Wireless Medium Access Control and CDMA, 3G and 4G Communication

Lesson 08

IS-95 CdmaOne

IS-95 cdmaOne System

- Developed by QUALCOM, USA in 1991
- Accepted as a standard in 1997
- Pre-3G/2G+ technology
- 824-849 MHz and 869-894 MHz with multiple analog channels forming one digital carrier
- FDD for forward and reverse links, as in the case of GSM systems

Forward link

- Called downlink in GSM between the BTS and MS
- Frequency 870.000 MHz + 0.030*i*, where *i* is the channel number
- The channel numbers are between channel 1 to 777 when $1 \leq i \leq n1$; $n1 = 777$
- Channel numbers are between channel number 1013 to 1023 when $-10 \leq i \leq 0$

Reverse link

- Frequency 45 MHz less than the forward link
- 825.000 MHz + 0.030*i*, where *i* = channel number
- The channel numbers are $1 \leq i \leq n1$ between 1 and 777 where $n1 = 777$and are $n2 \leq i \leq n3$

Reverse link

- Channel numbers, when *n*2 is between –10 and *n*3 = 0, are called channels 1013 to 1023

System-A services

- Using channels 1 to 311, 689 to 694, and 1013 to 1023

System-B services

- Ones using channels 356 to 644 and 739 to 777
- Guard band between the A and B services

Pseudo-noise spreading codes PN_Q and PN_I

- 15 degree generator polynomials G_Q and G_I
- 32767 (= 2^{15}–1) chip sequence generator using the LFSR based circuit used for spreading

Pseudo-noise spreading codes PN_Q and PN_I in BTS

- Each BTS adds one of the 512 offsets to the PN codes, so that each BTS in a cell is identified
- During the handover, the offset value changes when an MS moves from a cell to another cell

Carrier Modulation

- Quadrature and in-phase base-band signals then modulated by QPSK in forward channels
- OQPSK in reverse channels

Forward Link Channels

- Four channels
- Traffic
- Paging
- Synchronization
- Pilot channels
- The forward channel from the BTS uses orthogonal Walsh codes

Power Control

- BTS transmitter TR
- *R*eceiver MS R
- TR raises or lowers its power as per *R*'s data for received signal power
- Close loop control– both ends BTS TR and MS *R* transmit the signal strengths received from the other ends and use it for power control

Power Control

- Open loop control— only one end (BTS TR) transmits the signal strength received from the MS *R* data
- The input data of signal strength detected at an end controls the power used by the transmitter
- The forward channel open loop power control

Pilot Channel

- Transmitted by the BTS to MS before the data is transmitted
- MS transmits the data at reduced power if the pilot is strong and raises the power if weak
- Provides a reference to all the MSs in a cell

