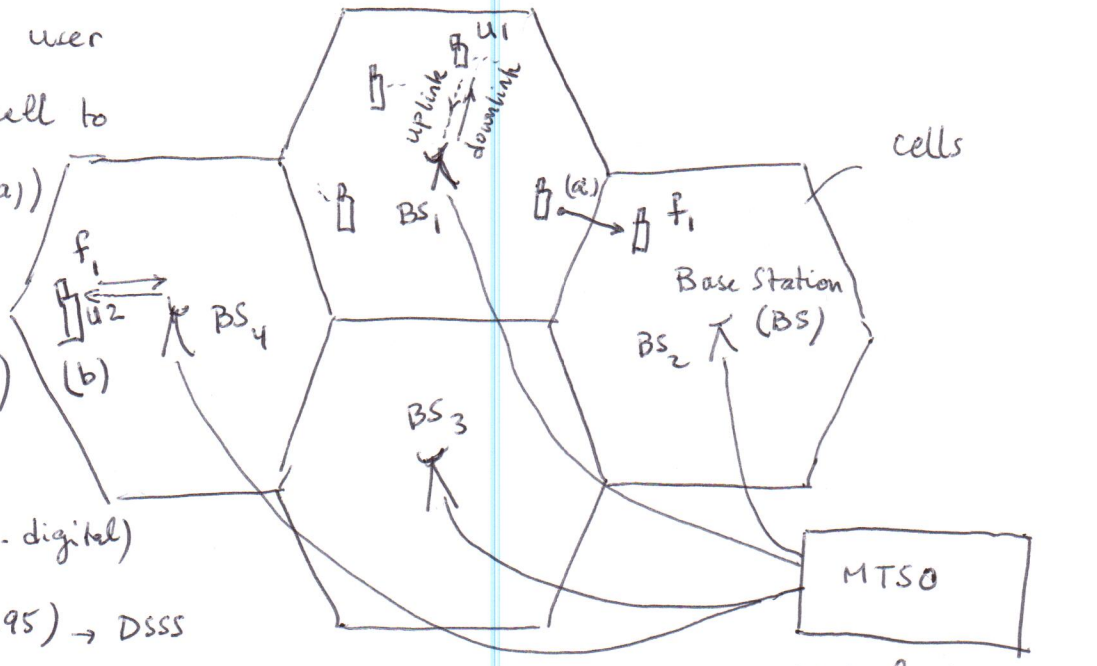
Lecture 20

Popular applications

1- Cellular networks

* Handoff when user moves from one cell to another (as in (a))

- Frequency reuse (as in (b))



- 2G → GSM (2nd Gen. digital)
  - CDMA one (IS-95) → DSSS

- U1 and U2 communicate through BS_1 and BS_4.

2 CDMA in GPS

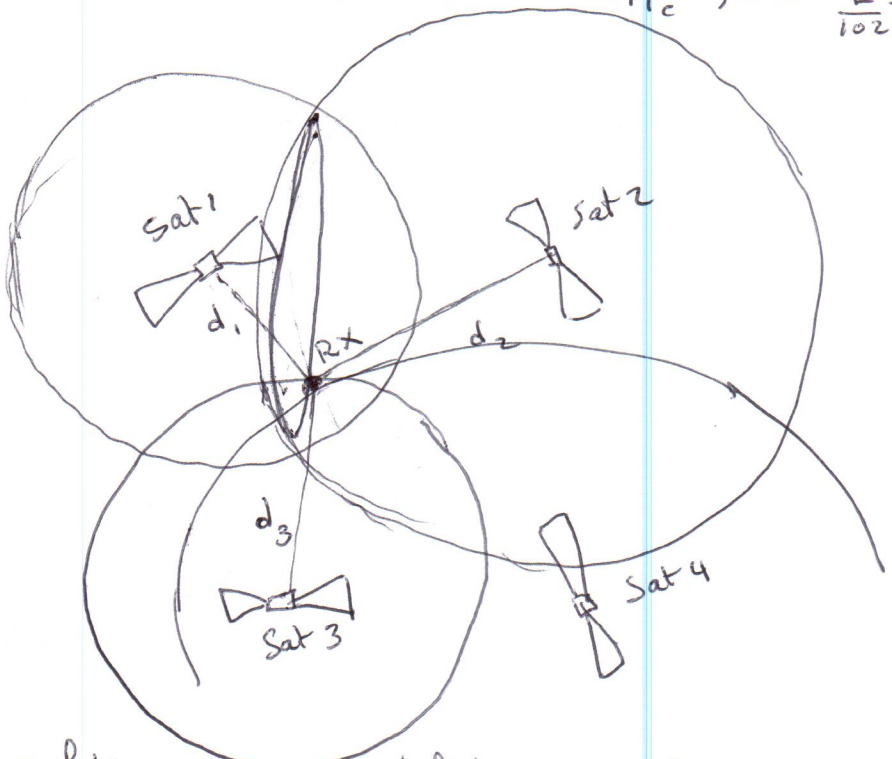
* Constellation of 24 satellites in Medium Earth Orbit. They rotate the earth in 12 hrs each, and enable a GPS RX to determine location, speed and direction via triangulation as shown in figure.

* Each satellite continuously broadcasts its navigation message (BPSK at 50 b/s). This message is transmitted by means of two CDMA spreading codes: one for the coarse acquisition (C/A) mode and one for precise (P) mode (encrypted for military use)

* Three satellites suffice for triangulation and a fourth for synchronization to adjust bias of RX clock. (4 unknowns and 4 equations)

* Principle of operation: Measure time delay between its own message and that received from satellite ⇒ compute d

C/A code: PN sequence with period 1023 chips at 1.023 Mchips/sec. The spreading gain = L = 20460 (note: navigation msg from satellite is BPSK at 50 b/s so $T_b = 20\,msec$, $T_c \simeq 1\,\mu sec$ ⇒ $L = T_b/T_c$, also $\frac{L}{1023} = 20$, i.e. 20 periods/symbol short code)



Triangulation using 3 satellites, and 4th for synchronization

P spreading code : 10.23 Mchips/sec ⇒ L = 204,600

period is 6.1871×10^{12} chips (1 week long!), which is a very long code as the period spans a large # of symbols.

* Differential GPS is used to increase accuracy of the coarse positioning system by correcting error in relation to landmarks.

Why Spread spectrum in GPS ?

1- Protect from unauthorized use (codes)

2- Allows reasonable power levels (c.f satellite requirement and processing gain of SS)

3- Satellites can use same freq. band without mutual interference owing to the near orthogonality of each user's signal.