Forward Traffic Channels

- **Forward Traffic Channels**

- At the end of this section, the following objectives will have been accomplished:
    - Understand what Forward Traffic Channels are used for, how they are generated and which are the main modulation parameters associated with them.
    - Introduce the concept of “Service Options”.
    - Understand the process of analog-to-digital signal conversion
    - Understand the role of the vocoders, the type of vocoders used in CDMA, and where they are physically located.
    - Understand the Forward Traffic Channel frame structure for both the 8 kb and the 13 kb vocoder and the purpose of the “tail bits”.
    - Understand the purpose of the Symbol Puncturing step applied to the modulation symbols when the 13 kb vocoder is used.
    - Introduce the concept of Power Control Subchannel and identify its effect on the Forward Traffic Channel bit stream.
    - Demonstrate how spreading and despreading work in a composite signal made of three different bit streams.
    - Understand the concept of “Composite I” and “Composite Q”
    - Understand the concept of QPSK, “I” and “Q” mapping, signal constellations, and phase transitions
    - Understand how the CDMA Forward Channels are demodulated and the concepts of “correlator”, “search correlator”, “finger” and “rake receiver”.
    - Understand the concept of Traffic Frame Staggering
    - Summarize the messages transmitted on the CDMA Forward Channels

CDMA Forward Traffic Channels



Forward Traffic Channel

Σ

CDMA Cell Site

Pilot

Forward Traffic Channel

Sync

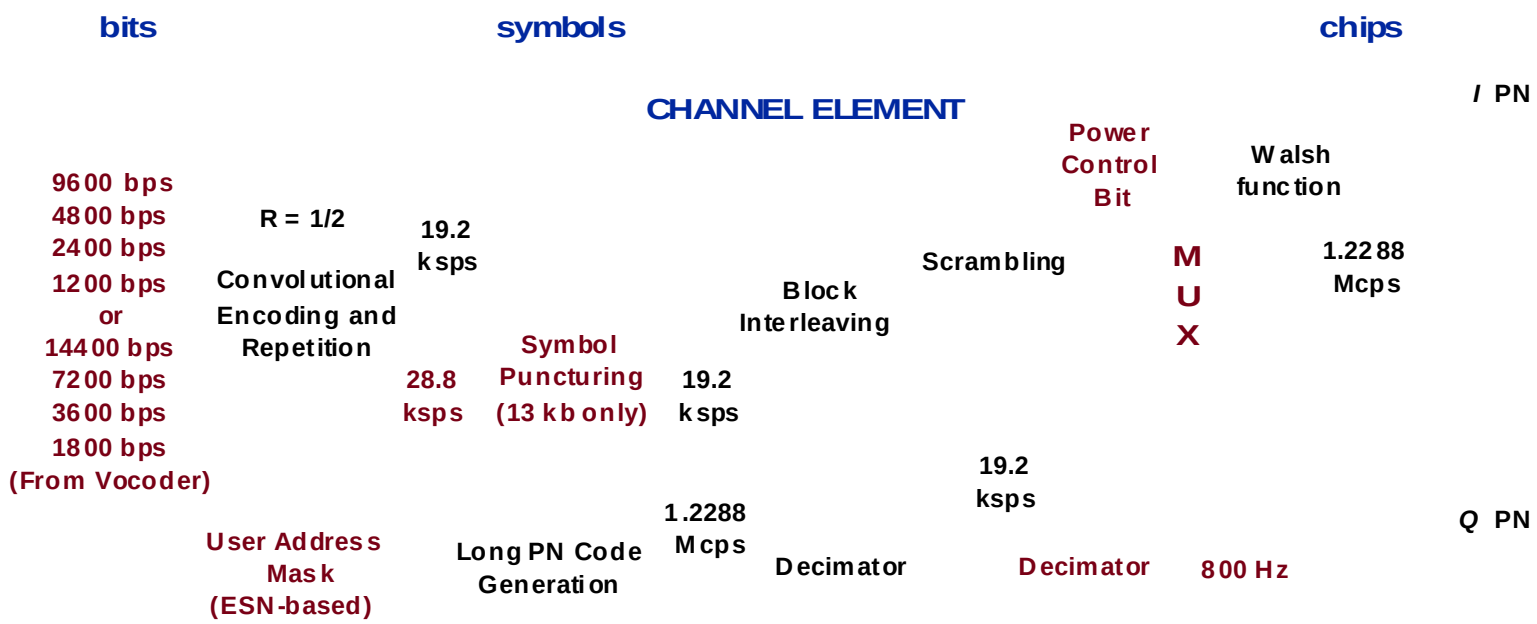
Forward Traffic Channel

Paging

Forward Traffic Channel

