Evolution of CDMA

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Objectives

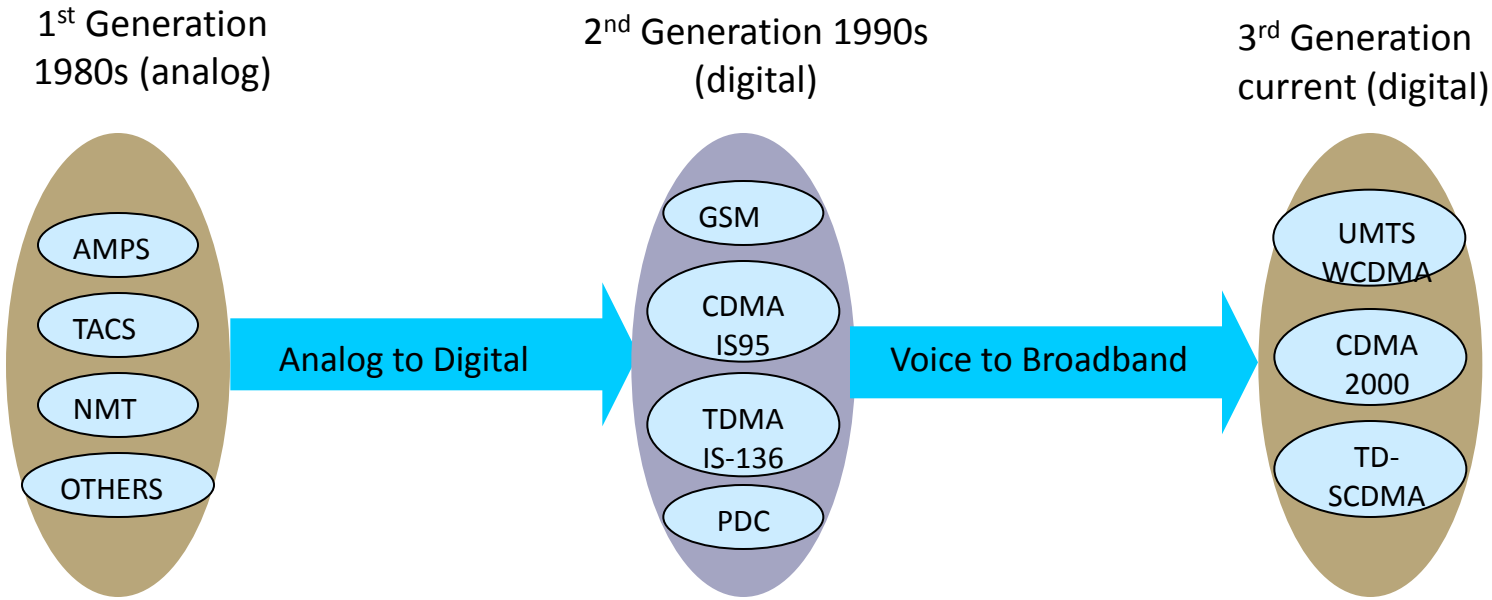
After completion of this course participants will be able to

- Understand the structure of CDMA 2000 1X
- State the signal process flow of CDMA 2000 1X
- State the technology of CDMA 2000 1X
- Describe the interfaces of CDMA 2000 1X
- Describe the numbers in CDMA 2000 1X

Contents

- Introduction
- Basic knowledge
- Key technology
- Air interface
- Important numbers

