Fractional frequency reusing technique based on emission interference temperature changes

Yansong Li[1,*]

[1]Department of Electronic Engineering, Southwest University of Science and Technology, Sichuan, China

*Corresponding author: chrimolee2022@163.com

Abstract: In order to reduce the impact on the transmission interference temperature on the transmission system, save the loss of signal transmission, and achieve efficient signal transmission. Thus reducing production costs and improving economic efficiency. In this paper, under the limitation of transmission interference temperature, based on the hive transmission model of 19-Cell, a fractional frequency reusing algorithm is designed by combining the advantages of frequency reusing algorithm in signal transmission with stable, efficiency and small loss.

Keywords: Transmit interference, Fractional Frequency Reusing, 5G.

1. Introduction

The high-performance and efficient transmission of signals is of great significance to the development of information technology, the convenience of people's livelihood and the convenience of the national economy.[1] Accurate, high-performance signal transmission is an important part of the information transmission system. Signal loss or transmission efficiency directly affects the subsequent working status of the information system, and has a great impact on signal reception, analysis of signal information, transmission of work instructions, and cost reduction.[2] Traditional signal transmission is based on channel transmission, such as baseband transmission, coded digital transmission and modulated analog transmission are flawed.

2. The basic functions of fraction frequency reusing techniques

2.1 The structure of 19-Cell's hive simulation

The cellular structure of 19-Cell is a mathematical model of a network based on the prior communication of multiple cells. Building such a structure requires first defining each cell and setting parameters. Next, according to each cell pair with the same distance to the cell set the same parameters, you can get a 19*19 rho function matrix. The model divides users into central users and edge users, when some frequency reusing algorithms use this structure, the system will allocate the algorithm to the corresponding frequency band, and at the same time make the center user and edge user reasonably use the corresponding frequency band through dynamic scheduling frequency bands. Therefore, mutual interference between small cells can be reduced, interference between channels can be reduced, and reuse channels to reduce costs.[3] The structure is shown in Figure 1.

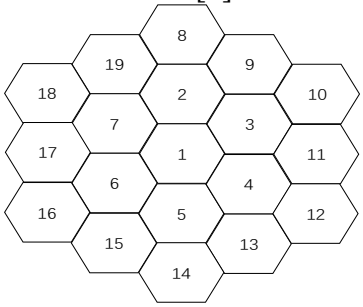


Figure 1. 19*19 cellular network communication structure

Description of the basic principles of some frequency reusing techniques ：

(1) In contrast to most frequency multiplexing, fractional frequency reusing means that the frequency reusing factor is 1 in some of these sub-bands and greater than 1 in others. [4] By analyzing each frequency band and using the scheduling algorithm, the base station dynamically schedules each frequency band to each center user and edge user. And for the upstream and downlink scheduled by the base station, there is no essential difference between them, because they are both dynamically scheduled by the base station.

(2) If distributed according to power, then all cells use sub-bands of equal power (the frequency multiplex factor is 1), while the rest of the power distributed between adjacent sub-bands is coordinated between adjacent cells, so the fringe band of the cell is composed of a low-interference sub-band generated between adjacent cells. [5] This is shown in Figure 2.

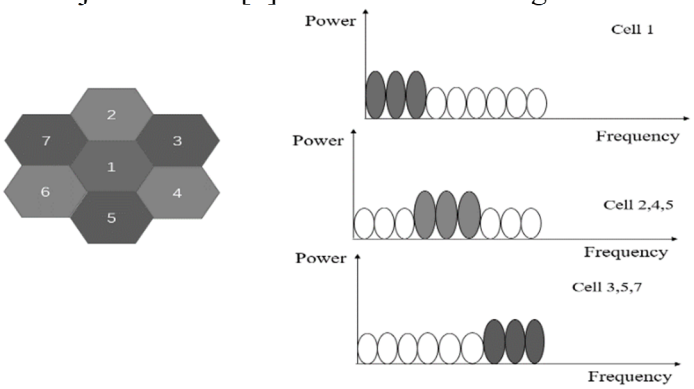


Figure 2. Simple schematic of frequency reusing

The frequency resource is divided into two reused sets by the system, one applied to the central user scheduling frequency set reusing factor is 1, the other applied to the edge user scheduling frequency set reusing factor is greater than 1. [6]

