ECS455: Chapter 4

Multiple Access

4.8 IS-95

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IS-95 System

cdmaOne

- Based on direct sequence CDMA (**DS-CDMA**)
  - **First** CDMA-based digital cellular standard.
- The brand name for IS-95 is cdmaOne.
  - Also known as TIA-EIA-95.
- Proposed by Qualcomm in 1989 and adopted in 1993.
  - North America
- Replaced by IS-2000 (CDMA2000)
- **1.25 MHz Channel BW**
- 1.228 Mb/s chip rate
- WH sequences of order 64 are extensively used in the IS-95 system.
- Remarks
  - IS-95B = cdmaOne
    - Upgrade IS-95A
  - Can carry data at rates up to **14.4 kbps** for IS-95A and **115 kbps** for IS-95B.


Evolution of cellular network

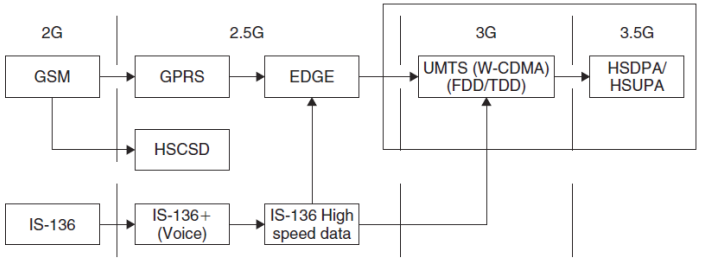


Figure 1.1 *Evolution of 2G networks based on TDMA technology.*

[Abu-Rgheff, 2007]

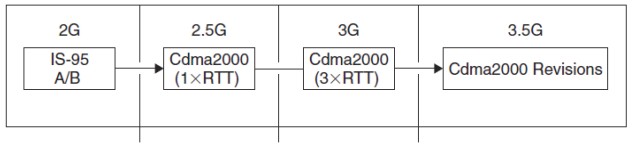
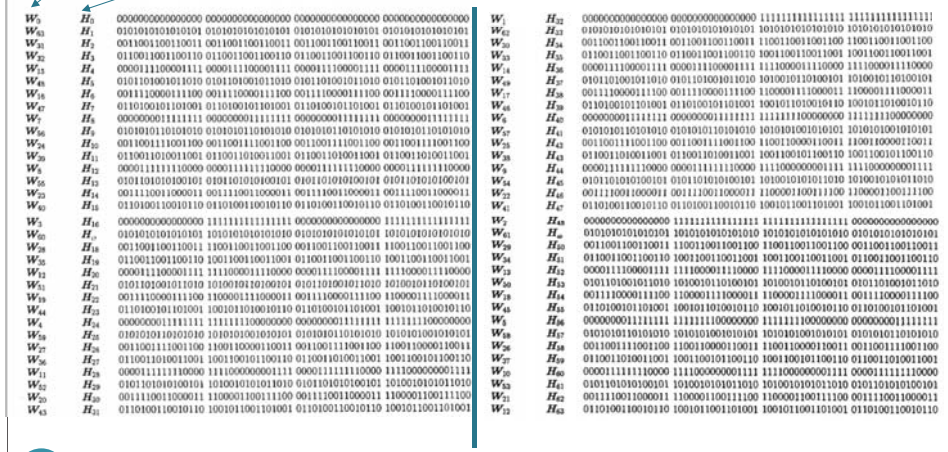


Figure 1.2 *Evolution of 2G networks based on CDMA technology.*

Walsh and WH Sequences of order 64

as indexed in IS-95

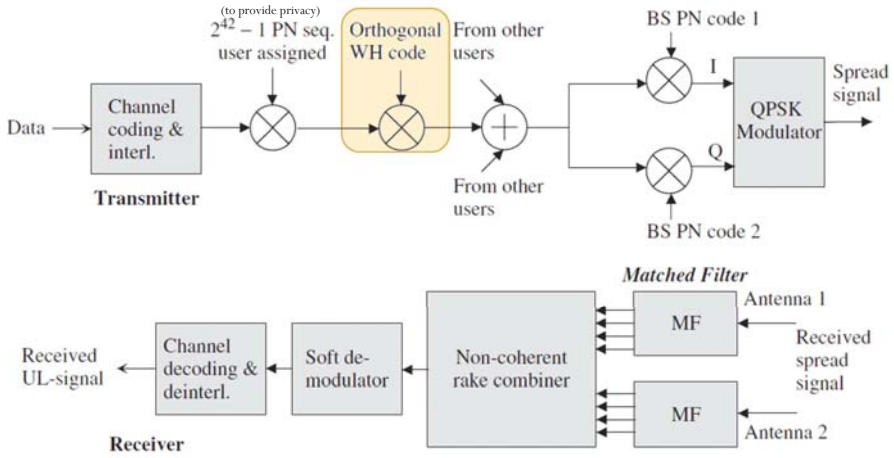


[Lee and Miller, 1998, Table 5.8]

