CHAPTER VII

PROPOSED NOMA WITH JOINT TRANSMISSION

Heterogeneous Network (HeNet) is one of new technologies defined by 3GPP to improve LTE advanced network performance, it consists the deployment of macro cell with different cells such as microcells, femtocells, and picocells which enhance cellular network capacity [54].

The orthogonal design of multiple access is a reasonable choice for achieving good system-level throughput performance in packet-domain services with a simplified receiver design. However, in order to boost further the spectrum efficiency in the future, more advanced receiver designs are required in order to mitigate intra-cell and inter-cell interference. As a candidate multiple access for FRA including further LTE enhancement beyond Release 12, Non orthogonal multiple access (NOMA) over orthogonal multiple access (OMA) are adopted as downlink access scheme for future 5th generation mobile communication.

In NOMA multiple users are multiplexed in power domain in base station (transmitter side) and in receiver side serial interference cancellation (SIC) are used to separate multiuser signals [55]. From an information-theoretical point of view, it is well-known that non-orthogonal user multiplexing using superposition coding at the transmitter and SIC at the receiver not only outperforms orthogonal multiplexing, but also it is optimal in the sense of achieving the capacity region of the downlink broadcast channel.

Cooperative communication allows communication terminals in a network to hear and help the information transmission of each other, by taking advantage of the broadcast nature of wireless communication. It can be used in improving network connectivity, enhancing power and spectrum efficiency, and improving communication reliability. Moreover, comparing to other emerging techniques that could achieve similar performance advantages, such as multiple input multiple output (MIMO) technique, cooperative communication is superior in deployment flexibility and hardware feasibility.

In this chapter, we present a heterogeneous LTE network deployed according to the models described in [40]. We compare between orthogonal multiple access (OMA) and non orthogonal multiple access (NOMA) to evaluate user throughput between two multiple access schemes. We propose new transmit power allocation scheme and compare it with used in [56]. We show that the proposed transmit power allocation scheme achieves better user throughput compared to scheme in [56].

We extend our simulation with NOMA to base station (BS) cooperative cellular downlink for future radio access. Since the MIMO capacity is increased as the numbers of transmitter and receiver antennas are increased, while the allowable numbers of these antennas per BS and user terminal are limited, employing a combination of BS cooperation and multiuser MIMO is an effective way to enhance the cellular system performance. For the proposed NOMA in a BS cooperative scenario, we employ NOMA with Joint transmission in this thesis. We show that the proposed NOMA scheme with BS cooperation achieves better system-level throughput compared to OMA. We also show that the effect of the proposed NOMA scheme is more significant when BS cooperation is assumed since the BS cooperation improves the channel conditions of the cell-edge users, which are appropriate for obtaining a higher non-orthogonal user multiplexing gain.

In section 7.1, we compare between orthogonal multiple access (OMA) and non orthogonal multiple access (NOMA) when using the same simulation parameters as described in chapter 4, we also show the effect of imperfect interference cancellation on user throughput. In section 7.2 we present user selection with fixed power allocation scheme and compare with scheme used in [56]. Proposed NOMA scheme with BS cooperation is explained in section 7.3 and compared with NOMA scheme without COMP. Simulation parameters are described in chapter 5.

7.1 User Selection with Fixed Power Allocation For NOMA

7.1.1 OMA and NOMA

First, we compare between orthogonal multiple access and non orthogonal multiple access in deployment scenario, as shown in figure 7.1