2.2 Simultaneous Water-Filling

We should start with user 1(As defined in 19-cell in the previous article), The mathematical calculations of Equation (1) and Equation (2) are then repeated in the emulator until convergence occurs.

$$p_k[n] = (w_k - c_k[n])^+ \tag{1}$$

$$\sum_{n=1}^{N} (w_k - c_k[n])^+ = P_k \tag{2}$$

In the formula, k represents the kth user, P_k represents the power budget for the kth user, $c_k[n]$ represents inverse SINR on the nth frequency for the kth user. By completing the simulation of the simultaneous water filling theorem, we calculate the capacity of the channel used for each frequency to obtain the maximum capacity of the channel, which assists the algorithm in the efficient work of transmission.[7]

2.3 Transmit Interference Temperature Limit

As mentioned above, we should start with user 1 and judge the size of the reverse SINR on the nth frequency of the kth user compared to the threshold set by the physical temperature - S_k. (As shown in Equation (3)) The result of the judgment is brought into Equation (4) for calculation. Until convergence occurs.[8]

$$p_k[n] = (w_k - c_k[n])^+ \begin{cases} p_k[n] = (w_k - c_k[n])^+ & \text{if } c_k[n] \le S_k \\ 0 & \text{if } c_k[n] > S_k \end{cases} \tag{3}$$

$$\sum_{n=1}^{N}(w_k - c_k[n])^+ = P_k \tag{4}$$

3. Results

3.1 Analysis of experimental results

Establish a mathematical model of the correlation between the average capacity of the transmission system and the signal-to-noise ratio parameters. By setting different physical temperature thresholds and observing the average capacity of the transmission system, it is determined whether the signal transmission system meets the SWF solution. The parameters set are shown in the following table. The result is shown in the following figures.

Table.1. Emission interference temperature threshold and related parameter settings

	Transmit temperature limit	Users for per cell	Frequency channels	SNR range
a	100	5	10	0:2:10
b	200	5	10	0:2:10

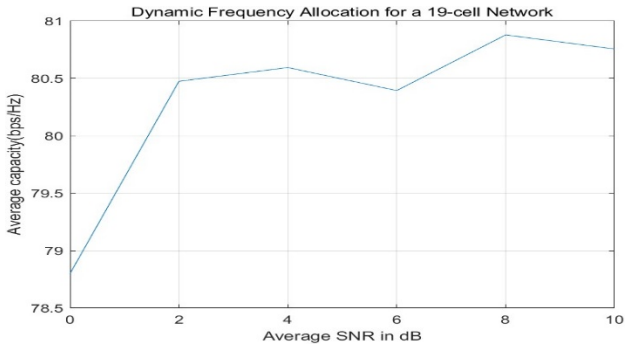


Figure 3. (a) System capacity at a temperature threshold of 100

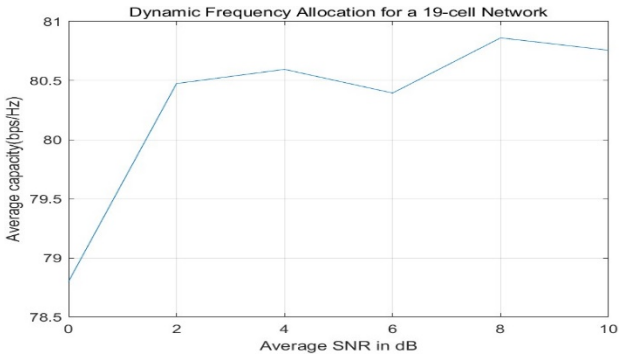


Figure 3. (b) System capacity at a temperature threshold of 200

When the system needs to choose the value of S carefully, when S is very large, the result is closer to that of the SWF solution, but when S is very small, the algorithm will not work. Thinking of beta as a coefficient for the entire transmission system, and by adjusting its value to express the temperature threshold and the number of frequency channels we need.[9] The output result is shown in the following figures.

