

# **King Fahd University of Petroleum & Minerals Computer Engineering Dept**

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**COE 543 – Mobile and Wireless  
Networks**

**Term 032**

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## **Lecture Contents**

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## CDMA Development

- Reference model developed by the Telecommunication Industry Association (TIA)
- The committee TR-45 develops performance, compatibility, interoperability, and service standards for mobile and PCS in the 800 MHz and 1,800 MHz
  - TR-45.3: TDMA technologies
  - TR-45.5: CDMA technologies
  - TR-45 is closely working with 3GPP2 group to specify the cdma2000 started
- TR-46 is the adaptation of TR-45 for PCS band
  - New elements:
    - data message handler (DMH)
    - Internetworking function (IWF)
    - Auxiliary equipment (AUX)

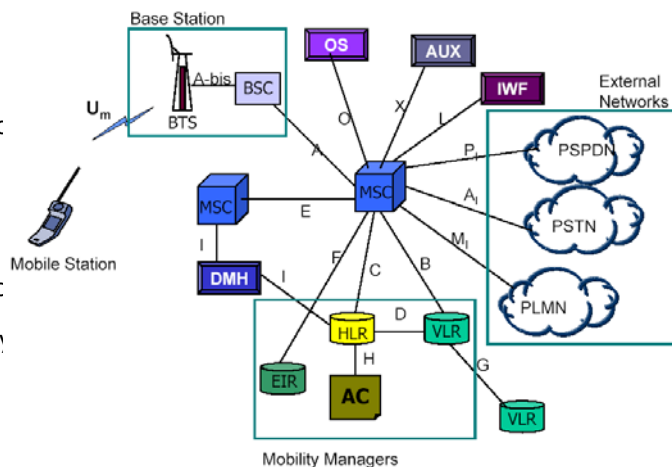
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## TR-45/46 Reference Model

- Infrastructure communication ~ SS7
  - IS-634: open interface standard between MSC and basestatic radio subsystem
  - IS-41: intersystem roaming and specifies basic and supplemental services (between MSCs).



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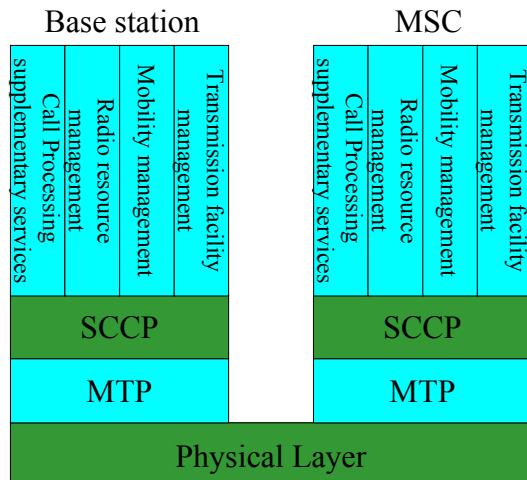
Mobility Managers

## 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!

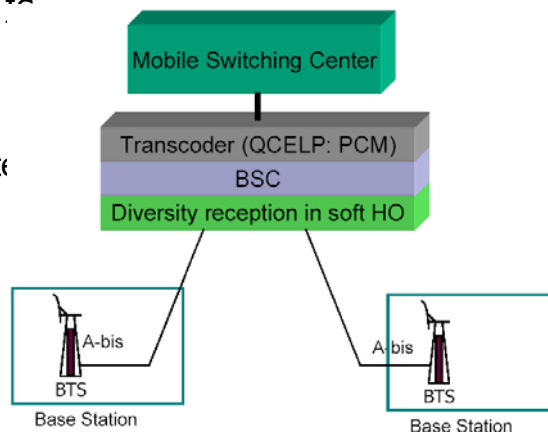
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## IS-634 Functional Architecture

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



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## IS-41 Standard for MSC-MSC interface

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- 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

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- 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

