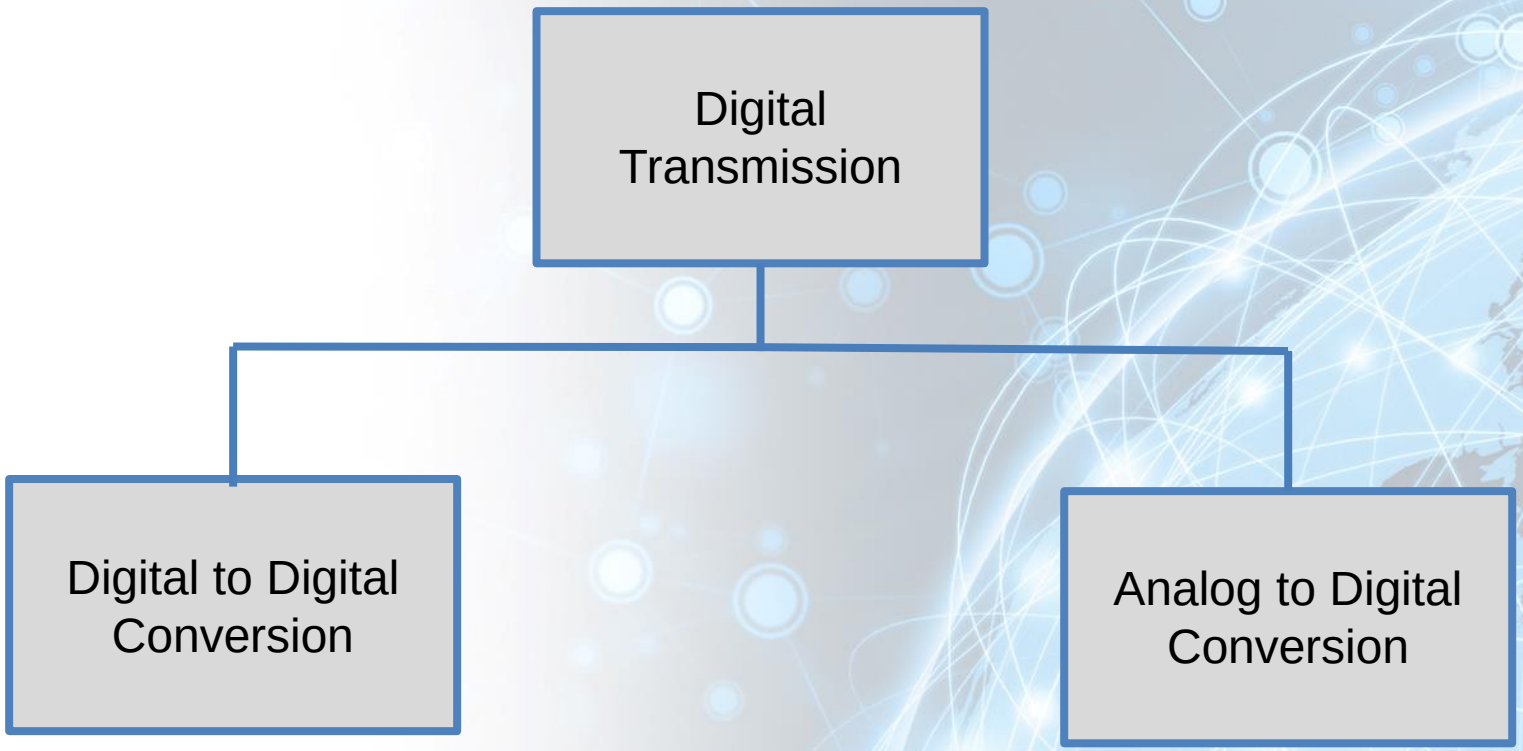
