Lec26

Saturday, March 21, 2020 4:48 PM

Downlink - 20min

Monday, March 31, 2008 3:45 PM

Key: understand how spreading codes are assigned and agreed upon by the receiver.

Downlink

Fig 8.19

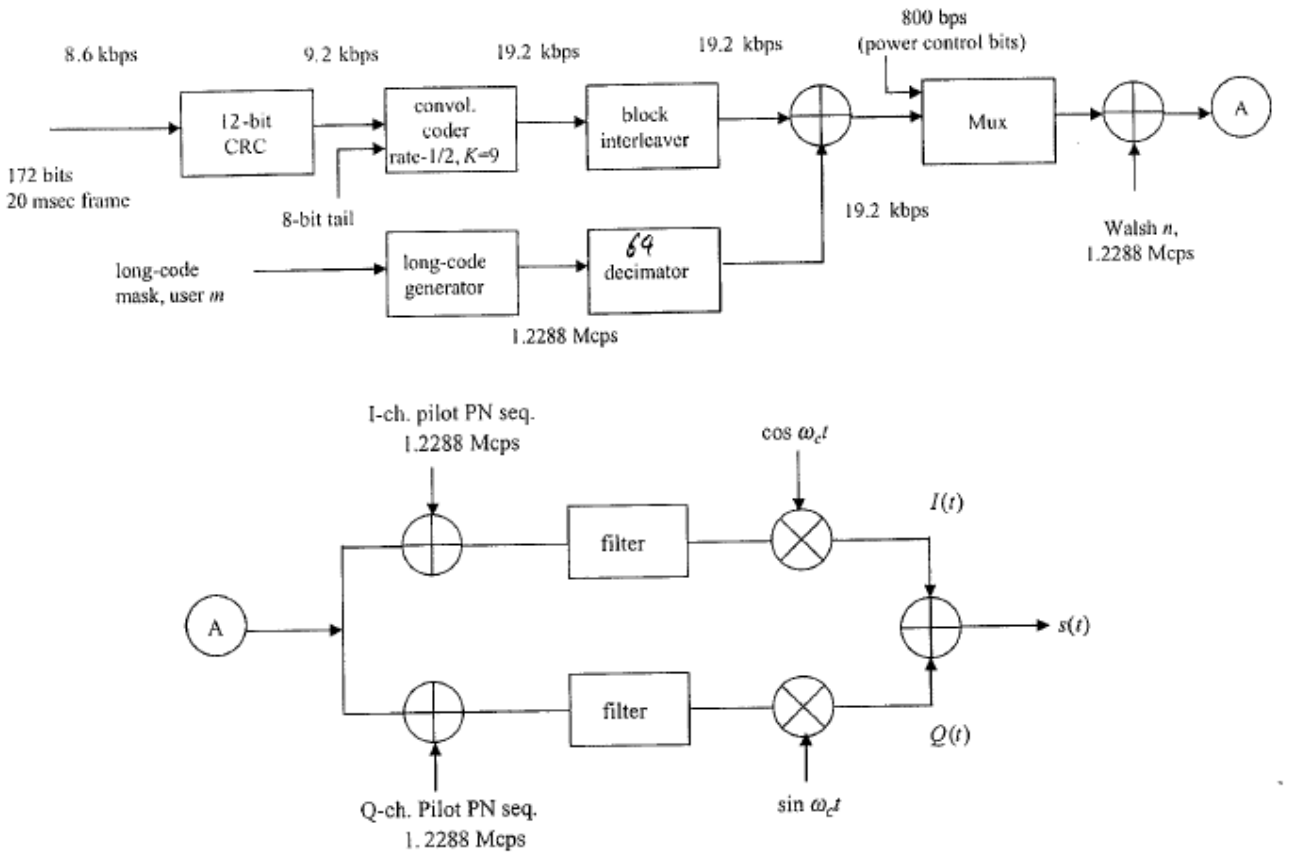


Figure 8.19 IS-95 forward traffic channel, user m, full-rate case

- 8.6 kbps full rate, or 4800/2400/1200
- 1/2 error control code
- long-code: for scrambling/encryption only.
  - decimated to a low rate 19.2kbps
  - not for spreading!
  - receiver need to know the long-code mask to decode information

  Long-code mask:
  - 32 bit ESN (electronic serial #) assigned permanently to each mobile terminal
  - plus 10 bits known sequence.
  - provided by MS at call initiation.
- block interleaver: combat deep fades

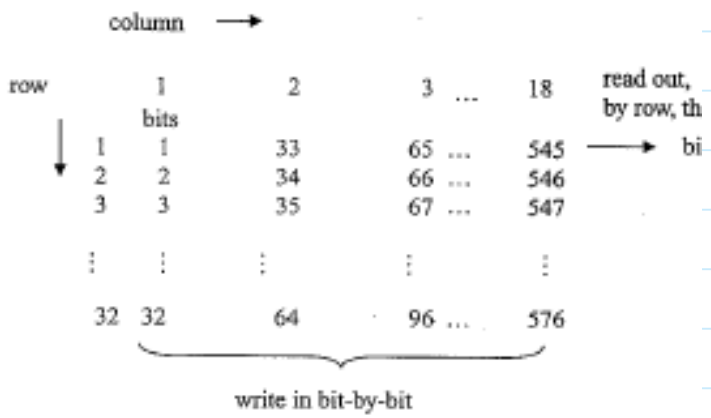


Figure 8.20 Block interleaver operation

- 800 bps power-control bits:
  - puncture code
  - uses 2 per 24 bits
  - treated as error in traffic info (voice)
  - tolerated by error control codes
- 64 bit - Walsh code: used to designate traffic & control channels
  - actual spreading occurs here
- pilot PN - sequence
  - provides additional spreading so that Walsh code can be reused
  - short-code
    - length 15
  - each basestation uses a specified time-offset (of 512 possible) of the PN sequence.
    - same offset on all forward channels & all freq.
    - identifies a BS so that Walsh code can be reused
    - offset may be reused if two BS are far apart

— provided through a pilot signal.