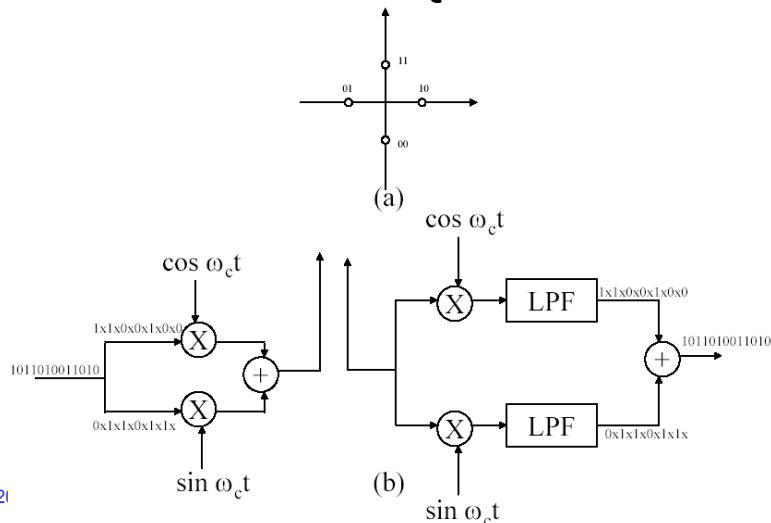
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## IS-95 Forward Link

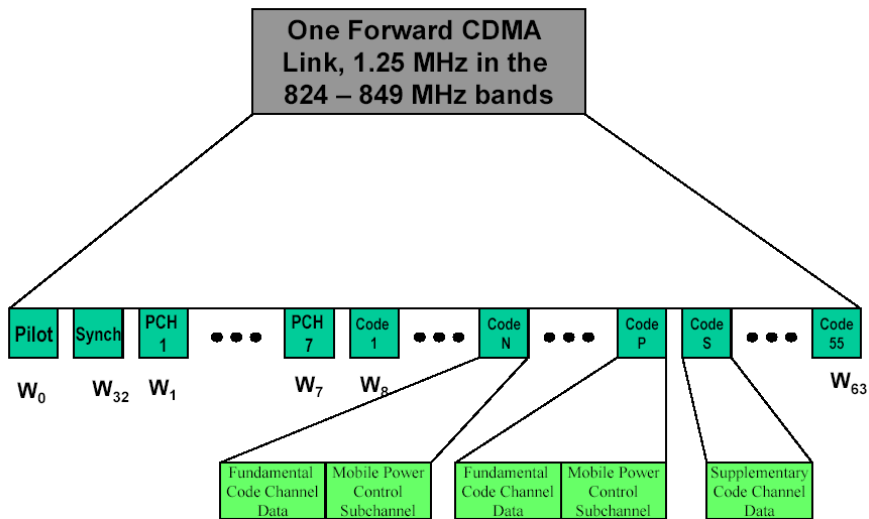
- Forward link modulation: QPSK



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## IS-95 Forward Channels



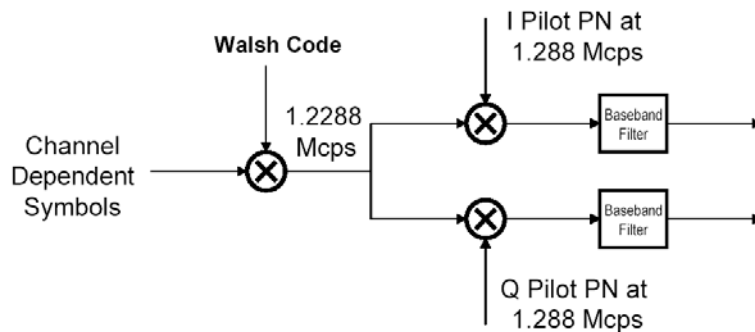
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## IS-95 Forward Channel Spreading Procedure

- 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)



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## Walsh Codes

- Obtained from Hadamard matrices

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

$$H_8 = \begin{bmatrix} H_4 & H_4 \\ H_4 & H_4 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \end{bmatrix} \begin{matrix} W_0 \\ W_1 \\ W_2 \\ \vdots \\ W_7 \\ W_8 \end{matrix}$$

In general

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

Any two rows of these matrices are orthogonal

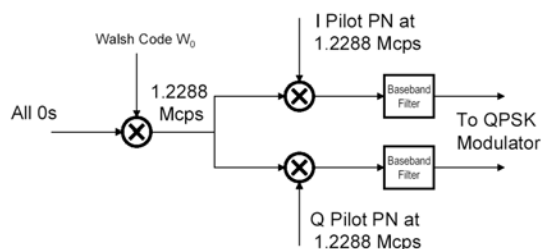
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## Pilot Channel

- 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)



