Wireless Communications (ITC731)

Lecture Note 1

05-03-2013

Prof. Young-Chai Ko

Course Information

- Instructor
  - Prof. Young-Chai Ko (koyc@korea.ac.kr, Tel: x3254, Room#416)
- Textbook
  - Principles of mobile communications (by G. Stuber)
  - Wireless communications (by A. Goldsmith)
- Grading
  - Midterm (40%), Final (50%), Homework (10%)

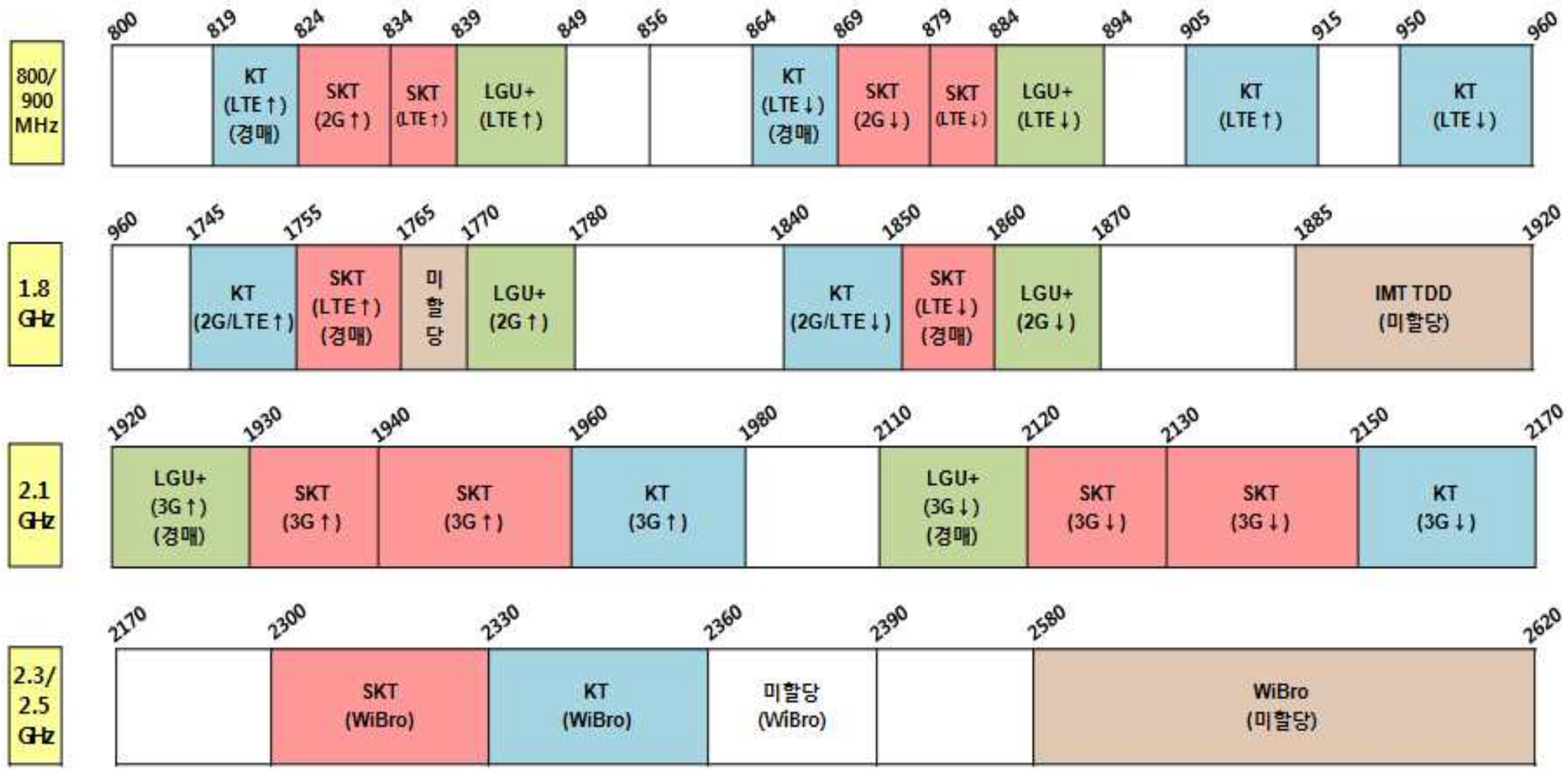
Summary

- Frequency band
- Cellular concept
- Co-channel interference
- Cellular size and capacity

