

King Fahd University of Petroleum & Minerals Computer Engineering Dept

**COE 543 – Mobile and Wireless
Networks**

Term 022

Dr. Ashraf S. Hasan Mahmoud

Rm 22-148-3

Ext. 1724

Email: ashraf@ccse.kfupm.edu.sa

4/16/2003

Dr. Ashraf S. Hasan Mahmoud

1

Lecture Contents

1.

4/16/2003

Dr. Ashraf S. Hasan Mahmoud

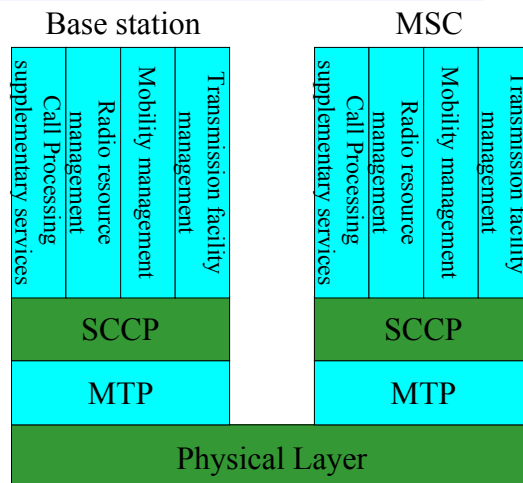
2

IS-634 (TIA/EIA-634)

- Defines functional capabilities, including services and features of the messages communicated along the MSC-BS interface
- A-interface
- BS and MSC can be bought from different vendors!
- Partitioning of tasks – without dictating the implementation

IS-634 Layered Architecture

- Physical Layer: ISDN over one or multiple T1 @ 1.544 Mb/s
 - Signaling info
 - User traffic
- Message Transport Part (MTP) and Signaling Connection Control Part (SCCP)
 - Same as for GSM
 - Error-free signaling
- Applications: call processing, RRM, MM, etc.



IS-634 Services - Examples

- Call Processing : MS/BS \leftrightarrow MSC
 - Call origination
 - Call termination
 - Call release
 - Etc.
- Supplementary Services: BS \leftrightarrow MSC
 - Call waiting
 - Call forwarding
 - Etc.
- Mobility Management: MS \leftrightarrow MSC
 - Registration
 - Deregistration
 - Authentication
 - Voice privacy
 - Etc.
- RRM: BS \leftrightarrow MSC
 - Maintaining an acceptable radio link quality
 - Supervision, management and handoff initiation
 - Softhandoff (for CDMA)
 - Etc.
- Transmission Facility Management: BS \leftrightarrow MSC
 - Handle terrestrial circuits that carry voice, data, or signaling
 - E.g. bypass transcoder for mobile-to-mobile calls!

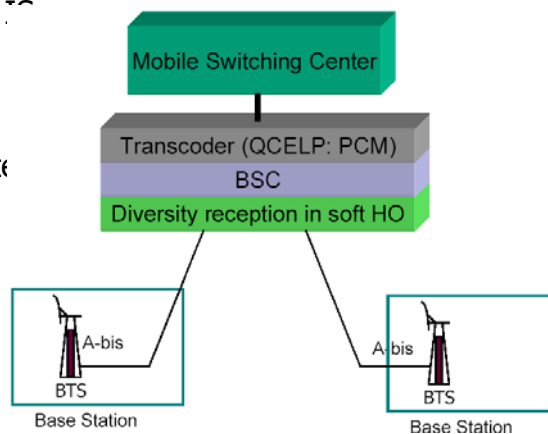
4/16/2003

Dr. Ashraf S. Hasan Mahmoud

7

IS-634 Functional Architecture

- Several BTSs connection to one BSC
- From perspective of IS-634 BSC = BTS
- Transcoder: QCELP \leftrightarrow PCM
- Base station subsystem responsible for softhandoff



4/16/2003

Dr. Ashraf S. Hasan Mahmoud

8

IS-41 Standard for MSC-MSC interface

- Services:
 - Automatic roaming
 - Authentication
 - Intersystem handoff
 - IS95 call handedoff to an AMPS system or visa versa
 - SMS
 - Etc.
- Connects MSC, HLR, VLR, EIR and AC
- Contents:
 - Handoff procedures – original!
 - Roaming – Rev A
 - dual AMPS/TDMA handoff – Rev B
 - Authentication, CDMA handoff, and SMS – Rev C
 - International roaming – Rev D
 - QoS and multimedia handling – Rev E
- Intersystem (interMSc) handoffs utilize IS-41
 - Handoffs within one MSC

Network Reference Model

- The previous protocols describe the network architecture and protocols used within the network
 - ALL previous slides apply to any north american cellular system (IS-136, IS-95, etc.)