— For this to work, different BS must be accurately synchronized.

— use GPS

— QPSK

(g) Why Walsh code sufficient for spreading at the downlink?

(h) perfect synchronization maintained by BS.

Differentiating forward channels by Walsh code

— Fig 8.22

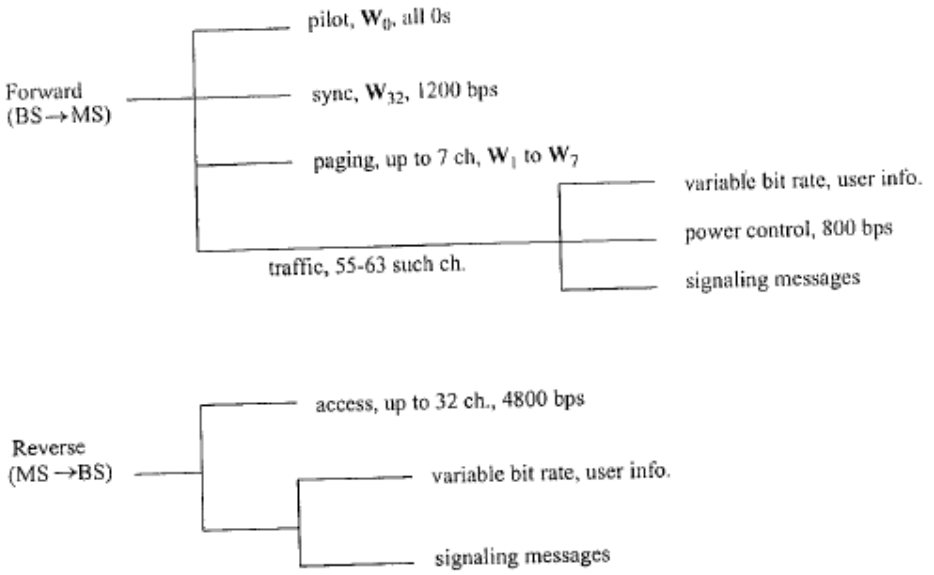


Figure 8.22 Traffic and control channels, IS-95

- W_0: all-zero, pilot channel,
  - provide phase & timing reference ↑ for coherent detection
  - allow MS to identify the correct offset of PN-sequence (80/3 ms)
  - means for signal strength measurement.

- W_{32}: 32bits (000 -- 111), sync channel
  - system time

as well as system configuration

- e.g. information about system/network id. 9-bit PN-sequence offset, state of the long-code

- needed by the mobile to use the access control channel (uplink) discussed later

- $W_1 - W_7$: up to 7 paging channels
  - page mobile
  - ack of access control channel to assign users to traffic channel.

others : traffic channel.