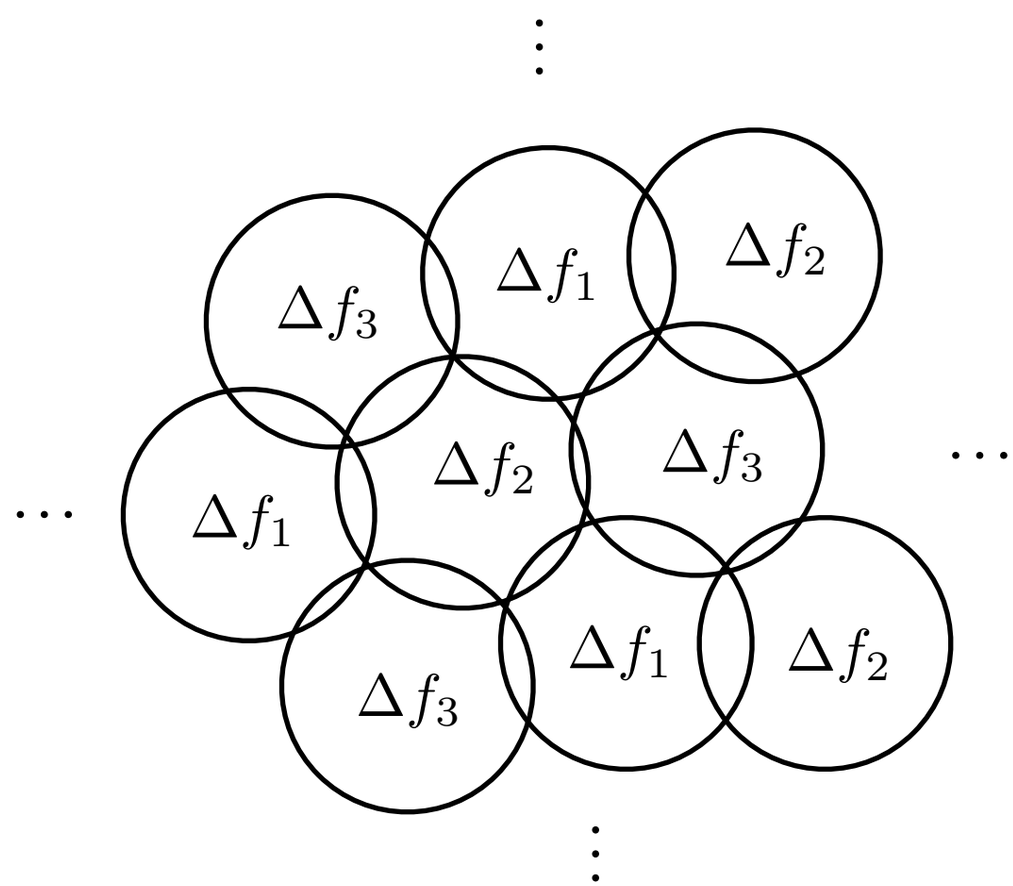
Frequency Band Allocation for Mobile Service Companies

Company	Frequency band (MHz)	Bandwidth	Systems
SKT	824~834 (10) / 869~879 (10)	20 MHz	2G (CDMA)
	834~839(5) / 879~884(5)	10 MHz	3G or LTE
	1755~1765(10) / 1850~1860(10)	20 MHz	3G or LTE
	1930~1940(10) / 2120~2130(10)	20 MHz	3G or LTE
	1940~1960(20) / 2130~2150(20)	40 MHz	3G or LTE
	2300~2327(27)	27 MHz	WiBro
	Total	137 MHz	
KT	819~824(5) / 864~869(5)	10 MHz	3G or LTE
	905~915(10) / 950~960(10)	20 MHz	3G or LTE
	1745~1755(10) / 1840~1850(10)	20 MHz	2G, 3G or LTE
	1960~1980(20) / 2150~2170(20)	40 MHz	3G or LTE
	2331.5~2358.5(27)	27 MHz	WiBro
	Total	117 MHz	
LGU+	839~849(10) / 884~894(10)	20 MHz	3G or LTE
	1779~1780(10) / 1860~1870(10)	20 MHz	2G, 3G or LTE
	1920~1930(10) / 2110~2120(10)	20 MHz	3G or LTE
	Total	60 MHz	

Frequency Allocation per Frequency Band



Cellular Concept



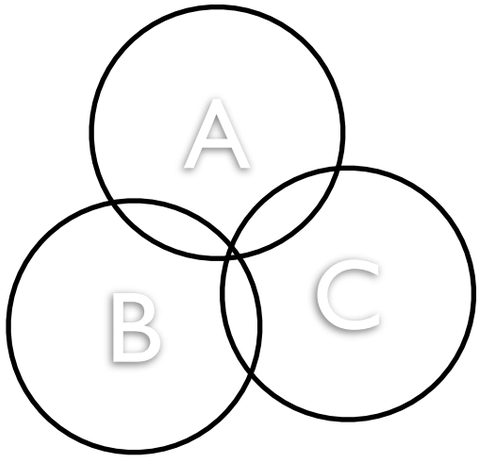
$$\Delta f_1 + \Delta f_2 + \Delta f_3 = \Delta f$$