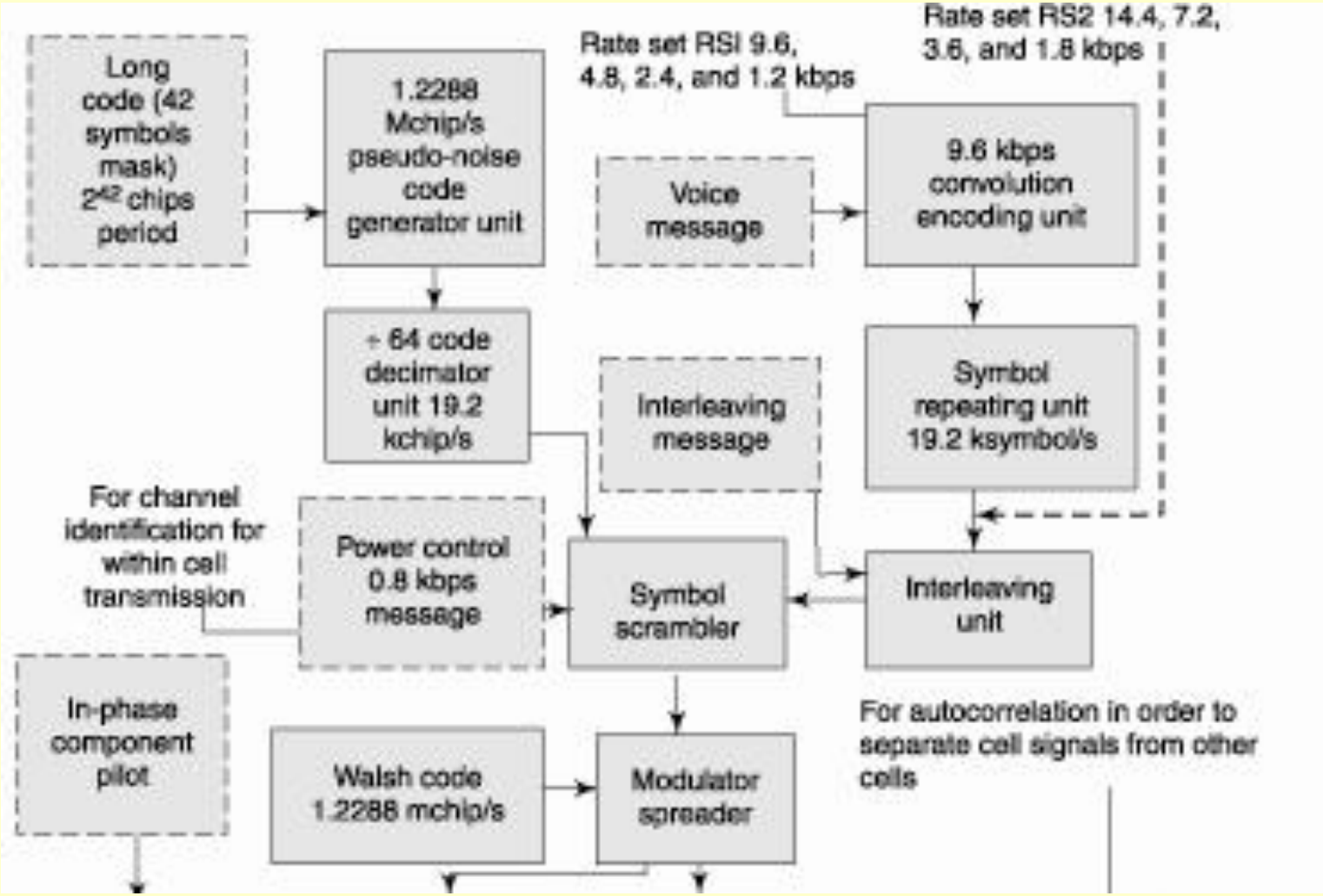
Pilot Channel

- Transmits with all 0s in place of voice-data traffic through the in-phase and quadrature spreading units
- Uses the Walsh code W_0
- A circuit consisting of PN_I in-phase and PN_Q quadrature spreaders, base-band filters, and QPSK modulator