- Used for the transmission of user and signaling information to a specific mobile station during a call
- Maximum number of traffic channels: 64 minus one Pilot channel, one Sync channel, and 1 through 7 Paging channels
  - This leaves each CDMA frequency with at least 55 traffic channels
  - Unused paging channels can provide up to 6 additional channels
  - Realistic loading will typically be about 17 subscribers when using the 13 kb vocoder (22 when using the 8 kb vocoder)

Forward Traffic Channel Generation



Forward Traffic Channel Modulation Parameters

Data Rate (8 kb vocoder) (13 kb vocoder)	9600 14400	4800 7200	2400 3600	1200 1800	Bits Per Second
PN Chip Rate	1.2288	1.2288	1.2288	1.2288	Mega Chips Per Second
Code Rate	1 / 2	1 / 2	1 / 2	1 / 2	Bits Per Code Symbol
Code Symbol Rate (8 kb) (13 kb)	19200 28800	9600 14400	4800 7200	2400 3600	Code Symbols Per Second
Code Repetition	1	2	4	8	Mod. Symbols* Per Code Symbol
Mod. Symbol Rate (8 kb) (13 kb)	19200 28800	19200 28800	19200 28800	19200 28800	Mod. Symbols Per Second
Puncturing Rate (13 kb)	2/3	2/3	2/3	2/3	—
Mod. Symbol Rate Going Into Block Interleaver	19200	19200	19200	19200	Mod. Symbols Per Second
PN Chips / Mod. Symbol	64	64	64	64	PN Chips / Mod. Symbol
PN Chips / Bit	128	256	512	1024	PN Chips / Bit
E_s	$E_b/2$	$E_b/4$	$E_b/8$	$E_b/16$	Energy per Mod. Symbol

* each repetition of a “code symbol” is called a “modulation symbol”

Tail Bits (step 1)

$b_3\ b_2\ b_1$ 0 0 0

$C_{0,1}$

$b_3\ b_2$ **b_1** **0** **0** **0**

$C_{1,1}$

$b_3\ b_2$ b_1 0 0 0

Tail Bits (steps 2 & 3)

b_3 b_2 b_1 0 0

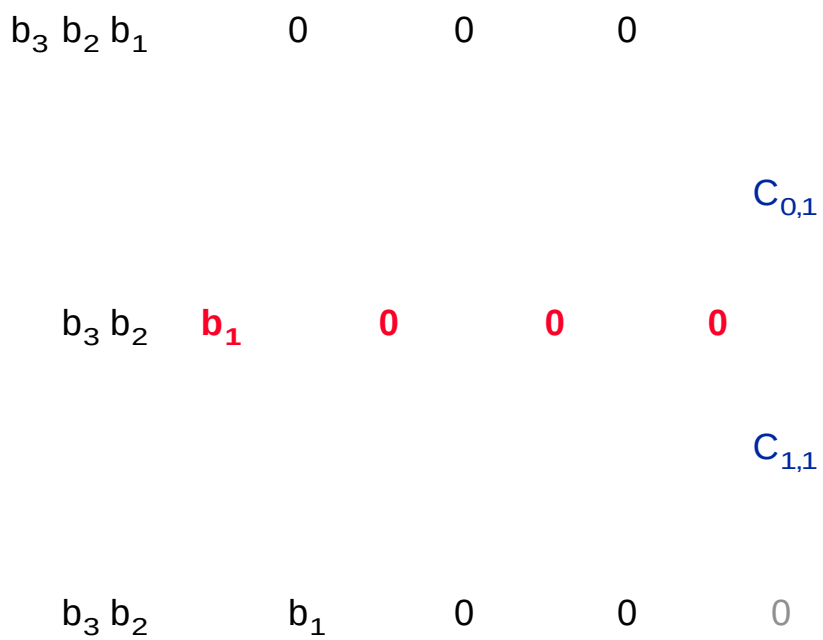
$C_{0,3}$ $C_{0,2}$ $C_{0,1}$

b_3 **b_2** **b_1** **0**

$C_{1,3}$ $C_{1,2}$ $C_{1,1}$

b_3 b_2 b_1 0

Tail Bits (steps 2 & 3) – cont.