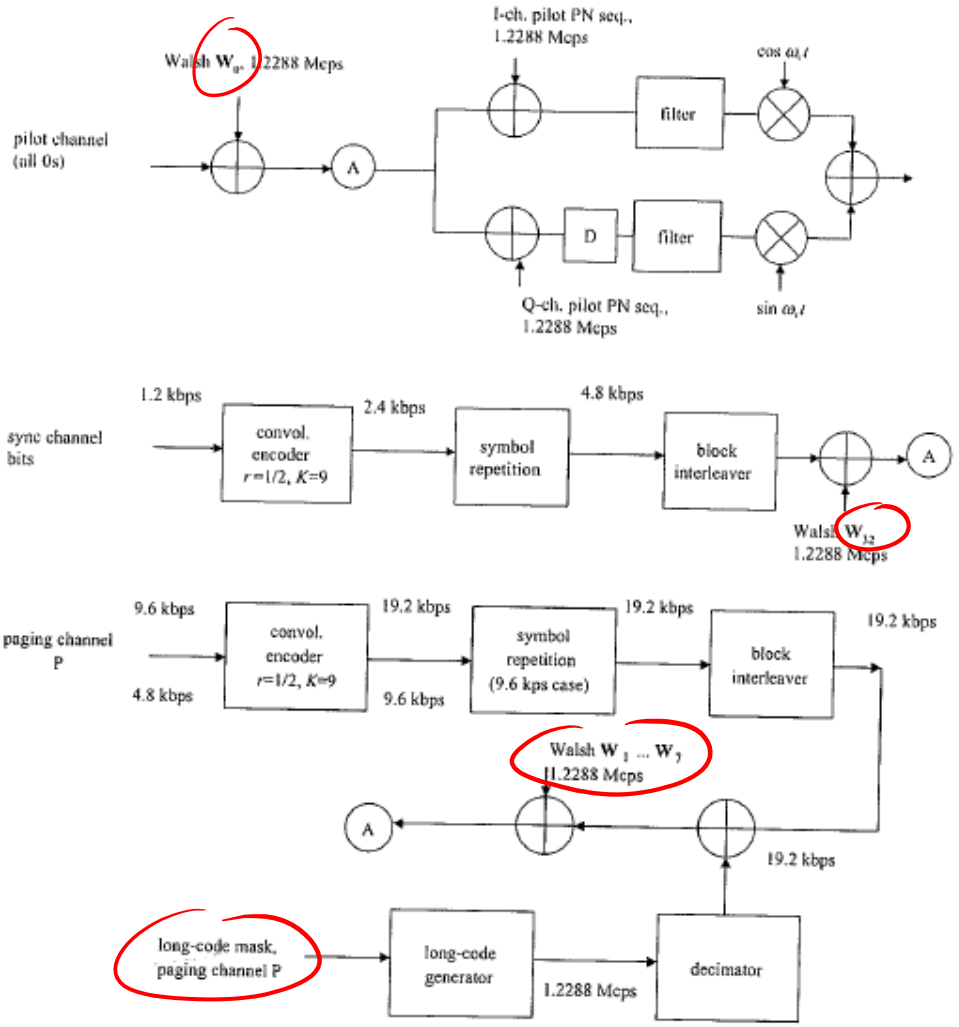


Figure 8.24 IS-95 forward control channel block diagrams

30

Forward traffic channel - handout

Wednesday, April 02, 2008 11:16 PM

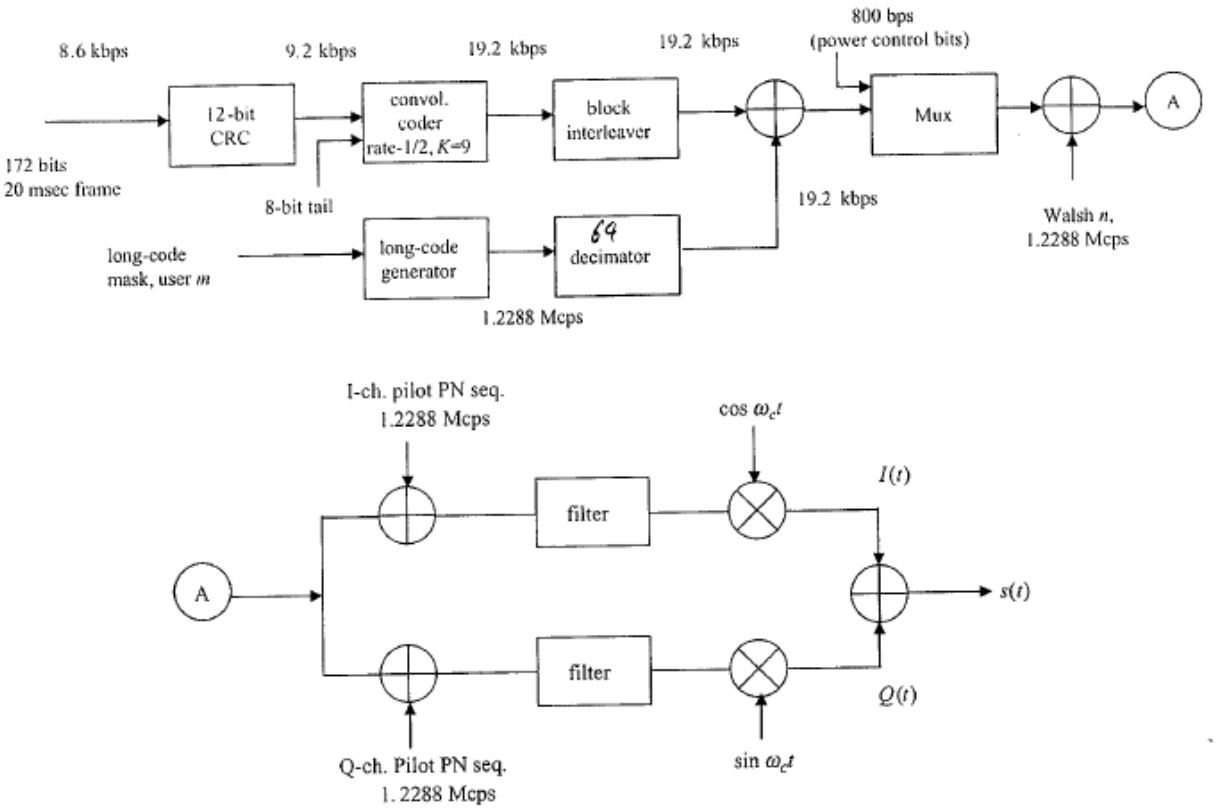


Figure 8.19 IS-95 forward traffic channel, user m, full-rate case

