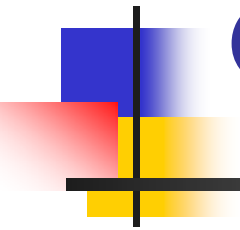
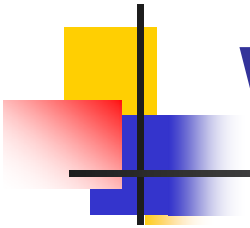
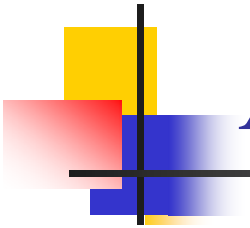


CDMA Technology & IS-95



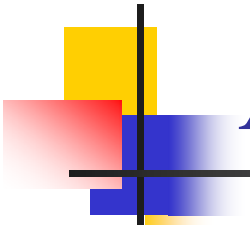
What is CDMA

- Both an access method and air-interface
- Rest of the network is very similar
  - Radio resource management, mobility management, security are similar
  - Power control and handoffs are different
- Uses DSSS and ECC
- Frequency reuse factor is 1
- 3 systems
  - IS-95 2G, W-CDMA, and CDMA2000



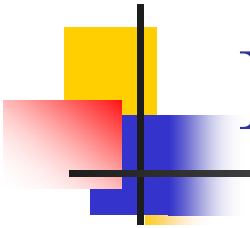
Advantages of CDMA Cellular

- Higher capacity
- Improves voice quality (new coder)
- Soft-handoffs
- Less power consumption (6-7 mW)
- Choice for 3G systems



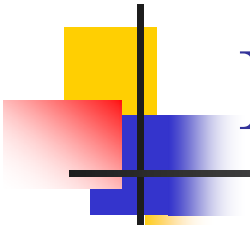
Advantages of CDMA Cellular

- Frequency diversity – frequency-dependent transmission impairments have less effect on signal
- Multipath resistance – chipping codes used for CDMA exhibit low cross correlation and low autocorrelation
- Privacy – privacy is inherent since spread spectrum is obtained by use of noise-like signals
- Graceful degradation – system only gradually degrades as more users access the system



Drawbacks of CDMA Cellular

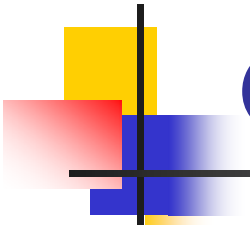
- Self-jamming – arriving transmissions from multiple users not aligned on chip boundaries unless users are perfectly synchronized
- Near-far problem – signals closer to the receiver are received with less attenuation than signals farther away
- Soft handoff – requires that the mobile acquires the new cell before it relinquishes the old; this is more complex than hard handoff used in FDMA and TDMA schemes



Drawbacks of CDMA Cellular

- Air-interface is the most complex
- Not symmetrical (unlike TDMA)
  - Forward and reverse channels are different
  - Forward channel (1→Many) synchronized
  - Forward channel uses orthogonal spreading codes
  - Reverse channel transmissions are not synchronized
  - Orthogonal codes are used for orthogonal waveform coding

Mobile Wireless CDMA Design Considerations



- RAKE receiver – when multiple versions of a signal arrive more than one chip interval apart, RAKE receiver attempts to recover signals from multiple paths and combine them
  - This method achieves better performance than simply recovering dominant signal and treating remaining signals as noise
- Soft Handoff – mobile station temporarily connected to more than one base station simultaneously

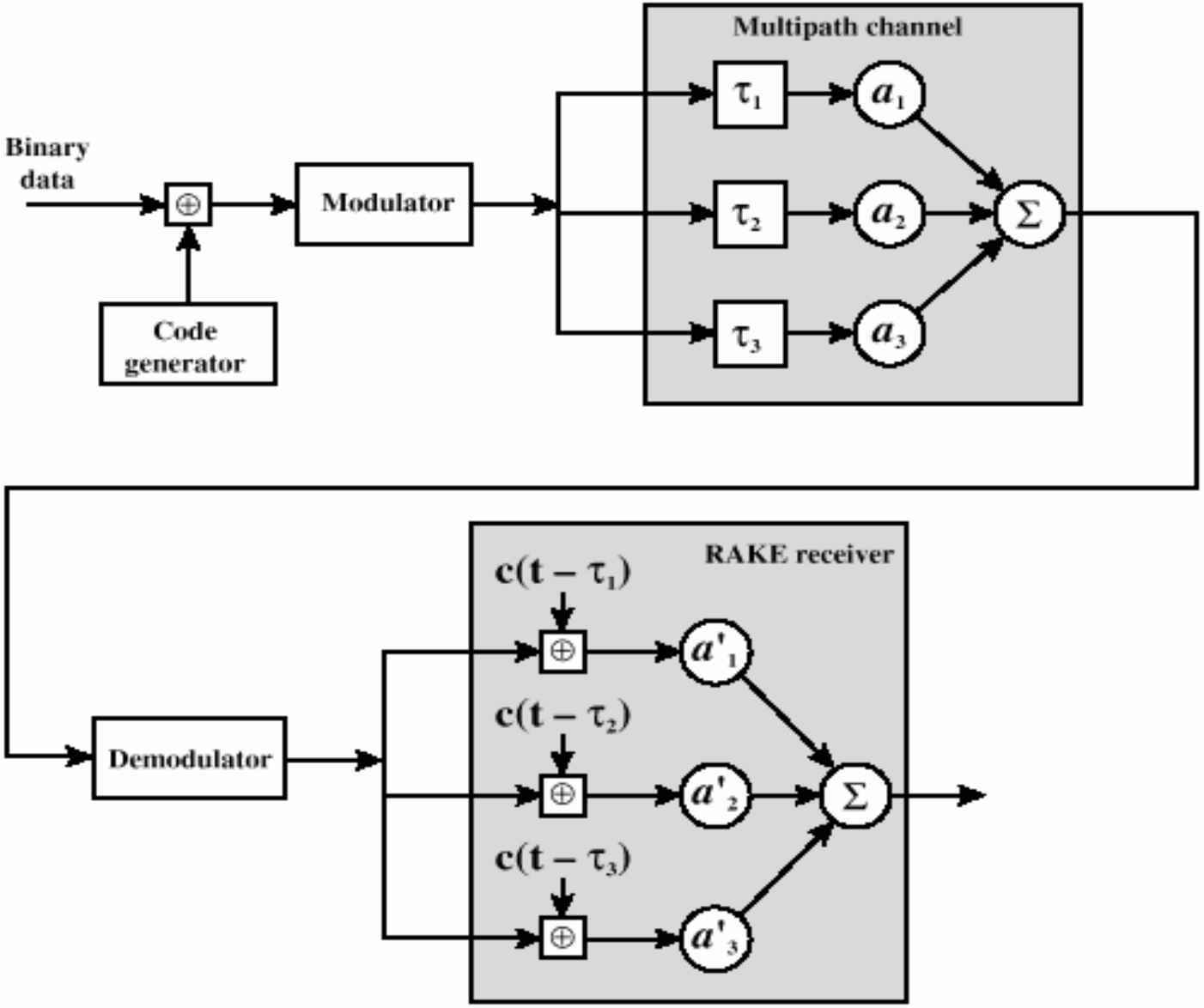
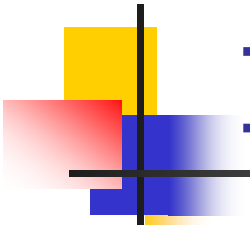