Total bandwidth

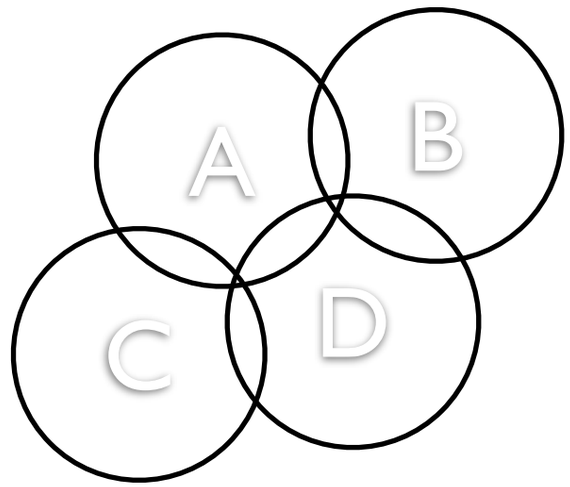
Key idea of cellular system: frequency reuse

Cellular Reuse Cluster

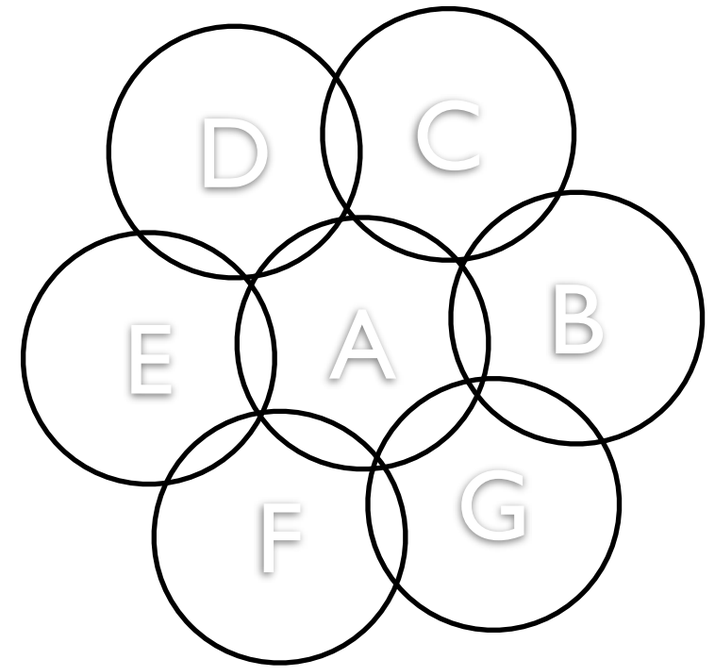
A *tessellating* reuse cluster of size N



