Part 7

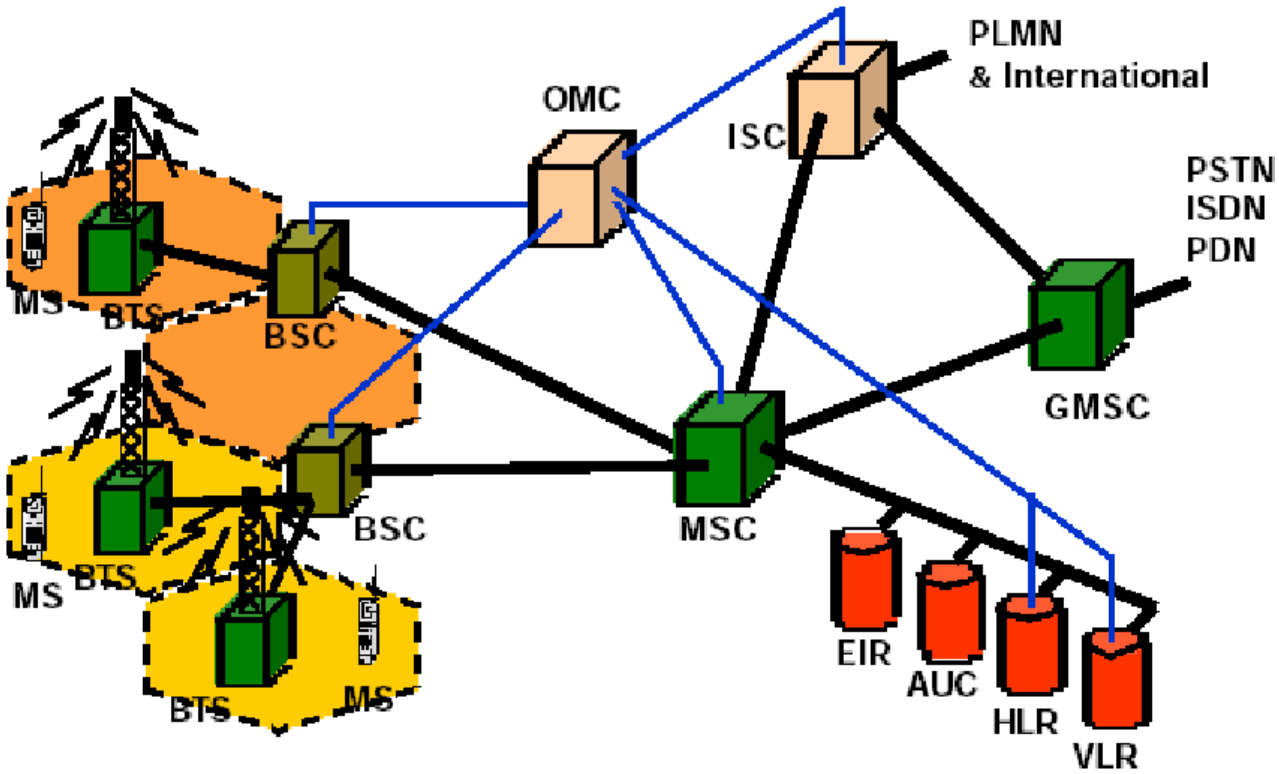
CDMA digital cellular mobile communication system(IS-95)

Introduction to CDMA system

- What are the benefits?
  - –Increased capacity
  - –Increased quality
  - –Simplified system planning
  - –Enhanced privacy
  - –Improved coverage (fewer cells)
  - –Increased talk time (battery life)
  - –Bandwidth on demand

