Network : Cellular

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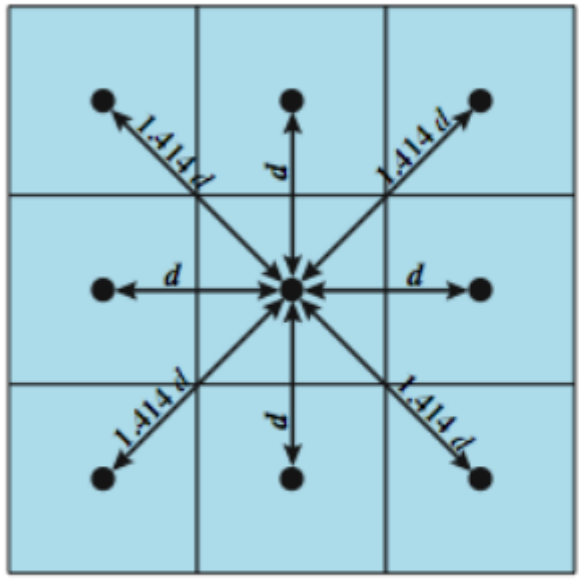
Reference

William Stalling, Data and Computer Communications 10/E, Prentice Hall

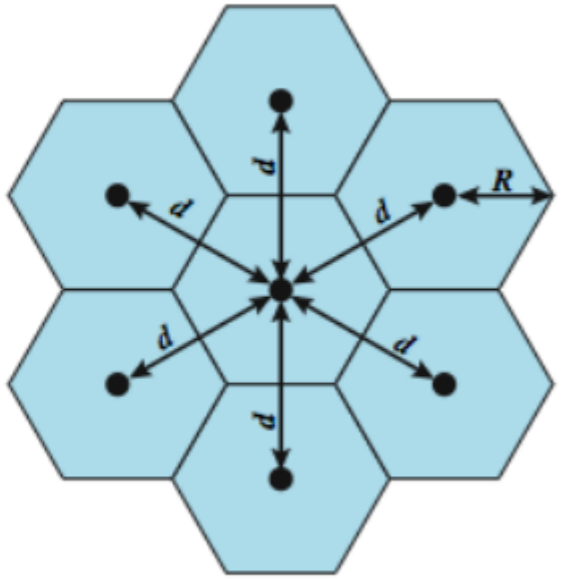
Cellular Wireless Networks

- Developed to increase the capacity available for mobile radio telephone service
- Key technology for mobiles, wireless networks etc.
  - Based on the use of multiple low power transmitters
- Area divided into cells
  - In a tiling pattern to provide full coverage
  - Each with own antenna, along with own range of frequencies
  - Served by base station : consisting of transmitter, receiver, and control unit
  - Adjacent cells re assigned different frequencies to avoid crosstalk : cells sufficiently distant can use same frequency band

Cellular Geometries



(a) Square pattern

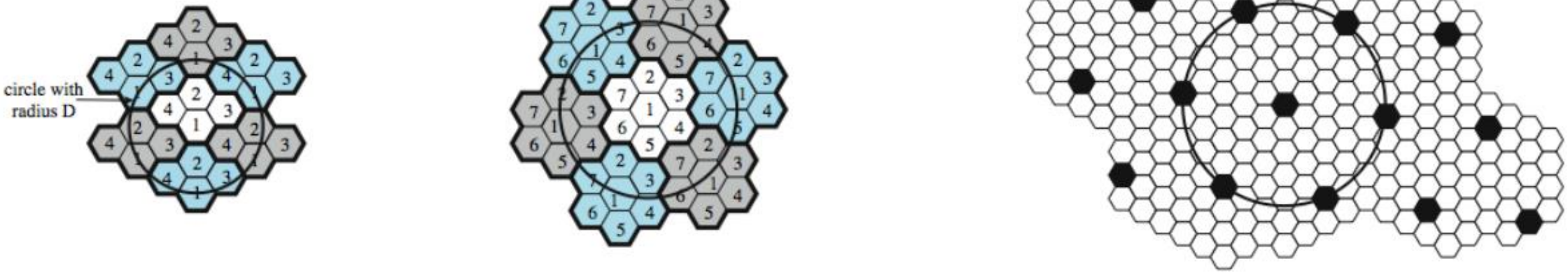


(b) Hexagonal pattern

Frequency Reuse (1)

- Object is to share nearby (but not adjacent) cell frequencies without interfering with each other
  - Allows multiple simultaneous conversations with the same frequency, at the different areas
  - 10 to 50 channels per cell
- Power of base transceiver controlled
  - Allow communications within cell using a given frequency
  - Limit escaping power to adjacent cells

Frequency Reuse (2)



