

# Introduction to Wireless and Mobile Networking: Homework 6

## Submission rule

1. The file name of the report should be **b07901xxx\_hw6\_report.pdf**
2. The file name of the readme should be **b07901xxx\_hw6\_readme.pdf**
3. The readme should describe **how to “USE” your code** to get the result in your report
4. If you use C++, please DON'T submit .exe
5. Put the report, readme and codes (MATLAB or C++ or Python) in the same folder, which is named **b07901xxx\_hw6**
6. Compress the folder to **b07901xxx\_hw6.rar/b07901xxx\_hw6.zip**
7. Submit the .rar/.zip to Ceiba before deadline.

Please note that the homework submission system will turn off upon deadline.

If you have troubles so that you cannot submit on time, please email to TA.

However, the grade of late submission will be lower compared to those submitted on time.

## Problem description

19 base stations are located in an urban area with temperature 27°C, which form a 19-cell map shown in Fig. 1. In this homework, we refer to the base stations that are surrounded by other base stations as **inner base stations**. The coordination of the central BS is (0, 0) and ISD (inter site distance) is 500 m. The channel bandwidth is 10MHz. The power of each base station is 33dBm. The transmitter antenna gain and the receiver antenna gain for each device, including base station and mobile devices, are 14 dB. The height of each base station is 1.5m, which is located on the top of a 50m high building. The position of each mobile device is 1.5m high from the ground.

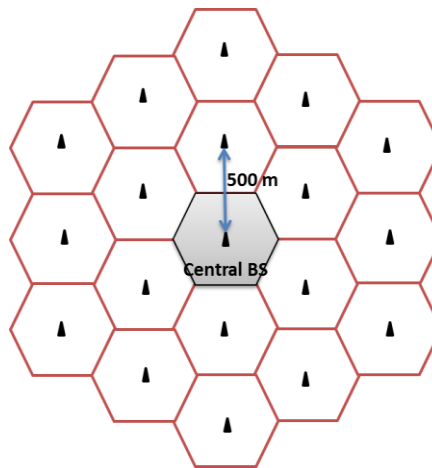


Fig. 1

Consider the **path loss** only radio propagation (without shadowing and fading). Use Two-ray-ground model as the propagation model for your simulation.

HINT: Please refer to slide 52 of Lec 2 for two-ray-ground model.

## 1. [Point-to-Multipoint (PTM) Multicast]

There are  $X$  mobile stations randomly dropped in the coverage of each **inner base station**, where  $X$  is uniformly distributed in  $[5, 15]$ . All of the base stations use the same carrier frequency (FRF = 1), the downlink interference for a specific mobile station comes from other base stations. For multicast scenario, a single data packet is delivered to multiple mobile stations on the single channel. However, the data rate of the multicast transmission is limited by the bottleneck mobile station. **The bottleneck mobile station is the one with the poorest channel quality in the base station.**

- 1-1. Please give a figure to describe how you arrange cell IDs to Fig. 1.  
HINT: Cell IDs should be 1~19 for simplicity.
- 1-2. Please plot a figure that describes the statistical distribution of the poorest channel quality. In the figure, the x-axis should be SINR (in dB) and the y-axis should be a probability mass function (PMF) or a cumulative distribution function (CDF). For each randomly generated topology, there are 7 outcomes, and you are suggested to run the simulation multiple times to get smoother curves.
- 1-3. The resource efficiency can be defined as the **sum of received data rate under unit bandwidth**. According to the result in 1-2, please calculate the average data rate as well as the resource efficiency of the inner base stations.

## 2. [Single Frequency Network (SFN) Multicast]

In SFN transmissions, all of the 7 inner base stations cooperate with each other. They transmit the same data packet on the same 10MHz band simultaneously. By doing so, **the signals reaching the mobile stations become constructive instead of interference.**

Consider the topology generated in Problem 1. The data rate of the SFN multicast transmission is also limited by the bottleneck mobile station. The bottleneck mobile station is the one with the poorest channel quality **in the coverage of the 7 inner base stations.**

The interference comes from the outer 12 BSs.

- 2-1 Please plot a figure that describes the statistical distribution of the poorest channel quality. In the figure, the x-axis should be SINR (in dB) and the y-axis should be a probability mass function (PMF) or a cumulative distribution function (CDF). You should run the simulation at least 100 times to plot the figure.
- 2-2 According to the result in 2-1, please calculate the average data rate as well as the resource efficiency in the system.
- 2-3 Under which conditions does SFN multicast transmission performs better than PTM from the perspective of resource efficiency? Please provide your observation and explanation.