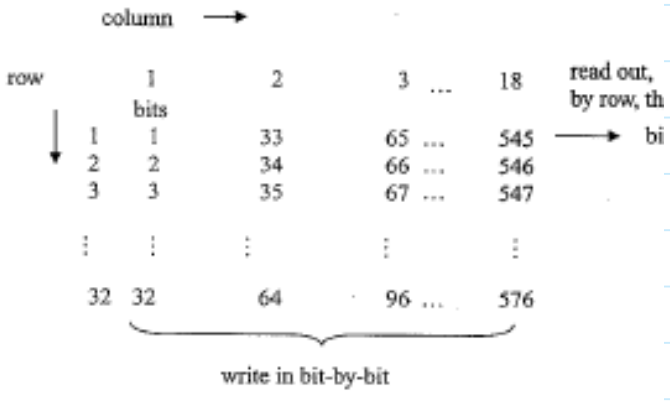


Figure 8.20 Block interleaver operation

Forward control channel - handout

Wednesday, April 02, 2008 11:16 PM

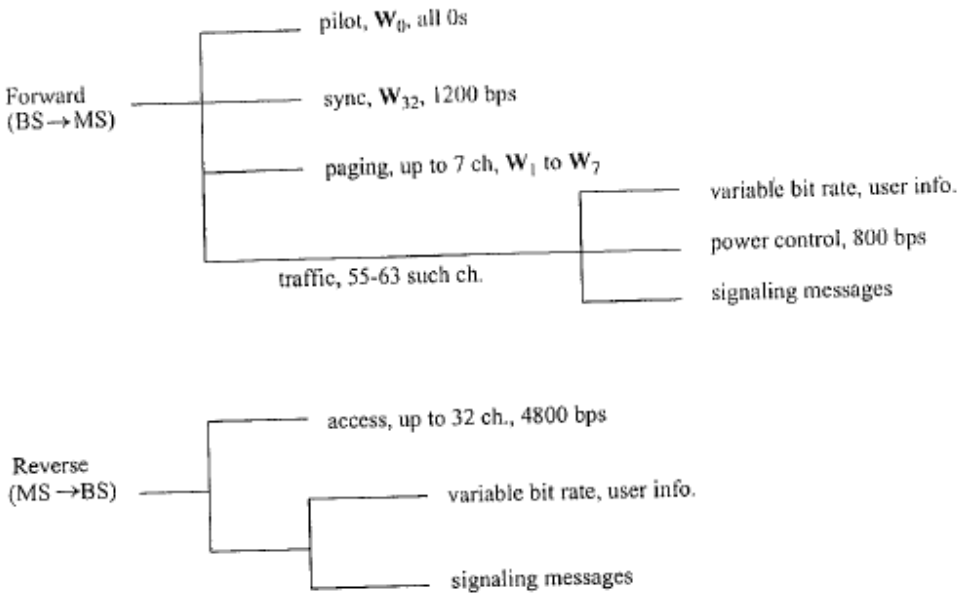
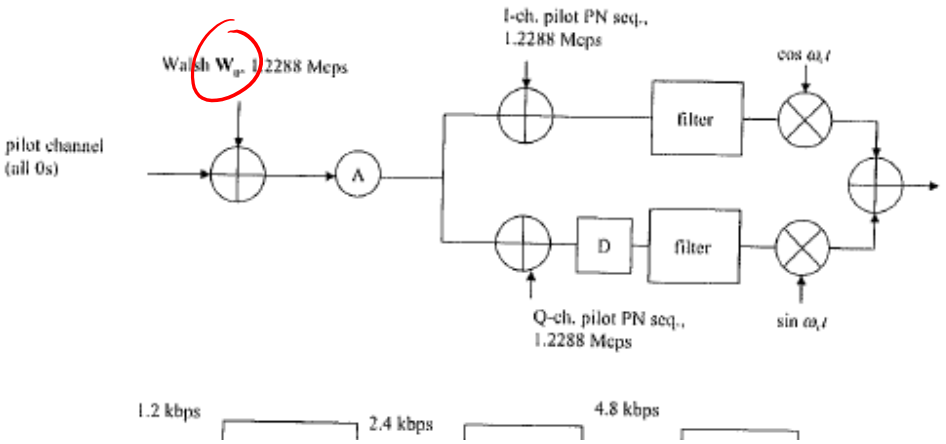