3-cell, $N = 3$



4-cell, $N = 4$



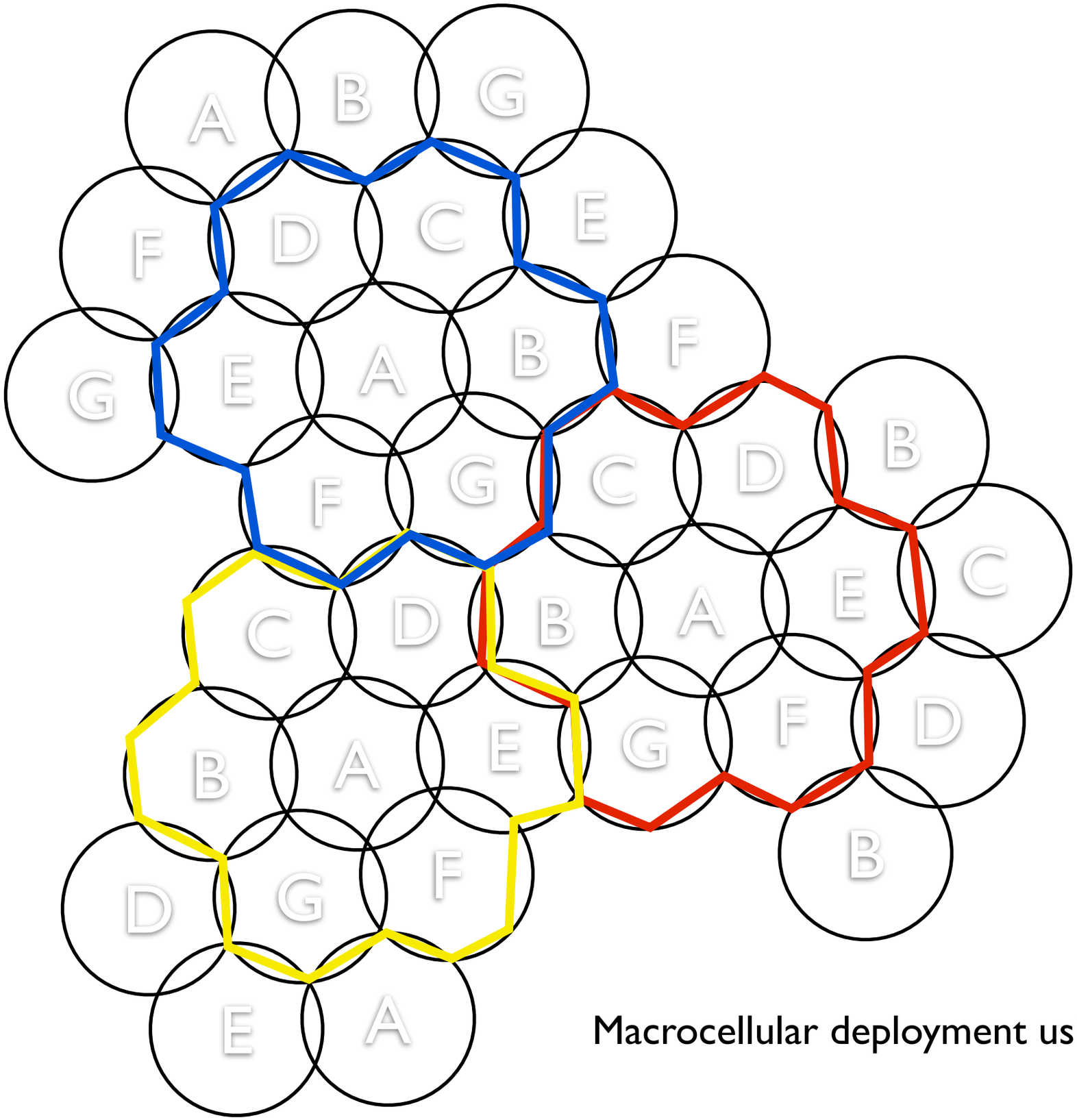
7-cell, $N = 7$

$$N = i^2 + ij + j^2 \qquad i \geq j$$

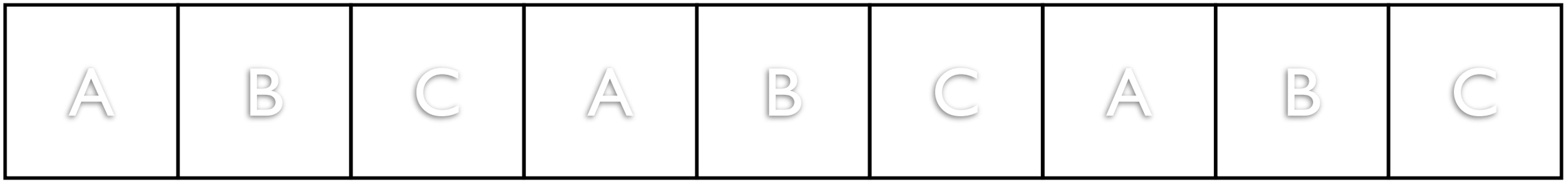
$$N = 1^2 + 1 \cdot 0 + 0^2 = 1 \qquad N = 2^2 + 2 \cdot 0 + 0^2 = 4$$