Development of Mobile Communications

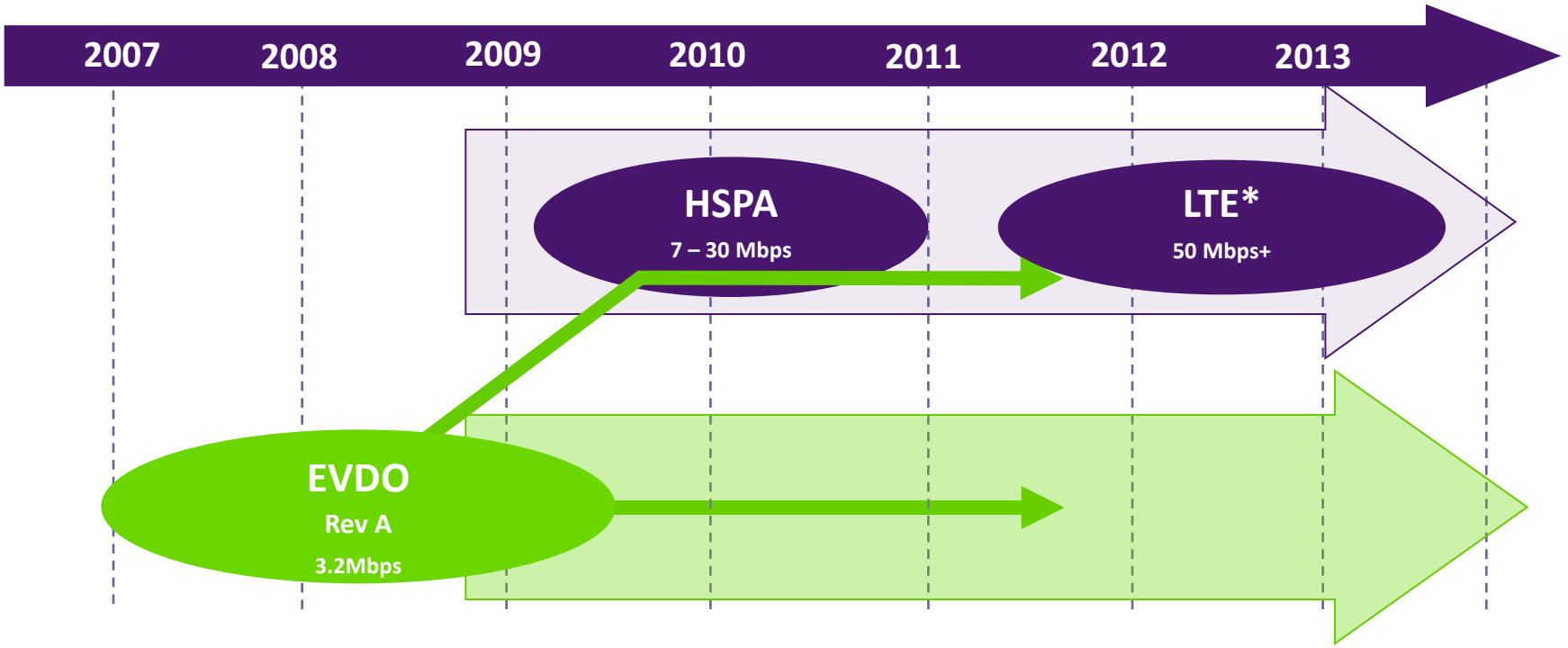


3G provides:

- ✓ Complete integrated service solutions
- ✓ High bandwidth
- ✓ Unified air interface
- ✓ Best spectral efficiency and

…… a step towards PCS

Technology Roadmap



GSM/UMTS Ecosystem

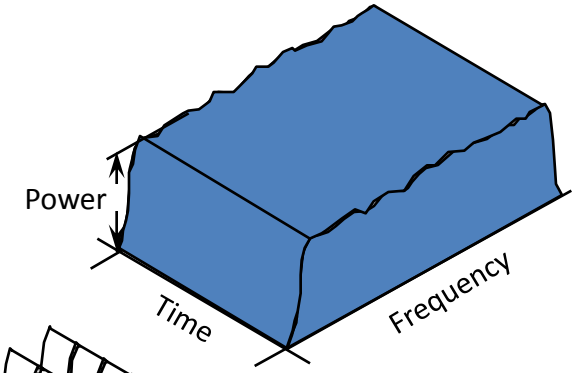
CDMA 2000 Ecosystem

* Theoretical. Standards in progress

Future proofing our technology roadmap

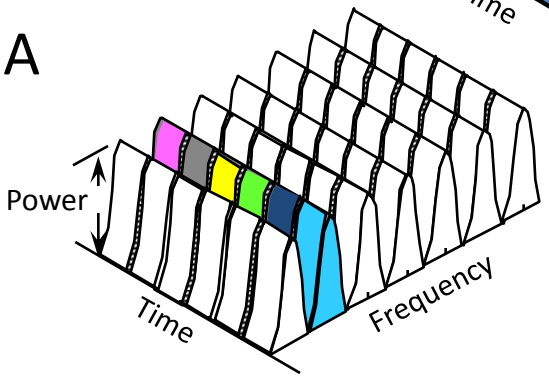
Transmission Techniques

CDMA



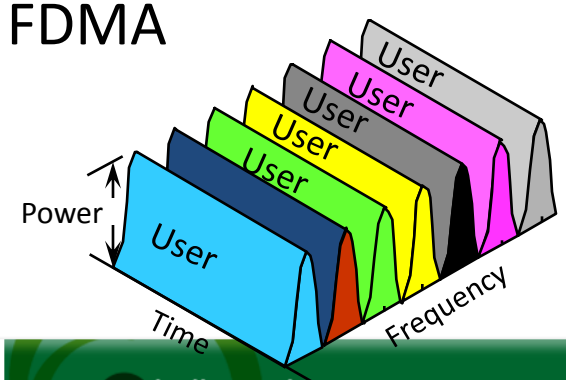
Traffic channels: different users are assigned unique code and transmitted over the same frequency band, for example, WCDMA and CDMA2000