Table.2. The coefficients and related parameter settings of the system

Beta	Transmit temperature limit	Users for per cell	Frequency channels	Random simulation	SNR range
β =0.8	100	5	10	50	0:2:10
β =1.5	100	5	10	50	0:2:10

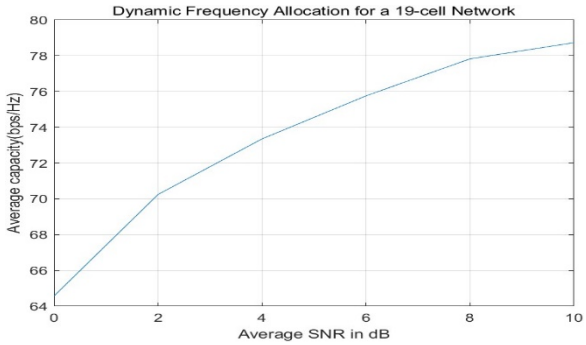


Figure 4. (a) System capacity at a system coefficient of 0.8

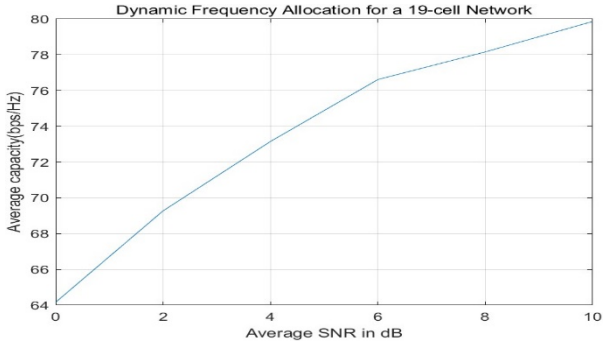


Figure 4. (b) System capacity at a system coefficient of 1.5

If the system chooses $\beta > 1$, it means that the system needs a larger S and uses more frequency channels, and the result is closer to the SWF-Solution. If the system chooses $0 < \beta < 1$, it means that the system needs a smaller S and uses fewer frequency channels.

3.2 The advantages and disadvantages of the algorithm

Since FFRs are more cumbersome and indistinguishable from a single algorithm, they are fused with IFR1 and IFR3 algorithms, respectively. Compare it to the original algorithm that was not integrated with the FFR algorithm. The display result is shown in the following figure.

Table.3. The number of reuse factors and the setting of the correlation coefficient

Reuse factor	Frequency channels for inner area	Frequency channels for inner area	Average number of user per cell	Random simulation	SNR range
1	4	15	19	500	0:2:100
3	4	15	19	500	0:2:100

