

City University of Hong Kong

Department of Electronic Engineering

EE4316 Mobile Data Networks

Assignment (2%)

1. Assume that we wanted to deploy an analog FM AMPS system with half band of 15 kHz rather than the existing 30kHz. Also assume that in analog FM, the signal-to-interference ratio (SIR) requirement is inversely proportional to the square of the bandwidth (4 times increase in SIR requirement for dividing the band into two).

- a. What is the required SIR in dB for the 15 kHz channel if the required SIR for the 30 kHz systems is 18dB?

[1 mark]

Ans:

The required SIR in dB for the 15 kHz channel is **24 dB**.

- b. Determine the frequency reuse factor N needed for the implementation of this 15 kHz per user analog cellular system.

[2 marks]

Ans:

$$S_r^* \leq 1.76 + 20 \log N$$

$$1.112 \leq \log N$$

$$N \geq 10^{1.112} = 12.942$$

The frequency reuse factor N needed is **13**.

- c. If a service provider had a 12.5 MHz band in each direction (up-link and down-link) and it would install 30 antenna sites to provide its service, what would be the maximum number of simultaneous users (capacity) that the system could support in all cells? Neglect the channels that are used for control signaling.

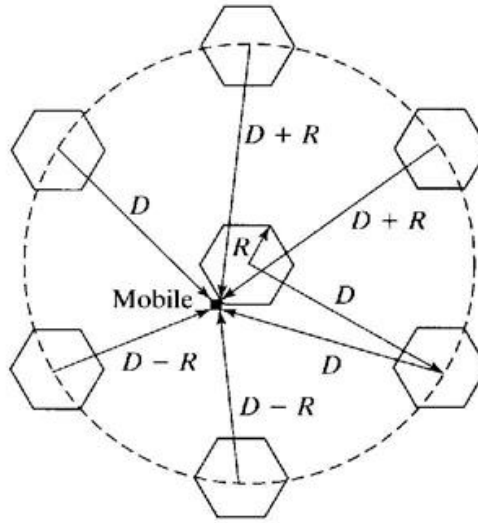
[2 marks]

Ans:

$$n = \left(\frac{W}{B}\right) \left(\frac{m}{N}\right) = \left(\frac{12.5 \times 10^6}{15 \times 10^3}\right) \left(\frac{30}{13}\right) = 1923$$

The maximum number of simultaneous users that can support in all cells are **1923**.

2. Consider that the mobile is at the cell boundary, where it experiences worst case cochannel interference. An approximation of the distance between the mobile and the first-tier base station is shown in the following figure. Assume that the path loss exponent be 4.



- a. For a frequency reuse factor of 7, calculate the worst-case signal-to-cochannel interference ratio.

[2 marks]

Ans:

$$S_{r.worst} \approx \frac{R^{-\alpha}}{J_s D^{-\alpha}} = \frac{R^{-4}}{6D^{-4}} = \frac{1}{6} \left(\frac{D}{R} \right)^4$$

$$\frac{D}{R} = \sqrt{3 \times 7} = 4.583$$

$$S_{r.worst} = 10 \log \left(\frac{1}{6} (\sqrt{3 \times 7})^4 \right) = 18.663 \text{ dB}$$

Hence, the worst case of **SIR = 18.663 dB**.

- b. Assume that the mobile requires at least 18dB signal-to-cochannel interference ratio. Is a frequency reuse factor of 7 acceptable in terms of cochannel interference? If not, what would be a better choice of frequency reuse factor?

[3 marks]

Ans:

If $N = 7$ is adopted, $SIR = 18.663 \text{ dB} > 18 \text{ dB}$, which is acceptable.

$$10 \log \left(\frac{3}{2} N^2 \right) \geq S_{r.worst} = 18 \text{ dB}$$

$$N \geq 6.486 \approx 7$$

The best choice of frequency reuse factor is **$N = 7$** .