Figure 8.22 Traffic and control channels, IS-95



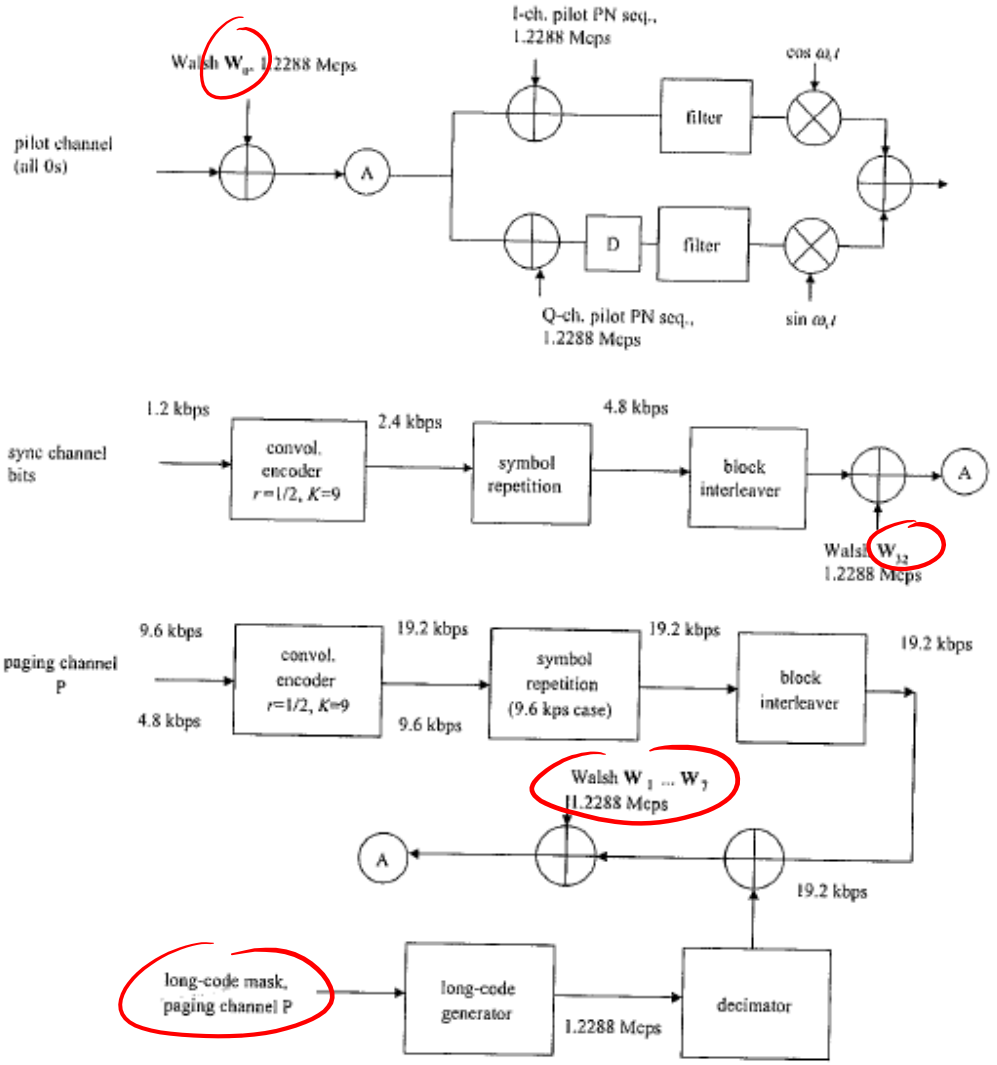


Figure 8.24 IS-95 forward control channel block diagrams

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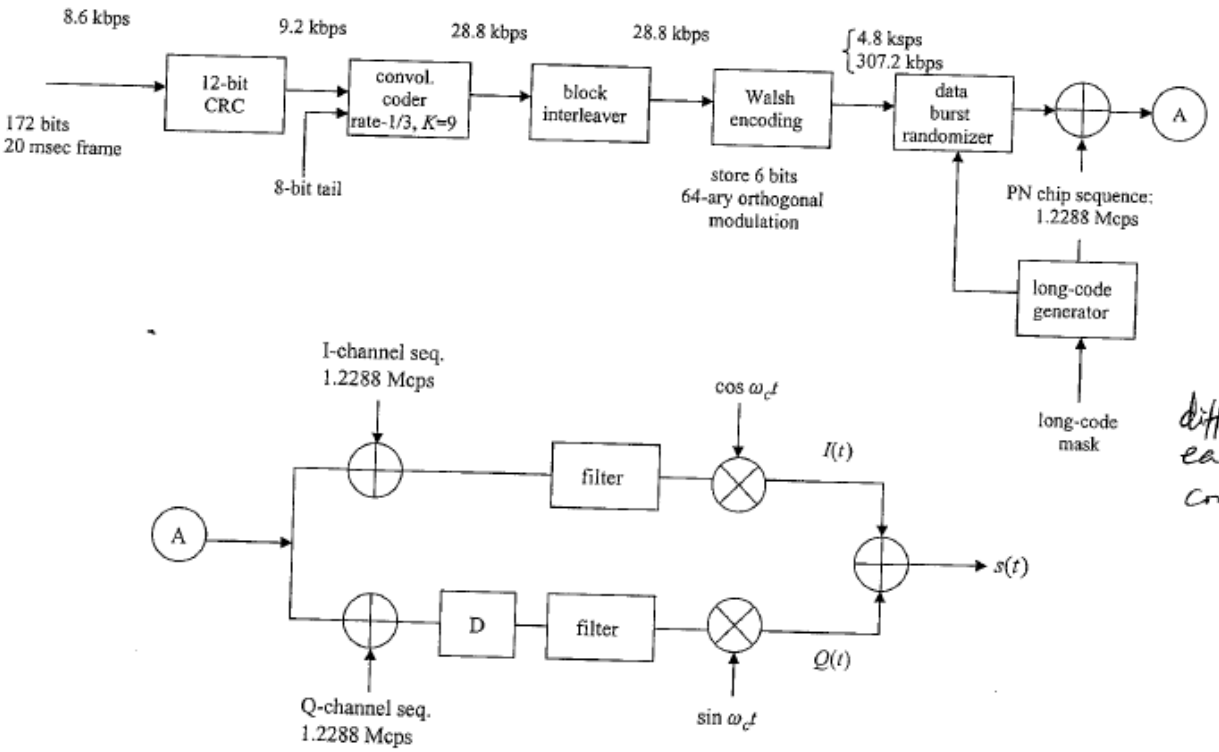
Uplink - 20min

Wednesday, April 02, 2008 9:23 AM

Uplink

- Fig 8.18



different for each user & control channel

Figure 8.18 IS-95 reverse traffic channel diagram, full-rate case only

- No pilot signal
- 8.6 kbps full rate, or 4800/2400/1200
- 1/3 coder: improve error correction

capability for uplink

- versus 1/2 coder in downlink

- block interleaver: combat deep fades

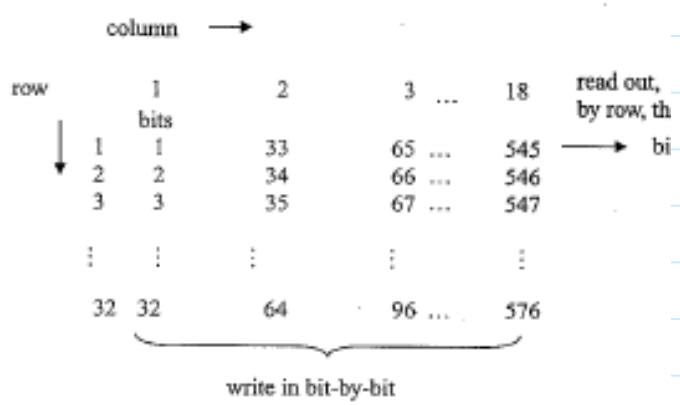


Figure 8.20 Block interleaver operation

- Walsh encoding: acts as an orthogonal modulator to enable non-coherent demodulation

  - every 6-bit maps to a 64-bit Walsh code

  - coherent modulation (like PSK) would have required a phase reference, like a pilot signal, which is not practical for uplink (due to the energy required for pilots).

- long-code: generated by 42-bit long-code mask that uniquely

identify a mobile (known' also to BS)

- 32 bit ESN (electronic serial #) assigned permanently to each mobile terminal
- plus 10 bits known sequence.
- needed by BS to decode.
- mobile ESN is transmitted to BS in access channel control msgs, as part of the mobile id, during the initial access channel.

- The state of the 42-bit MLSR is sync by GPS

- Processing gain:

$$\frac{1.2288M}{9.6K} = 128$$

- Additional spreading at In-phase & Quadrature channels with the same rate.
  - use the same short-code PN-sequence per BS
    - combined with the long code repeats in 37 centuries

- OQPSK modulation

- offset Quadrature PSK

- Q-channel delayed by half a chip duration
- lower amplitude change.
- burst randomizer: turn off bits at rates below 9600 bps
  - reduce interference.

Other than the user channel for traffic, the reverse link also defines the access control channel.