IS-95 Forward Link

- Occupies the same frequency band as that for IS-136 and AMPS
- Carrier spacing: 1.25 MHz
- Forward Channels:
 - Pilot
 - Synch
 - Paging
 - Traffic

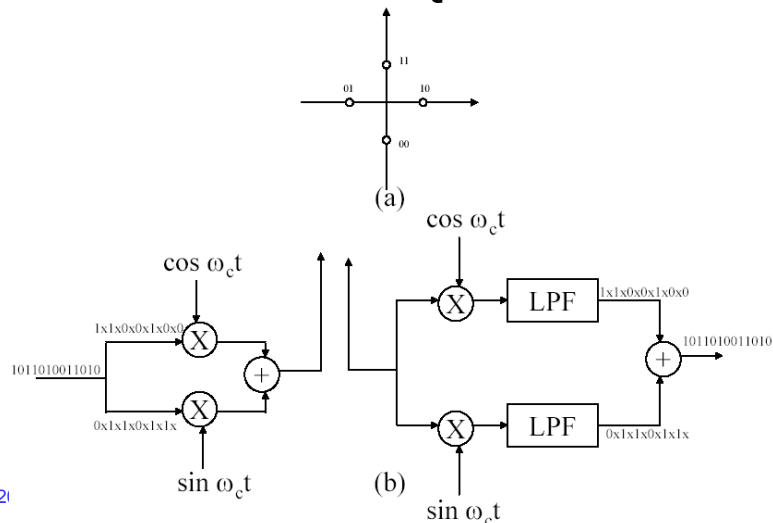
4/16/2003

Dr. Ashraf S. Hasan Mahmoud

11

IS-95 Forward Link

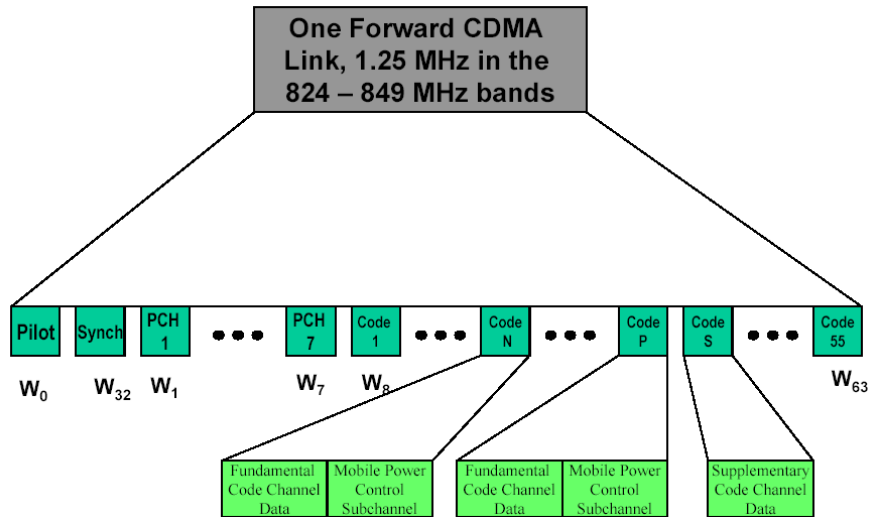
- Forward link modulation: QPSK



4/16/20

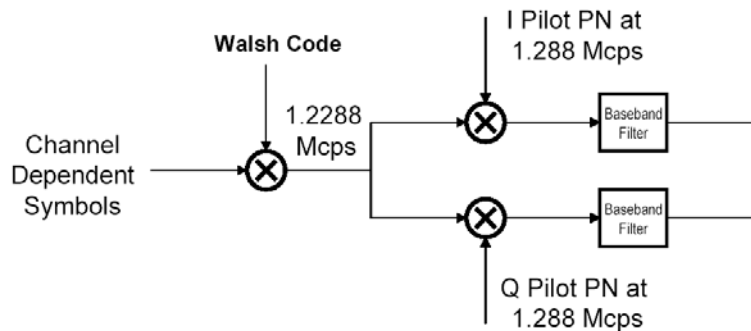
12

IS-95 Forward Channels



IS-95 Forward Channel Spreading Procedure

- Walsh codes – channelization of forward link users with in a cell
- Short PN-sequence:
 - Not exactly orthogonal
 - M-sequences generated by linear feedback shift registers (LFSRs) of length 15 and a period of 32,768 chips
 - Separate transmissions across different cells
 - Different BTS use different "offsets" for the same PN code – synchronization required through GPS – 512 different offsets (64 chips each)



Walsh Codes

- Obtained from Hadamard matrices