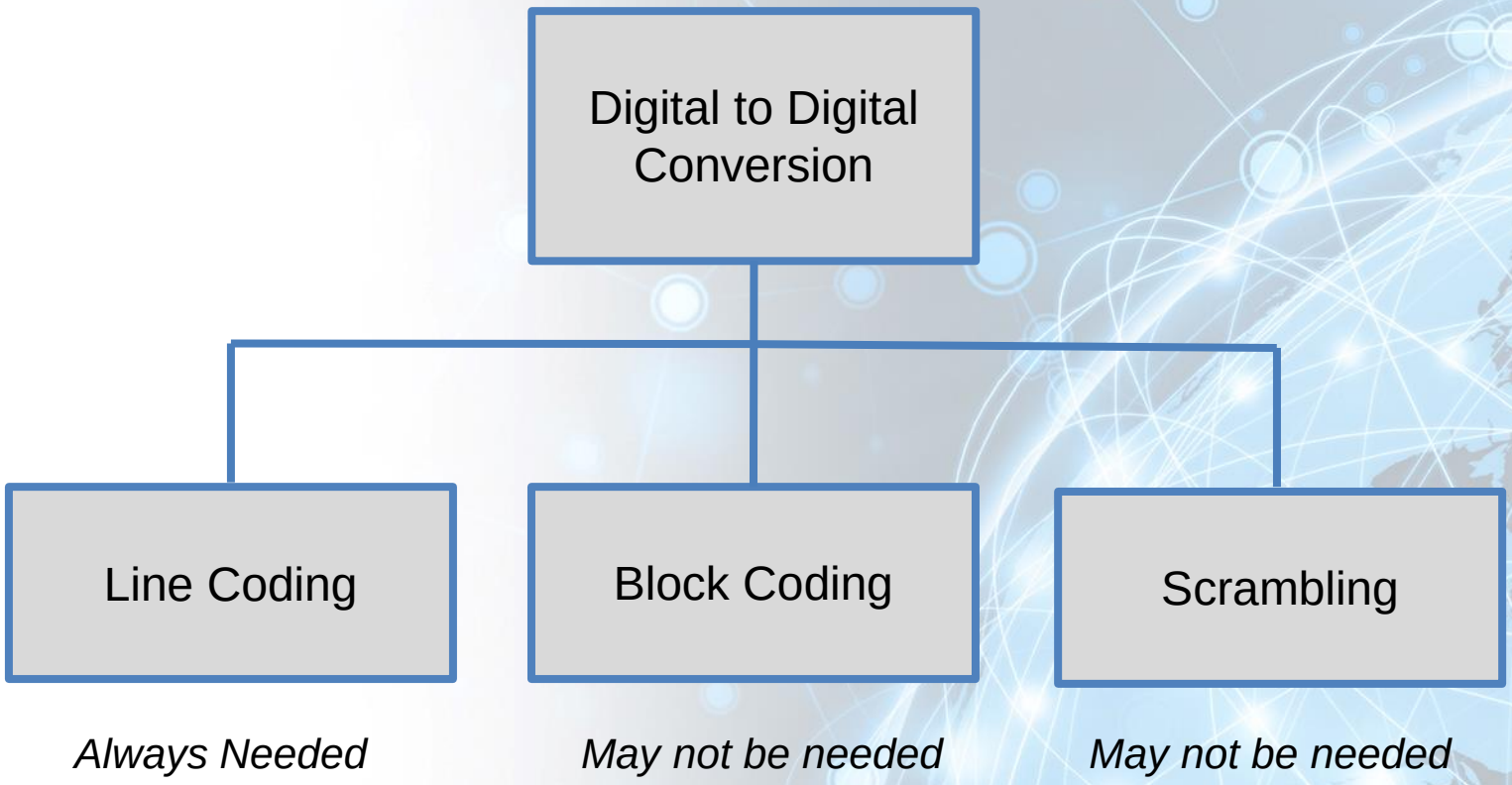
Digital-to-digital Conversion