- similar to RACH in GSM

Fig 8.22/8.23

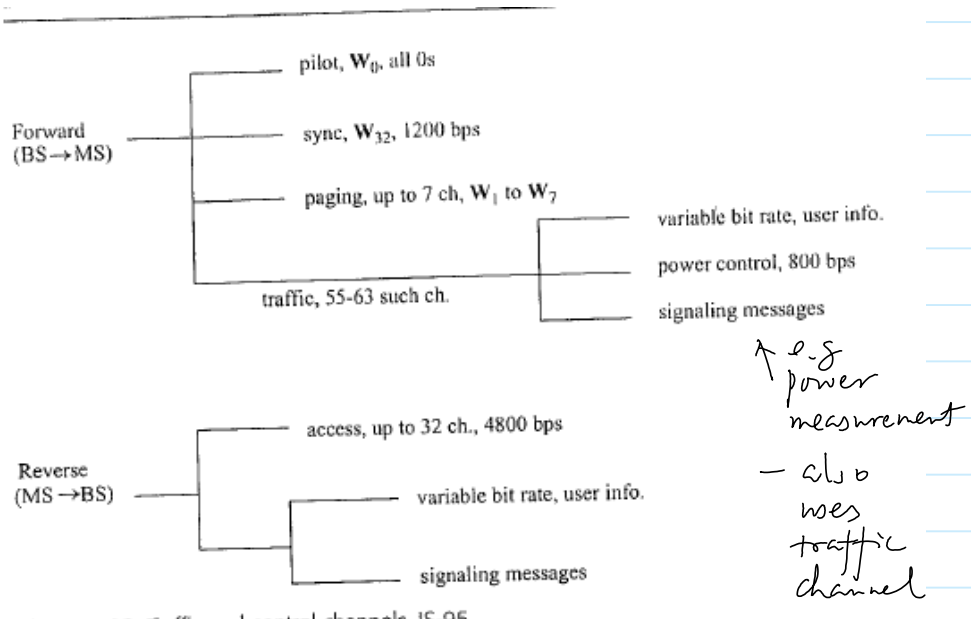


Figure 8.22 Traffic and control channels, IS-95

↑ e.g. power measurement

- also uses traffic channel

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Similar repetition used in

Similar repetition used in traffic channel at low rates too.

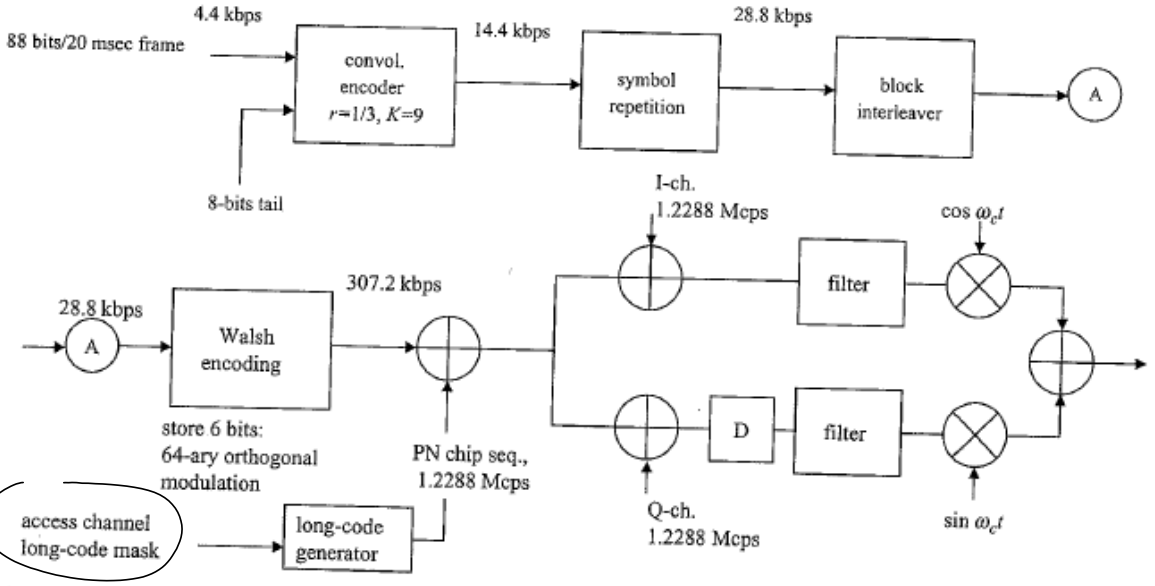


Figure 8.23 IS-95 access channel block diagram

Access control channels:

- used by mobile to initiate communication with BS or, respond to paging
- identified by unique long-code masks
  - 16-bit BS id
  - 9-bit pilot PN-offset #
    - corresponds to one of the 512 possible offsets assigned to the BS
  - 3-bit paging channel #
    - each paging channel (in downlink) must have