TDMA



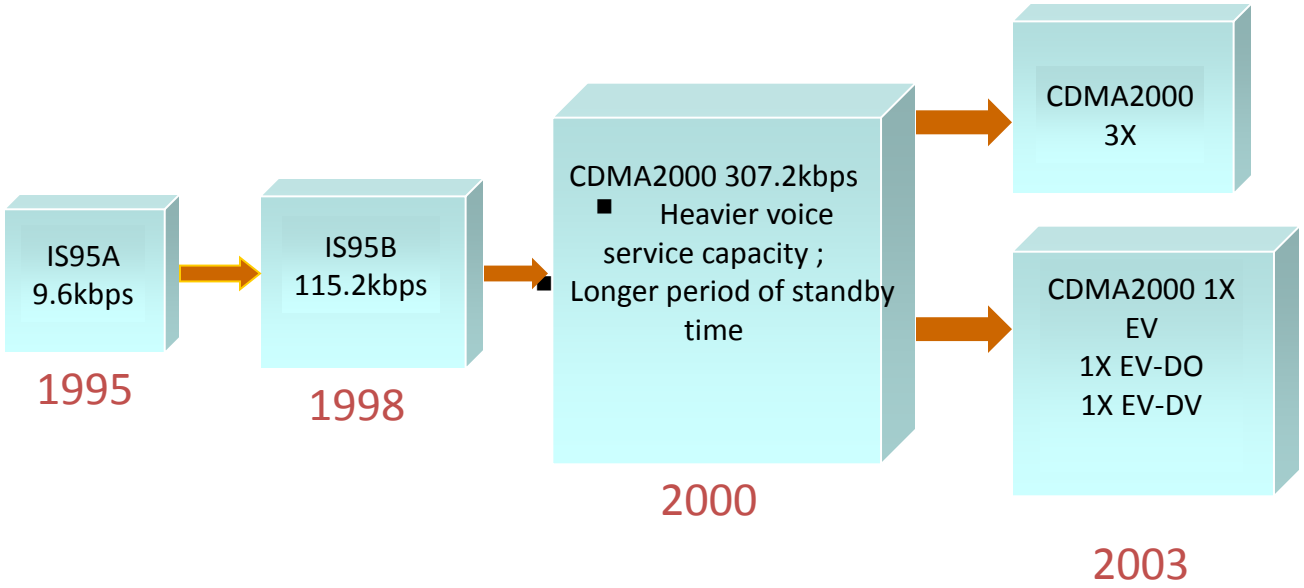
Traffic channels: different time slots are allocated to different users, for example, DAMPS and GSM

FDMA



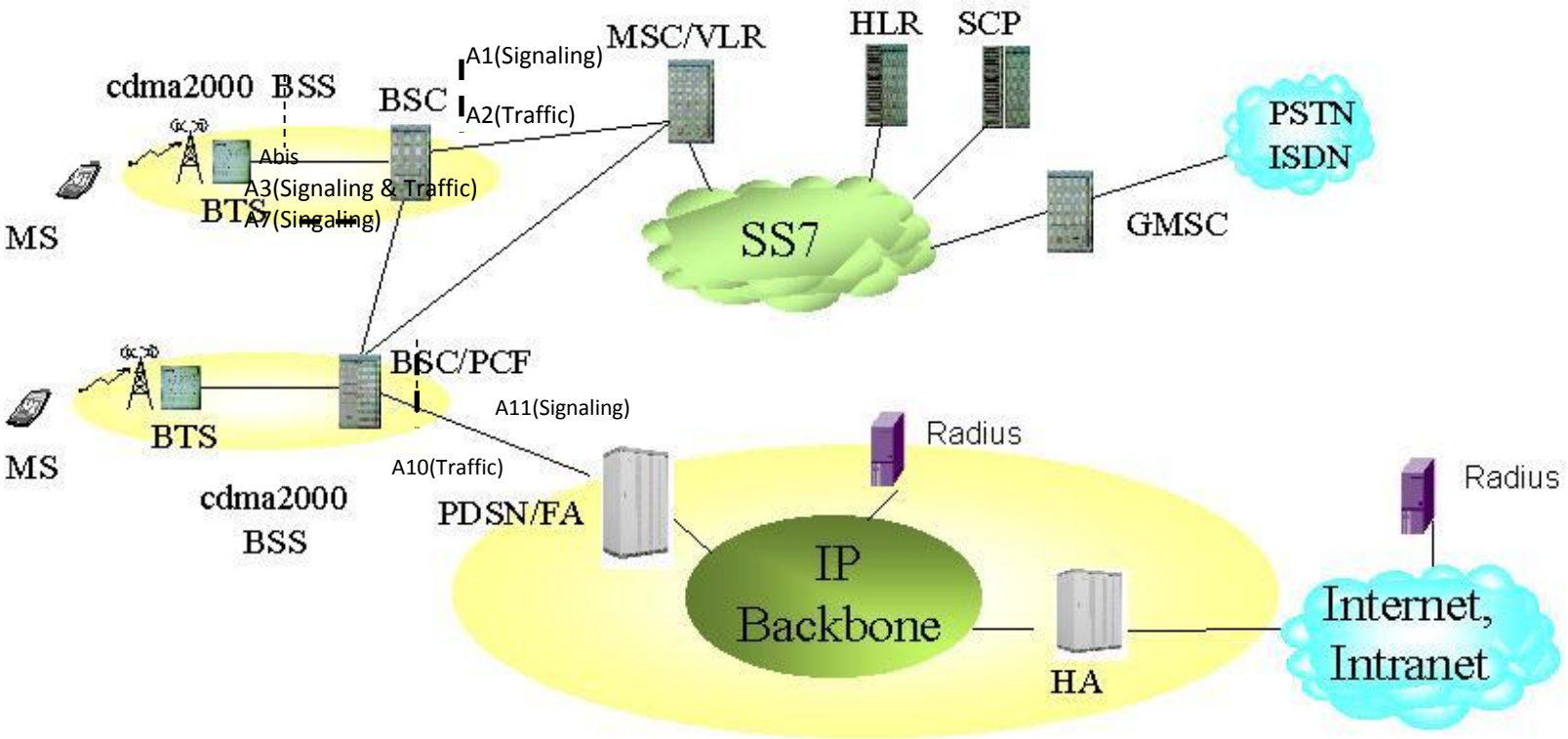
Traffic channels: different frequency bands are allocated to different users,for example, AMPS and TACS