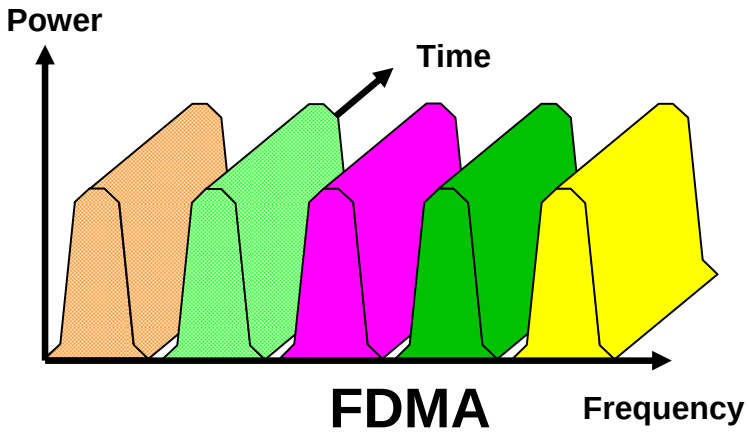
Introduction to CDMA system

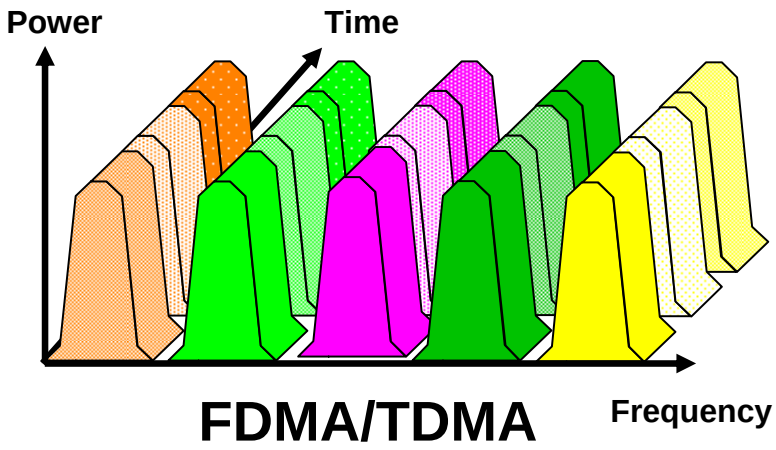
- CDMA systems have a similar network architecture to GSM network, consisting of MS, BTS, BSC, MSC, OMC, relevant database(EIR, AUC, HLR, VLR)
- The major differences between GSM and CDMA system are BTS, MS, air interface between BTS and MS