- Data → Analog or Digital
- Signals → Analog or Digital
- Digital Transmission
- Analog Transmission

Digital Transmission



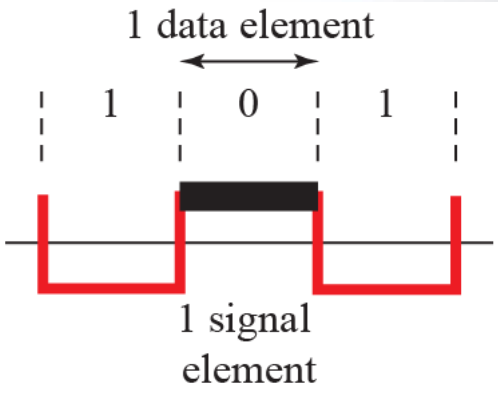
Digital to Digital Conversion



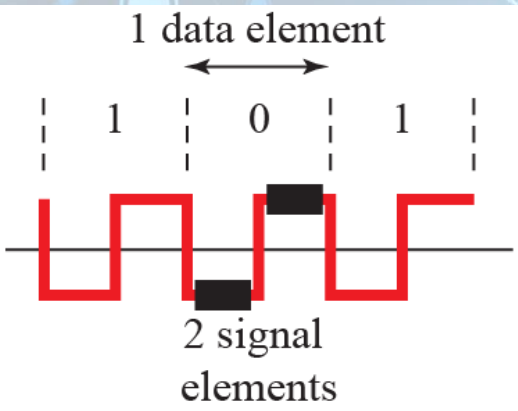
Signal Element versus Data Element

- A Data element is the smallest entity that can represent a piece of information → Bit
- A Signal element is the shortest unit of a digital signal
- Data Elements: Carried
- Signal Elements: Carriers

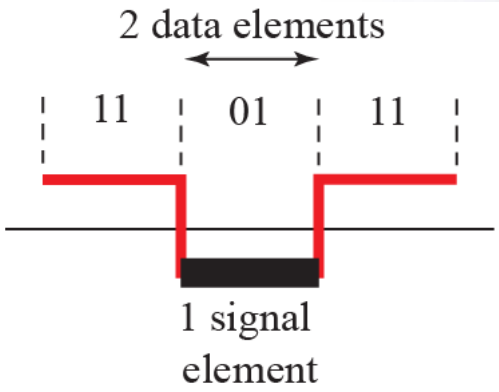
Signal Element versus Data Element



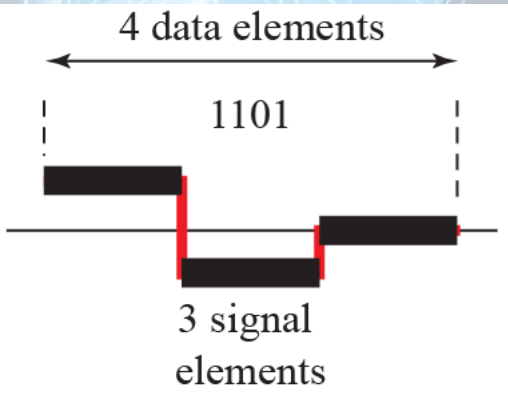
a. One data element per one signal element (r = 1)



b. One data element per two signal elements $\left(r = \frac{1}{2}\right)$



c. Two data elements per one signal element (r = 2)



