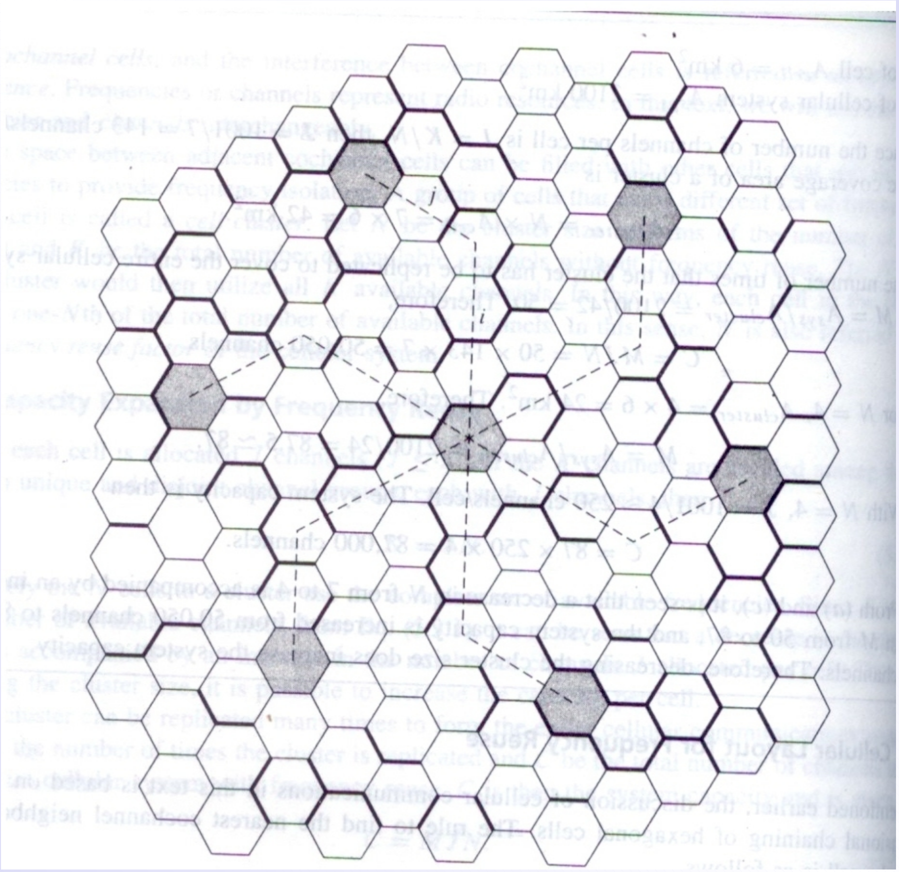
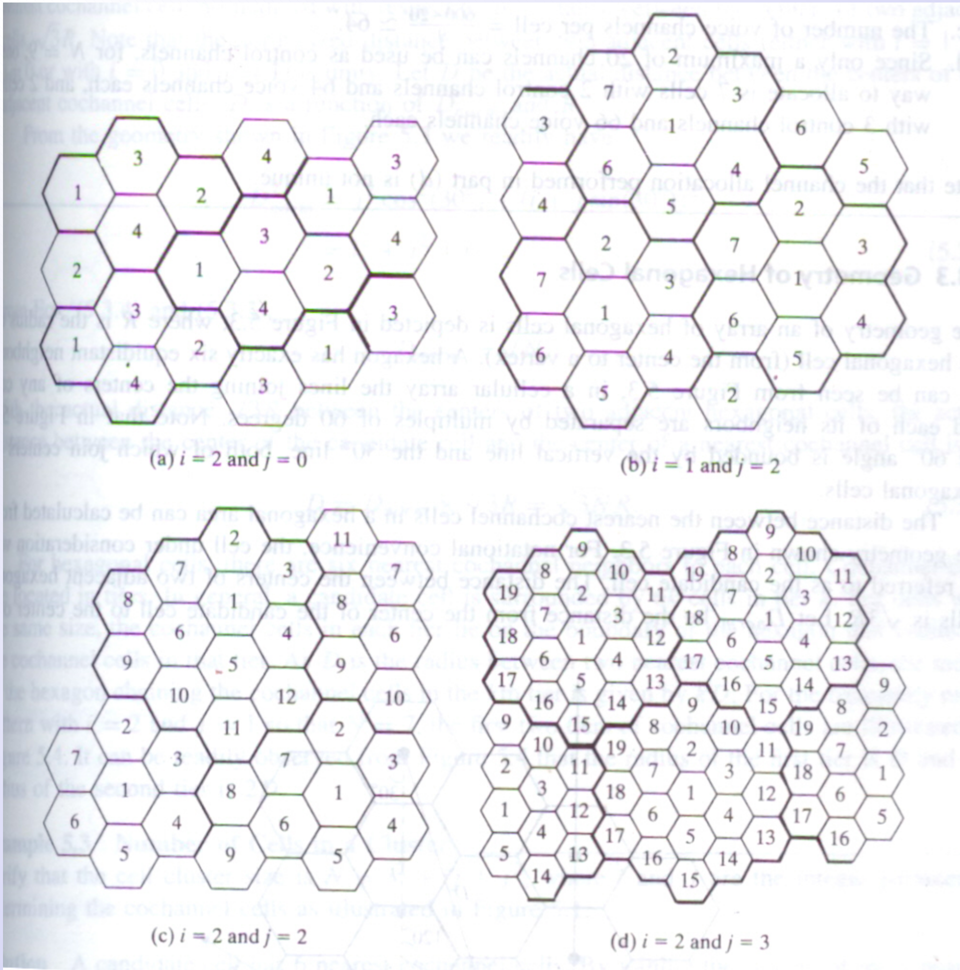
Cellular Layout for Frequency Reuse