Figure 10.18 Principle of RAKE Receiver [PRAS98]



IS-95 CDMA Forward Channel

- The forward link uses the same frequency spectrum as AMPS (824-849 Mhz)
- Each carrier 1.25MHz
- 4 types of logical channel: A pilot, a synchronization, 7 paging, and 55 traffic channels
- Channels are separated using different spreading codes
- QPSK is the modulation scheme
- Orthogonal Walsh codes are used (64 total)
- After orthogonal codes, they are further spread by short PN spreading codes
- Short PN spreading codes are M sequences generated by LFSRs of length 15 with a period of 32768 chips.

Forward channel-2

- Why we have two spreading codes?
- The orthogonal codes are used to differentiate between the transmissions within a cell
- The PN spreading codes are used to isolate different cells (BSs) that are using the same frequencies.
- The same PN sequence is used in all BSs.
- The offset for each BS is different. Of course, this requires synchronization
- Synchronization is achieved by GPS.

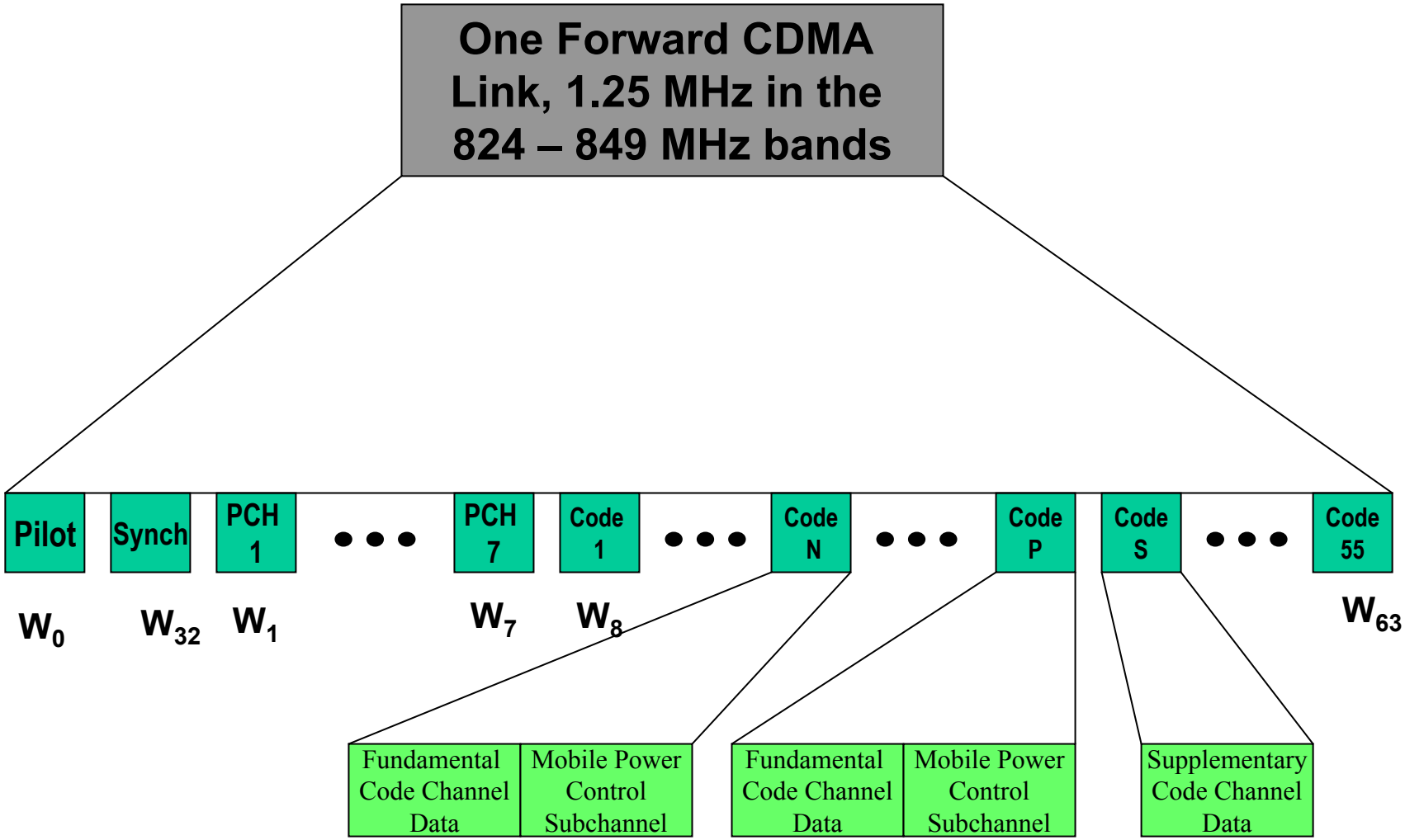


Figure 8.4: IS-95 Forward Channel

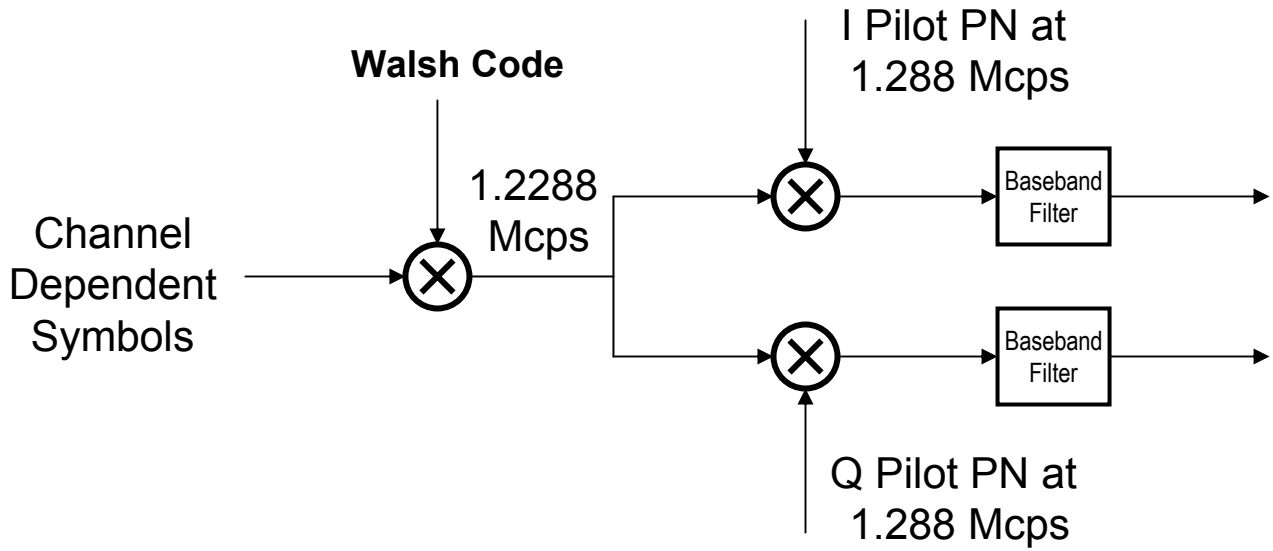
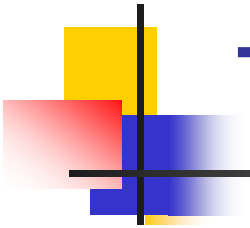


Figure 8.5: Basic Spreading Procedure on the Forward Channel in IS-95



The pilot channel

- Provide a reference signal for all MSs that provides the phase reference for COHERENT demodulation
- 4-6 dB stronger than all other channels
- Used to lock onto other channels
- Obtained using all zero Walsh code; i.e., contains no information except the RF carrier
- Spread using the PN spreading code to identify the BS. (512 different BS*64 offsets)
- No power control in the pilot channel