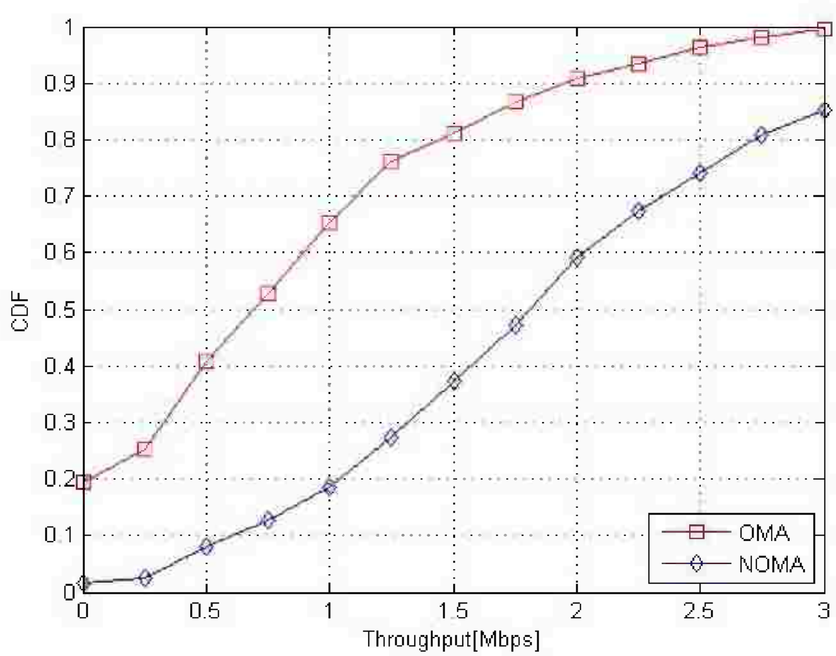

Figure 7.1 Compare Macro users throughput when using OMA and NOMA

In fact not all interference power is removed under cancellation; the parameter $\varepsilon \rightarrow [0, 1]$ gives the residual power of user after cancellation. $\varepsilon = 0$ for perfect interference cancellation.

7.1.2 Imperfect Interfernce Cancellation

Figure 7.2 compares between the effects of different imperfect interference cancellation on macro users throughput, it shows throughput improved when imperfect IC decreased.

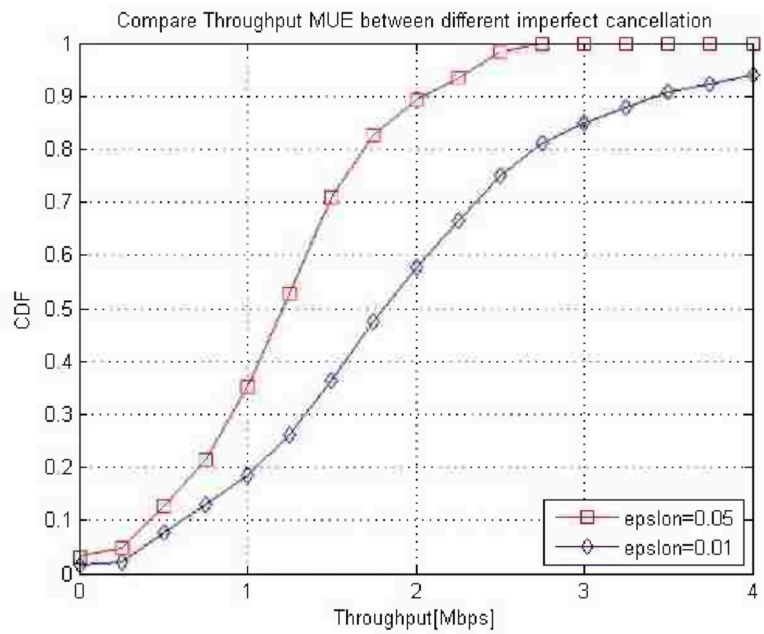

Figure 7.2 Compare Macro users throughput when using imperfect IC

7.1.3 User Sorting Power Allocation (USPA)

Due to power domain multi user multiplexing, the transmit power allocation (TPA) is important consideration in NOMA downlink. It affects the achievable throughput of not only that user but throughput of system. The simulation compared between two transmit power allocated schemes. The first is used in [56], which is called Pre defined user group and per group fixed power allocation (FPA) and the second is our proposed scheme. Our power allocation scheme is user sorting power allocation (USPA).

In the first Scheme, the users are divided into two different user groups according to their channel gains and pre defined threshold. In FPA, the users can be paired together only if they belong to different user groups as shown in figure 7.3 [56].

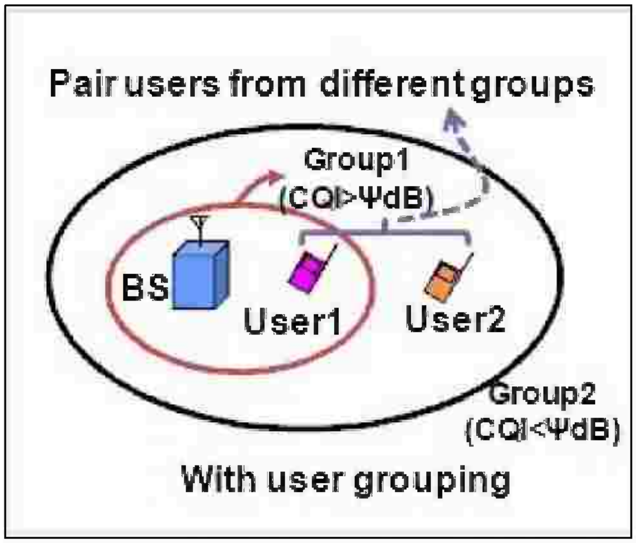

Figure 7.3 User grouping in NOMA

In the second scheme, the concept of this scheme is to pair two users. The difference SIR of two users is large.