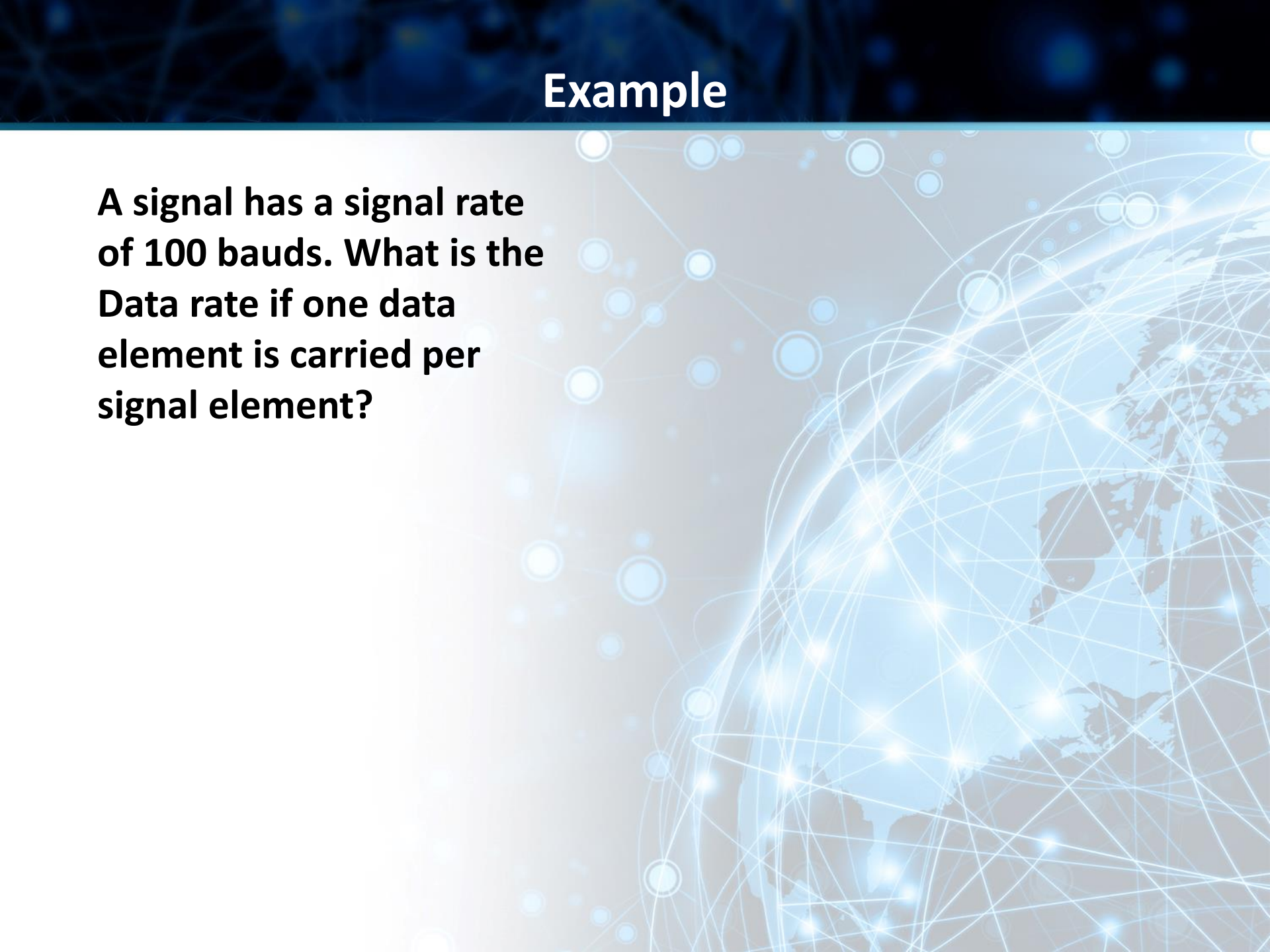
d. Four data elements per three signal elements $\left(r = \frac{4}{3}\right)$

Data Rate versus Signal Rate

- Data Rate is number of data elements sent in 1 sec (bps)
- Signal Rate is number of signal elements sent in 1 sec (baud)
- Data Rate → Bit Rate
- Signal Rate → Pulse Rate, Modulation Rate or Baud Rate

Example

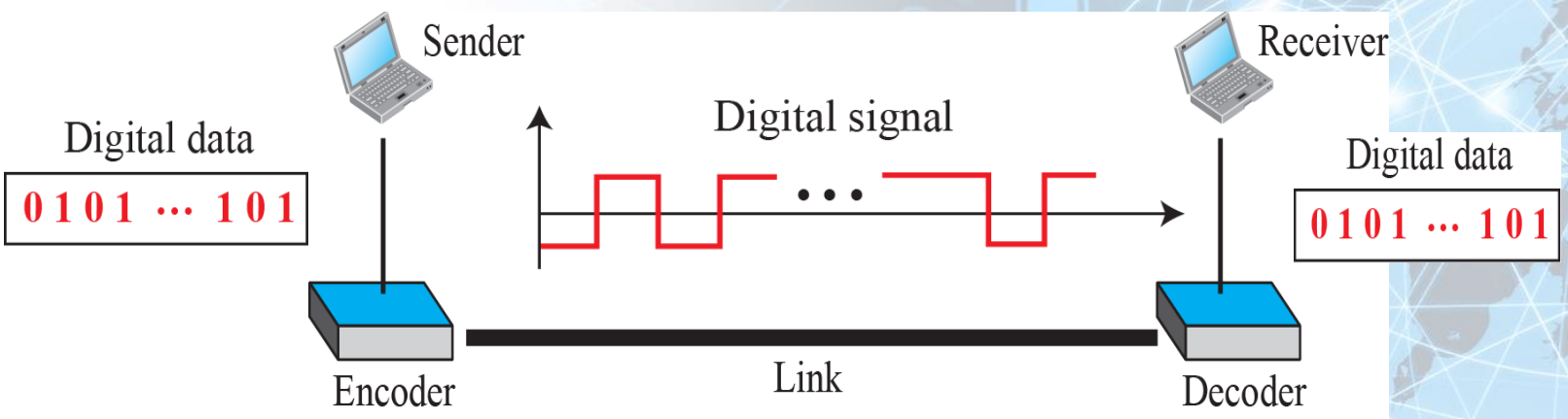
A signal has a signal rate of 100 bauds. What is the Data rate if one data element is carried per signal element?