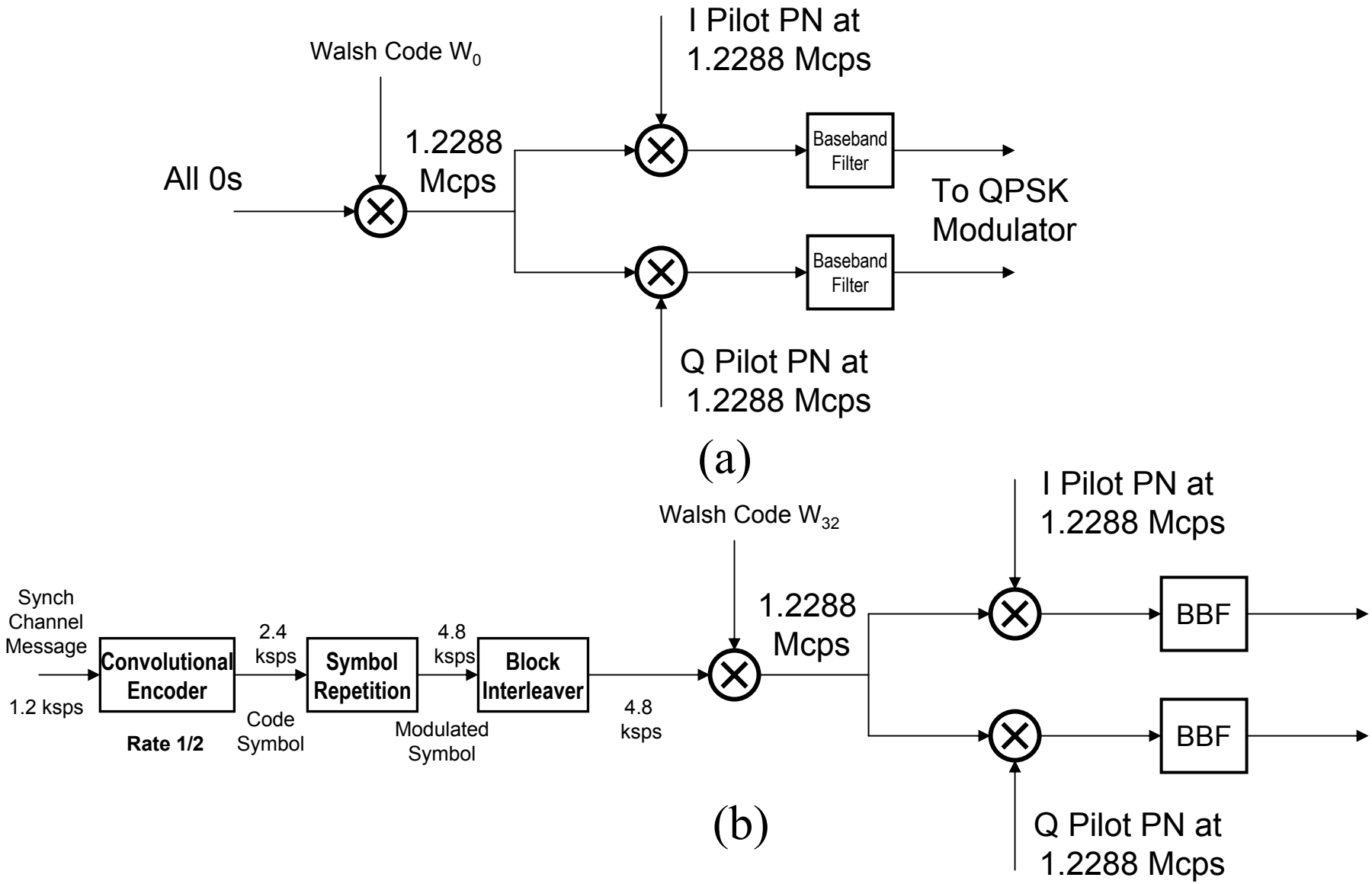
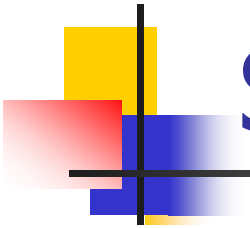


Figure 8.6: (a) Pilot and (b) Sync Channel Processing in IS -95



Sync channel

- Used to acquire initial time synchronization
- Synch message includes system ID (SID), network