First we use proportional fair scheduling algorithm to sort users depending on priority, then we rearrange users according to their SIR. We divide users into two groups, and then we pair two users from two groups.

The user sorting power allocation (USPA) is described as follow:

- PF scheduling calculates maximum priority for each user and sorts Users corresponding to their maximum priority.

- Users which will be selected by PF are sorted in descending order according to their signal to interference ratio (SIR), so high SIR users are the top of this list.

- The Scheduler Divides this list into two groups

- The users can paired together from different group (top of group 1 will be paired with top of group 2,etc)

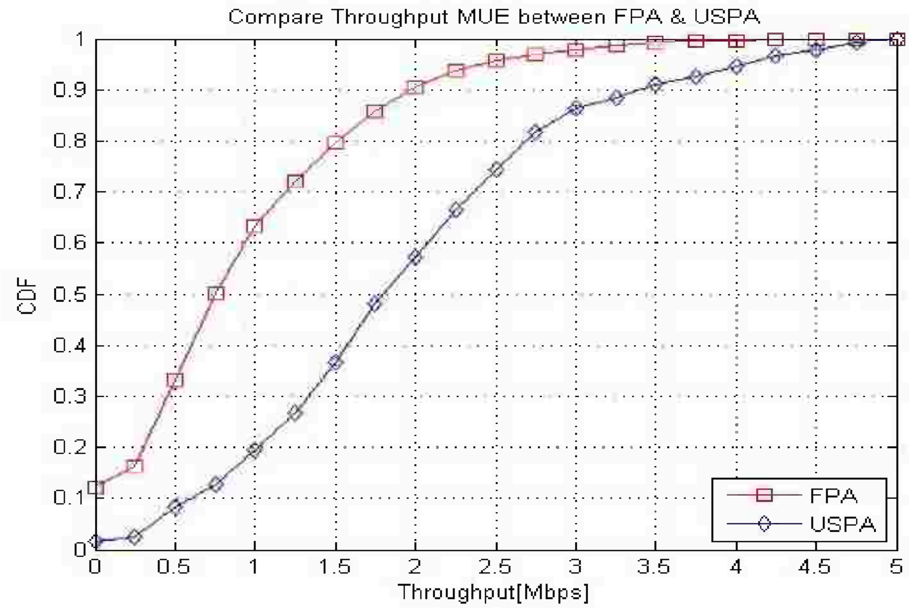

Figure 7.4 Compare throughput of MUE between FPA and USPA

Figure 7.4 shows that MUE throughput improves when using USPA, 90% of users in USPA are getting more than 0.5 Mbps versus 87% of users are getting more than 0.5 Mbps in FPA.