Development of CDMA System



- Higher spectrum efficiency and network capacity
- Higher packet data rate and more diversified services
- Smooth transit to 3G

CDMA2000 1X Network Structure

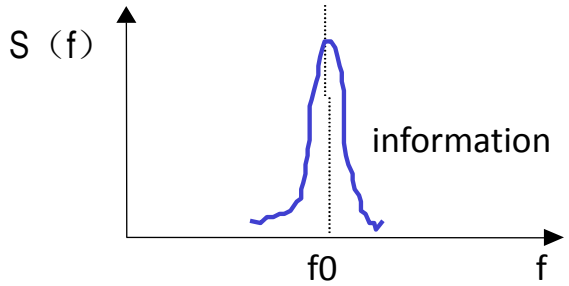


MS: Mobile Station — BTS: Base Transceiver Station
BSC: Base Station Controller — MSC: Mobile Switching Center
HLR :Home Location Register — VLR: Visitor Location Register
PCF: Packet data Control Function — PDSN: Packet Data Service Node
HA: Home Agent — FA: Foreign Agent
SCP: Service Control Point — Radius: Remote Authentication Dial-in User Service

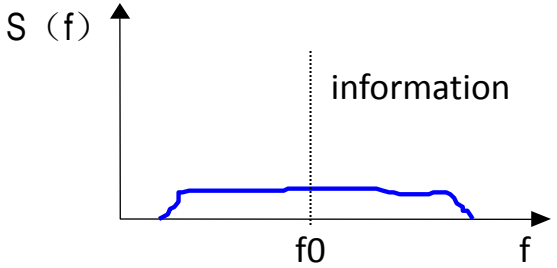
FA & HA : In Mobile Internet Protocol (Mobile IP), a home agent is a router on a mobile node's home network that maintains information about the device's current location, as identified in its care-of address. The home agent uses tunneling mechanisms to forward Internet traffic so that the device's IP address doesn't have to be changed each time it connects from a different location. A home agent may work in conjunction with a foreign agent, which is a router on the visited network. The foreign agent and the home agent are two types of mobility agents, defined in the Internet Engineering Task Force (IETF) RFC 2002 specification called IP Mobility Support.

Spreading and De-spreading

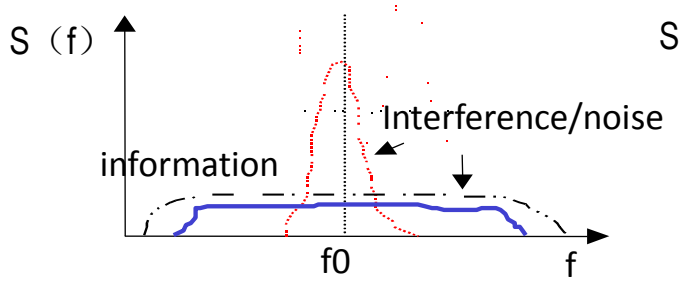
The improvement of time-domain information rate means that the bandwidth of spectrum-domain information is spread.