ID (NID), the offset of the PN short code, the state of the PN-long code, and the paging channel data rate (4.8/9.6 Kbps)
- Uses W32 for spreading
- Operates at 1200 bps

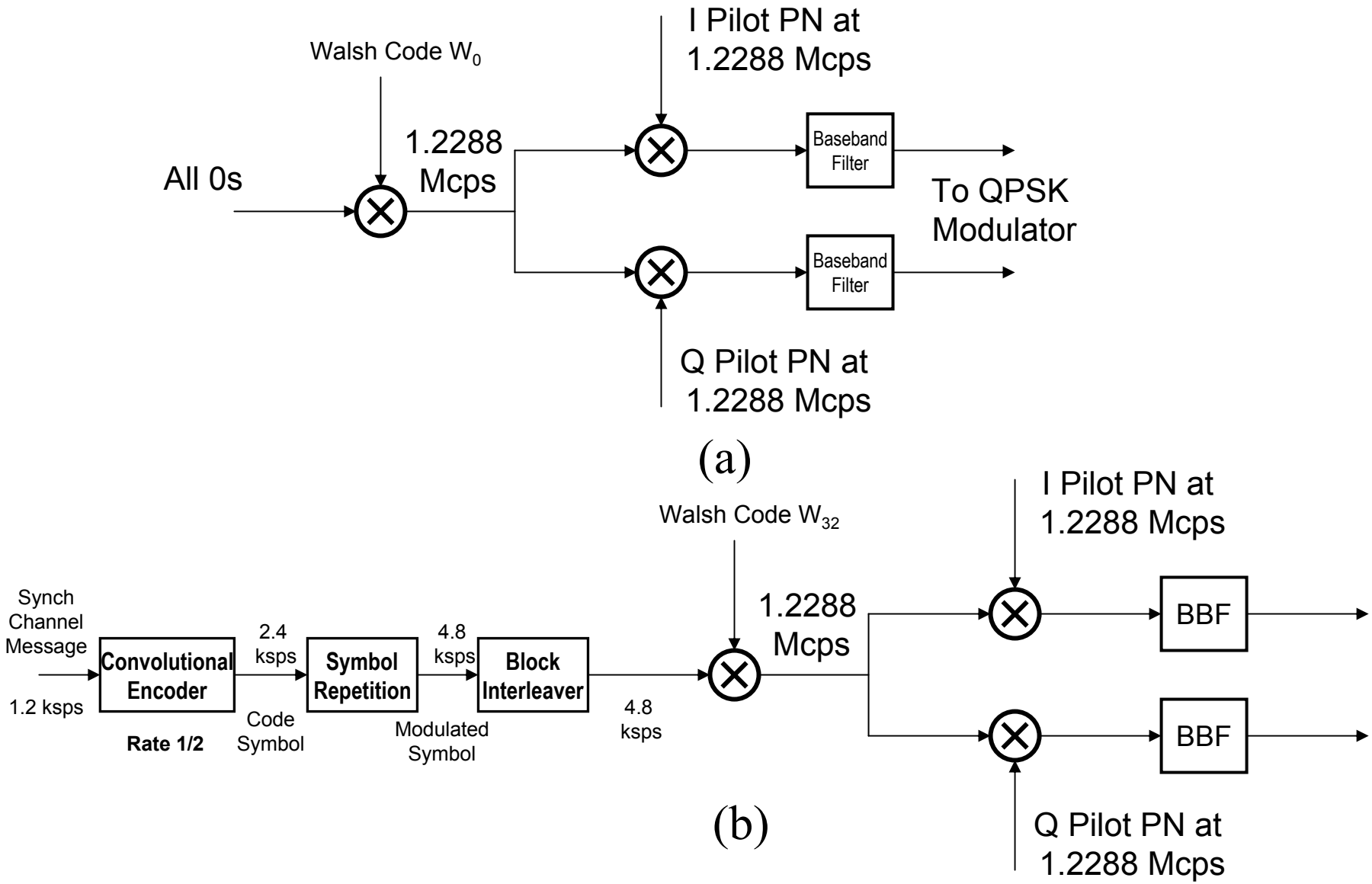
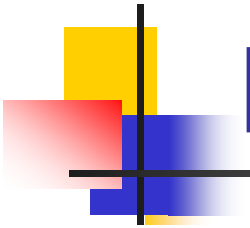


