

Comparison of FFR+IFR and IFR Models with Different Frequency Reuse Factors in Cellular Networks

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Abstract: With the development of information network transmission, how to efficiently complete frequency reuse has been studied by many scholars. Frequency reuse refers to reusing the same frequency in a digital cellular system. Generally, limited frequencies are divided into several groups. As we all know, fractional frequency reuse (FFR) and integer frequency reuse (IFR) are classical frequency reuse methods in cellular networks. The combination of FFR method and IFR method to find the best model has attracted the attention of researchers at home and abroad. Therefore, through the fusion and combination of the four models, this paper will first introduce two frequency reuse methods, IFR and FFR, as well as the combination of these two methods and the calculation methods of these two methods. Through Matlab software modeling and simulation, according to the average capacity results, study the impact of different user numbers on the average capacity of the central area and the edge area. The experimental results provide a new idea for future practical applications.

Keywords: Frequency reuse, FFR, IFR.

1. Introduction

In this information age, people rely more and more on mobile phones, computers, and other electronic products to enjoy the convenience of life services, which means that the communication network plays a more and more important role. Cellular networks divide a large area into several small cells and use several low-power transmitters instead of one high-power transmitter. Each cell uses a set of channels. If two cells are far enough apart, the same set of channels can be used, which is frequency reuse [1]. This paper will study the design of the frequency reuse method of FFR+IFR, by reducing the resources used by adjacent cell edge area, reducing interference by users, and improving the received Signal Noise Ratio(SNR) [2], finally compared with the frequency reuse method of IFR and get the result, discussing the influence of network user density in the center area and the edge area [3].

2. Method

In 19 cell networks, each cell is divided into the central user part and edge user part, and the average capacity is obtained by using the integer frequency reuse method and partial frequency reuse method.

2.1 IFR

Each regular hexagon represents a cell, and cells of the same color represent the channel using the same frequency. when the frequency channel is a part, just like IFR1, this is shown in Figure1, and Figure2 means IFR3.

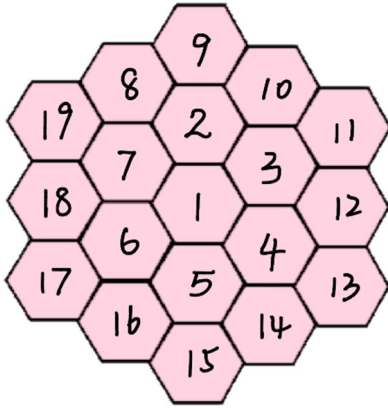


Figure 1. IFR1

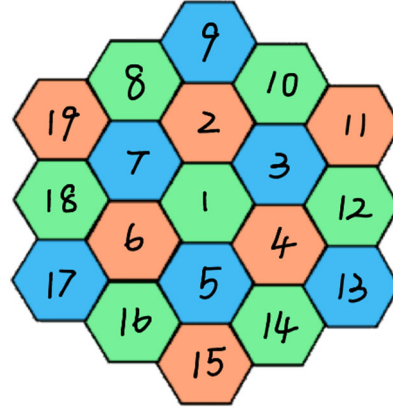


Figure 2. IFR3

2.2 FFR+IFR

The idea of FFR is that the system divides the frequency resources into two reuse sets, one is applied to the central users' scheduling, is the frequency set with frequency reuse factor 1, and the other is applied to the edge users' scheduling, is the frequency set with a frequency reuse factor of more than 1 [4-5]. By ensuring that the users at the edge of the cell are in different frequency states, the interference between the cell will be avoided. This is shown in Figure 3, the center of the cell takes the frequency sets with reuse factor 1, and the edge of the cell takes the frequency sets with reuse factor 3. Figure 4 can be regarded as FFR+IFR1.