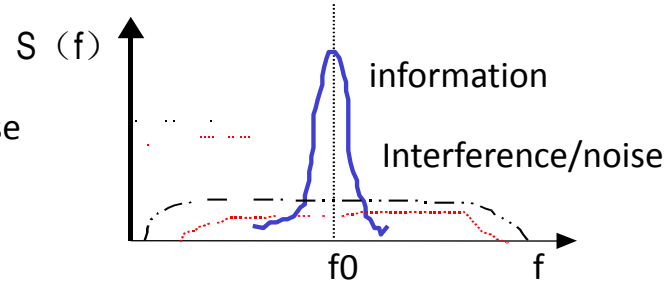
The spectrum before spreading



The spectrum after spreading



The spectrum before despreading

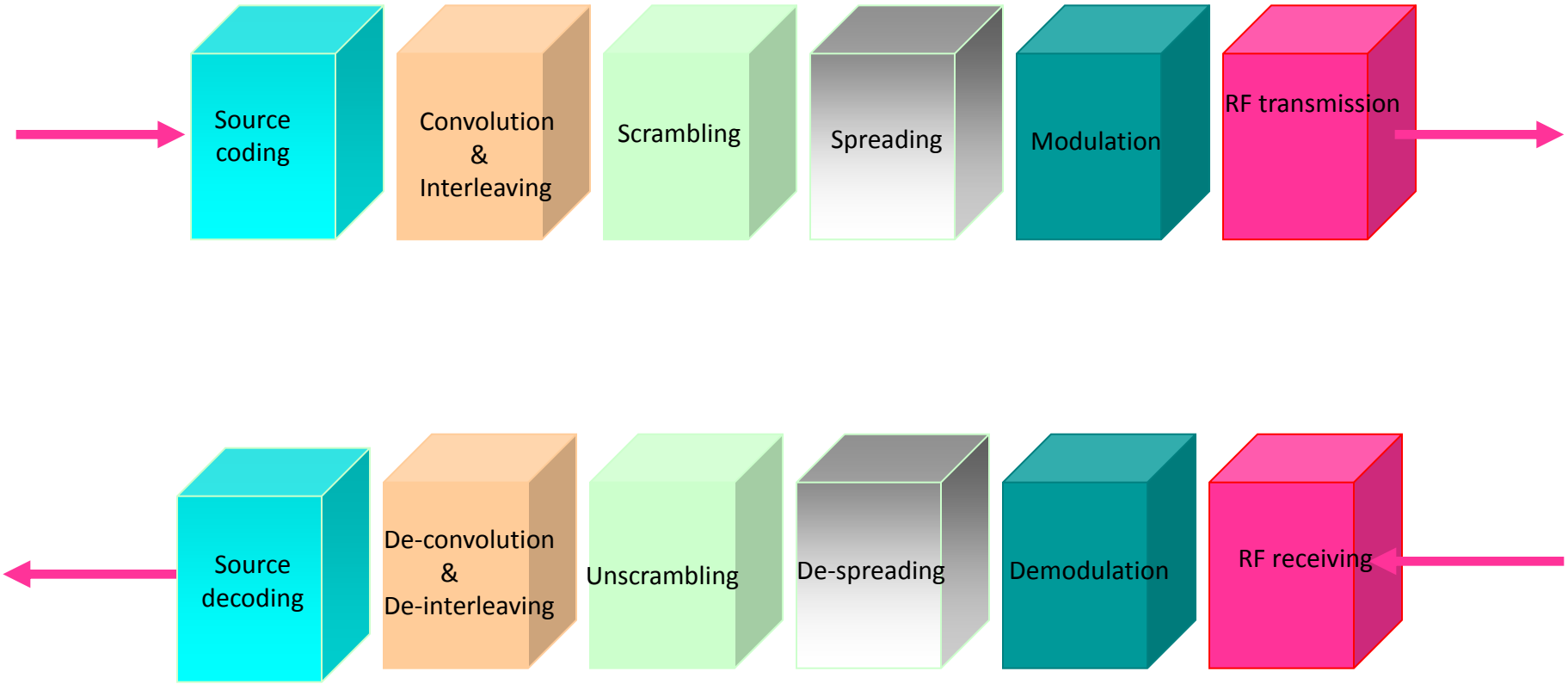


The spectrum after despreading

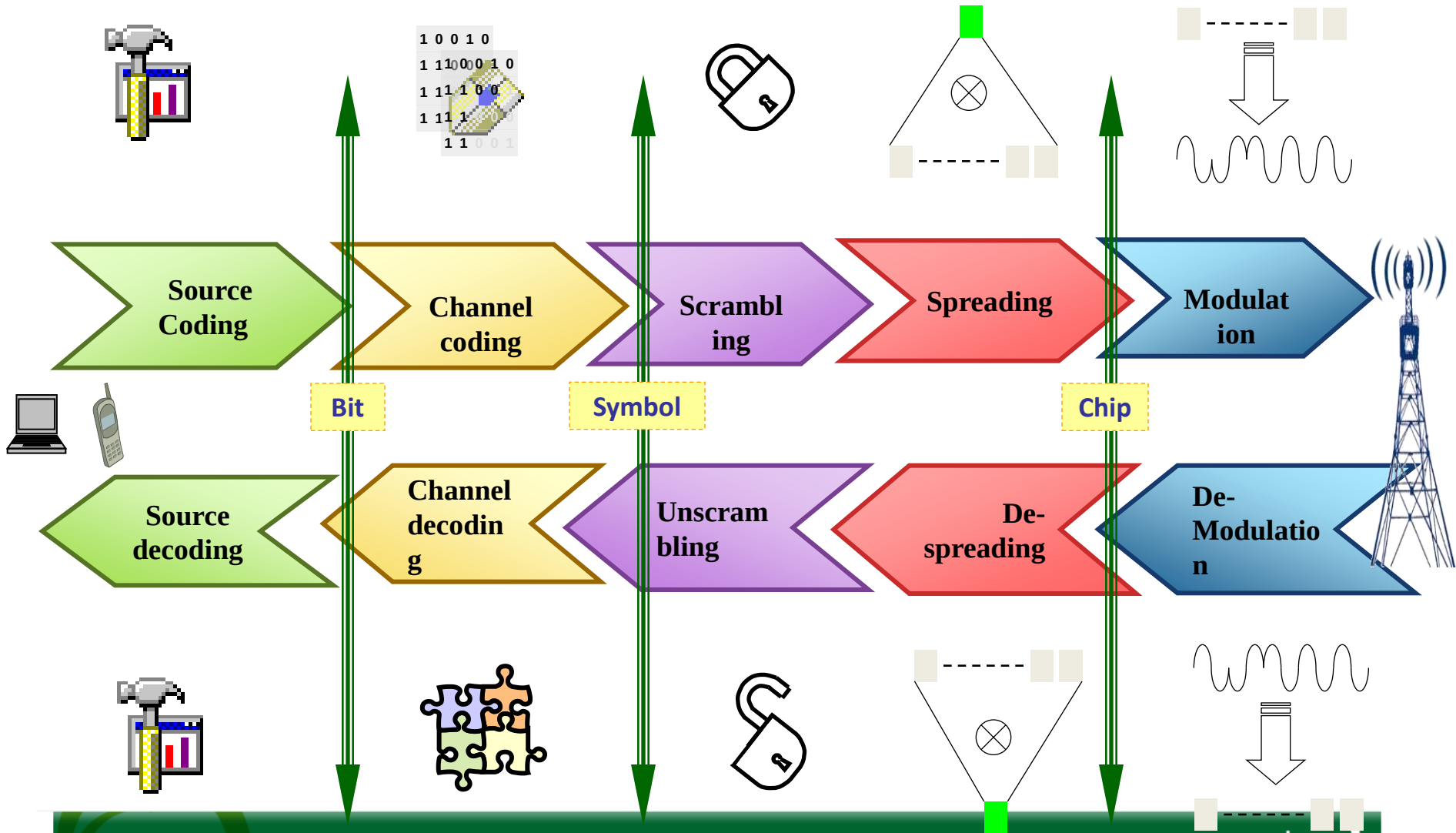
information　　pulse interference　　White noise

