Line Codes

Used in digital communication systems to improve performance.

Will look at ones to generate many transitions between 0's and 1's even when not present in data — needed for digital rcvr synchronization.

Manchester Encoding:

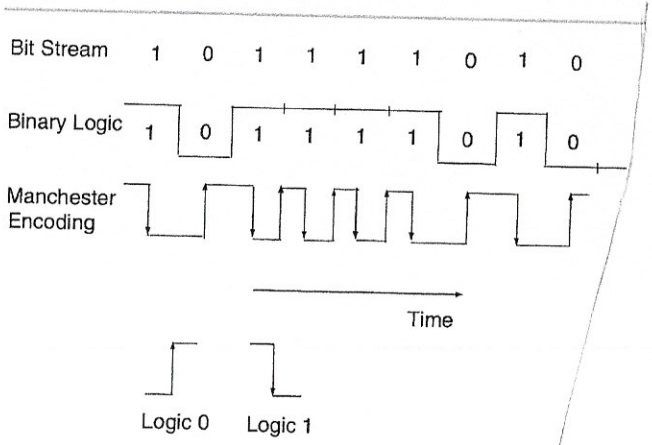

Fig. 4.18 Manchester encoding

[Efficiency = 50%]

[a) M.E. stream can be 2x faster as data stream.]

[No DC BIAS - can be capacitively or inductively coupled for isolation]

[Used in consumer infrared products and RFID technology.]

mBnb encoding

Add n−m extra bits to each m data bits

so one can select only words with frequent transitions.

4B5B

[Used in FDDI and 100 Mbps Fast Ethernet]

[4B5B has 25% overhead and 80% efficiency.]

[Other encodings possible, some used in magnetic recording]

Table 4.7 4B5B conversion table

Number	Binary	4B5B
0	0000	11110
1	0001	01001
2	0010	10100
3	0011	10101
4	0100	01010
5	0101	01011
6	0110	01110
7	0111	01111
8	1000	10010
9	1001	10011
10	1010	10110
11	1011	10111
12	1100	11010
13	1101	11011
14	1110	11100
15	1111	11101

8B10B

→ patented by IBM (expired now)

→ Produces DC balance, bounded disparity, and sufficient transitions for clock recovery

→ Used in Gigabit Ethernet, InfiniBand, FiberChannel

→ Uses 5b/6b code (and table) for first 5 bits and 3b/4b code (and table) for last 3 bits

→ 80% efficient (M.E. is 50% efficient)

→ Why not 8b/9b? Inventors of 8b/10b found implementation of 8b/9b problematic

64b/66b

Using 8b/10b in 10 Gbps Ethernet means with 25% overhead 12.5 Gbps laser required. A challenge.

So instead map 64 bits → 66 bits (3.125% overhead)

1. For 64 bits of data prefix is 01.
2. For 8 bit type field + 56 bit control message prefix is 10.
3. Prefix 00 and 11 not used — produce error
4. Guarantees bit transition every 66 bits

64b/66b (continued)

64b/66b addresses performance in a statistical way, not deterministically.

64 bits of data "scrambled" in hardware through a linear feedback register.

65 ones or 65 zeroes occurs once every 1900 years at 10 Gbps.

Mean time to FALSE PACKET ACCEPTANCE (MTTFPA) ~1 billion years for 10 Gbps Ethernet.

64b/66b continued

- Used in 10 Gbps Ethernet,
  10 Gbps Ethernet: Passive Optical Network (10 G-EPON),
  100 Gbps Ethernet
  some Fiber Channel versions
- Other codes: 64b/67b, 128b/130b, 128b/132b for certain design issues