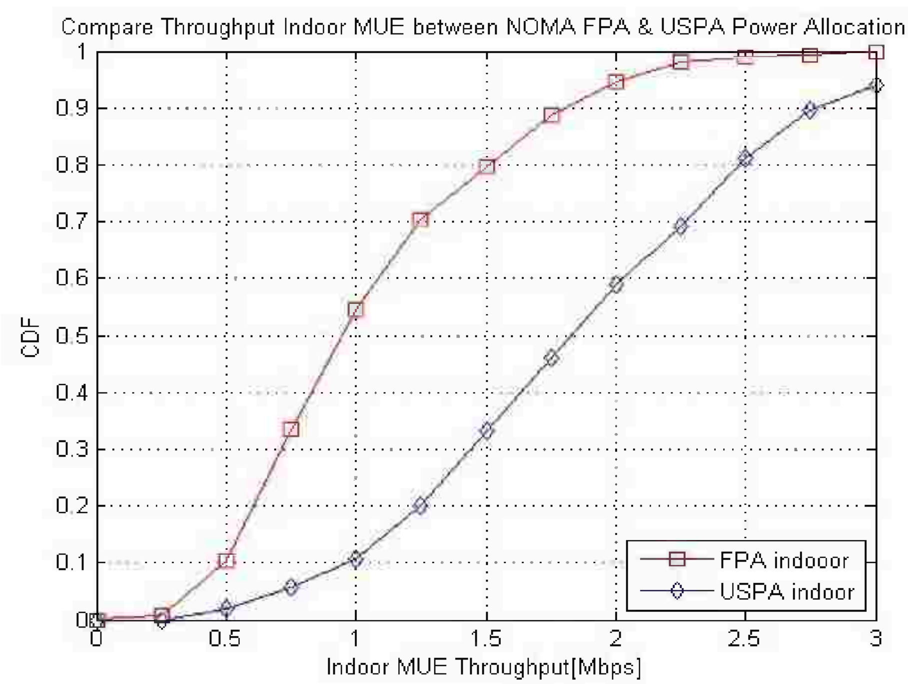

Figure 7.5 Compare Throughput indoor MUE between NOMA FPA and USPA power allocation

Figure 7.5 shows only indoor users throughput, we conclude that indoor users who will be affected with interference can be improved when using USPA than FPA, for example 68% of users are getting more than 1.5 Mbps but in FPA, only 20 % are getting more than 1.5 Mbps.

Figure 7.6 shows femto users' throughput when using two transmit power allocation methods; it is clear that throughput of HUE not affect with using two methods

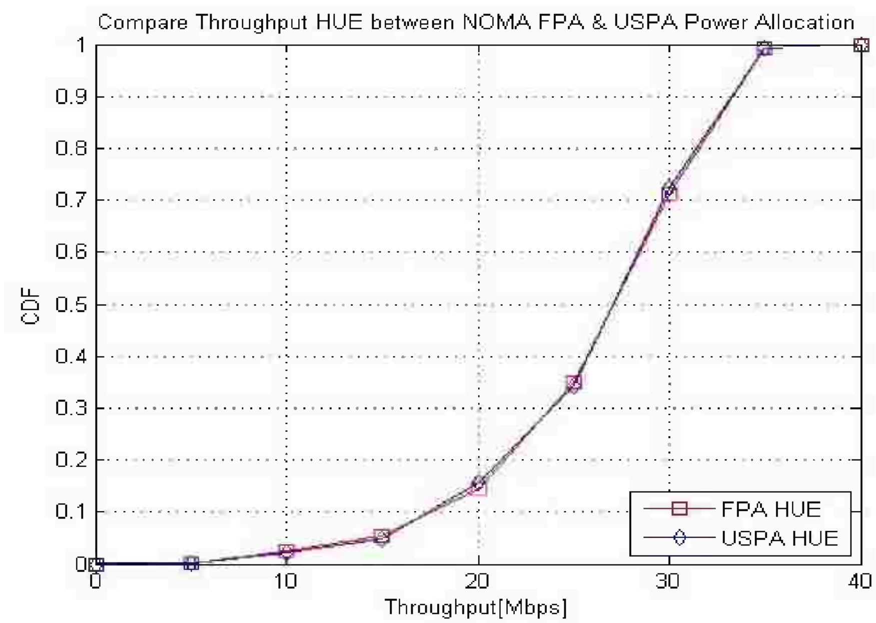

Figure 7.6 Compare throughput of HUE between NOMA FPA and USPA power allocation

7.2 PROPOSED NOMA WITH JOINT TRANSMISSION

We proposed NOMA with Coordinated Multipoint (COMP) in heterogeneous network.
For each frame, scenario will be:

- 1st Subframe:

- Macro base station (MNB) will select two users with different channel gain and send data using NOMA.

- Femto base station (HNB) will select its femto user and send data.

- 2nd Subframe (Almost Blank subframe (ABS)):

- Macro base station (MNB) will select two users with different channel gain and send data using NOMA.

- Femto base station will select two users; first its femto user, and second indoor macro user.

- Using Dynamic Cell selection(DCS) Indoor macro user measures R_X from two base stations if MNB is stronger than HNB; MNB send data using NOMA, and HNB will be silent (ABS).

- If HNB is stronger than MNB; MNB send full power to outdoor user, and HNB will send data to femto user and indoor macro user with NOMA.

Figure 7.7 shows the flow chart of proposed NOMA with Joint Transmission.

