KFUPM - COMPUTER ENGINEERING DEPARTMENT

COE-543 – Mobile Computing and Wireless Networks

Student Name:
Student Number:

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1) (10 points) Capacity expansion techniques.

AMPS is a cellular system is that requires 18 dB SIR to utilize 30 kHz channels. However, it is possible to utilize 15 kHz channels but the SIR requirement increases to 24 dB. Assume that band splitting is employed as explained in Example 5.13 of textbook page 248 or class notes slide 38. However, it is required to have the frequency reuse factor N1 (for the underlay cells) to be 7 while the frequency reuse factor N2 (for the overlay cells) to be 3. Assume a path loss exponent equal to 4.

a) Determine the capacity increase relative to a conventional network using frequency reuse of 7.

b) It is possible to extend the concept of band splitting and utilize channels of bandwidth equal to 7.5 kHz by implementing another level of overlay cells. However, designers must weigh the capacity increase against the drawbacks of multi-overlay approach. Explore the drawbacks of the multi-overlay approach.

Solution:

a) N1 = 7, D1/R1 = sqrt(3*N1); N2 = 3, D2 = 3R1 (from geometry).

Using the SIR figures ➔ 10 log { (D2/R2)^a / (D1/R1)^a } = 6 dB ➔ (D2/R2)^a / (D1/R1)^a = 4 ➔ (D2/R2) / (D1/R1) = sqrt(2) ➔ 3R1/R2 = (D1/R1)*sqrt(2) = sqrt(2*3*N1) ➔ R2 = 3/sqrt(2*3*N1) R1 or R2 = 0.463 R1.

Therefore, the overlay cell area, A2, is (0.463)^2 = 0.214 of the underlay cell area, A1.

Therefore, the area where the 30 kHz channels are used is the A1-A2 = 0.786 A1.

Let there be M 30 kHz channels in the area A1-A2, therefore, we must place 0.214/0.786 = 0.273 of M 15 kHz channels in the area A2.

Now we have the constraint that 7 x 30 kHz x M + 3 x 15 kHz x 0.273 M = 395 x 30 k Hz.

➔ M = 53.3

Therefore, we have 53.3 30 kHz channels in A1-A2, and

14.5 15 kHz channels in A2

Hence every cell now has 53.3 + 14.5 = 67.8 channels compared to the possible 395/7 = 56 30 kHz channels with N = 7.

The capacity increase is 1 – 67.8/56 = 0.21 ➔ 21% capacity increase.

b) The drawbacks are the increased number of handoffs as mobiles move back and forth from one overlay area to another. This adds significantly to the complexity of the system and may cause significant call drops.