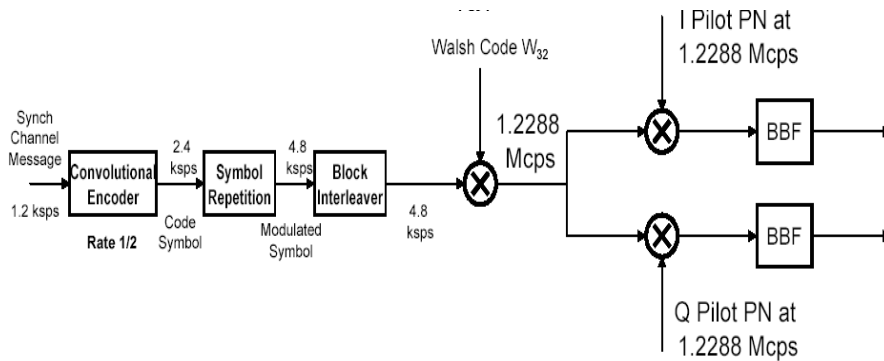
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## Sync Channel

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



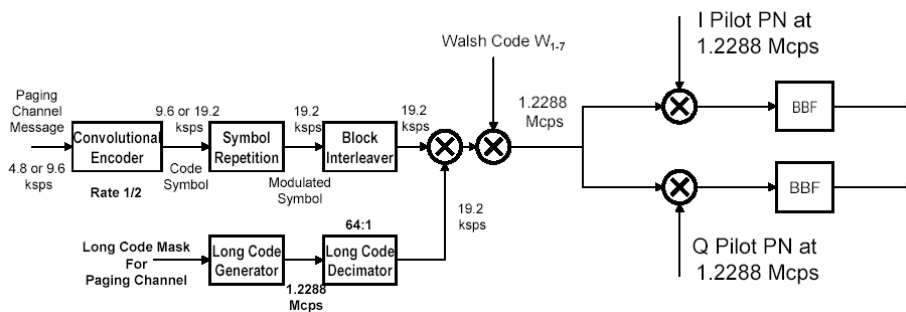
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## Paging Channel

- 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



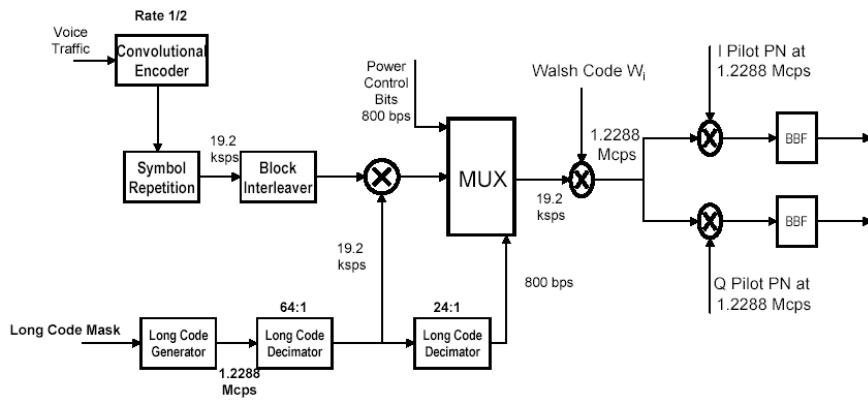
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## Traffic Channel – Rate Set 1

### Forward traffic channel structure (Rate Set 1)



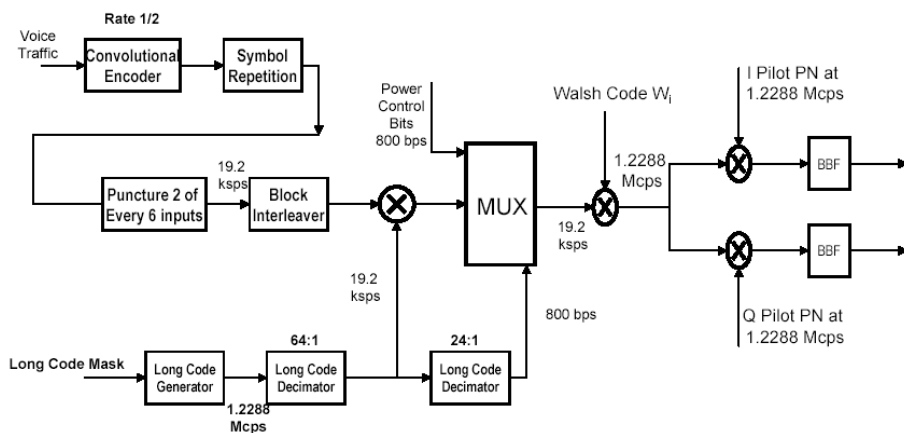
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## Traffic Channel – Rate Set 2