$$N = 1^2 + 1 \cdot 1 + 1^2 = 3 \qquad N = 2^2 + 2 \cdot 1 + 1^2 = 7$$

$$\cdots$$

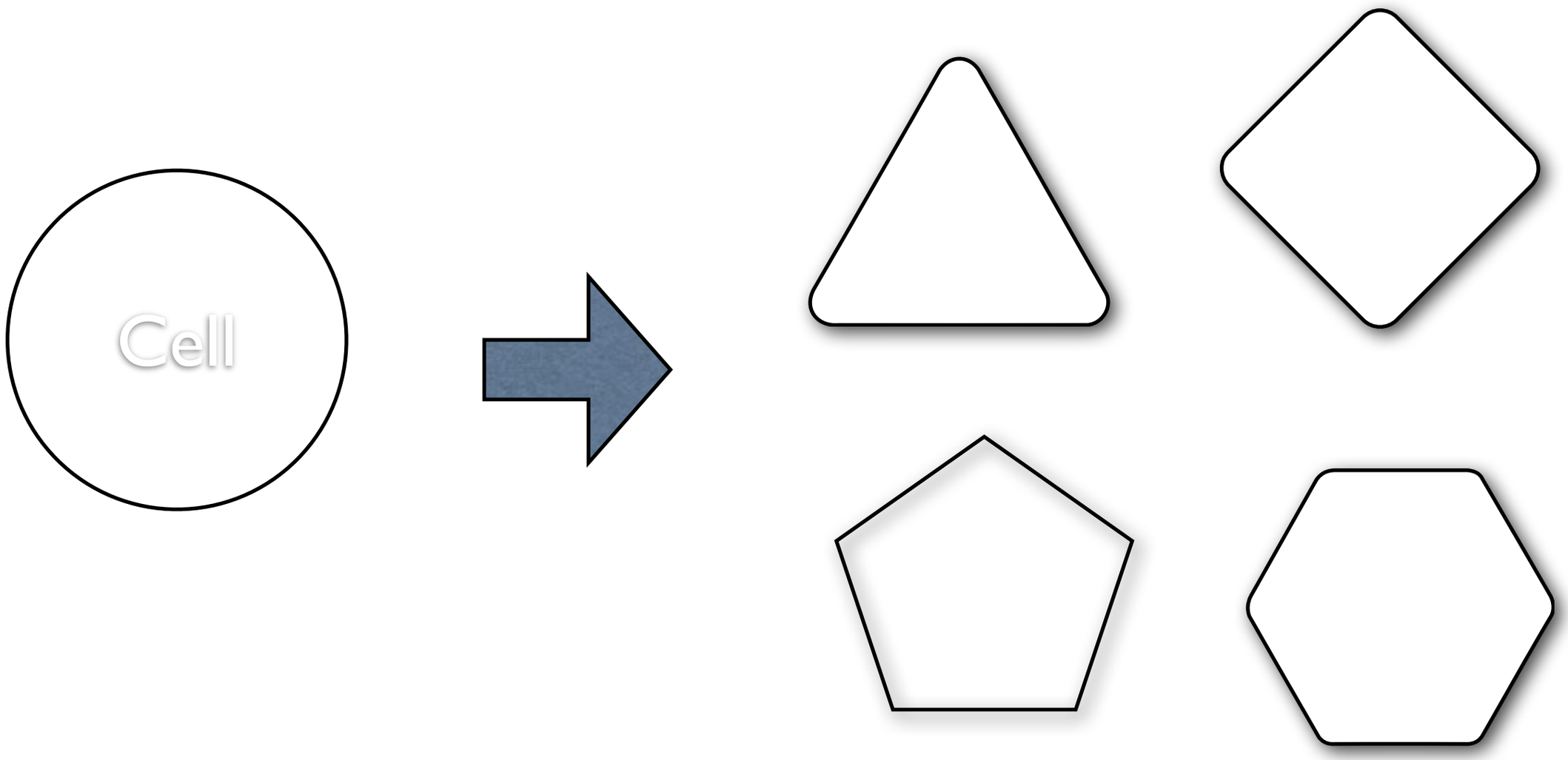