Tail Bits (step 4)

0 0 0 b_3 b_2 b_1 0

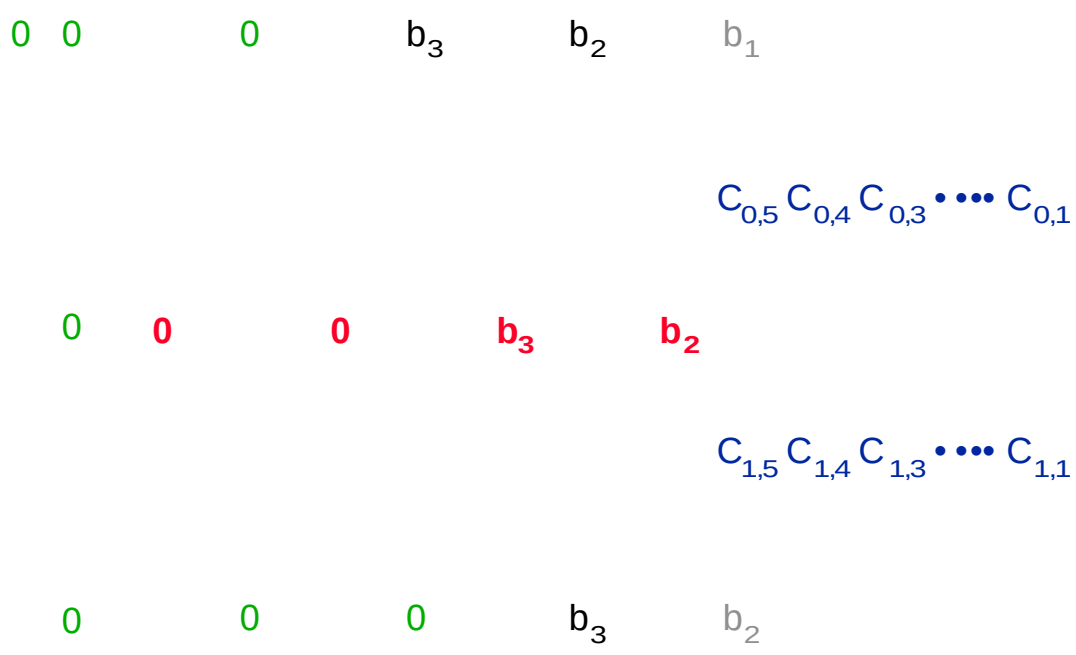
$C_{0,4}$ $C_{0,3}$ $C_{0,2}$ $C_{0,1}$

0 0 **0** **b_3** **b_2** **b_1**

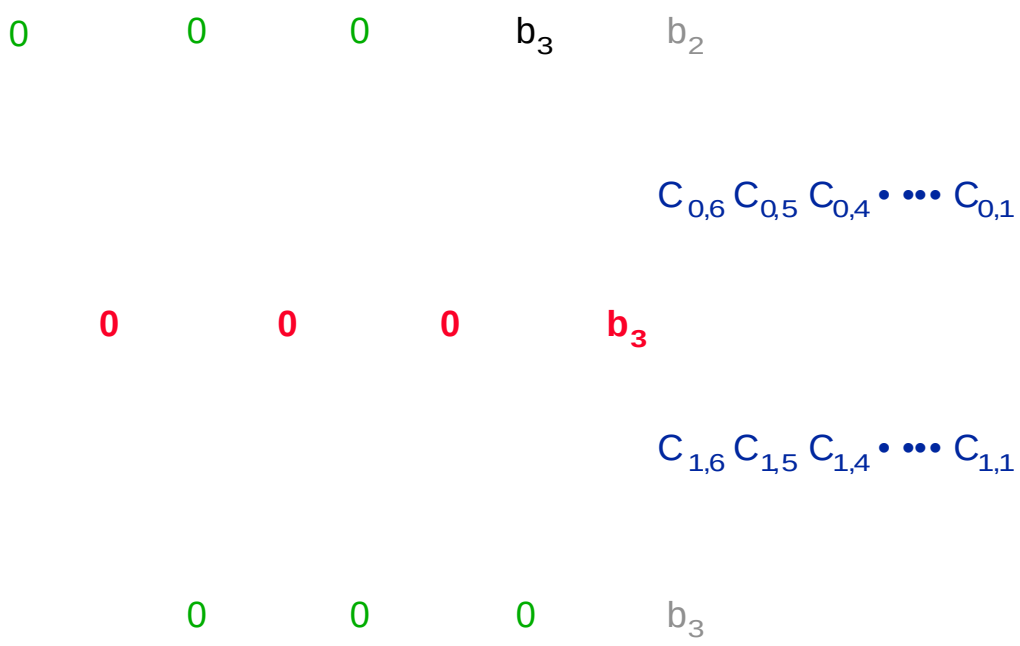
