frequency	2.5 GHz
Path-loss exponent indoor/outdoor	4/2
Carrier frequency	100 MHz

By simulation cluster formation is shown in Figure 7 and Figure 8 presented the SN selection using ESD method.

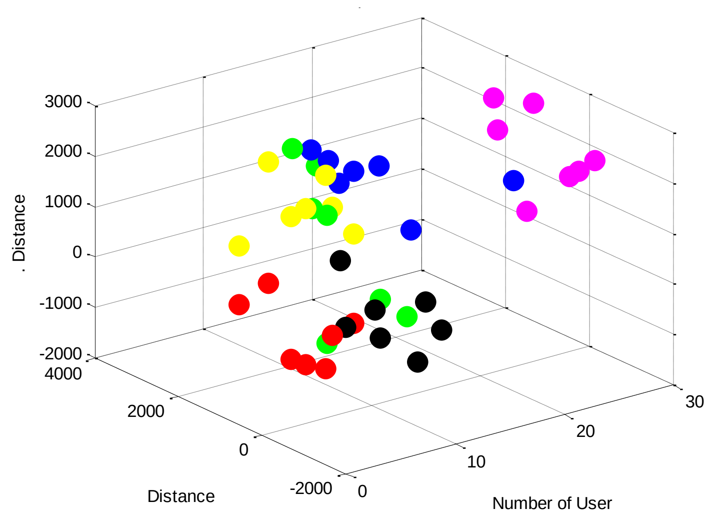


Figure 7. Cluster Formation Scenario

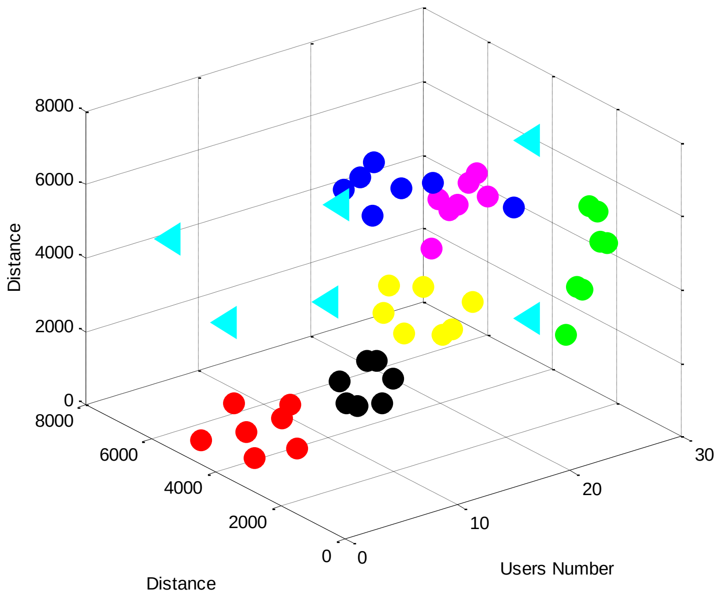


Figure 8. SN Selection Scenario

The cumulative distribution while the hypothesis is P_1 the Signal to Noise Ration (SNR) is presented in Figure 9.

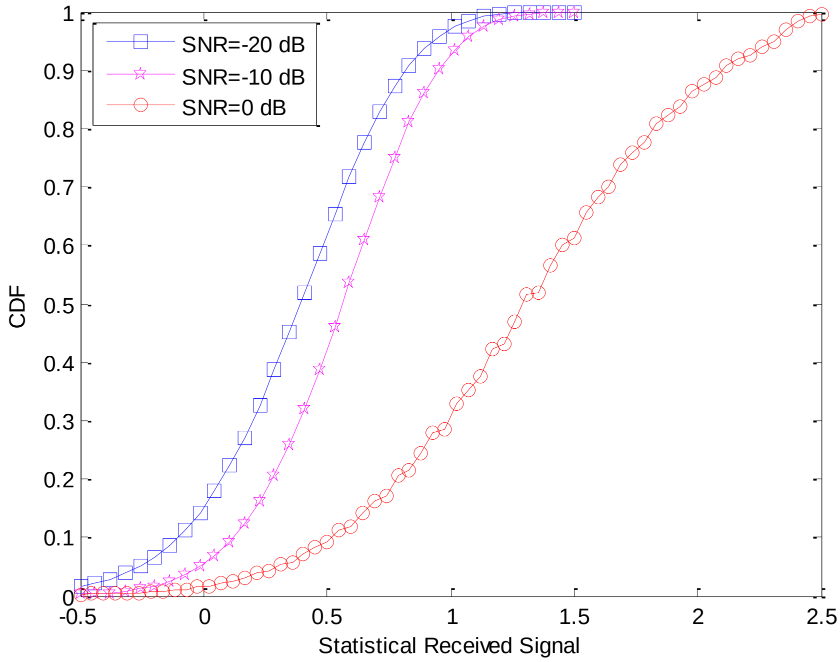


Figure 9. CDF vs Statistical received Signal for HetNet

The statistical received signal is shown in Figure 9 with respect to different SNR for HetNets. In addition, the total number of receiver was 35 in the simulation. The number of samples has considered as 18000, 9000, 5000, as well as 3000 respectively.

5. Conclusion

In this paper, the fundamental focus the proposing enhanced resource detection strategy to detect the vacant resources in the authorized MeNB with least resistance of blurring impacts. The plan has effectively figured out how to adapt out to the point. A bunch with hub Signaling choice calculation additionally acquainted which forces with the distinguishing ranges in HetNet. The recreation comes about have underlined the change of the range discovery. Moreover, various past works researched also. The future review plans to build up a novel scheming to enhance the OFMDA resources dynamically and to sharing to the users in order to alleviate the interferences (CTI and CSI) between cell impedances.

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