an access control channel associated with it

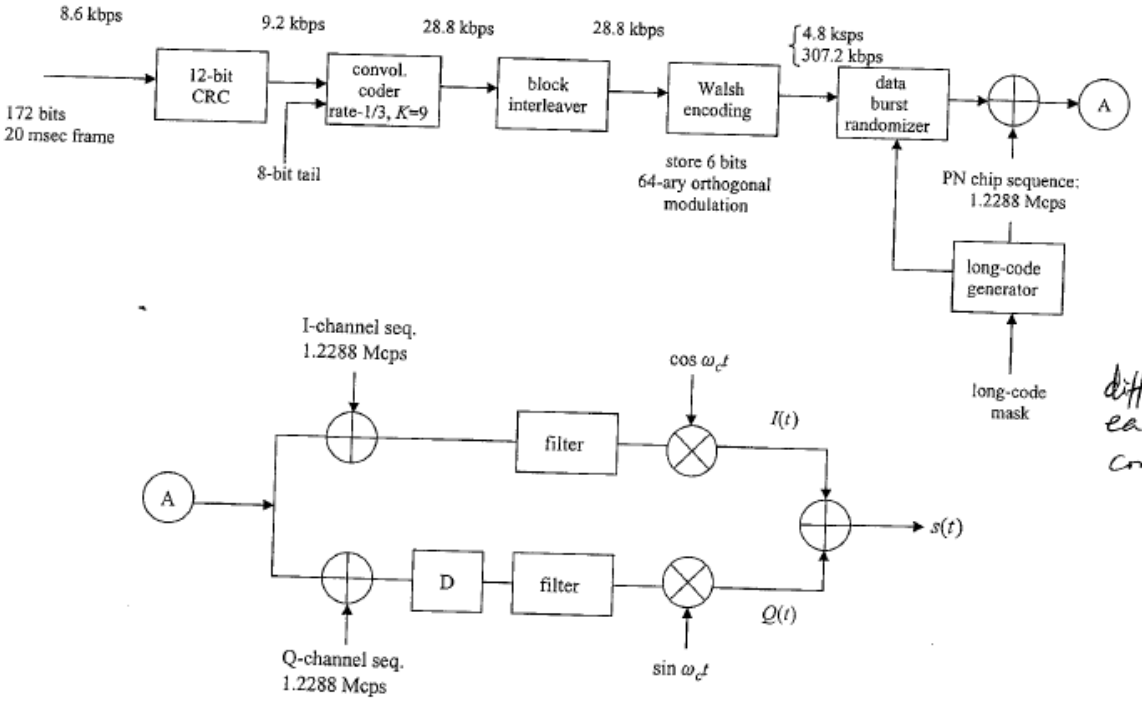
- 5-bit access channel #
  - max 32.
- 9-bit prescribed value ⇒ 42-bit total
- All these numbers & ids are provided to the mobile during initialization, through the sync channel in downlink & the paging channel msgs.

- use Aloha:
  - may need to retransmit at multiple power levels until success.
  - access control msgs contain the 34-bit mobile identification number (MIN) & the 32-bit ESN.

50

Reverse traffic channel - handout

Wednesday, April 02, 2008 11:18 PM



different for each user & control channel

Figure 8.18 IS-95 reverse traffic channel diagram, full-rate case only

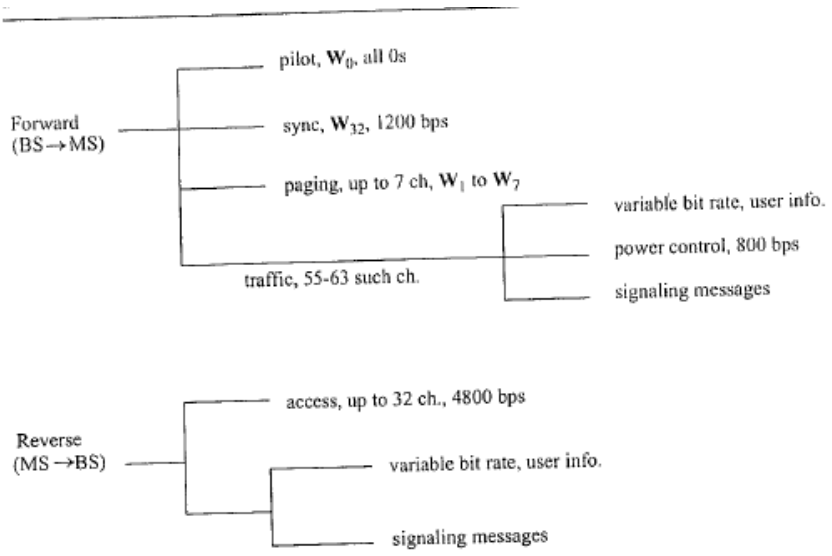


Figure 8.22 Traffic and control channels, IS-95

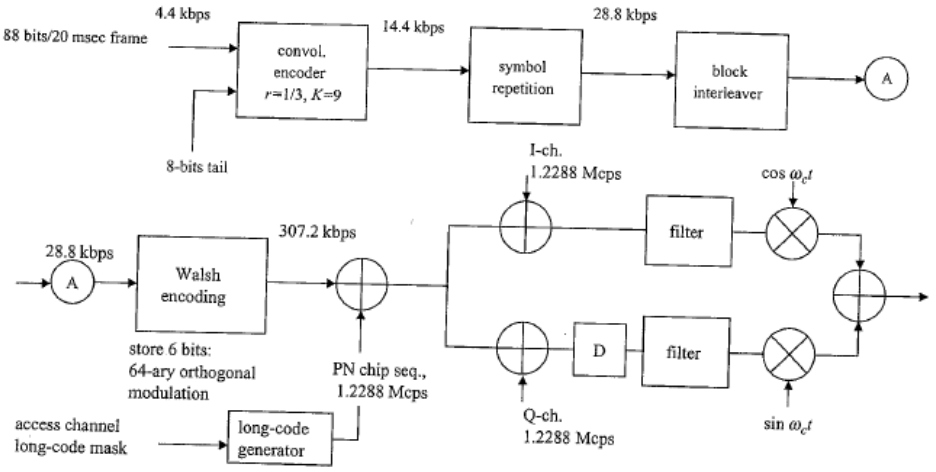


Figure 8.23 IS-95 access channel block diagram

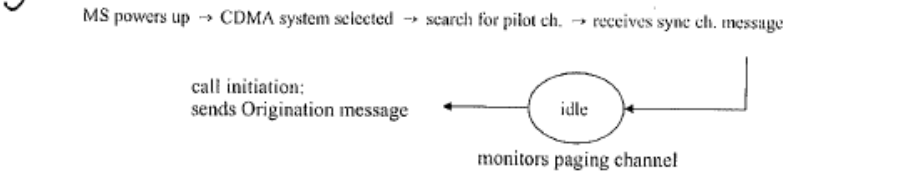


Figure 8.25 IS-95: preparation to set up a call

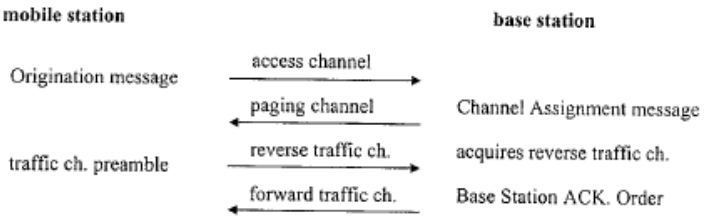


Figure 8.26 IS-95, call origination (simplified)