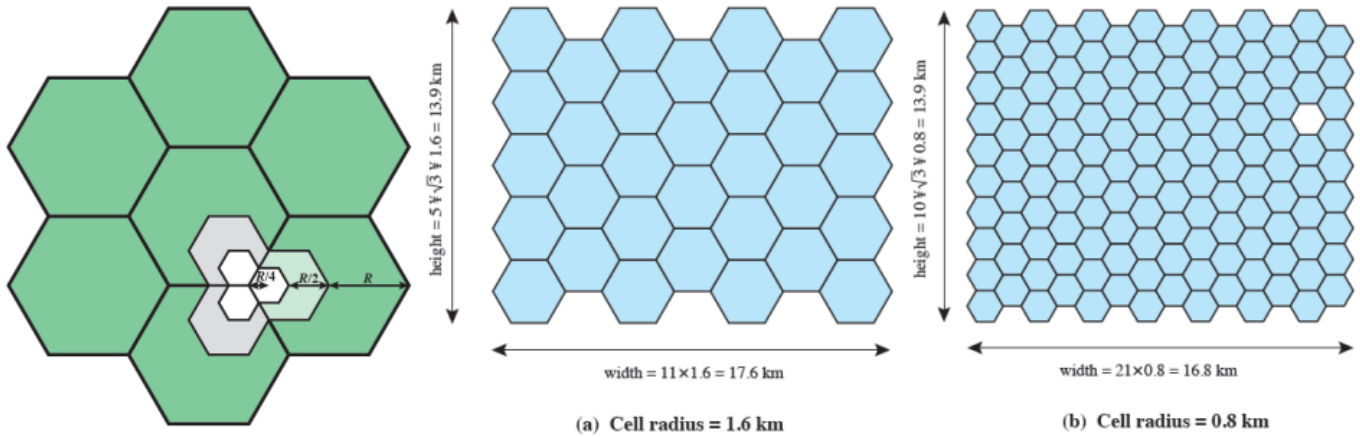
(a) Frequency reuse pattern for $N = 4$

(b) Frequency reuse pattern for $N = 7$

(c) Black cells indicate a frequency reuse for $N = 19$

Increasing Capacity (1)

- Add new channels
  - Not all channels used to start with
- Frequency borrowing
  - Taken from adjacent cells by congested cells
- Cell splitting
  - Use smaller cells in high use areas

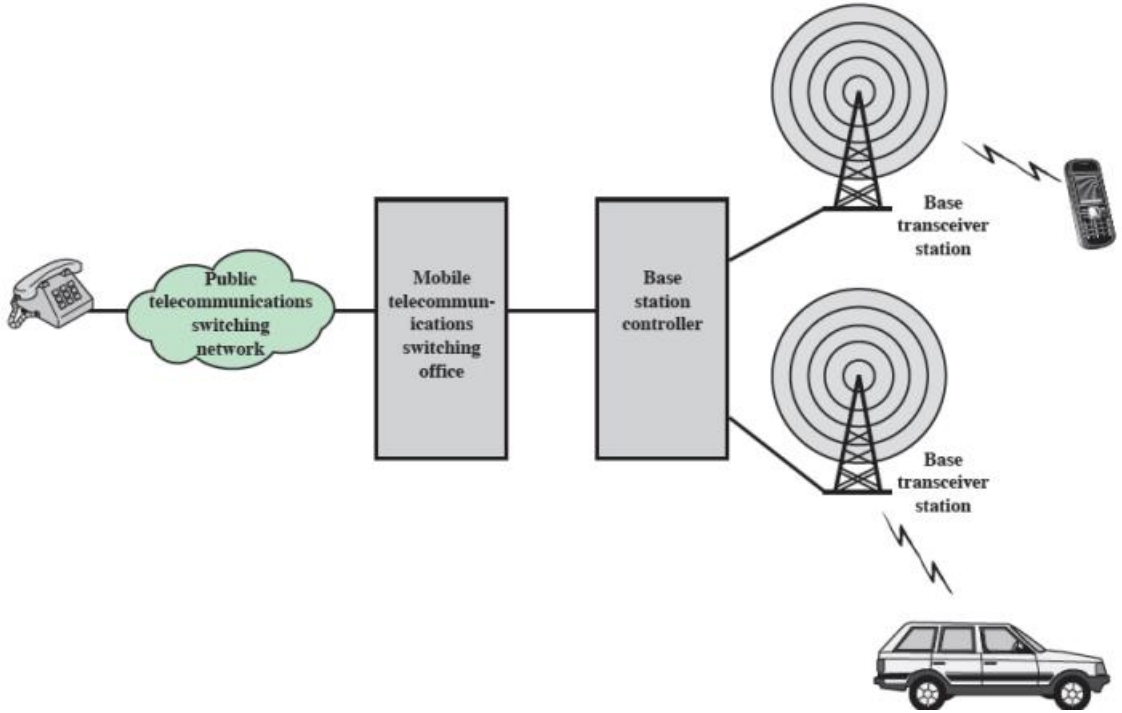


Increasing Capacity (2)