Macrocellular deployment using 7-cell reuse pattern



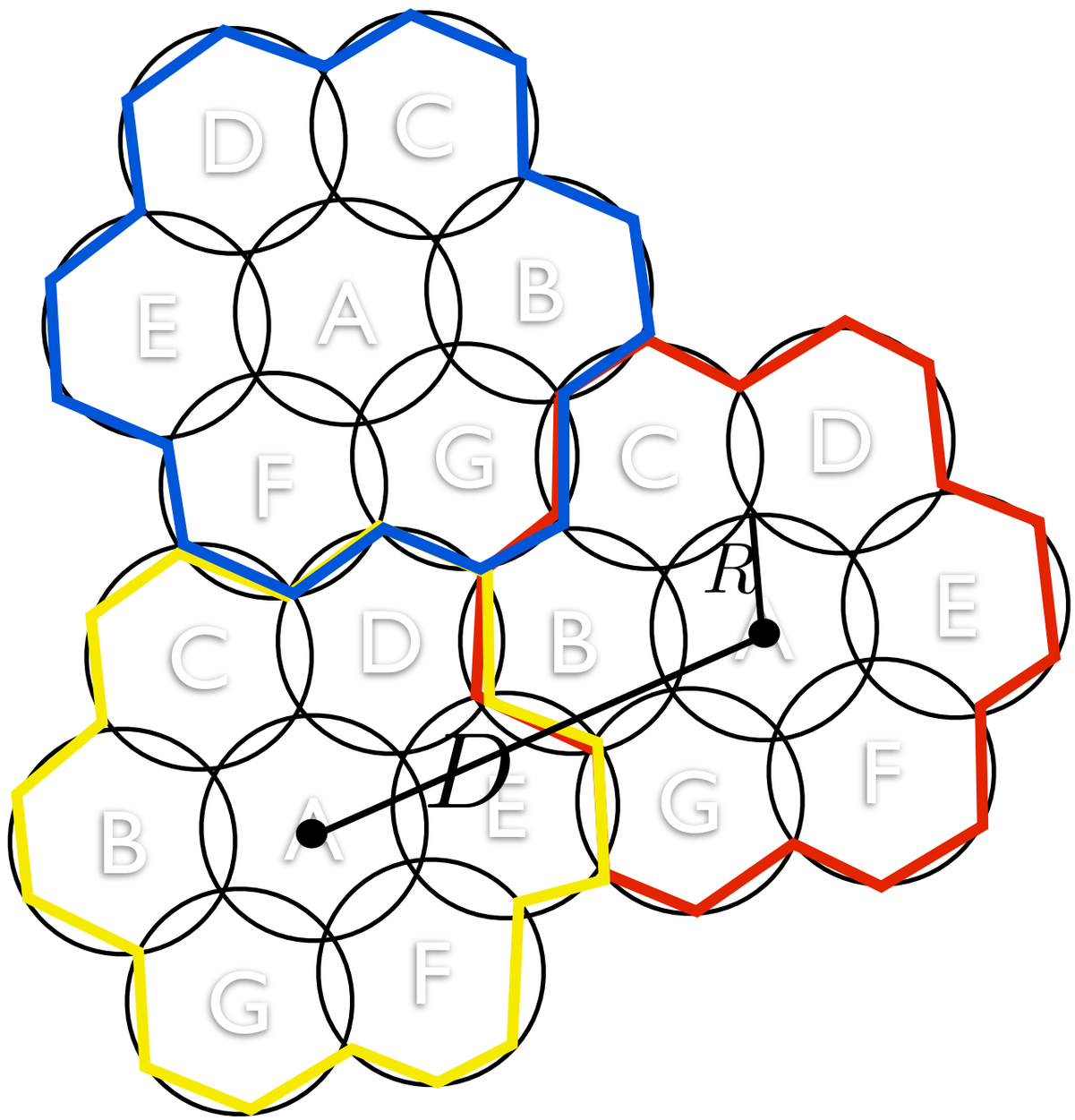
Microcellular deployment with a 3-cell reuse pattern