Table 8.3 *IS-95 Reverse Traffic Channel, 172-bit Frame (9600 bps case)*

bits per frame:

Format field bits					
Mixed mode	Traffic type	Traffic mode	Primary Traffic	Signaling Traffic	*Secondary Tr. (optional)*
0	–	–	171	0	0
1	0	00	80	88*	0
1	0	01	40	128*	0
1	0	10	16	152*	0
1	0	11	0	168**	0
1	1	00	80	0	88
1	1	01	40	0	128
1	1	10	16	0	152
1	1	11	0	0	168

*Notes: *dim-and-burst*
***blank-and-burst*

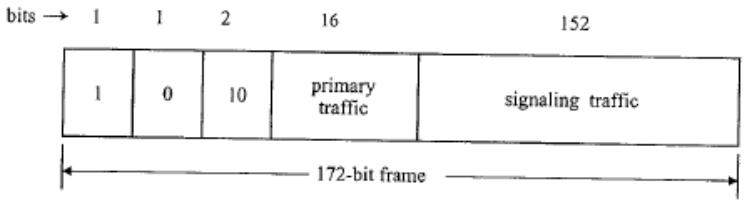


Figure 8.27 Example of IS-95 "dim-and-burst" frame, reverse traffic channel

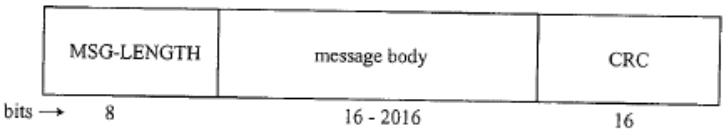


Figure 8.28 IS-95 signaling message format, reverse traffic channel

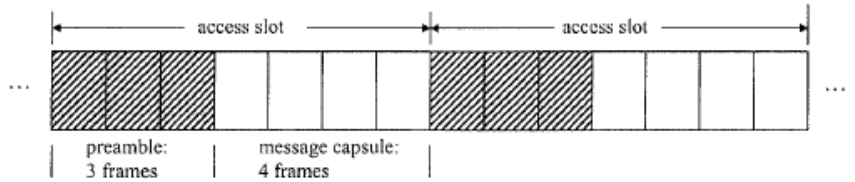


Figure 8.31 IS-95 access channel, transmission slot, 4800 bps

Call setup - 5min

Wednesday, April 02, 2008 6:23 PM

Call Setup in IS-95

- Fig 8.25/8.26

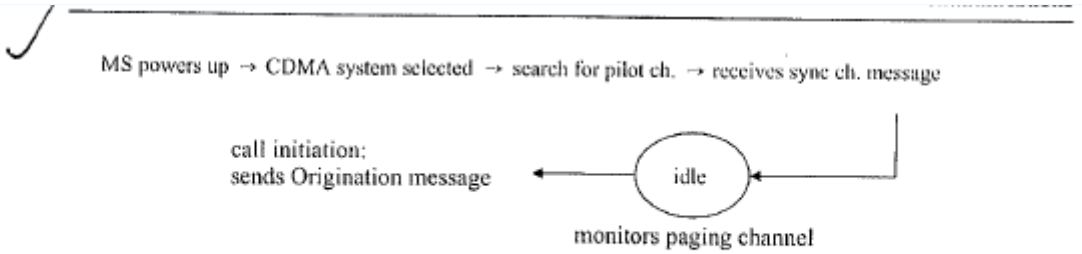


Figure 8.25 IS-95: preparation to set up a call

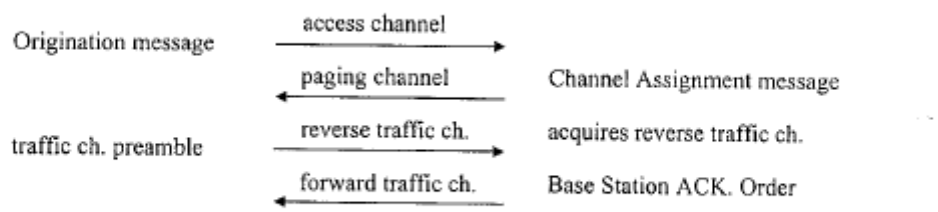


Figure 8.26 IS-95, call origination (simplified)

- acquire pilot channel
- acquire sync channel
  - decode 9-bit PN-sequence offset

- accurate timing, state of long-code

- monitor the paging channel
  - receive the id of the corresponding access control channel

- Initiate a call
  - MS provides ESN → long-code mask.
  - assign forward channel
  - BS acquire reverse channel

55

Summary - 10min

Wednesday, April 02, 2008 9:30 AM

Key to CDMA communication:

① how to let both end-points agree on the spreading code & the timing?

Downlink:

- combination of Walsh code & short-code
- the offset of short-code identifies BS
- per-user long code serves as scrambling
- How to let the MS agree
  - Walsh code
    - well-known channels
    - traffic channels, through ack msgs
  - short-code offset
    - use pilot channel (all zeros)
    - also by sync channel msg
  - Per-user long code

- provided by MS.

Uplink:

- use long-code with per-user/per-channel mask
- how to let the BS agree?
  - per-user channel
    - mask based on ESN, provided through access control channel msgs
      - offset provided by the state of the MLSR (in sync channel)
  - per access channel:
    - mask provided by BS through sync/paging channel msgs