Coding and Decoding Techniques

Digital Data, Digital Signals

- Digital signal – is a sequence of discrete, discontinuous voltage pulses.
- Bit duration - the time it takes for the transmitter to emit the bit.
- Issues
  - Bit timing
  - Recovery from signal
  - Noise immunity

NRZ (Non-Return-to-Zero) Codes

Uses two different voltage levels (one positive and one negative) as the signal elements for the two binary digits.

NRZ-L (Non-Return-to-Zero-Level)

The voltage is constant during the bit interval.

1 ⇔ negative voltage

0 ⇔ positive voltage

NRZ-L *is used for short distances between terminal and modem or terminal and computer.*

NRZ (Non-Return-to-Zero) Codes

NRZ-I (Non-Return-to-Zero-Invert on ones)

The voltage is constant during the bit interval.

1 ⇔ existence of a **signal transition** at the beginning of the bit time (either a low-to-high or a high-to-low transition)

0 ⇔ **no signal transition** at the beginning of the bit time

NRZI is a *differential encoding* (i.e., the signal is decoded by comparing the polarity of adjacent signal elements.)

Bi –Phase Codes

Bi- phase codes – require at least one transition per bit time and may have as many as two transitions.

➔ the maximum modulation rate is twice that of NRZ ➔ greater transmission bandwidth is required.

Advantages:

Synchronization – with a predictable transition per bit time the receiver can “synch” on the transition [self-clocking].

No d.c. component

Error detection – the absence of an expected transition can used to detect errors.

Manchester encoding

- There is **always** a mid-bit transition {which is used as a clocking mechanism}.
- The **direction** of the mid-bit transition represents the digital data.

1 ⇔ **low-to-high** transition

0 ⇔ **high-to-low** transition

Textbooks disagree on this definition!!

Consequently, there may be a second transition at the beginning of the bit interval.

Used in 802.3 baseband coaxial cable and CSMA/CD twisted pair.

Differential Manchester encoding

- mid-bit transition is **ONLY** for clocking.

1 ⇔ **absence** of transition at the beginning of the bit interval

0 ⇔ **presence** of transition at the beginning of the bit interval

Differential Manchester is both differential and bi-phase.

Note – the coding is the opposite convention from NRZI.

Used in 802.5 (token ring) with twisted pair.

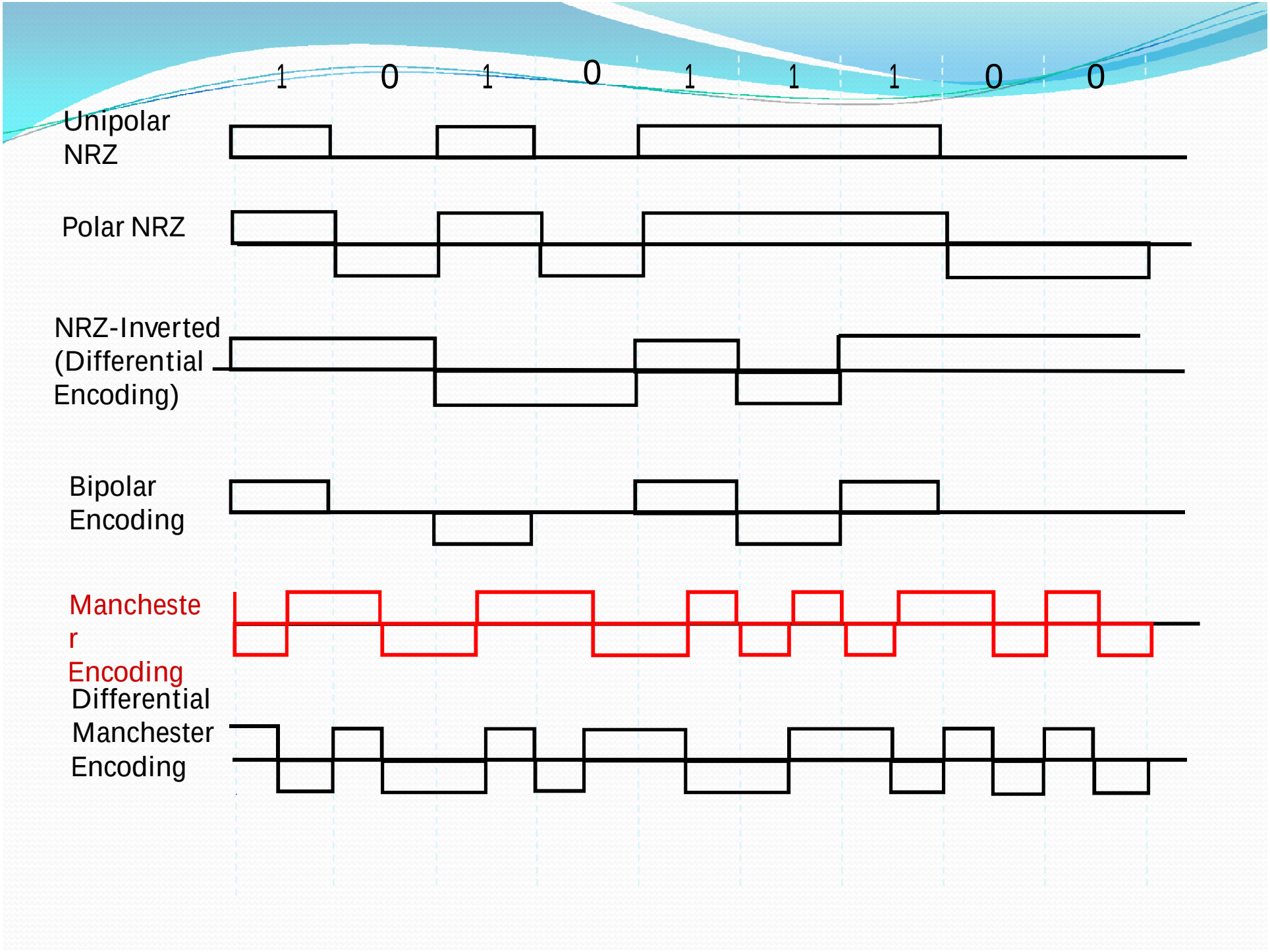
* Modulation rate for Manchester and Differential Manchester is twice the data rate ➔ inefficient encoding for long-distance applications.

Bi-Polar Encoding

1 ⇔ **alternating** +1/2 , -1/2 voltage

0 ⇔ **0** voltage

- Has the same issues as NRZI for a long string of 0's.
- A systemic problem with polar is the polarity can be backwards.


1 0 1 0 1 1 1 0 0
Unipolar NRZ
Polar NRZ
NRZ-Inverted (Differential Encoding)
Bipolar Encoding
Mancheste r Encoding
Differential Manchester Encoding