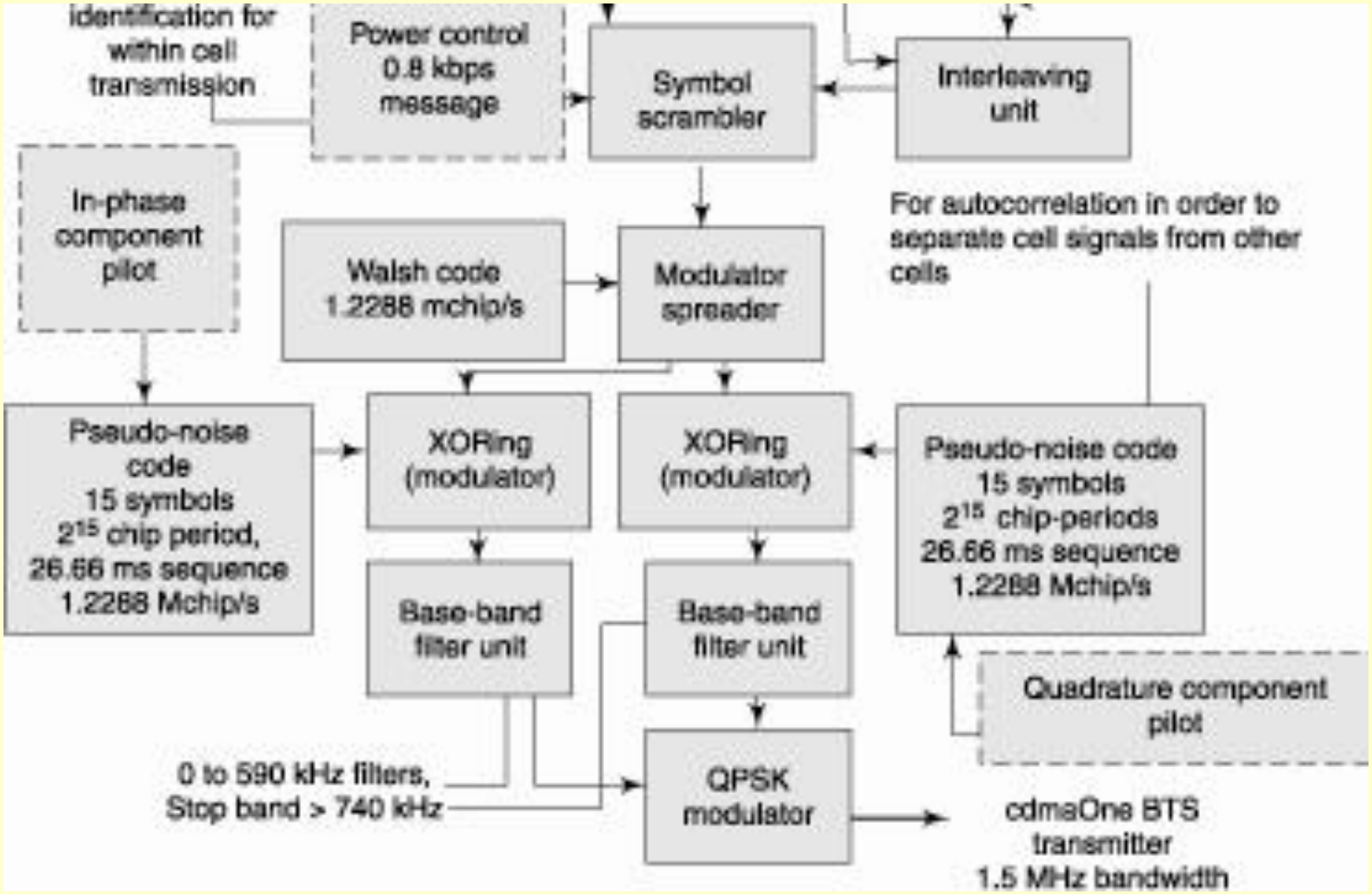
Traffic Channel

- Processing units used for base-band transmission of traffic channel and power control messages
- Uses of long code and mask, PN_Q, PN_I, and Walsh coding units

Processing units in Traffic channel and power control messages



Processing units and Walsh, PN_Q, PN_I, coding units



Multi-encoded Transmission of Signals in a Traffic Channel

- Signals at variable data rates after convolution coding
- RS1 and RS2 data rate symbols are matched, repeated, and interleaved so that before chipping, the symbol transmission rate is constant at 19.2 ksymbol/s

Data rate matching with a fixed rate for a channel

- Used to transmit multi-encoded signals using a constant spread factor and fixed length codes
- If a set of bits repeated in the same time period (for example, when matching a preset symbol rate by doubling it), then the symbol transmission rate doubles

Symbol

- Bit is user signal to be transmitted and extracted at the receiver
- Refers to the symbol to be XORed with the code at a given chipping frequency

Data Rate Matching

- Two rate sets, RS1 and RS2
- RS2 is optional in cdmaOne
- When a rate set is fast, for example, RS2, the puncturing of two bits out of every six inputs slows the data rate when using an additional puncturing unit

Symbol repetition and Interleaving units

- Symbol repetition doubles the data rate
- Interleaving allows two or more sets of data to be transmitted in the same channel
- Interleaving two sets of data doubles the traffic transmission rate

Example

- User symbols of RS2 rate 7.2 kbps are to be transmitted
- When bits in voice-data of rate 7.2 kbps are punctured, the data rate will become 4.8 kbps

Example

- 4.8 kbps signal after passing through a symbol repetition unit, the signal data burst will change to 9.6 ksymbol/s from 4.8 kbps
- After interleaving two RS2 7.2 kbps rate traffic channels, the rate will become 19.8 ksymbol/s

Puncturing, Symbol Repetition and Block Interleaving units

- The puncturing unit— match data after it is processed through the puncturing (slow data rate), symbol repetition and interleaving units
- Symbol repetition doubles the data rate
- Interleaving allows two or more sets of data to be transmitted in the same channel
- Doubles the traffic transmission rate

Interleaving

- A technique which enables the use of idle time-slots in the frames which have a pre-defined bit (or symbol) transmission rate in a channel
- Block interleaving means that between successive blocks of a data set, another data set block is inserted

Interleaving

- Block interleaving helps in sending two data sets simultaneously
- After two or four data sets interleave at a block-interleaving unit, the data symbol rate is kept the same at 19.2 ksymbol/s

Interleaving

- Interleaving is possible only when the interleaved signal frequencies are integral multiples of each other
- For example, an 800 bps signal can be interleaved with a 19.2 ksymbol/s signal because 19.2 ksymbol/s, when divided by 800 bps, gives 24 which is an integer

Long Code Scrambling

- long code used for identifying a traffic channel
- The chip generation rate is chosen as 19.2 kchip/s $\times$ 64 = 1.2288 Mchip/s
- A long code decimator reduces the chipping signal rate by a factor of 64

Long Code Scrambling

- The 19.2 ksymbol/s input, the 19.2 kchips/s input, and the 0.8 kbps power control input are interleaved and are coded at 1.2288 Mchip/s by a 64-bit Walsh code

Summary

- IS-95 cdmaOne
- Chipping rate 19.2 ksymbol/s
- Data rate matching
- PN long, Walsh and PN-short coding

End of Lesson 08

IS-95 CdmaOne