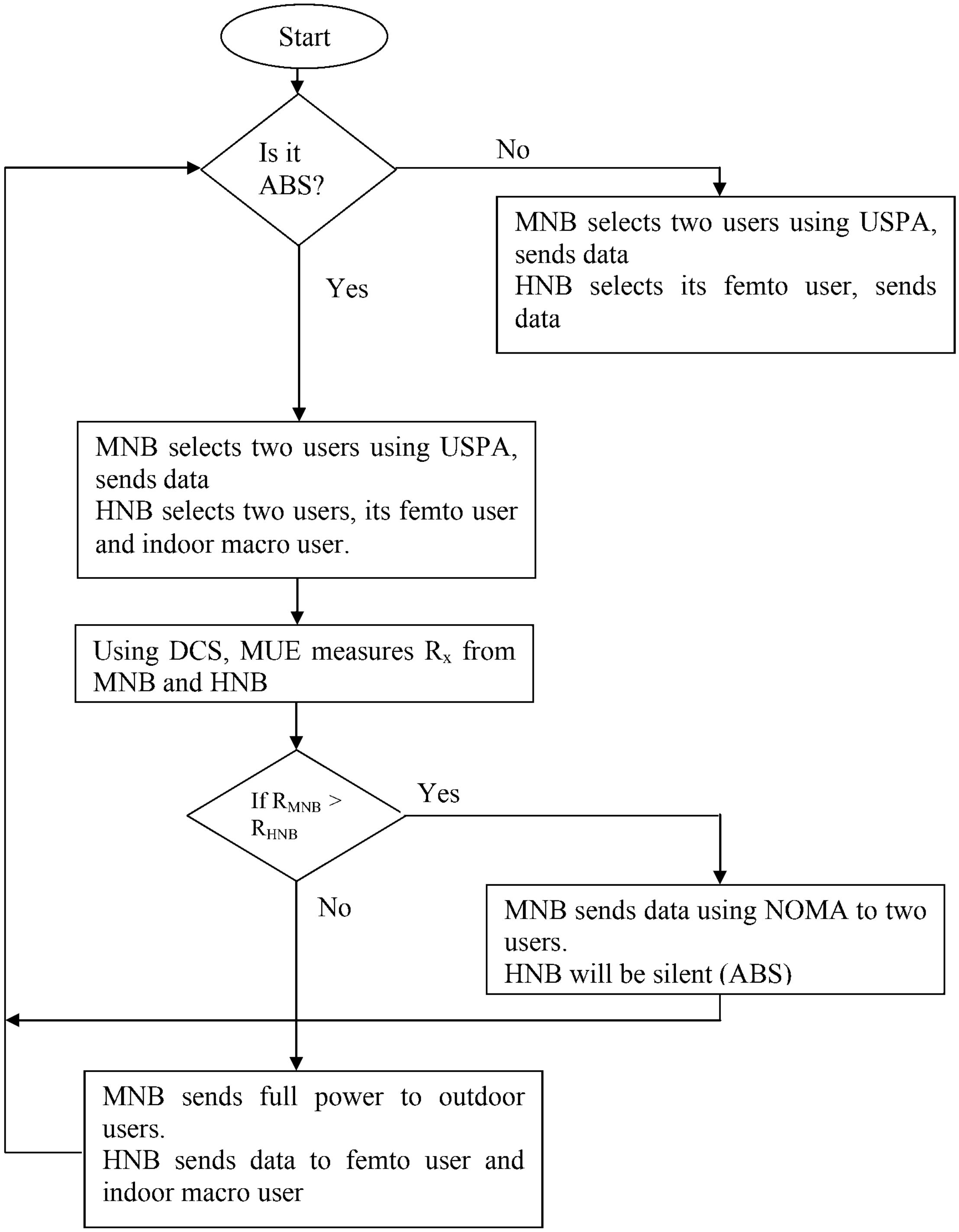

Figure 7.7 Flow chart of proposed NOMA with Joint Transmission

Figure 7.8 shows comparison between macro users' throughput with COMP and without COMP, with COMP; only 40 percent are getting lower than 3 Mbps but without COMP, approximately 80% are getting lower than 3Mbps.