$C_{1,4}$ $C_{1,3}$ $C_{1,2}$ $C_{1,1}$

0 0 0 b_3 b_2 b_1

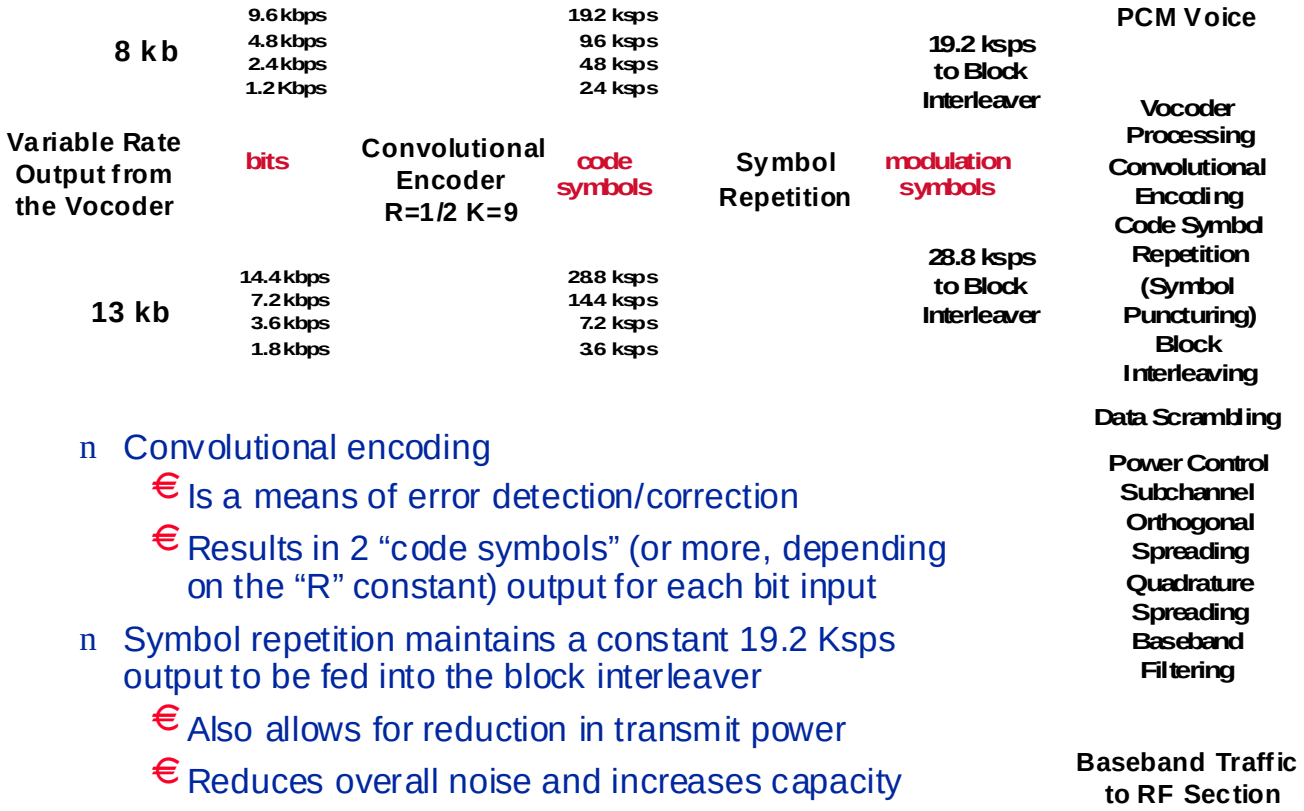
Tail Bits (steps 5 & 6)



Tail Bits (steps 5 & 6) – cont.