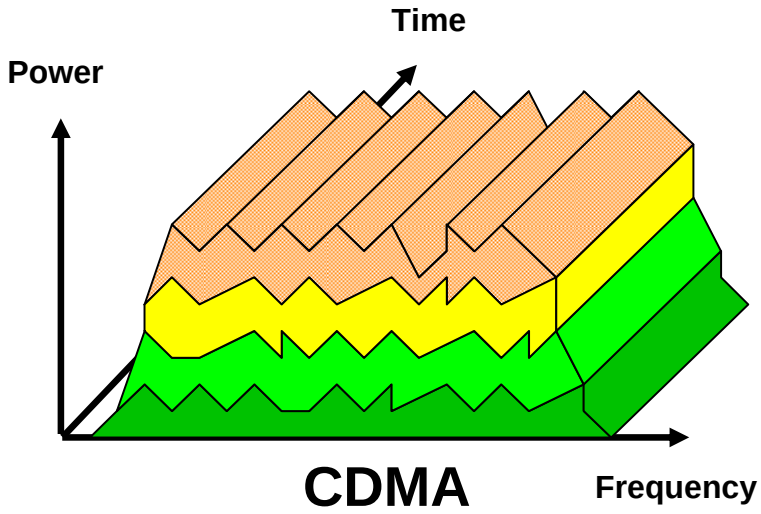


Concept: CDMA

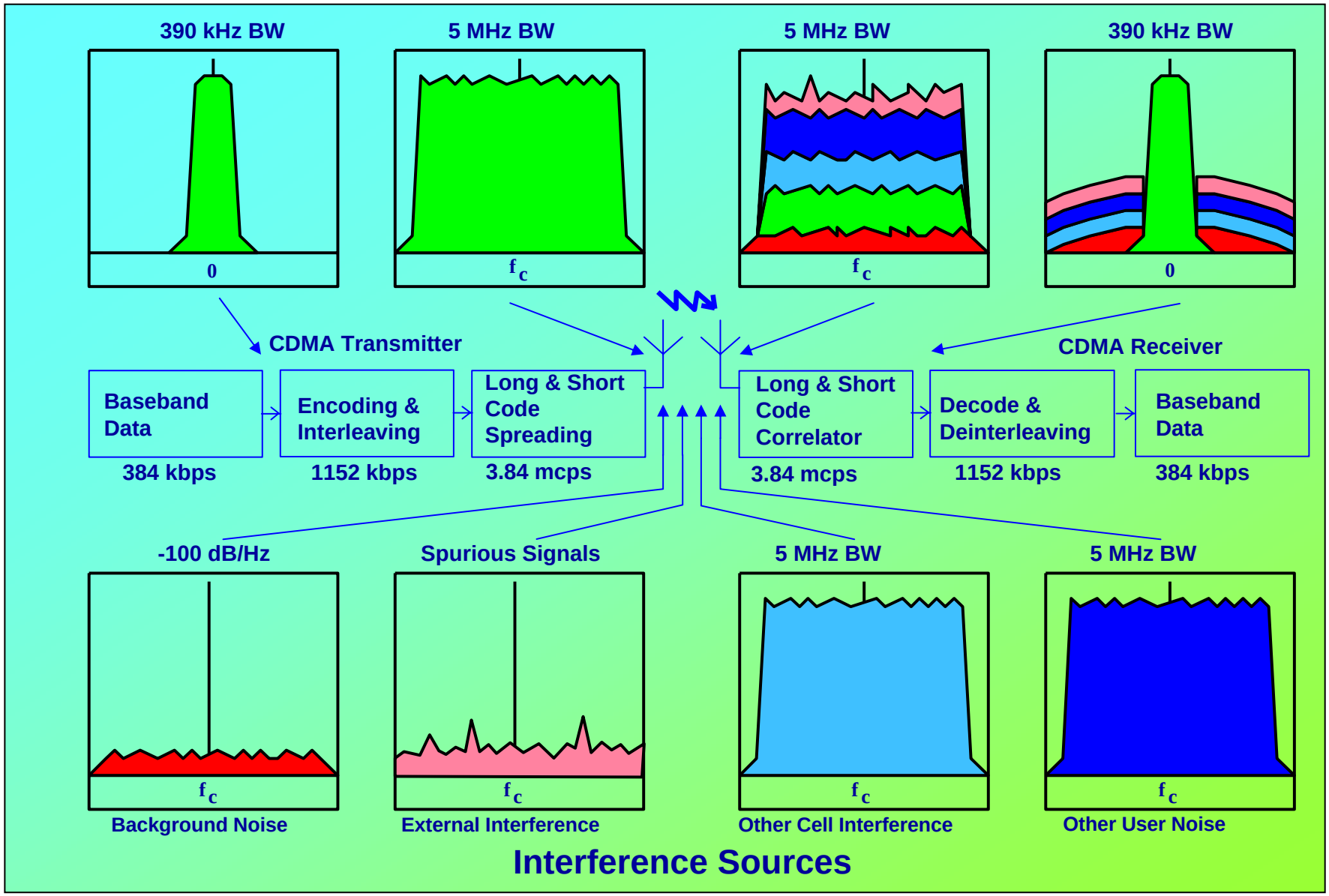
Evolution of multiple access techniques





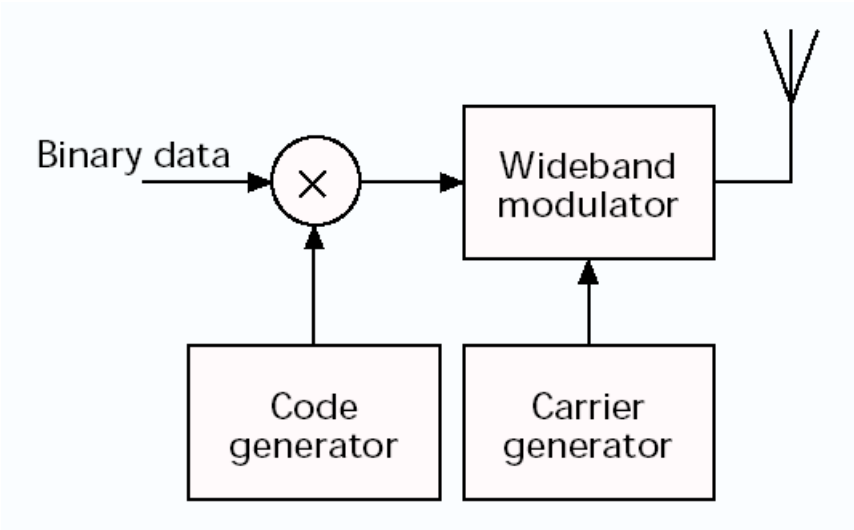


Concept: CDMA

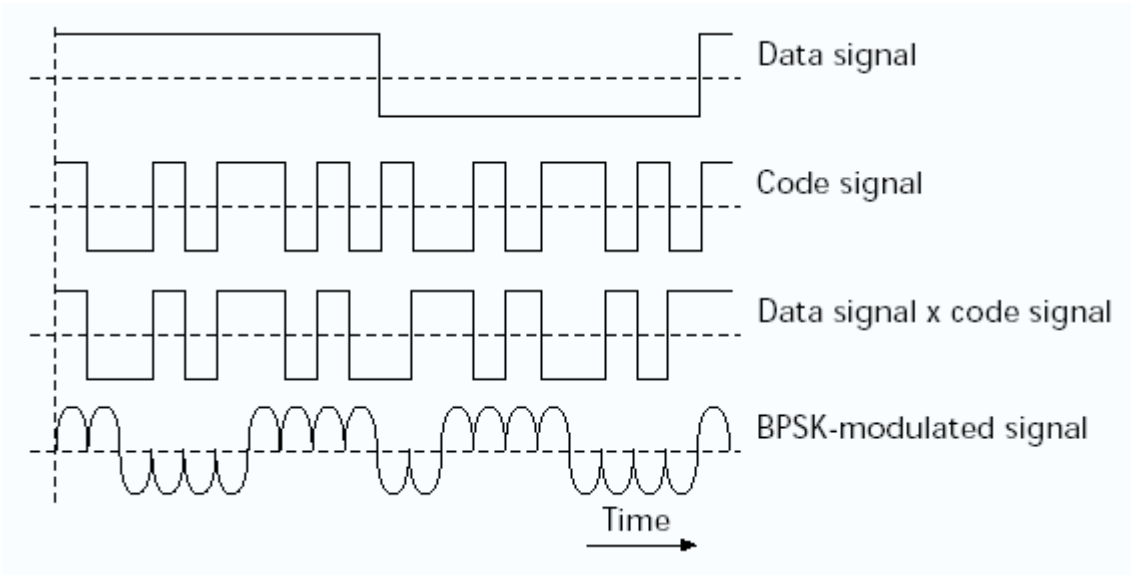


Spread spectrum signal

DS-CDMA transmitter



Generation of a BPSK-modulated SS signal



The most important properties of CDMA

- ***Multiple access****:* If multiple users use the channel at the same time, there will be multiple DS signals overlapping in time and frequency. At the receiver coherent demodulation is used to remove the code modulation. This operation concentrates the power of the desired user in the information bandwidth. If the cross correlations between the code of the desired user and the codes of the interfering users are small, coherent detection will only put a small part of the power of the interfering signals into the information bandwidth.
- ***Multipath interference****:* If the code sequence has an ideal autocorrelation function, then the correlation function is zero outside the interval [$-Tc$,Tc], where Tc is the chip duration. This means that if the desired signal and a version that is delayed for more than $2Tc$ are received, coherent demodulation will treat the delayed version as an interfering signal, putting only a small part of the power in the information bandwidth.
- ***LPI****:* Because the direct sequence signal uses the whole signal spectrum all the time, it will have a very low transmitted power per hertz. This makes it very difficult to detect a DS signal.

Other properties of CDMA

DS-CDMA has a number of other specific properties .

Advantages:

- The generation of the coded signal is easy. It can be performed by a simple multiplication.
- Since only one carrier frequency has to be generated, the frequency synthesizer (carrier generator) is simple.
- Coherent demodulation of the DS signal is possible.
- No synchronization among the users is necessary.