S(f) is the energy density.

Signal flow


Source coding
Convolution & Interleaving
Scrambling
Spreading
Modulation
RF transmission
Source decoding
De-convolution & De-interleaving
Unscrambling
De-spreading
Demodulation
RF receiving

CDMA flow


Source Coding
Channel coding
Scrambling
Spreading
Modulation
Bit
Symbol
Chip
Source decoding
Channel decoding
Unscrambling
De-spreading
De-Modulation

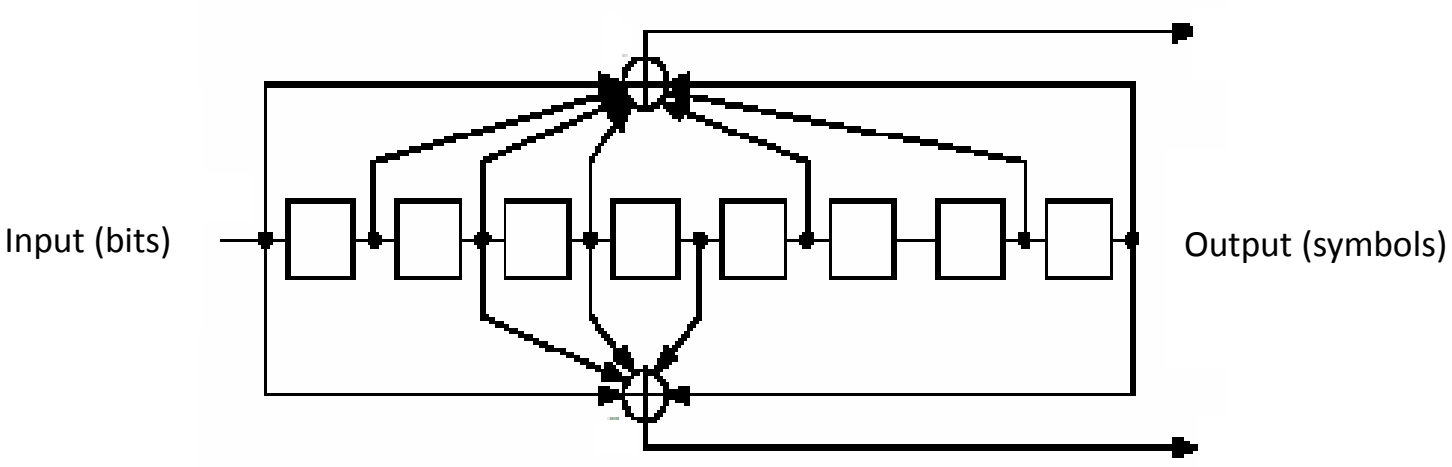
Common Technical Terms

- Bit, Symbol, Chip:
  - A bit is the input data which contain information
  - A symbol is the output of the convolution, encoder, and the block interleaving
  - A chip is the output of spreading
- Processing Gain:
  - Processing gain is the ratio of chip rate to the bit rate.
  - The processing gain in IS-95 system is 128, about 21dB.
- Forward direction: Information path from base station to mobile station
- Reverse direction: Information path from mobile station to base station

Channel Coding

Convolution code or TURBO code is used in channel encoding

Encoding efficiency= (total input bits / total output symbols)



convolution encoder

Turbo Code

Turbo code is used during the transmission of large data packet.