$$H_2 = \begin{bmatrix} 0 & 1 \\ 0 & 1 \end{bmatrix} \quad H_4 = \begin{bmatrix} H_2 & H_2 \\ H_2 & H_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 \end{bmatrix}$$

$$H_8 = \begin{bmatrix} H_4 & H_4 \\ H_4 & H_4 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \end{bmatrix} \begin{matrix} W_0 \\ W_1 \\ W_2 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ W_8 \end{matrix}$$

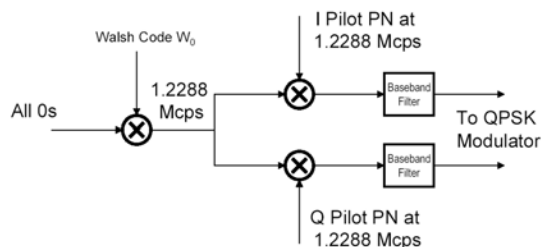
In general

$$H_{2N} = \begin{bmatrix} H_N & H_N \\ H_N & H_N \end{bmatrix}$$

Any two rows of these matrices are orthogonal

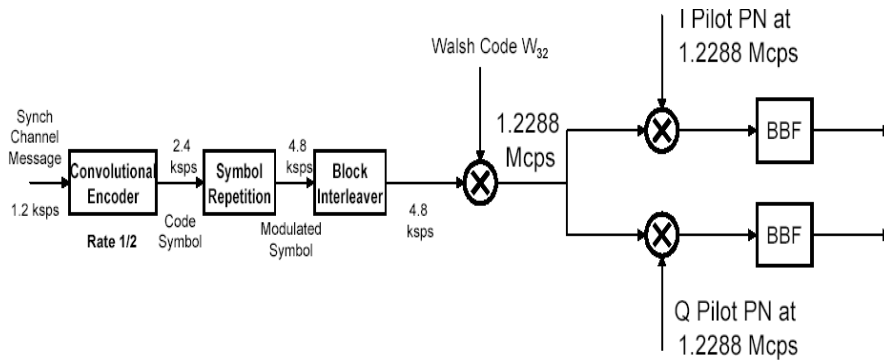
Pilot Channel

- Provides reference signal for all MSs for coherent demodulation at the mobile
- Uses $W_0 = [0 \ 0 \ \dots \ 0]$ (64 zeros) \sim pure RF carrier
- Transmitted at 4-6 dB higher than other channels
 - Used for signal strength comparisons (handoff)



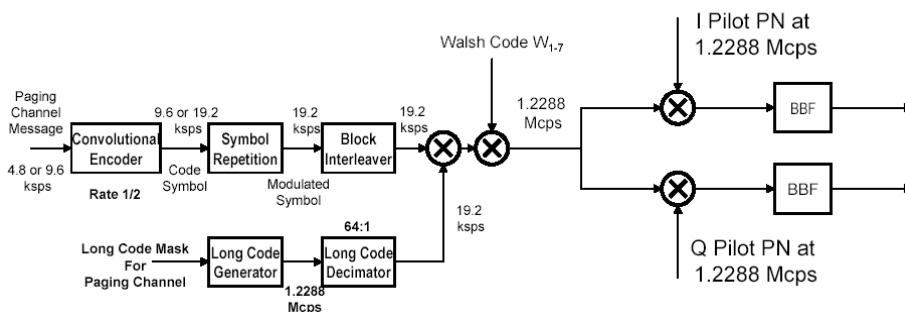
Sync Channel

- Used to acquire initial time synchronization
- Uses W_{32}
- Operates at 1200 b/s
- Not power-controlled