- Rule for determining the nearest Cochannel neighbors
  - Move i cells along any chain of hexagons
  - Turn 60 degrees counterclockwise and move j cells
- each cell is numbered and cells with the same number use the same set of frequencies (Co-channel cells)
- must be separated by a distance such that the cochannel interference is below a prescribed QoS threshold
- i and j measure the number of nearest neighbors between cochannel cells; the cluster size $N = i^2 + ij + j^2$
- with $i = 1$ and $j = 2$, $N = 7$, *i.e*, the frequency reuse factor is $N = 7$ since each cell contains one-seventh of the total number of available channels





(a) $i = 2$ and $j = 0$

(b) $i = 1$ and $j = 2$

(c) $i = 2$ and $j = 2$

(d) $i = 2$ and $j = 3$

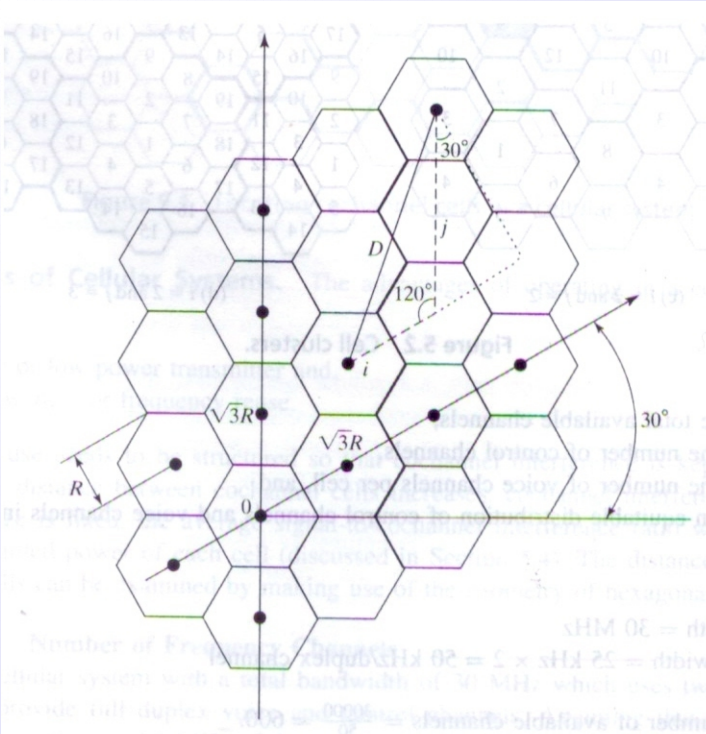
- feature: low power transmitter and frequency reuse
- distance between cochannel cells increase, cochannel interference will decrease
- Example: bandwidth 30 MHz, uses two 25 kHz simplex channels for fullduplex voice and control channels
- $N = 9$ and 1 MHz of total bandwidth for control channels
- Channel bandwidth = 50 kHz/duplex channel
- number of available channels = 30000/50 = 600
- number of control channels = 1000/50 = 20
- number of voice channels per cell = $(600 - 20)/9 \approx 64$
- 7 cells with 2 control channels, 64 voice channels
- 2 cells with 3 control channels, 66 voice channels

Hexagonal Cells

- R radius of hexagonal cell
- in a cellular array the lines joining the centers of any cell and each of its neighbors are separated by multiples of 60 degrees
- distance between the centers of two adjacent hexagonal cells is $\sqrt{3}R$
- D_{norm} distance from the center of the candidate cell (cell under consideration) to the center of a nearest cochannel cell, normalized with respect to the distance between the centers of two adjacent cells, $\sqrt{3}R$
- normalized distance between two adjacent cells ($i = 1, j = 0$ or $i = 0, j = 1$) is unity
- D actual distance between the centers of two adjacent cochannel cells

$$D^2_{norm} = j^2 \cos^2(30^\circ) + (i + j \sin(30^\circ))^2 = i^2 + j^2 + ij$$