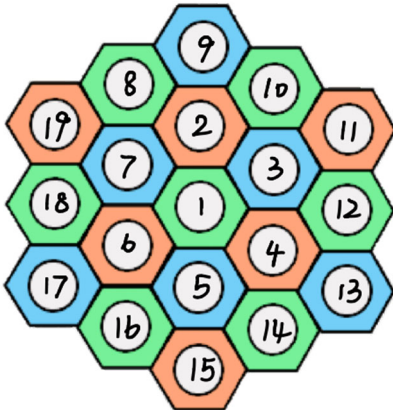


Figure 3. FFR+IFR3

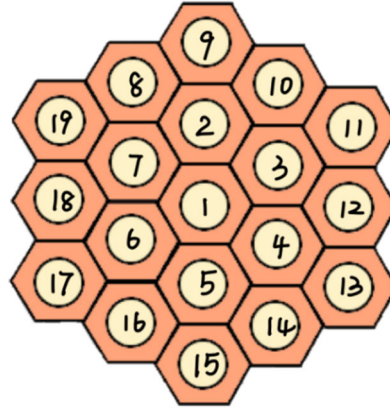


Figure 4. FFR+IFR1

2.3 Capacity calculation

(1)&(2) Capacity per user in a cellular network [6]. The total network capacity is the total capacity of each user

$$C_n = \log_2 \left(1 + \frac{|h_{n,n}|^2 P_n}{\sum_{m \neq n} |h_{n,n}|^2 P_m + \sigma^2} \right) \quad (1)$$

$$C_n = \log_2 \left(1 + \frac{|h_{n,n}|^2 P_n}{\sum_{m \neq n} \rho_{m,n} |h_{n,n}|^2 P_m + \sigma^2} \right) \quad (2)$$

$$C_{total} = \sum_n C_n \quad (3)$$

The user capacity is calculated according to the formula above. P_n means Transmit power from base station (BS) n , P_m means Transmit power from BS m , $|h_{n,n}|^2$ means channels from BS m to users n , σ^2 means noise power, $\rho_{m,n}$ means the parameter that adjusts the amount of interference from cell m to cell n . [7-8] The lowercase letter n in equation (2) represents the number of users, and C_n represents the capacity of each user.

3. Results

3.1 The establishment of simulation model

The frequency assignment model of a 19-cell network using IFR and FFR+IFR is implemented in Matlab software.

3.2 Analysis of experimental results

According to figure 5, the network configuration of the FFR+IFR3 is edited and compared with the FFR+IFR1, when the average number of users in the cell is 5, the average capacity of the FFR+IFR3 network configuration is slightly higher than FFR+IFR1. When changing the number of frequency channels of center users and edge users, it can be seen that when (center, edge)=(9,9), the average capacity in these groups is the highest. According to Figure 6, when the average number of users increases, the average capacity also increases.

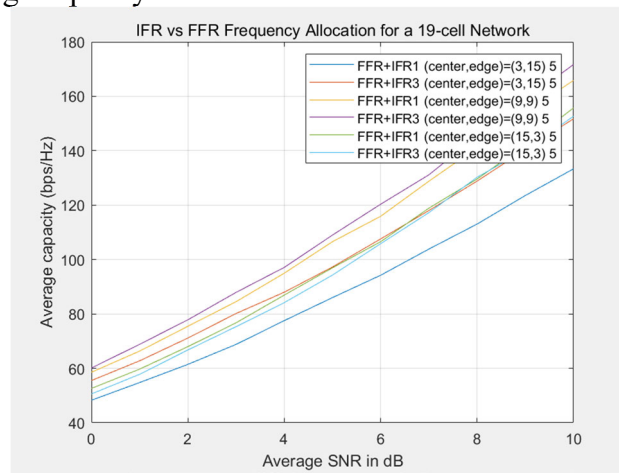


Figure 5. Comparison with the same number of total users

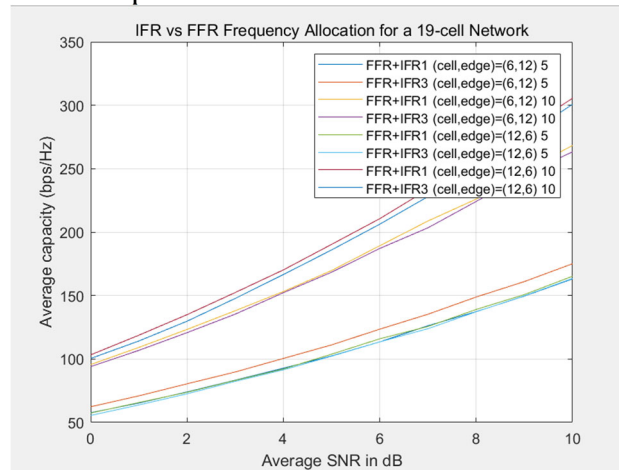


Figure 6. The control group

According to the following figures, when the number of frequency channels is equal, using the IFR1 allocation can get the largest average capacity, and using the IFR3 allocation can get the smallest average capacity [9-10]. The average capacity obtained by both distribution methods of FFR is larger than that of IFR3.