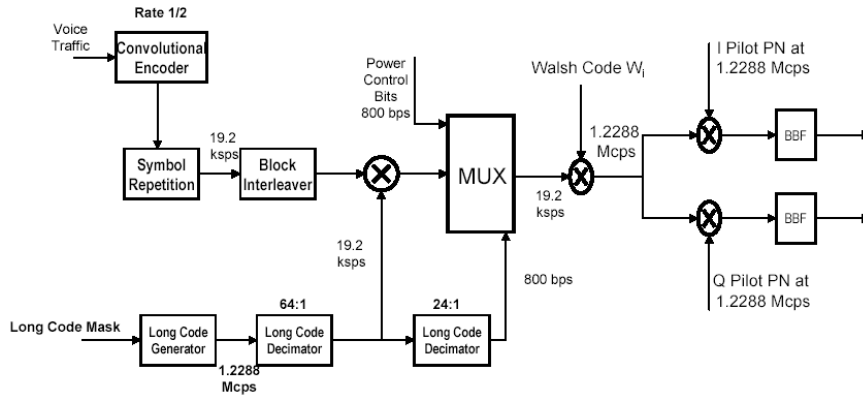
Paging Channel

- Functions:
 - Call setup/Incoming call
- W_1 to W_7 (up to 7 Walsh channels)
- Long code mask for paging channel of length 42 ~ generated using an LFSR of length 42 and has a period of 2^{42}
- Not power-controlled



Traffic Channel – Rate Set 1

Forward traffic channel structure (Rate Set 1)



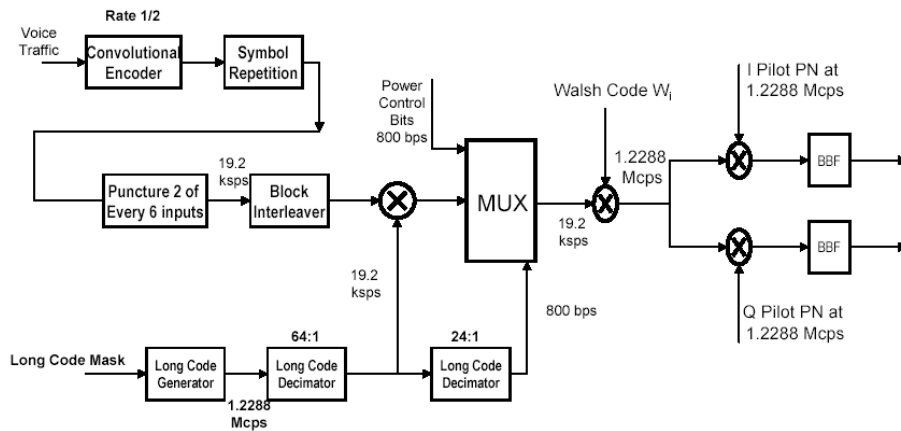
4/16/2003

Dr. Ashraf S. Hasan Mahmoud

19

Traffic Channel – Rate Set 2

Forward traffic channel structure (Rate Set 2)



