CHAPTER 6
MULTI-PARAMETER BASED SCHEDULER IN NETWORK CENTRIC MIMO SYSTEM

Recent scheduling addresses only the single base station issues like resource allocation, antenna allocation rather than entire network as a system. In this chapter a network centric multi-parameter based scheduling (NC-MPS) is described. Here multi-parameter based scheduling is used in all base stations which are attached to the network in a coordinated manner. By coordinating all base stations in the network, resource utilization of all base stations can be improved. This NC-MPS scheme is to offer improved performance in terms of a low BER, and improved resource utilization of a coordinated network. The performance of NC-MPS is simulated under resource constraint environment where one base station is in shortage of resource and another base station is in excess of resource. Simulation results prove that NC-MPS improve average BER performance and improve resource utilization.

6.1 INTRODUCTION

As an alternative to traditional scheduling, this chapter investigates cooperative scheduling among neighboring base stations (BS) in a multiple antenna system, where each base station adopts multi-parameter based scheduling. The advantage of cooperatively scheduled transmission can achieve a better link level if straightforward opportunistic scheduling is employed among neighboring base stations. A number of sub-optimal BS
coordination techniques have recently been proposed (Zhang et al. 2004, Ng et al. 2005, Ekbal et al. 2005 and Gesbert et al. 2006), including joint beam-forming, joint pre-coding, joint spatial multiplexing, and joint space-time coding in physical layer. If the coordinated base stations are treated as a virtual MIMO system, conventional multiuser MIMO techniques are applicable. In previous chapters different methods of medium access control (MAC) layer scheduling along with space time coding were proposed with single base station for BER performance improvement. The coordinated base station MAC layer scheduling can achieve better link level performance and effective resource utilization compared to non-coordinated system. In this chapter a new multi-parameter based scheduling is proposed in coordinated base station wireless networks for better resource utilization with the help of access controller.

6.2 SYSTEM OVERVIEW

In this section, downlink multiuser MIMO system is modeled with three base stations (BS) which are controlled by a common base station controller (BSC) as shown in Figure 6.1. Each base station is considered as one cell area in a mobile cellular network.

![Network diagram](image)

*Figure 6.1  Network connecting a user through three base stations with access controller (AC)*
Here a network is shown to connect a user through three base stations with the help of access controller (AC) which is placed inside the BSC. Let ‘L’ be the pair of transmit antenna available at each base station and ‘N’ is the number of active mobile users connected to each base station and each user with a pair of receive antenna. Here each BS scheduler probes all ‘N’ user channel state information. Then it schedules active users based on their channel quality and demand rate. Every BS uses 2X2 Alamouti -STBC code in physical layer. It is assumed that the channel quality stays stationary during a time slot. The scheduler in each base station grants available resources to the scheduled user. The number of available resources and the number of scheduled user in every base station are monitored by access controller. It helps in allocating excess resource of one base station to another base station user. Hence via AC, these base stations are under cooperation mode. User scheduling and resource granting process are carried out during the guard period. In subsequent data burst, the resource granted user performs data transmission. It is assumed that the base station knows the channel state information of all active users. It can select a group of users from all active users to achieve better performance with the help of schedulers at every base station. Here the equal number of transmit antennas (two) are allotted per user in the time slot by considering the number of resources available.

6.3 NETWORK CENTRIC MPS (NC-MPS)

In a network, multiple base stations are involved in user service. It does not guarantee the use of entire resource of all base stations. There may be situations in which one of the base stations is in excess of resource whereas another base station is in shortage of resource. To effectively utilize the resource of all base stations, coordination among the base stations must be created. In a network centric environment, different base stations are coordinated through access controller. Here, three base stations are modeled
with MPS scheduler. The role of the scheduler is to schedule the active user according to Table 5.1. After scheduling the active user if number of scheduled user is less than the available resource of concern base station, the resource remains unutilized in normal network. To avoid this resource wastage, coordinated access controller is used in network centric system. This AC monitors scheduled users of all base stations and identifies the resource available at various base stations. Suppose any one base station is in shortage of resource, then through access controller the unutilized resource of other base station will be assigned. Thus the access controller helps in utilizing the entire network resource. The following cases are possible in this network centric system.