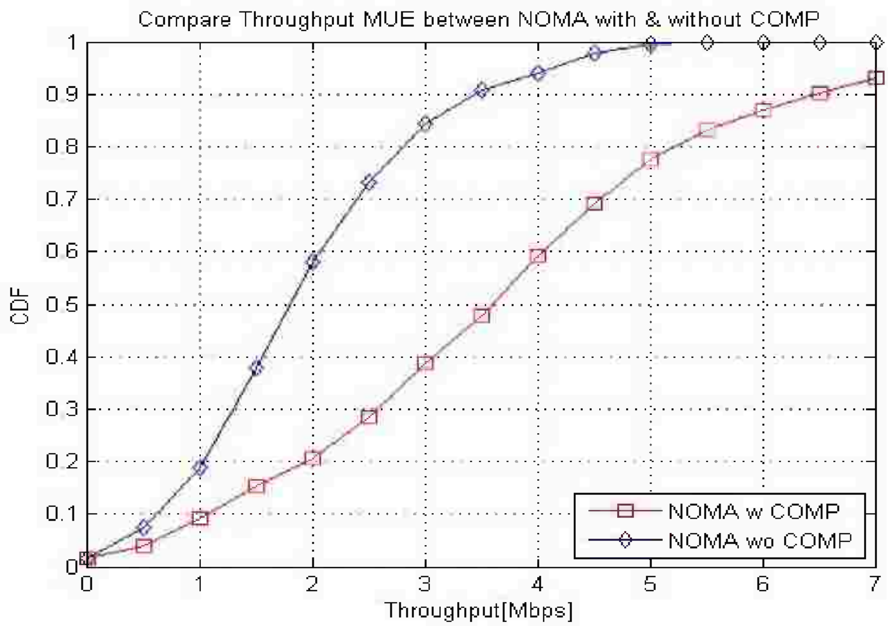

Figure 7.8 Compare throughput of MUE between NOMA with and without COMP

Figure 7.9 evaluates the CDF of indoor macro users' throughput. On 3.5 Mbps, however 50 percent of users are getting 3.5 Mbps throughput with COMP, 100% of indoor users are getting the same throughput without COMP.

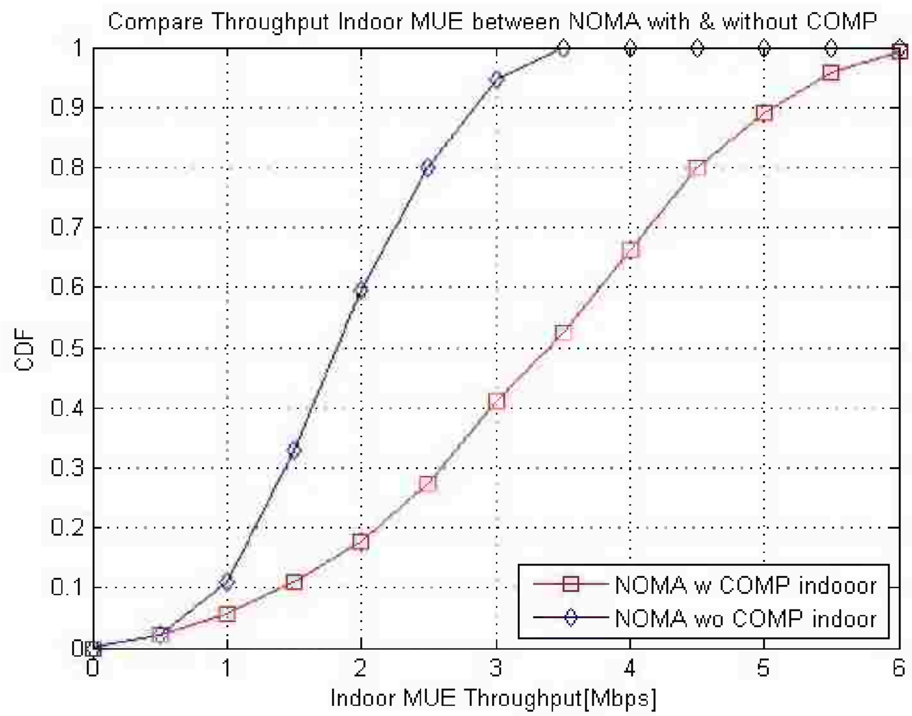

Figure 7.9 Compare indoor MUE users throughput between NOMA with and without COMP

Figure 7.10 compares throughput of HUE with COMP and without COMP using NOMA. We shows that the CDF of femto users approximately doesn’t change when using NOMA because in this scenario only macro base station use non orthogonal multiple access.