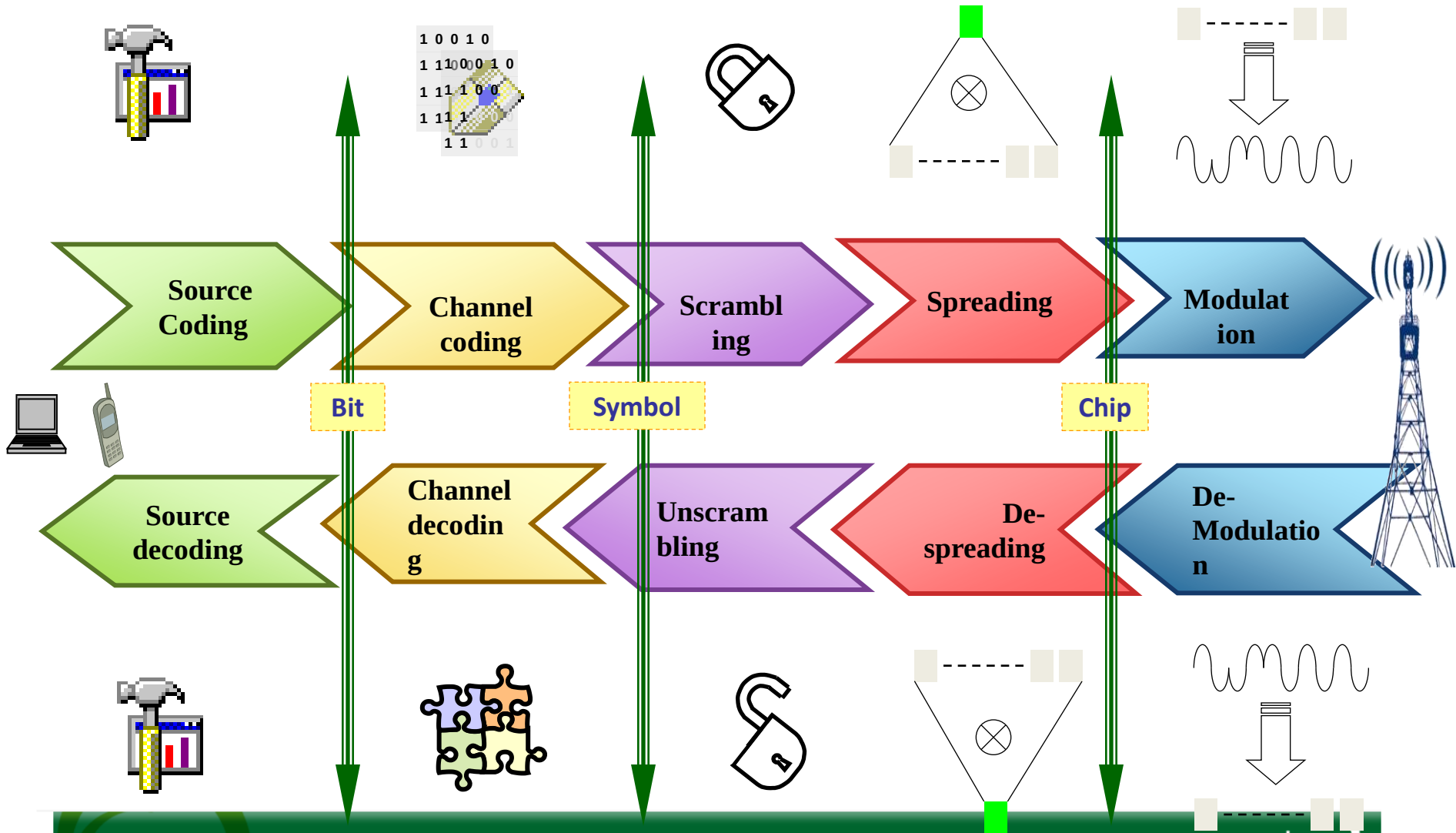
- Characteristics of the Turbo code:
  - The input information is encoded twice and the two output codes can exchange information with each other during decoding.
  - The symbol is protected not only by the neighborhood check bits, but also by the separate Check Bits.

The performance of a Turbo code is superior to that of a convolution code.

Long Code

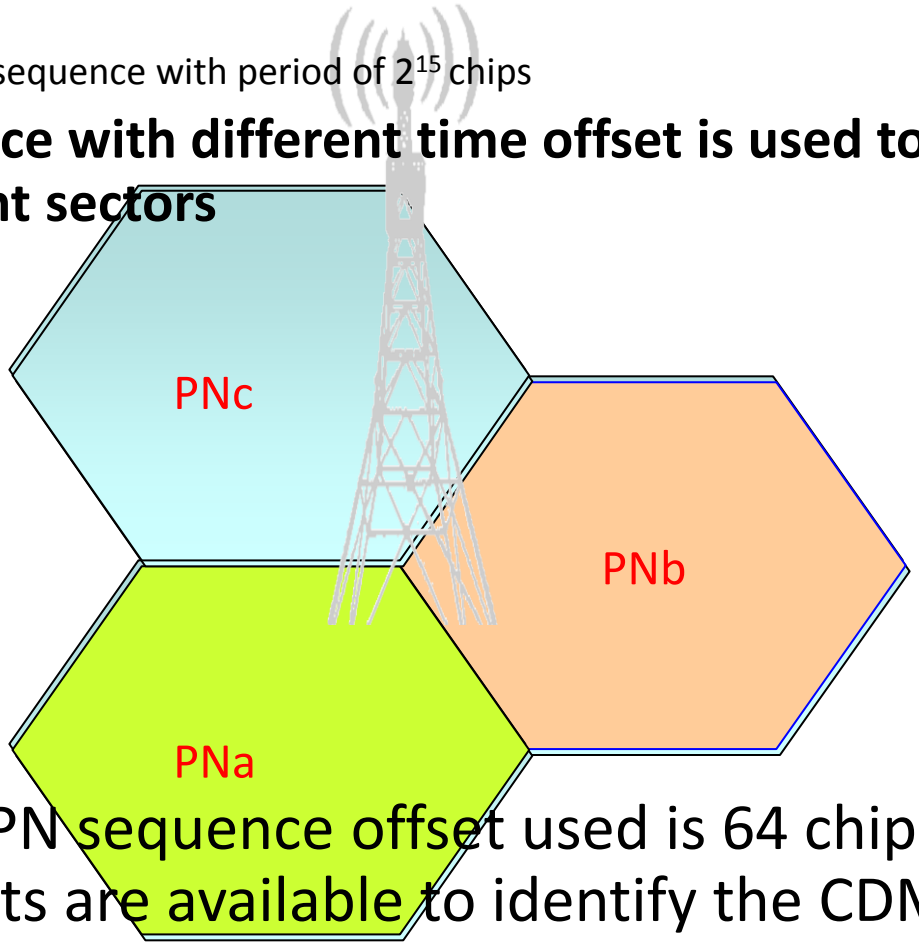
- The long code is a PN sequence with period of 2^{42} -1chips
- The functions of a long code:
  - Scramble the forward CDMA channel
  - Control the insertion of power control bit
  - Spread the information on the reverse CDMA channel to identify the mobile stations