WH Sequences in IS-95

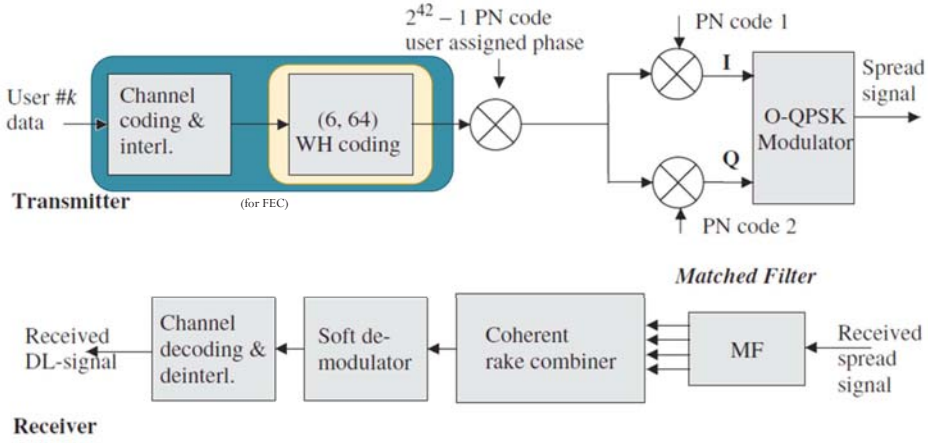
- **Forward link (Downlink)**
  - QPSK with a chip rate of 1,228,800 per second.
  - The **multiple access scheme** is accomplished by the use of 64-bit spreading orthogonal **WH sequences** (functions).
    - The (coded and interleaved) traffic channel signal symbols are multiplied with distinct repeating WH sequences that are assigned to each channel for the duration of the call.
  - Every base stations is synchronized with a GPS receiver so transmissions are tightly controlled in time.
- **Reverse link (Uplink)**
  - The WH sequences are employed as an **orthogonal modulation code**, which depends only on the data pattern (not channel), forming a 64-ary orthogonal modulation system.

IS-95 base station transceiver



[Fazel & Kaiser, 2008, Fig. 1-13]

IS-95 terminal station transceiver



[Fazel & Kaiser, 2008, Fig. 1-14]

IS-95

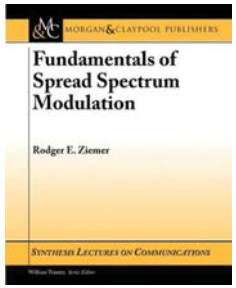
- The **reverse link** is subject to near-far effects.
- More powerful **error correction** is employed on the reverse link.
  - A rate 1/2 constraint length 9 convolutional code followed by an interleaver on the forward channel
  - A rate 1/3 constraint length 9 convolutional code followed by an interleaver is used on the reverse link.
    - Also with WH(6,64)
  - Interleaving is utilized to avoid large burst errors, which can be very detrimental to convolutional codes.
- **Power control**.
  - Use a subchannel on the forward link
  - Every 1.25 ms the base station receiver estimates the signal strength of the mobile unit.
  - If it is too high, the base transmits a 1 on the subchannel. If it is too low, it transmits a 0.
  - In this way, the mobile station adjusts its power every 1.25 ms as necessary so as to reduce interference to other users.

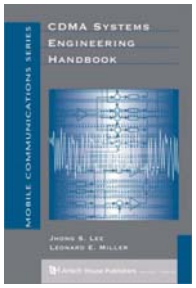
IS-95: Increased Spectral Efficiency

- Improve frequency reuse.
  - Narrow-band systems cannot use the same transmission frequency in adjacent cells because of the potential for interference.
  - CDMA has inherent resistance to interference.
    - Cluster size (N) = 1 (theoretically)
    - Although users from adjacent cells will contribute to interference level, their contribution will be significantly less than the interference from the same cell users.
    - Frequency reuse efficiency increases by a factor of 4 to 6.
- When used to transmit voice signals, CDMA systems may exploit the fact that voice activity typically lies at somewhat less than 40%, thus reducing the amount of interference to 40% of its original value.

References

- J. S. Lee and L. E. Miller, **CDMA Systems Engineering Handbook**, 1998.
  - Chapter 4 and 5
- R.E. Ziemer, **Fundamentals of Spread Spectrum Modulation**, 2007
  - Chapter 4





[TK5103.45 L44 1998]