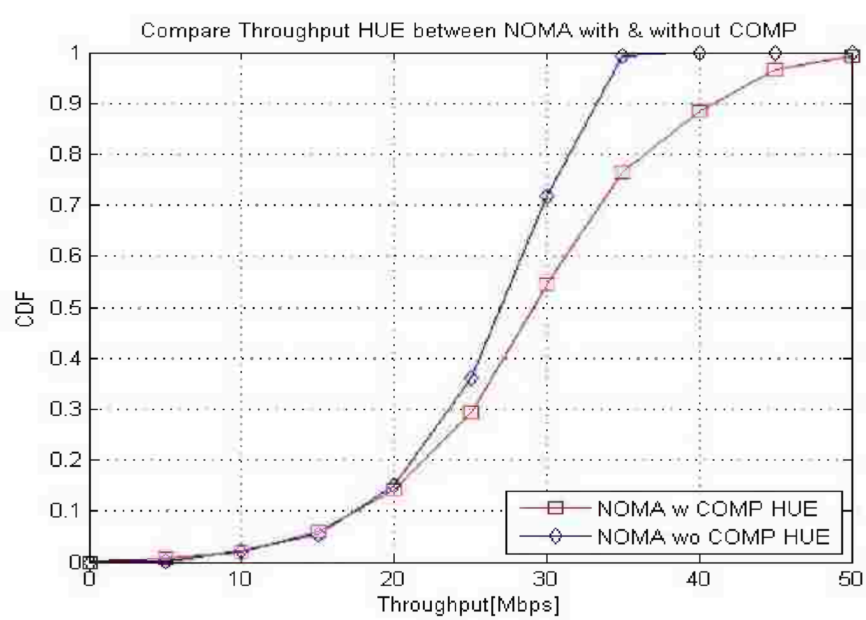

Figure 7.10 Compare HUE throughput between NOMA with and without COMP

Table 7.1 and figure 7.11 summarize the comparison between users with different schemes in deployment scenario, Joint Transmission with NOMA will improve cell throughput for macro and femto users and also for macro and femto cells.

Table 7.1 comparison between throughput of MUE and HUE

	Macro Cell Throughput (Mbps)	Femto cell Throughput (Mbps)
Orthogonal Multiple Access (OMA)	18.2	11.02
Fixed Power Allocation (FPA) with NOMA	20.22	22.03
User Selection Power Allocation (USPA) with NOMA	41.2	22.03
COMP with NOMA	69.35	30.87

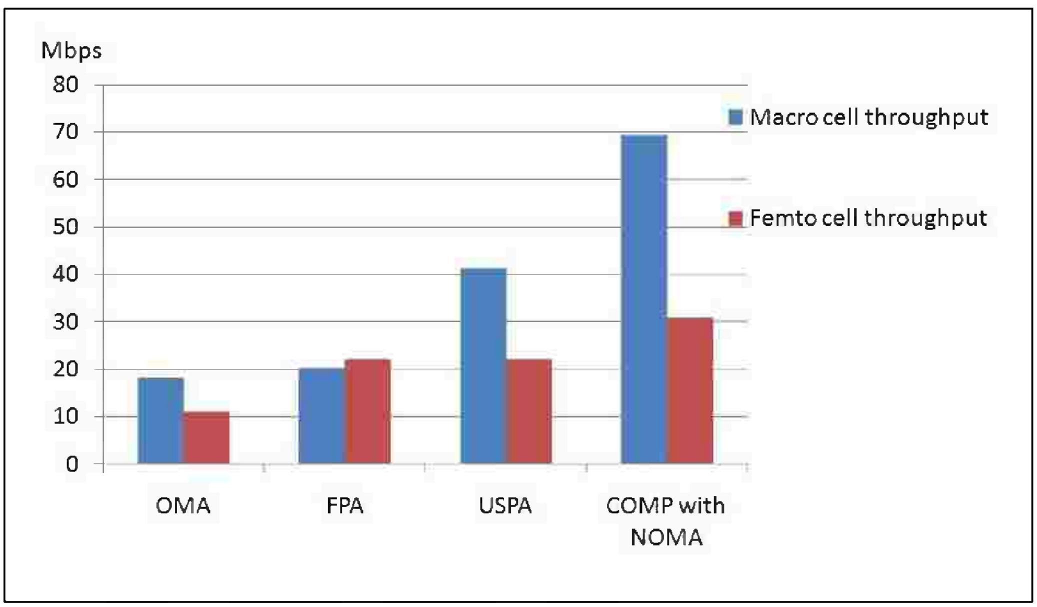

Figure 7.11 Comparison between throughput of MUE and HUE