Convolutional Encoding and Symbol Repetition



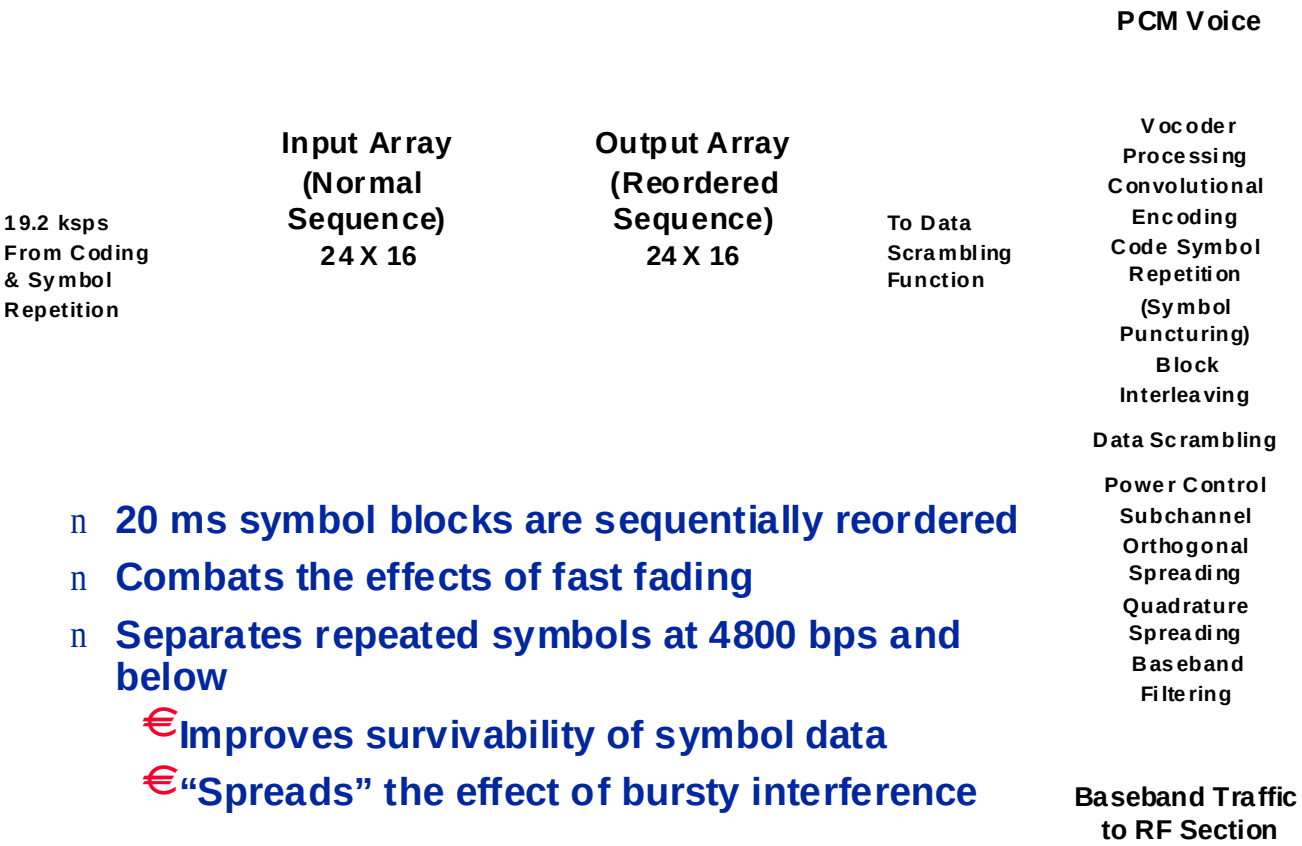
- Convolutional encoding
  - Is a means of error detection/correction
  - Results in 2 “code symbols” (or more, depending on the “R” constant) output for each bit input
- Symbol repetition maintains a constant 19.2 Ksps output to be fed into the block interleaver
  - Also allows for reduction in transmit power
  - Reduces overall noise and increases capacity

Symbol Repetition and Power Reduction

Data Rate (bps)	Energy per Modulation Symbol	Full Energy		
9600	$E_S=E_b/2$			
4800	$E_S=E_b/4$	1/2 Energy		
2400	$E_S=E_b/8$		1/4 Energy	
1200	$E_S=E_b/16$			1/8 Energy

- Symbol repetition provides a constant rate to the block interleaver
- Lower rates symbols are sent at reduced power levels
- The energy per bit across all rates is identical when integrated
- Overall signal power requirement (thus noise) is reduced

Block Interleaving



- 20 ms symbol blocks are sequentially reordered
- Combats the effects of fast fading
- Separates repeated symbols at 4800 bps and below
  - Improves survivability of symbol data
  - "Spreads" the effect of bursty interference