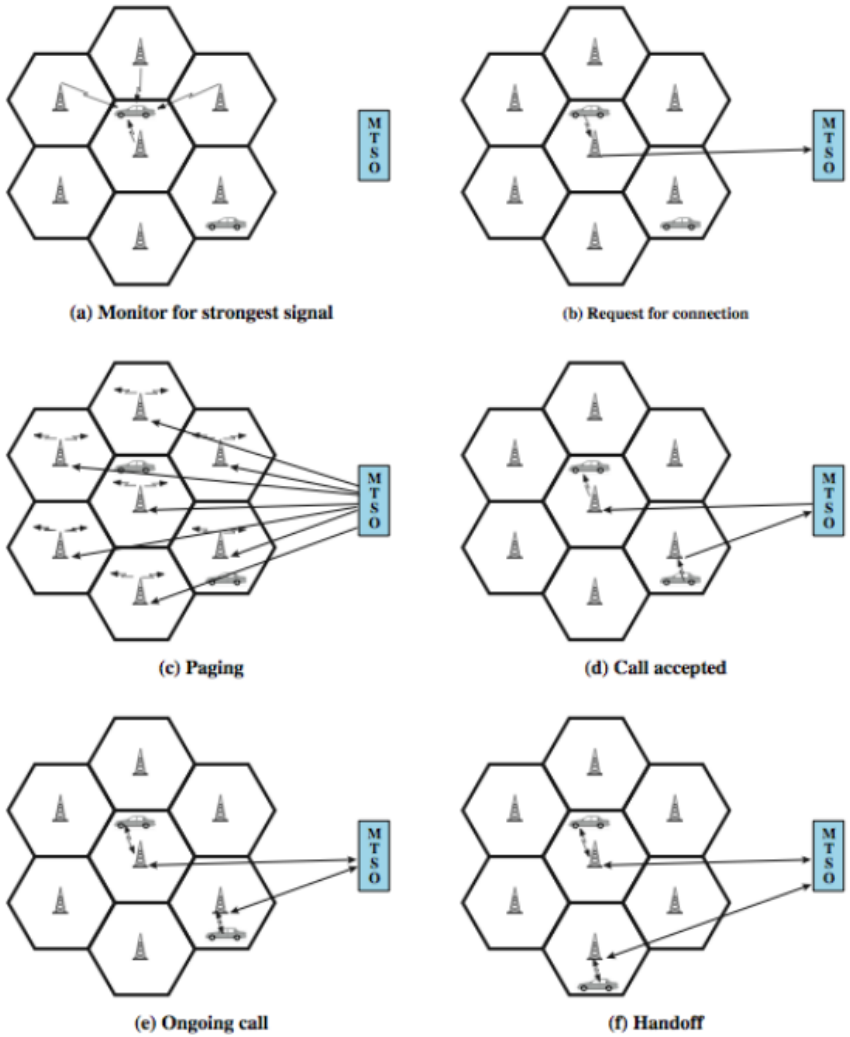
- Cell sectoring with directional antennas
  - Cell divided into wedge shaped sectors (3-6 per cell)
  - Each sector is assigned a separate subset of the cell's channels
  - Directional antennas are used to focus on each sector
- Microcells
  - As cells become smaller, antennas move from tops of hills and large buildings to tops of small buildings and sides of large buildings
  - Use reduced power to cover a much smaller area
  - Good for city streets in congested areas, along highways, inside large public buildings

Cellular System

- Cellular system channels between mobile and base station
  - Control channels : set up and maintain calls
  - Traffic channels : carry voice and data



Example of Cellular Call



Cellular Network Generations

Technology	1G	2G	2.5G	3G	4G
Design began	1970	1980	1985	1990	2000
Implementation	1984	1991	1999	2002	2012
Services	Analog voice	Digital voice	Higher capacity packetized data	Higher capacity, broadband	Completely IP based
Data rate	1.9. kbps	14.4 kbps	384 kbps	2 Mbps	200 Mbps
Multiplexing	FDMA	TDMA, CDMA	TDMA, CDMA	CDMA	OFDMA, SC-FDMA
Core network	PSTN	PSTN	PSTN, packet network	Packet network	IP backbone

System Performance		LTE	LTE-Advanced
Peak rate	Downlink	100 Mbps @20 MHz	1 Gbps @100 MHz
	Uplink	50 Mbps @20 MHz	500 Mbps @100 MHz
Control plane delay	Idle to connected	<100 ms	< 50 ms
	Dormant to active	<50 ms	< 10 ms
User plane delay		< 5ms	Lower than LTE
Spectral efficiency (peak)	Downlink	5 bps/Hz @2×2	30 bps/Hz @8×8
	Uplink	2.5 bps/Hz @1×2	15 bps/Hz @4×4
Mobility		Up to 350 km/h	Up to 350—500 km/h