Other properties of CDMA

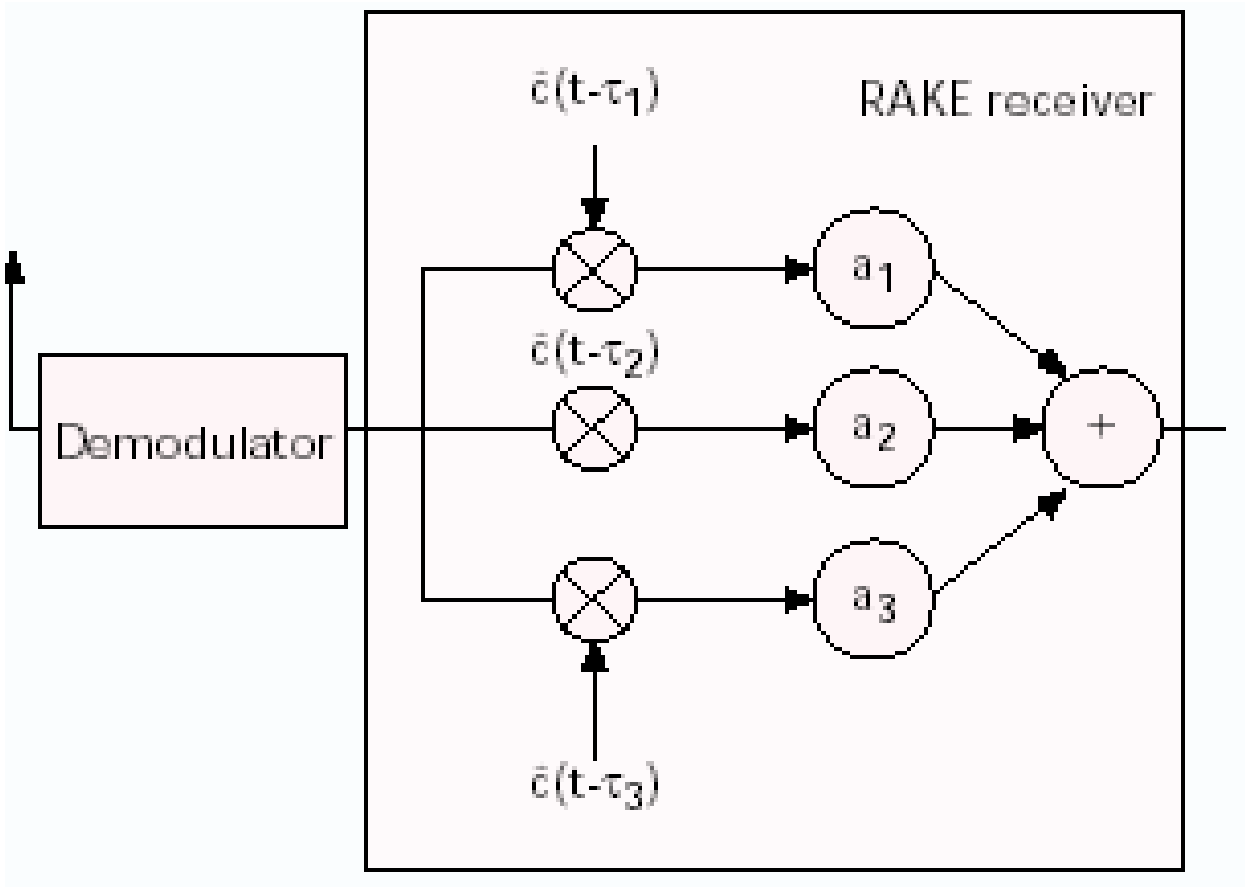
Disadvantages:

– It is difficult to acquire and maintain the synchronization of the locally generated code signal and the received signal. Synchronization has to be kept within a fraction of the chip time.

– For correct reception the synchronization error of locally generated code sequence and the received code sequence must be very small, a fraction of the chip time.

– The power received from users close to the base station is much higher than that received from users further away. Since a user continuously transmits over the whole bandwidth, a user close to the base station will constantly create a lot of interference for users far from the base station, making their reception impossible, this called “near-far effect”. It can be solved by applying a power control algorithm so that all users are received by the base station with the same average power. However power control proves to be quite difficult.

Rake receiver of CDMA system



Power control of CDMA system

- Due to the propagation mechanism, the signal received by the base station from a user terminal close to the base station will be stronger than the signal received from another terminal located at the cell boundary. Hence, the distant users will be dominated by the close user. This is called the *near-far effect*.
- To achieve a considerable capacity, all signals, irrespective of distance, should arrive at the base station with the same mean power. A solution to this problem is power control, which attempts to achieve a constant received mean power for each user. Therefore, the performance of the transmitter power control (TPC) is one of the several dependent factors when deciding on the capacity of a DS-CDMA system.

IS-95 Air interface parameters

Bandwidth	1.25 MHz
Chip Rate	1.2288 Mc/s
Frequency band uplink	869–894 MHz 1930–1980 MHz
Frequency band downlink	824–849 MHz 1850–1910 MHz
Frame length	20 ms
Bit rates	Rate set 1: 9.6 Kb/s Rate set 2: 14.4 Kb/s IS-95B: 115.2 Kb/s
Speech code	QCELP 8 Kb/s ACELP 13 Kb/s
Soft handover	Yes
Power control	Uplink: open loop + fast closed loop Downlink: slow quality loop
Number of RAKE fingers	4
Spreading codes	Walsh+Long M-sequence

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