CDMA flow


Source Coding
Channel coding
Scrambling
Spreading
Modulation
Bit
Symbol
Chip
Source decoding
Channel decoding
Unscrambling
De-spreading
De-Modulation

Short Code

- Short code is a PN sequence with period of 2^{15} chips
  - **Sequence with different time offset is used to distinguish different sectors**



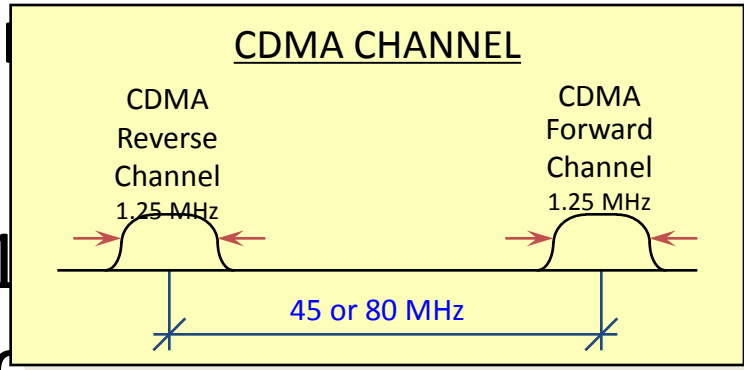
- Minimum PN sequence offset used is 64 chips, that is, 512 PN offsets are available to identify the CDMA sectors ($2^{15}/64=512$).

Walsh Code

- In forward direction, each symbol is spread with Walsh code
- Walsh code is used to distinguish the user in forward link
- For CDMA2000, in the reverse, Walsh function is used to define the type of channel (RC 3-9)

Main Parameters

CDMA Channel or CDMA Carrier Frequency



- Duplex channel made of two 1 bands of electromagnetic spect each for forward and reverse link
  - In 800 Cellular these two simplex 1.25 MHz bands are 45 MHz apart
  - In 1900 MHz PCS they are 80 MHz apart

CDMA Forward Channel

- 1.25 MHz Forward Link

CDMA Reverse Channel

- 1.25 MHz Reverse Link

CDMA Codes

- Long Code
- Short Code
- Walsh Code
-

Forward and Reverse link

Forward Link

- Channels include: Pilot, Sync, Paging and Forward Traffic channels

Reverse Link

- Channels include: Access and Reverse Traffic channels

Review

Process flow of Signal

Following are the steps:

- Source Coding
- FEC Coding
- Scrambling
- Spreading
- Modulation

Source Coding

- Following are the types of source coding:
- 8K QCELP (sample rate = 9.6 kbps)
- 13K QCELP (sample rate = 14.4 kbps)
- EVRC

First two are used by Qualcomm and later is by Motorolla

FEC Coding or Channel Coding

- Convolution or turbo code is used in channel coding
- Convolution is used for voice
- Turbo is used for data

Scrambling

- Main purpose of scrambling is to secure the data with some code at source side and same is unlocked at other side
- It uses shift register and mask register
- This kind of generator is named as linear feedback shift register
- In scrambling two types of codes are used named as PN Long and PN short code

PN Long Code

The function of a long code is

- To scramble the forward CDMA channel
- To control the insertion of power control bit
- To spread the information on the reverse CDMA channel to identify the mobile stations
- The long code is a PN sequence with period of 2^{42} -1chips

PN Short Code

- These are used to identify the different sectors
- Min PN offset is 64 chips it means that 512 PN off sets are available to identify the CDMA sectors
- Minimum PN sequence offset used is 64 chips, that is, 512 PN offsets are available to identify the CDMA sectors ($2^{15}/64=512$).

Walsh Code

- Walsh codes are orthogonal
- Due to this property there is no interference
- Array of 64 walsh codes is used

Contents

- Power Control
- Handoff
- Diversity and RAKE Receiver

Power Control

- Reverse power control
  - Open loop power control
  - Closed loop power control
    - Inner loop power control: 800 Hz
    - Outer loop power control
- Forward power control
  - Message transmission mode:
    - threshold transmission
    - periodic transmission
  - Closed loop power control