Figure 8.6: (a) Pilot and (b) Sync Channel Processing in IS -95



Paging channels

- Used to page the MS in case of an incoming call, or to carry the control messages for call set up
- Uses W1-W7
- There is no power control
- Additionally scrambled by PN long code, which is generated by LFSR of length 42
- The rate 4.8 Kbps or 9.6Kbps

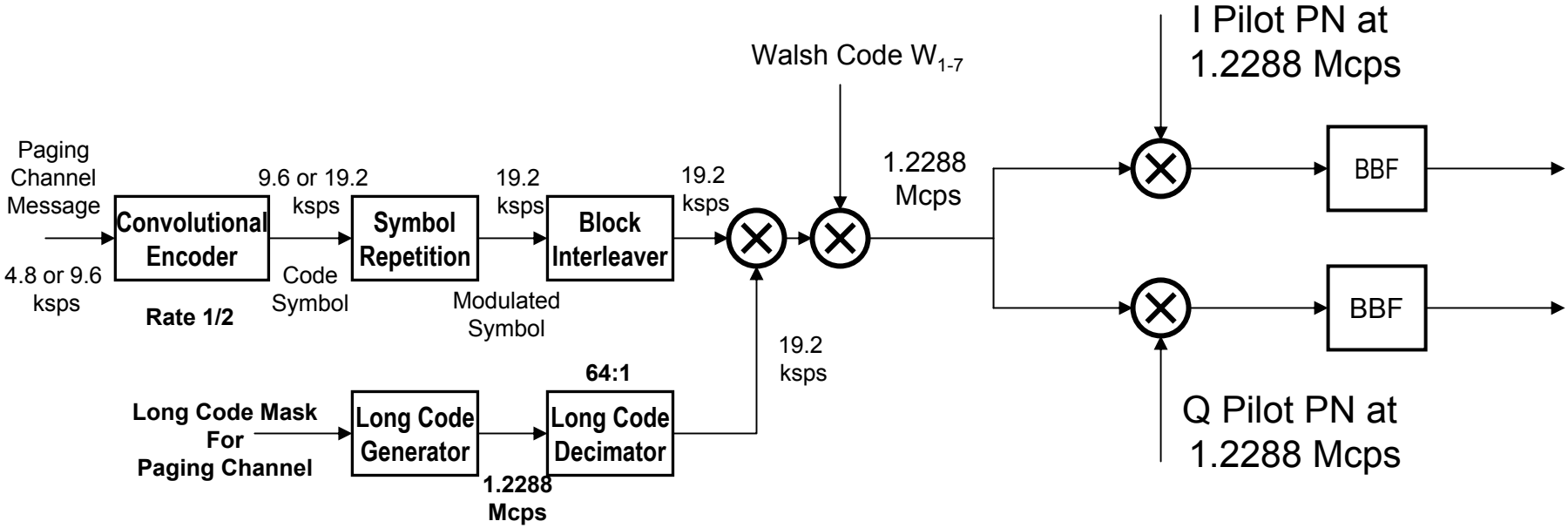
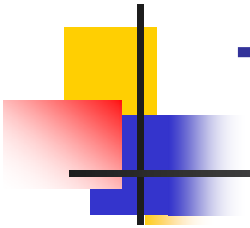


Figure 8.7: Paging Channel Processing in IS -95

The traffic channels



- Carry user information
- Two possible date rates
  - RS1={9.6, 4.8, 2.4, 1.2 Kbps}
  - RS2={14.4, 7.2, 3.6, 1.8 Kbps}
- RS1 is mandatory for IS-95, but support for RS2 is optional
- Also carry power control bits for the reverse channel