- One base station have more number of scheduled users compared to L. Other two base station is in excess of resource.

- Two base stations have more number of scheduled users compared to L. Another base station is in excess of resource.

- All base stations are in shortage of resources

- All base stations are in excess of resources

Let \( x = \{x_1, x_2, x_3, \ldots x_n\} \) be the users request received at time slot \( t_k \), \( x' = \{x'_1, x'_2, x'_3, \ldots x'_p\} \) be the MPS scheduled users at base station 1, \( x'' = \{x''_1, x''_2, x''_3, \ldots x''_q\} \) be the MPS scheduled users at base station 2, \( x''' = \{x'''_1, x'''_2, x'''_3, \ldots x'''_s\} \) be the MPS scheduled users at base station 3, and let \( 'p' \) be the total number of scheduled user of base station 1, \( 'q' \) be the total number of scheduled user of base station 2 and \( 's' \) be the total number of
scheduled user of base station 3. In our simulation base station 1 has shortage of resources and base stations 2 and 3 have excess of resources. Hence the excess scheduled user of base station 1 utilizes the resources of base station 2 and 3.

6.4 SIMULATION RESULTS OF NC-MPS

The system is modeled using three base stations, ‘N’ number of active users in every base station and ‘L’ number of resources available at each base station. The BS receives users’ SNR and their demand data rates and schedule the users based on MPS algorithm. Simulation parameters at each base station are shown in Table 6.1. The performance of MPS is simulated under network centric environment and compared with conventional non-network centric system.

Table 6.1 NC-MPS simulation parameters for MIMO-STBC system

<table>
<thead>
<tr>
<th>System</th>
<th>MIMO-STBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Base stations</td>
<td>3</td>
</tr>
<tr>
<td>Number of Transmit antenna for every user</td>
<td>2</td>
</tr>
<tr>
<td>Number of Receive antenna for every user</td>
<td>2</td>
</tr>
<tr>
<td>Channel</td>
<td>Rayleigh flat fading</td>
</tr>
<tr>
<td>Noise</td>
<td>AWGN</td>
</tr>
<tr>
<td>Modulation</td>
<td>BPSK</td>
</tr>
<tr>
<td>Number of active user N</td>
<td>25</td>
</tr>
<tr>
<td>Number of resource L</td>
<td>9</td>
</tr>
</tbody>
</table>
Figure 6.2 shows the BER performance of MPS in network centric environment. Simulation results of MPS in network centric (MPS-nc) environment is compared with MPS without network centric (MPS-wnc) environment. When the number of active users increases, every base station MPS schedule more number of users. Under this situation some of the base stations may be in need of resources.

**Figure 6.2  BER performance of all base stations in network centric environment**

Figure 6.2 shows the BER performance of all base stations. It shows that base station 1 is in excess of scheduled users and BS 2 and BS 3 are in excess of resource. Excess resources of BS 2 and BS 3 are used for BS 1 resource required users via access controller. With network centric system, base station 1 gives similar performance compared to non-network centric system performance since the number and order of user of base station 1 is the
same. As far as BS 2 and BS 3 are concerned, the average BER performance is improved with network centric system.

Figure 6.3 shows the overall simulation results of network-centric system. The average BER attained by this system with MPS scheduler is compared with non-network centric system performance. It is observed that average BER performance of network centric system is found improved by 55.8% when N=22 with L=9.

Figure 6.3 BER performance of 2X2 MPS in network centric environment

6.5 SUMMARY

In this chapter, MPS in network centric MU-MIMO system is described for performance improvement and efficient resource utilization. The multi-parameter based scheduler in every BS works based on users SNR
strength and their demand rate. The performances of this scheme with BPSK modulations in flat Rayleigh fading channels are compared with MPS in non-network centric environment. From the simulation results, it is found that MPS in network centric environment outperforms in BER performance. This scheme provides a network BER of about $3 \times 10^{-5}$. 