### Forward traffic channel structure (Rate Set 2)



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## IS-95 Reverse Link

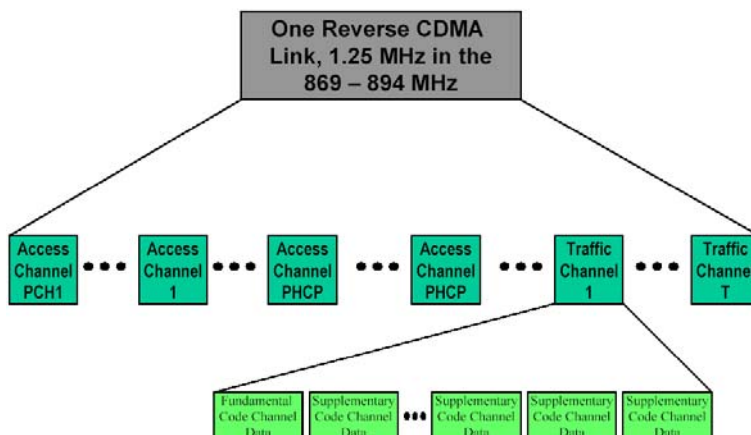
- Employs OQPSK (closer to a constant envelope scheme)
  - Signal in one of the modulator branches is delayed by  $T/2$
- Orthogonal codes are NOT used for signal spreading but for Waveform ENCODING
  - Mary-orthogonal modulation on the reverse link
  - A bank of 64 Walsh codes or symbols → we group 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

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## IS-95 Reverse Channels



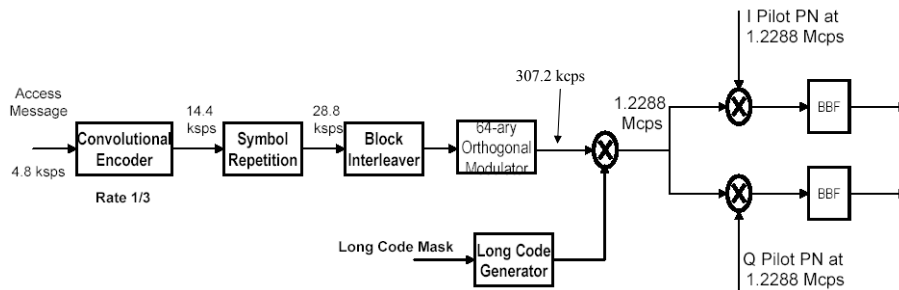
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## IS-95 Access Channel

- 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



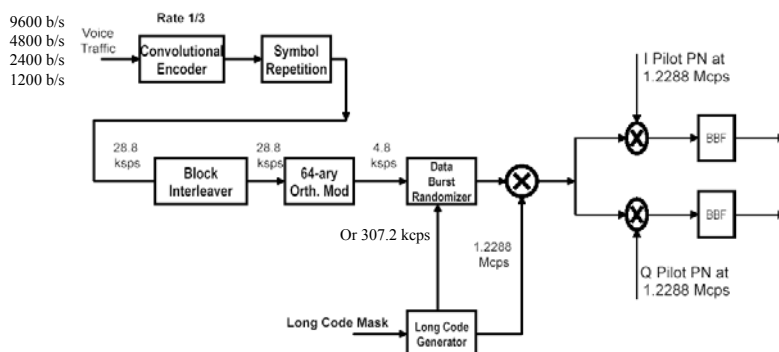
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## IS-95 Traffic Channel

- Employs



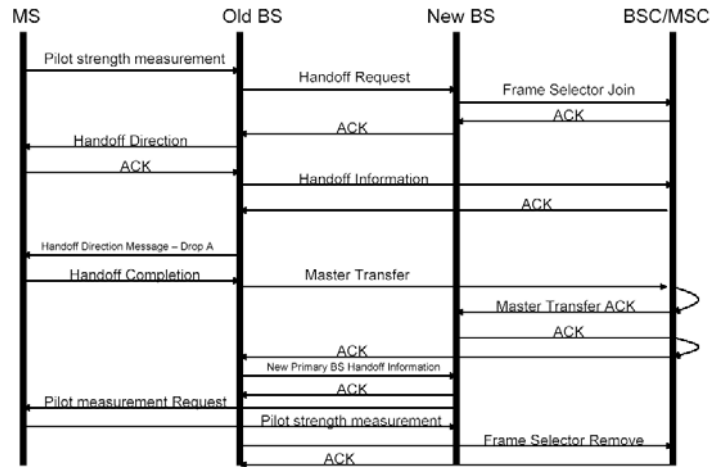
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## Mobility and RMM

- Setup and ending of soft handoff



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## Power Control

- Refer to previous slides
- Refer to section 8.3.4.2

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## **IMT-2000**

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- Refer to section 8.4