Line Coding

- Digital data to Digital signals
- Data (Text, Numbers, Pictures, Audio, or Video) is stored in computer memory as sequences of bits
- Line coding converts a sequence of Bits to a Digital Signal

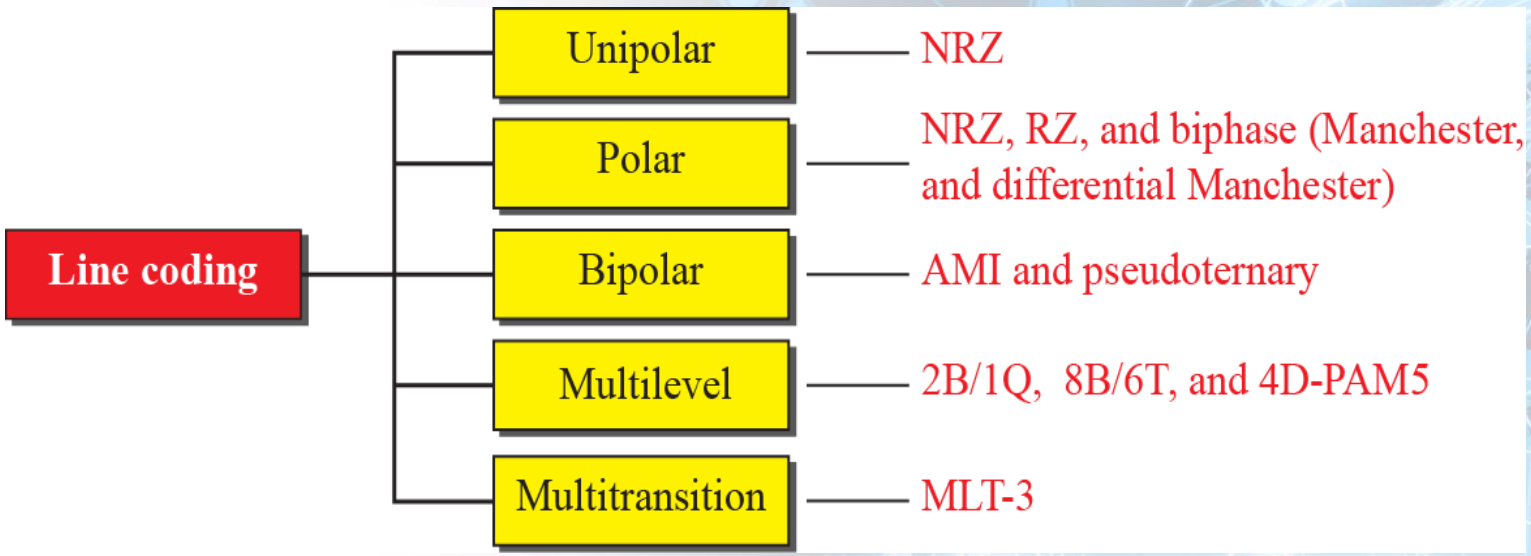
Line Coding and Decoding



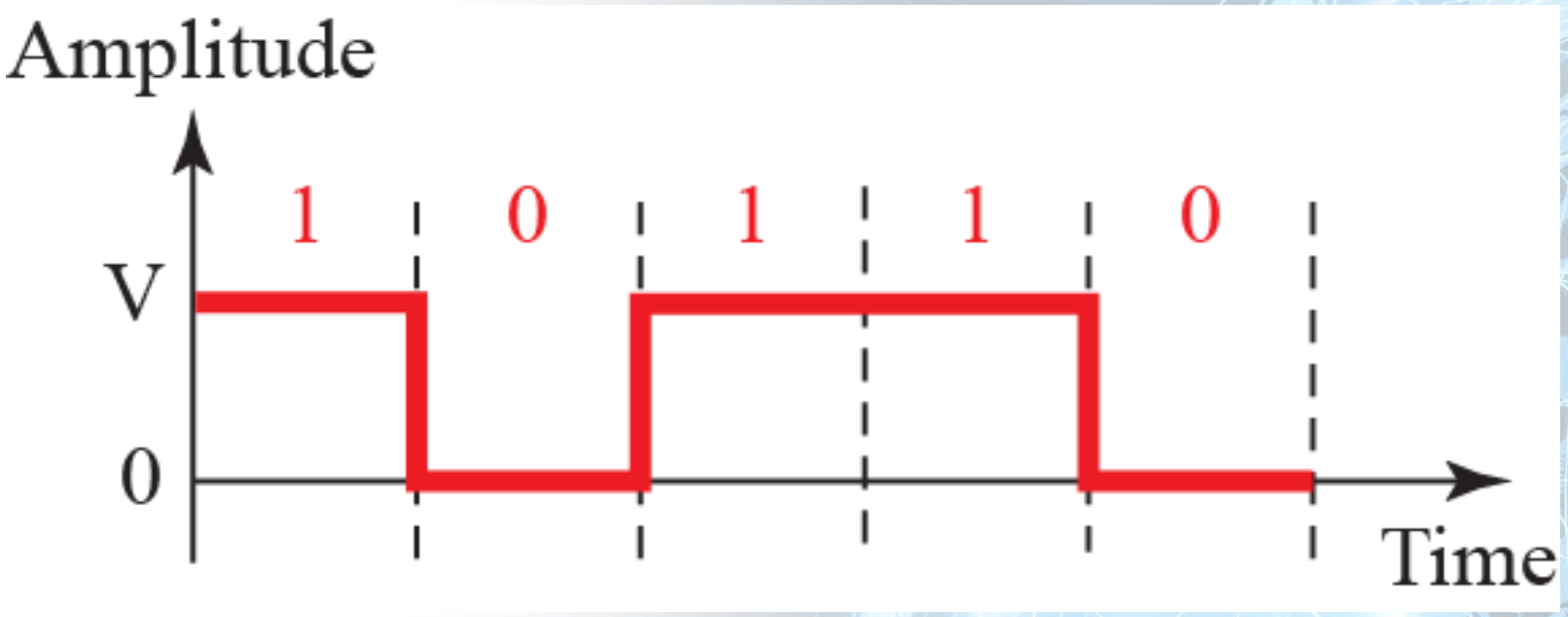