Shapes of Cellular: Tessellating shapes



Hexagons are typically used as models for wireless systems.

Co-Channel Reuse Factor



D : Reuse distance

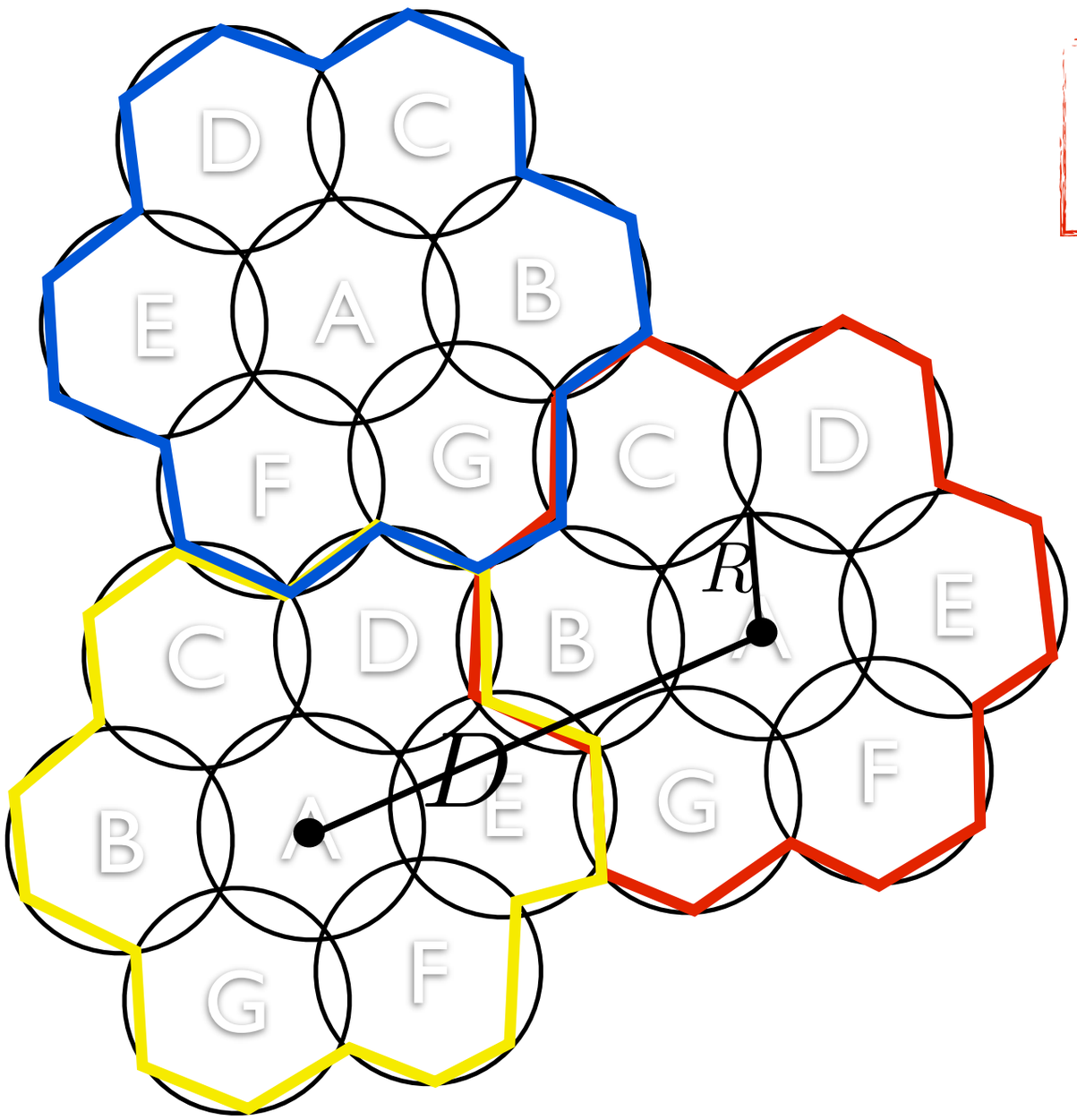
R : Cell radius

N : Cluster size

Co-channel reuse factor

$$Q = \frac{D}{R} = \sqrt{3N}$$

Co-Channel Interference



The cells with same frequency band experiences the co-channel interference!

Co-channel interference cells are separated by a "reuse distance" D.

Terminology

- One-way or two-way
  - Simplex
  - Half-duplex
  - Full-duplex (or simply duplex)
- Division
  - FDD
  - TDD

Choice of Cluster Size N

- Consider a cluster with N cells with S duplex channels/cluster.

- Each cell is allocated k channels/cell, where $k \leq S$ so that we have

$$S = kN$$

- If cluster is replicated M times within the system, the total number of channels available for the cellular system is

$$C = MkN = MS$$

measure of capacity

Remark

$$C = MkN = MS$$

$$M \uparrow \Longrightarrow C \uparrow$$

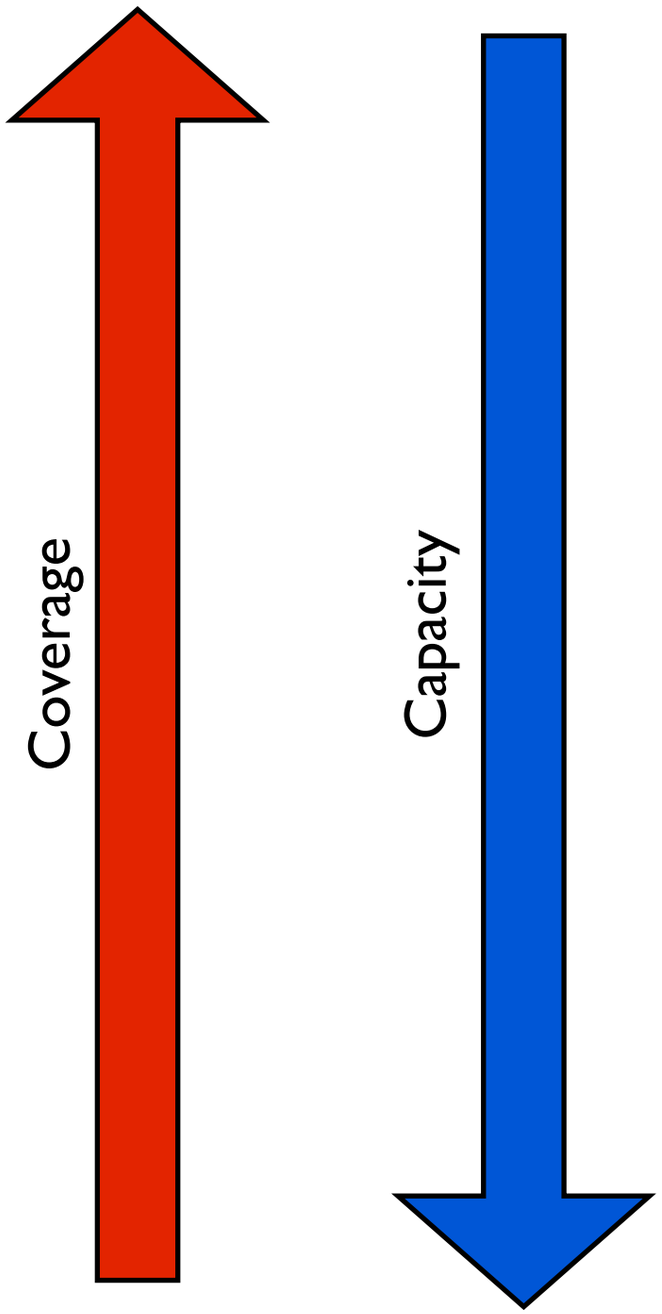
$$D \downarrow,\ M \uparrow \Longrightarrow C \uparrow$$