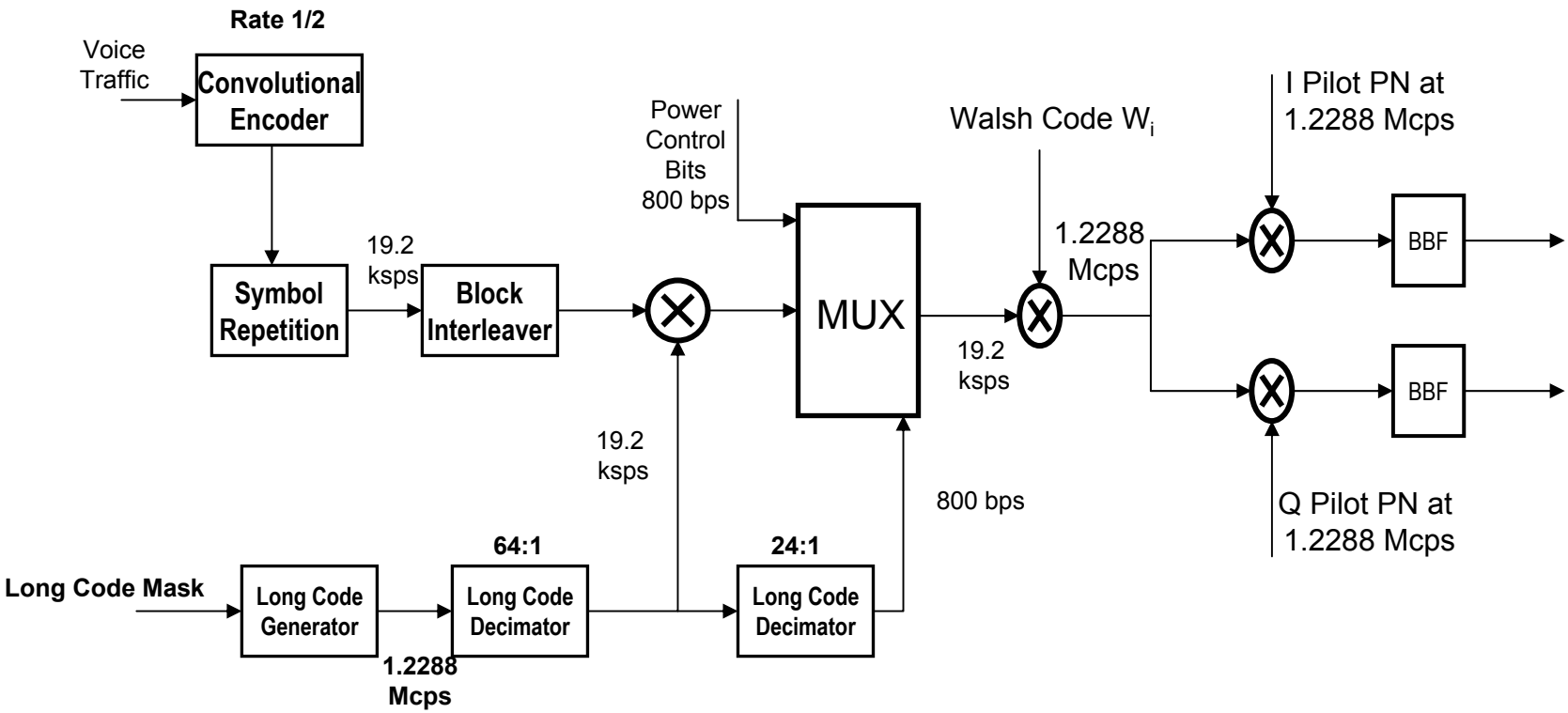


Figure 8.8: Forward Traffic Channel Processing in IS –95 (Rate Set 1)

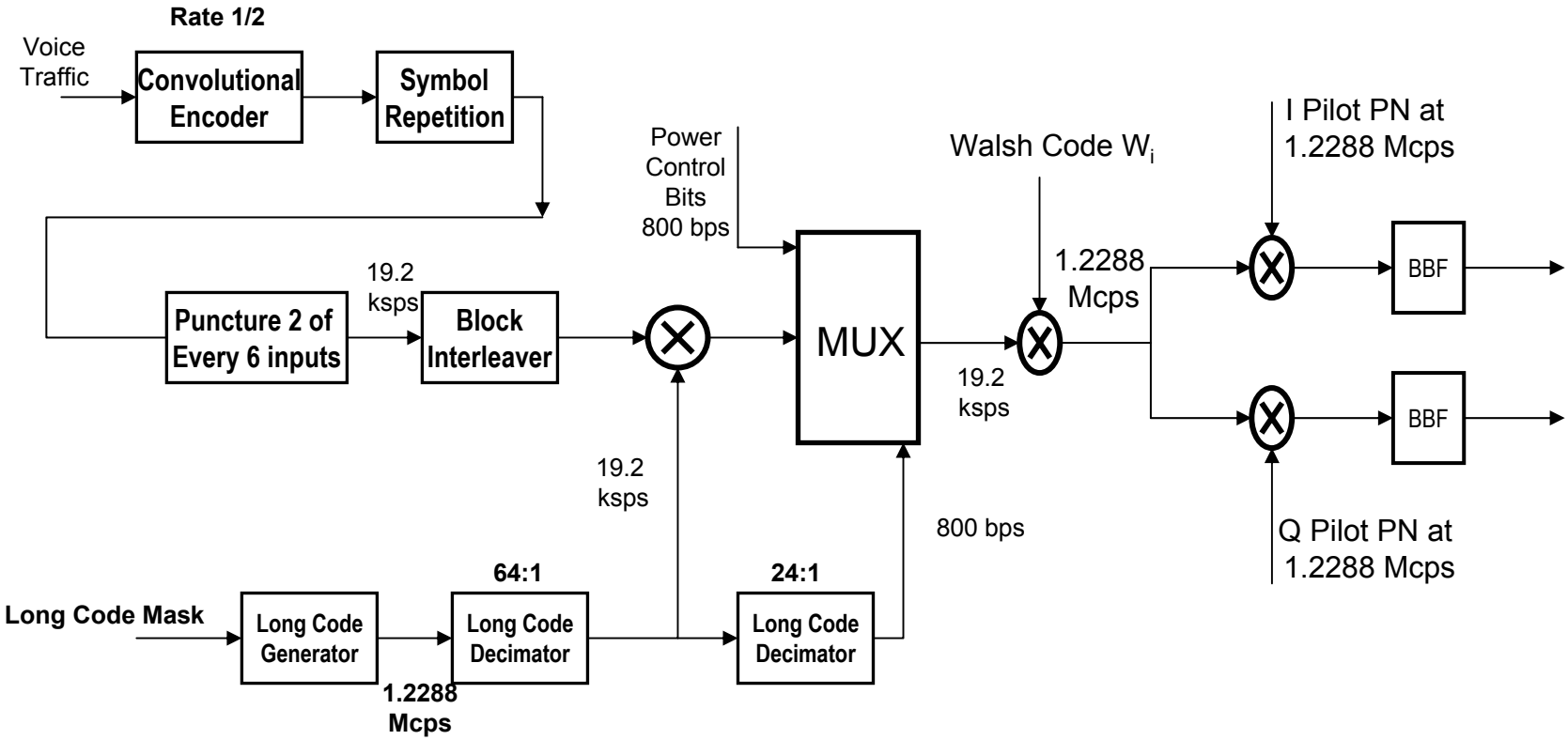
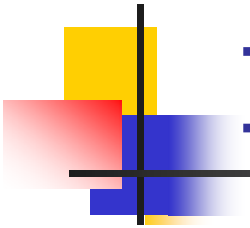