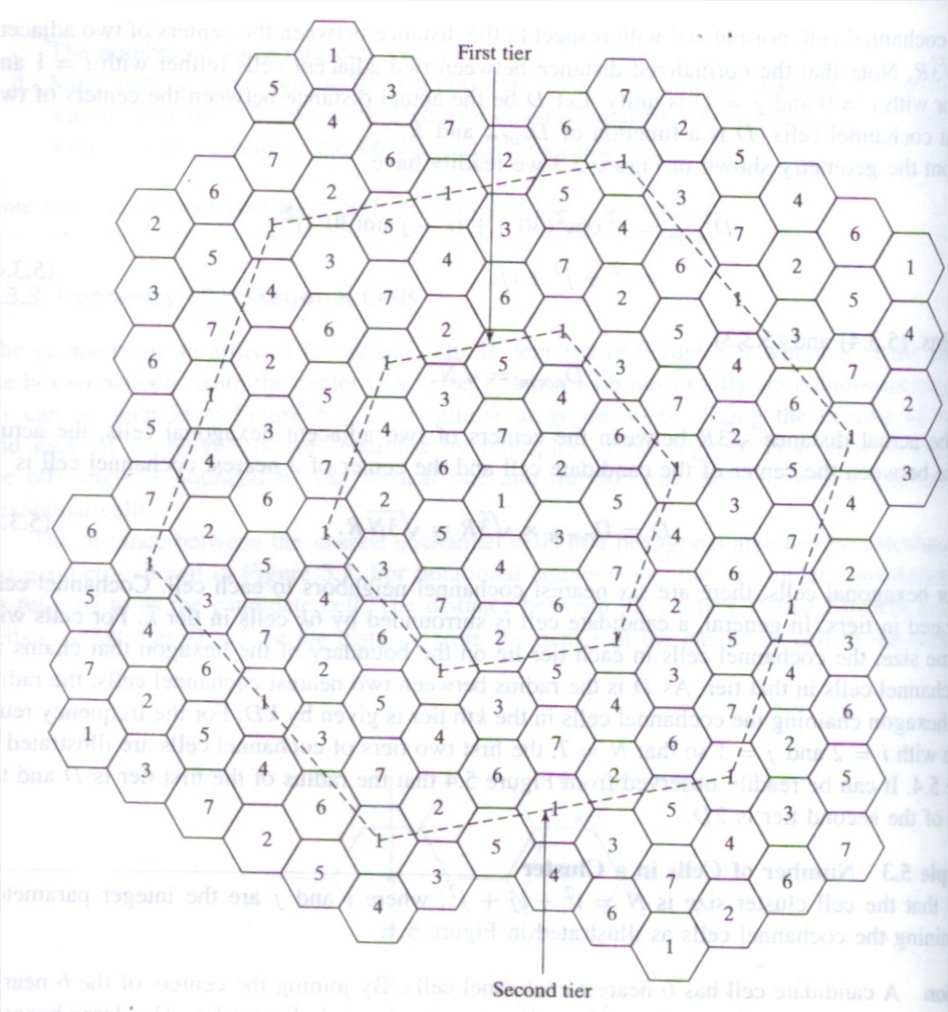
- $D_{norm} = \sqrt{N}$ and $D = D_{norm} \times \sqrt{3}R = \sqrt{3N}R$


30°
j
D
120°
i
30°
$\sqrt{3}R$
$\sqrt{3}R$
R
0

- six nearest cochannel neighbors to each cell
- cochannel cells are located in tiers
- a candidate cell is surrounded by $6k$ cells in tier k
- cochannel cells in each tier lie on the boundary of the hexagon that chains all the cochannel cells in that tier
- D is the radius between two nearest cochannel cells, the radius of the hexagon chaining the cochannel cells in the kth tier is given by kD
- candidate cell has 6 nearest cochannel cells, join the centers of the 6 nearest neighboring cochannel cells gives large hexagon having radius D, is also cochannel cell separation

$$D = \sqrt{3}RD_{norm} = \sqrt{3(i^2 + ij + j^2)}R$$

- area of hexagon is proportional to square of its radius
- $A_{large} = \beta D^2$ and $A_{small} = \beta R^2$


First tier
Second tier

- number of cells in the large hexagon = $3(i^2 + ij + j^2)$
- from geometry, the large hexagon encloses the center cluster of N cells plus 1/3 the number of the cells associated with six other peripheral large hexagons
- the total number of cells enclosed by the large hexagon is $N + 6\left(\frac{1}{3}N\right) = 3N$, *i.e.* $N = i^2 + ij + j^2$
- *Frequency reuse ratio* $q \triangleq \frac{D}{R} = \sqrt{3N}$ *(cochannel reuse ratio)*
- *For example,* $(i, j) = (1, 1)$ $N = 3$ $q = 3.0$
- q *increases with* N*, a smaller value of* N *has the effect of increasing the capacity of the cellular system but increases cochannel interference*