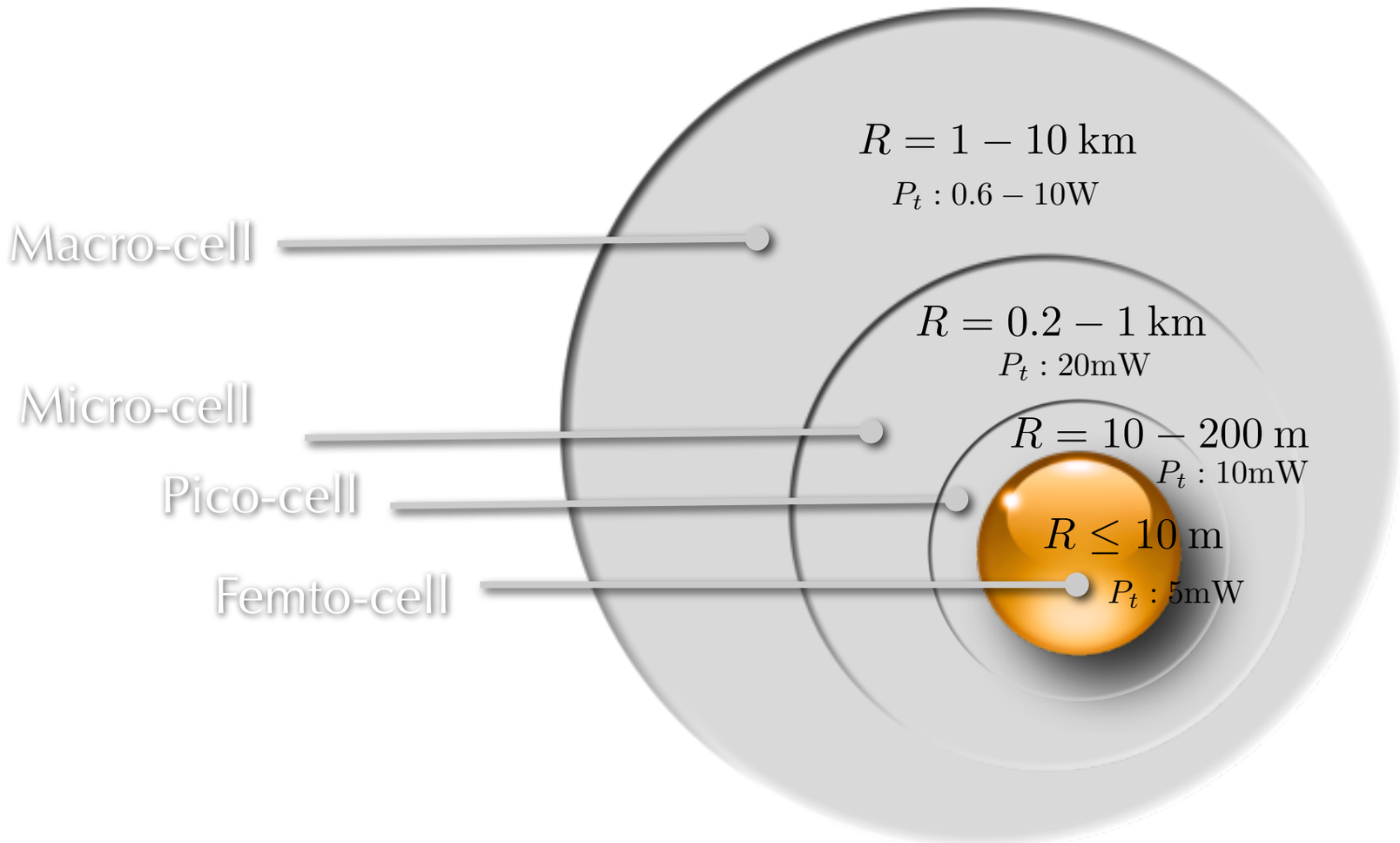
So choose the cluster size N as small as possible in order to increase capacity C.

Choose high N (high Q) to improve the QoS due to small level of CCI.

Trade-off between capacity and QoS

Cell Size vs. Cell Capacity





Wireless Multimedia Challenges

- Goal/vision
  - Cost effective multimedia (voice, data, video) anywhere
- Issues
  - Mobility/QoS/Capacity
- Multimedia requirement

	Voice	Data	Video
Delay	< 100ms	-	<100ms
BER	10^{-3}	10^{-6}	10^{-6}
Data rate	8-32 kbps	limitless	limitless
traffic	Continuous	Bursty	Continuous

Challenges

- Link layer
  - Hardware
  - Good channel models + Good channel estimation technique
  - Spectral efficient modulation and coding techniques
  - Techniques to mitigate fading and CCI
- Multiple access layer
  - Dynamic resource allocation
- Networking layer
  - Routing and mobility
  - Integration of wireless/wireline backbone networks