Line Coding Schemes

- We can roughly divide line coding schemes into five broad categories

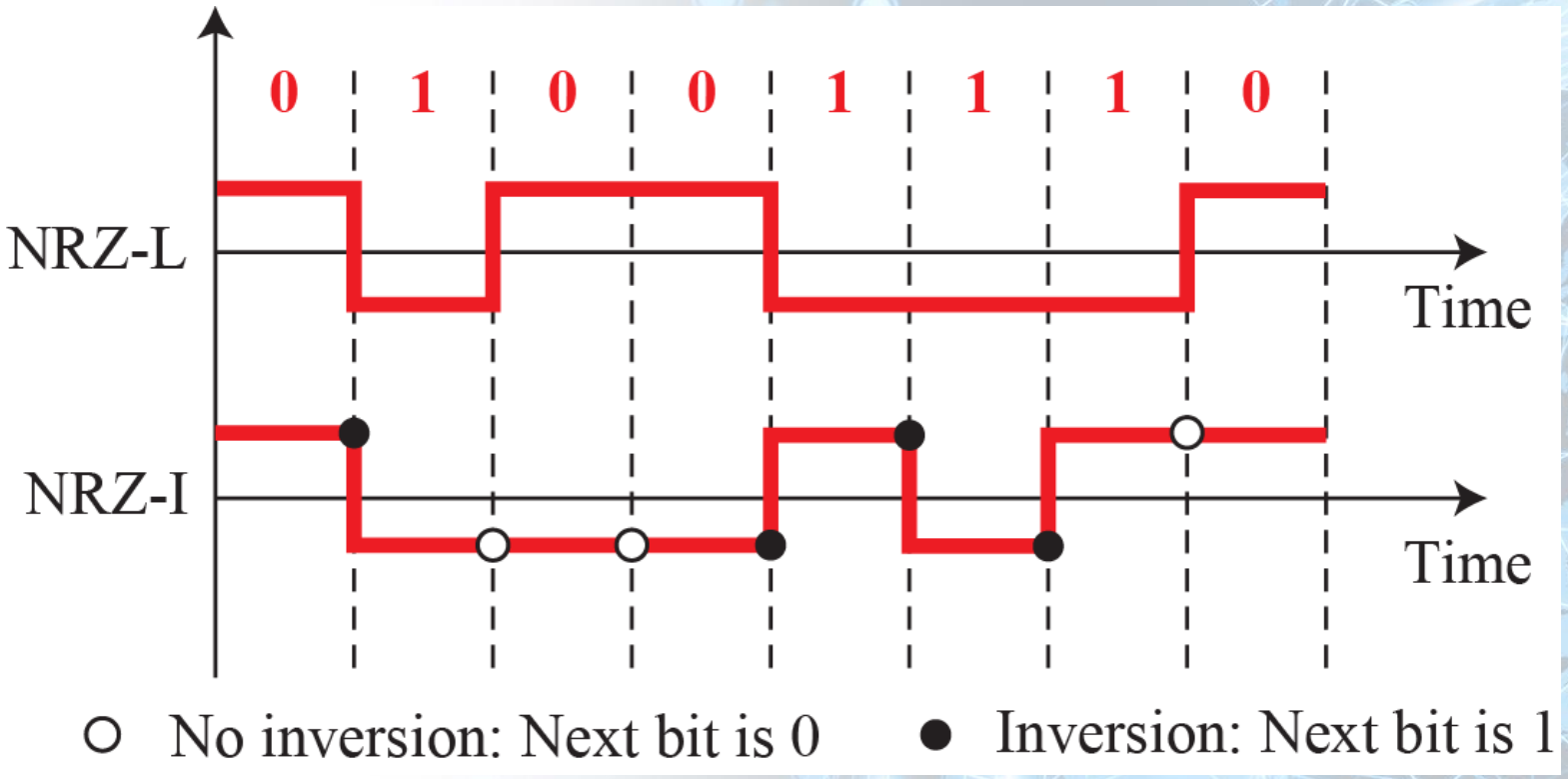
Line Coding Schemes