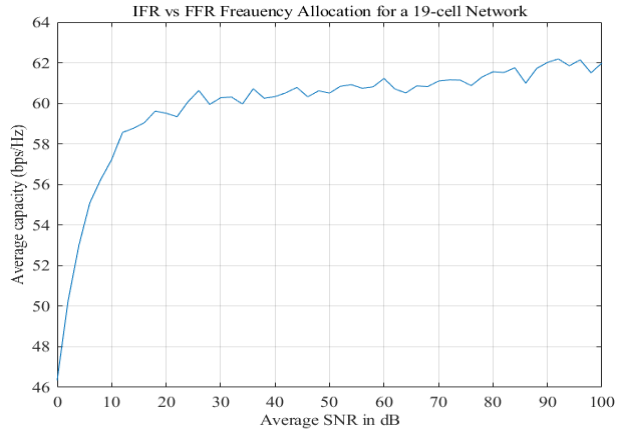


Figure. 5 (a) reuse factor is 3

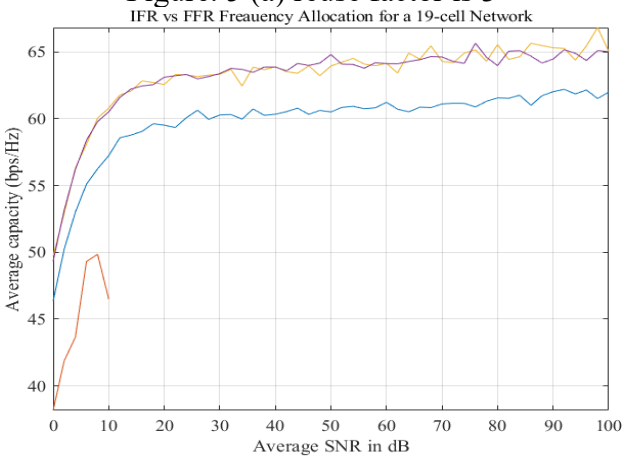


Figure. 5 (b) reuse factor is 1

From the simulation results of the selection of FFR, it can be seen that when the multiplexing coefficient is 3, the system is more stable and the system capacity is larger.When the same parameters are introduced into the system without the FFR algorithm, the system gets the following results.

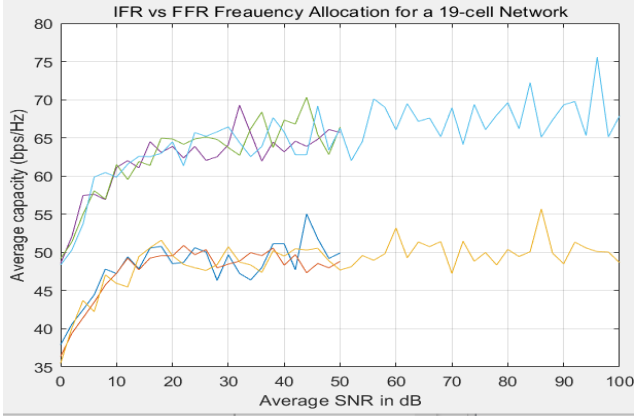


Figure.6 (a) Average capacity of the system when the multiplexing factor is 1

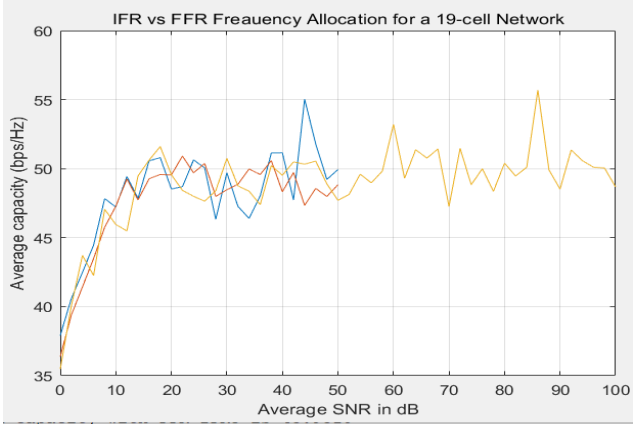


Figure.6 (b) Average capacity of the system when the multiplexing factor is 3

Obviously, whether the reuse factor is equal to 3 or 1, the system is extremely unstable. And the system capacity is not as large as the system that integrates the FFR algorithm.[9] Therefore, the superiority of the FFR algorithm can be seen: it can make the transmission channel have a larger capacity, and the system is stable and efficient. When the results are optimal, the reuse factor should be 3.

4. Conclusions

As the signal-to-noise ratio parameters change over a wide range, the average capacity of the transmission system begins to increase and then begins to decline at some tipping point. Therefore, in order to maximize the transmission capacity of the system, the system needs to find the correct frequency and signal-to-noise ratio. [10] The use of transmission technology without FFR by users at different emission interference temperatures will make the average capacity of the transmission system extremely unstable and small in the face of a wide range of signal-to-noise ratio changes. Therefore, using FFR can solve this problem well, but the best multiplex factor must be found. Depending on the transmit interference temperature, the system can allocate smaller transmit power to the area where the user is concentrated, that is, inside the cell, and conversely, the larger transmit power should be distributed to the outside of the cell. In this way, by reducing power heat production, the ground interference caused by the emission temperature can be effectively reduced.

References

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