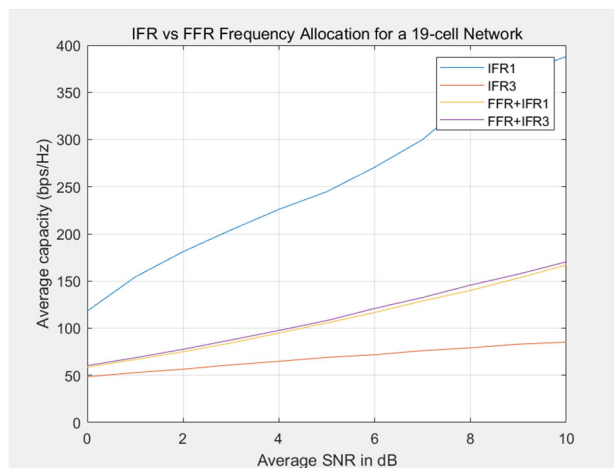


Figure 7. Comparison1(center, edge)=(9,9) 5

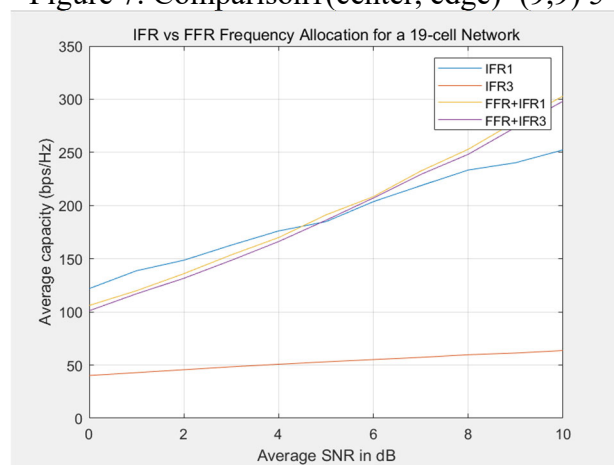


Figure 8. Comparison2(center, edge)=(9, 9) 10

When the center users are more and the edge users are fewer, the average capacity generally increases.

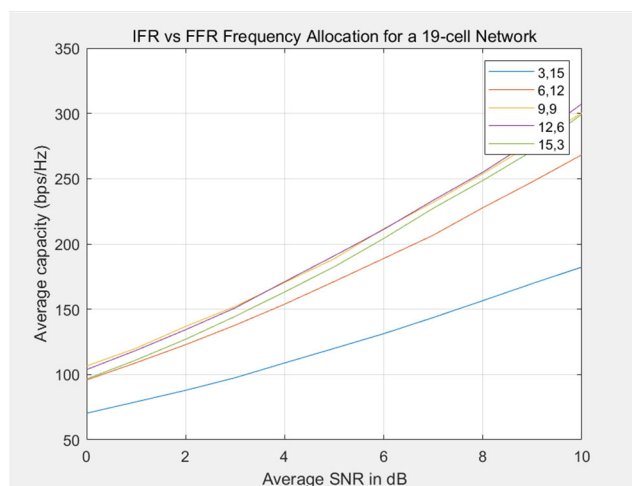


Figure 9. FFR+IFR1 (center, edge)=(,)

4. Conclusions

Thus, the modeling analysis and comparison of FFR+IFR and IFR are carried out by Matlab. The conclusion is that when the average capacity of users is small, the average capacity of FFR+IFR is small, and is also lower than IFR1. When the average capacity of users is large, the average capacity of FFR+IFR will exceed the average capacity of IFR1 with the rise of SNR. The average capacity of

IFR3 is consistently smaller than that of the other three. And when the center users are more and the edge users are fewer, the average capacity generally increases.

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