Figure 8.9: Forward Traffic Channel Processing in IS –95 (Rate Set 2)



IS-95 CDMA Reverse Channel

- Fundamentally different from the forward channels
- Uses OQPSK for power efficiency
- QPSK demodulation is easy
- 869-894 MHz range.
- No spreading of the data using orthogonal codes
- Same orthogonal codes are used for WAVEFORM encoding
- Two types of logical channels: The access channels and the reverse traffic channels

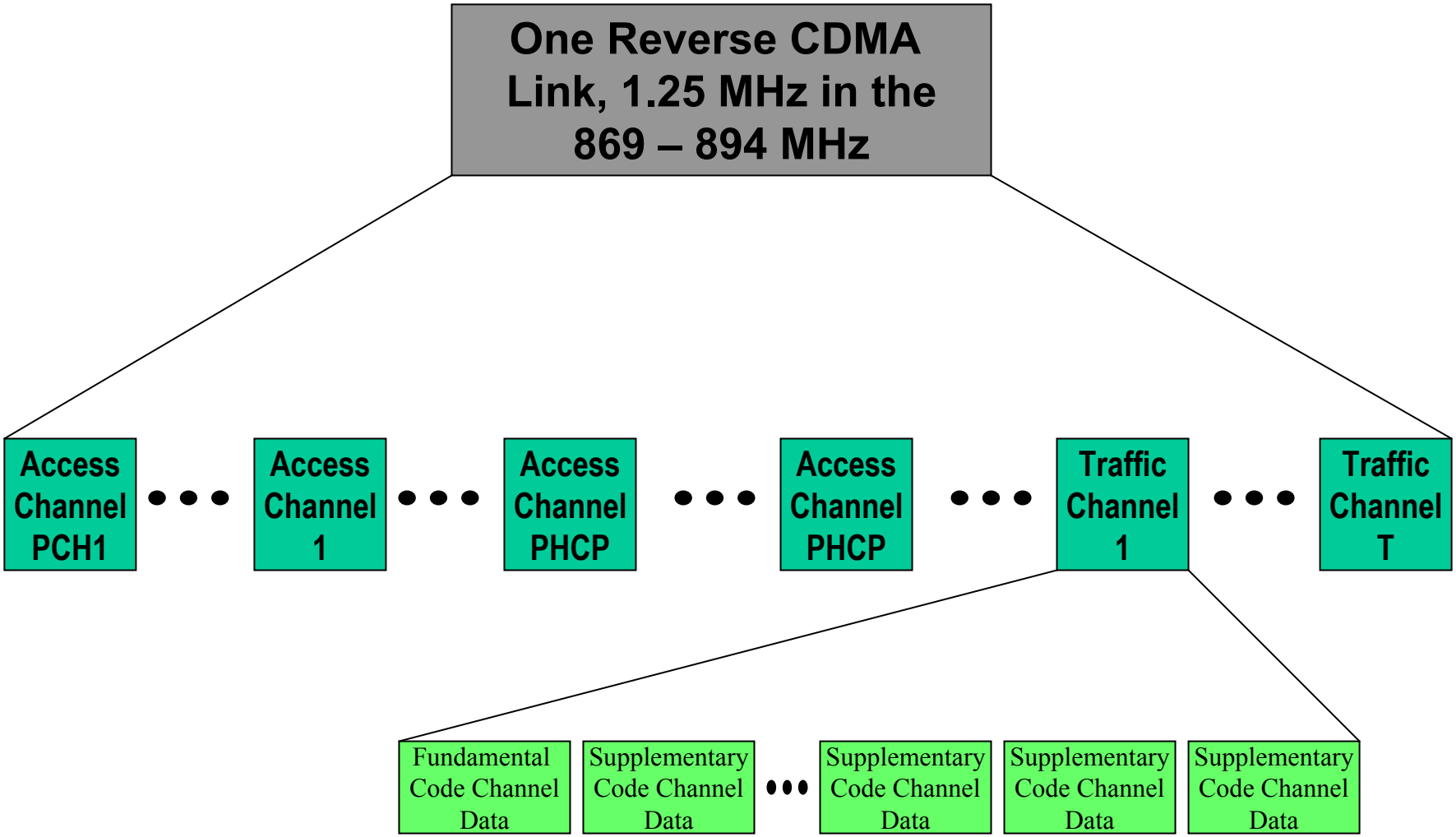


Figure 8.10: IS-95 Reverse Channel

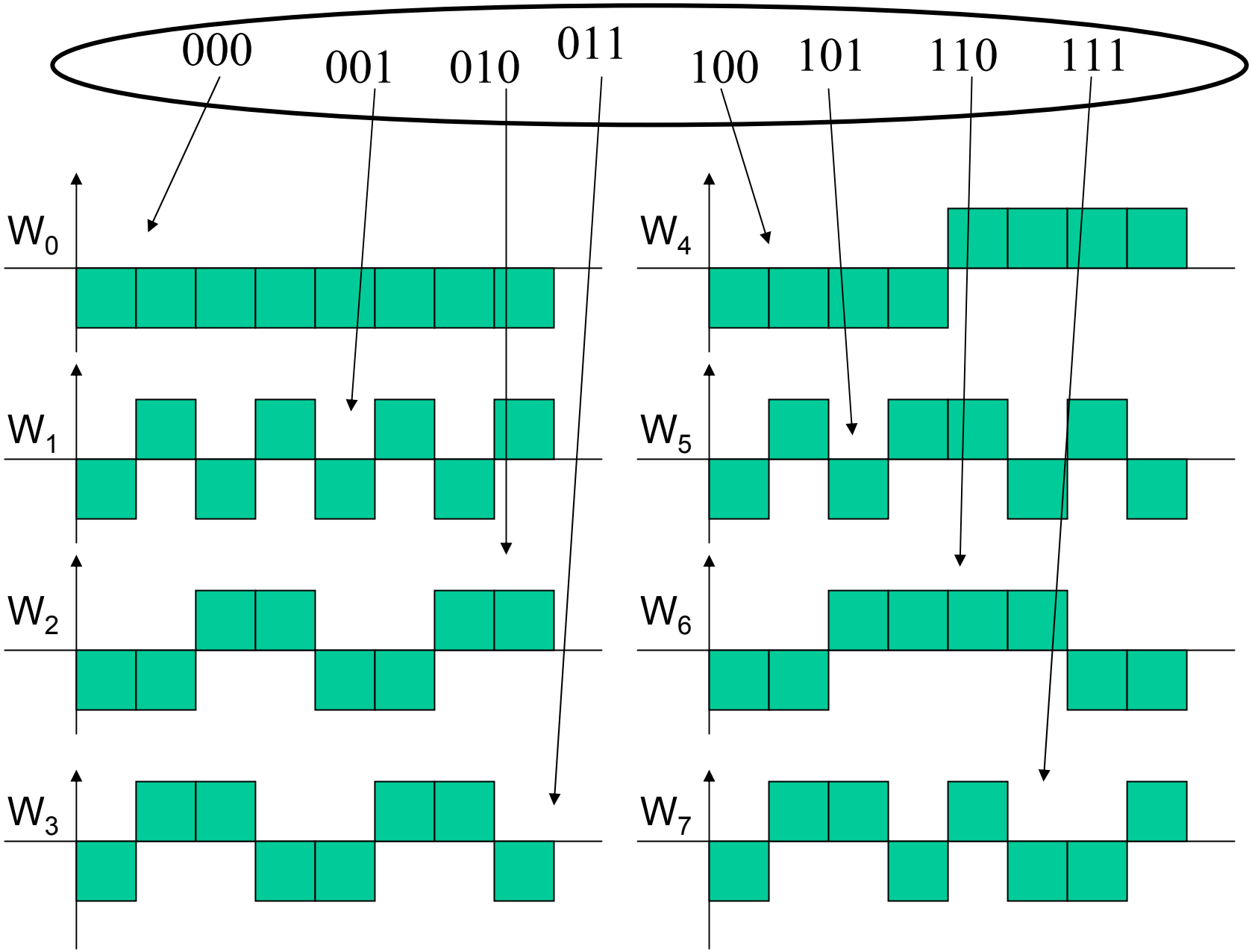


Figure 8.11: Mapping data bits to Walsh encoded symbols

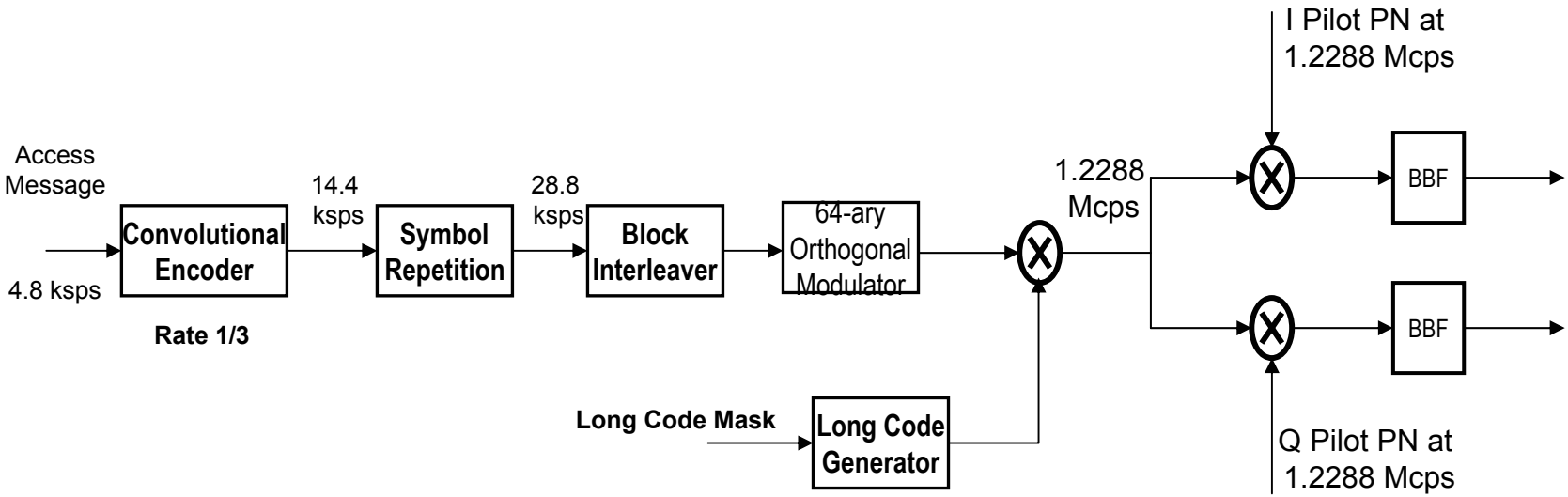


Figure 8.12: Access Channel Processing in IS-95