4/16/2003

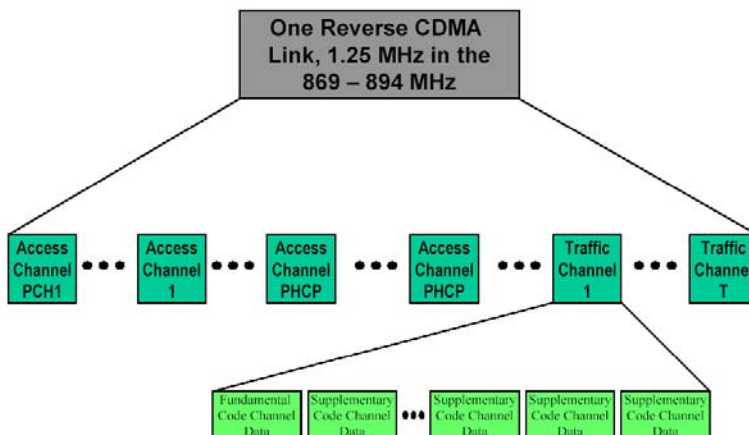
Dr. Ashraf S. Hasan Mahmoud

20

IS-95 Reverse Link

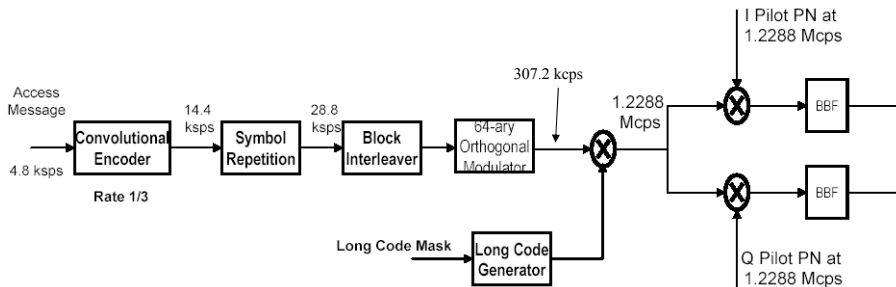
- Employs OQPSK (closer to a constant envelope scheme)
 - Signal in one of the modulator branches is delayed by $T/2$
- Orthogonal codes are NOT used for signal spreading but for Waveform ENCODING
 - Mary-orthogonal modulation on the reverse link
 - A bank of 64 Walsh codes or symbols \rightarrow we group bits into groups of 6
 - E.g. 000000 is encoded using W_0 , 000001 is encoded using W_1 , ..., 111111 is encoded using W_{63}
- Two types of channels
 - Access
 - Traffic

IS-95 Reverse Channels



IS-95 Access Channel

- Used
 - At call origination
 - Response to paging
- Fixed rate of 4800 kb/s
- Every 6 bits are mapped into one Walsh symbol
- The long PN code differentiates different access channels – spreading by a factor of 4



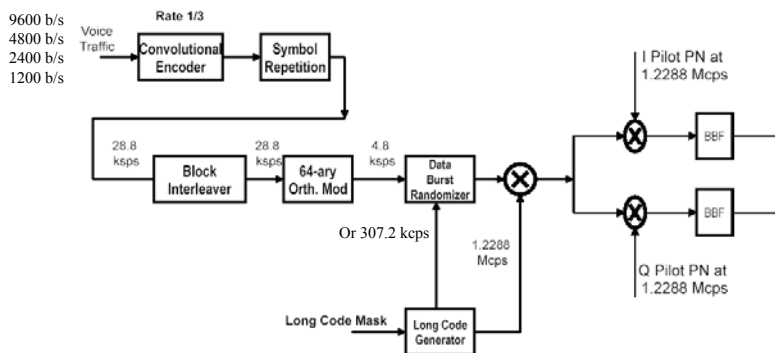
4/16/2003

Dr. Ashraf S. Hasan Mahmoud

23

IS-95 Traffic Channel

- Employs



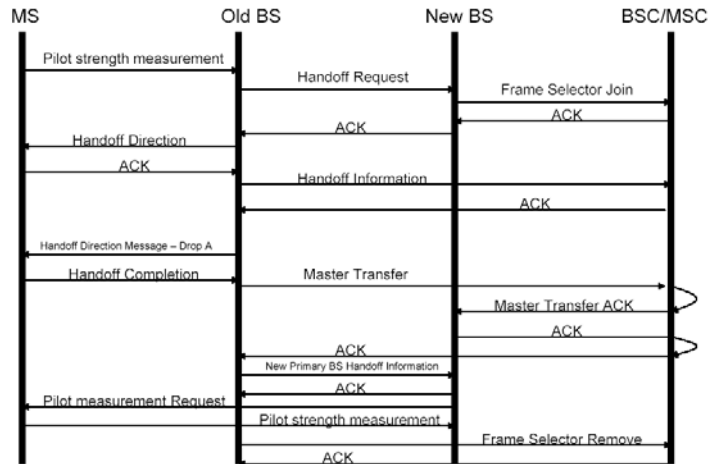
4/16/2003

Dr. Ashraf S. Hasan Mahmoud

24

Mobility and RMM

- Setup and ending of softhandoff



4/16/2003

Dr. Ashraf S. Hasan Mahmoud

25

Power Control

- Refer to previous slides
- Refer to section 8.3.4.2

4/16/2003

Dr. Ashraf S. Hasan Mahmoud

26

IMT-2000

- Refer to section 8.4