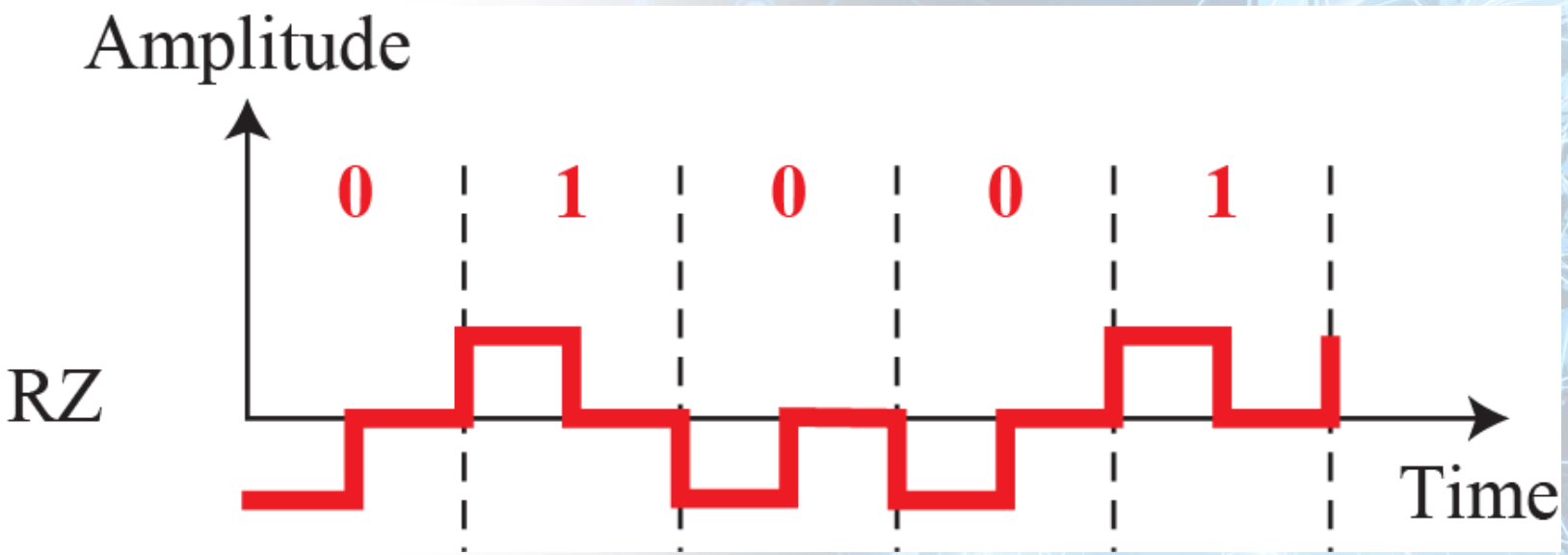
Unipolar NRZ scheme



Polar schemes (NRZ)



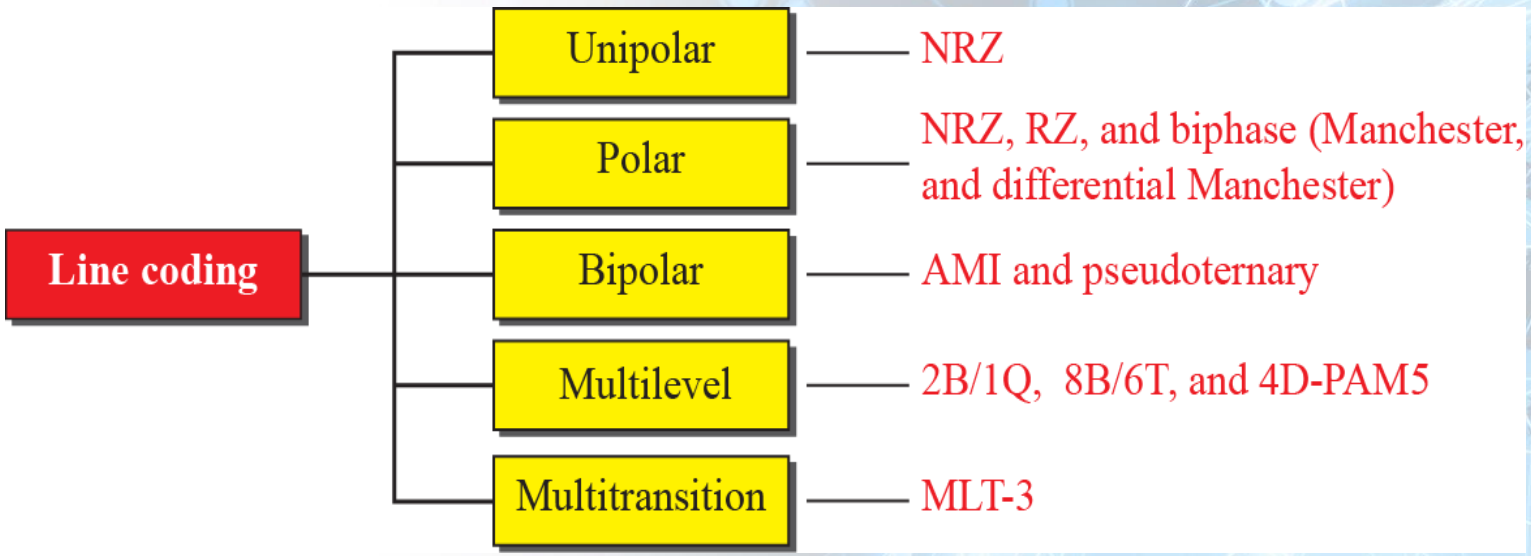
Polar schemes (RZ)



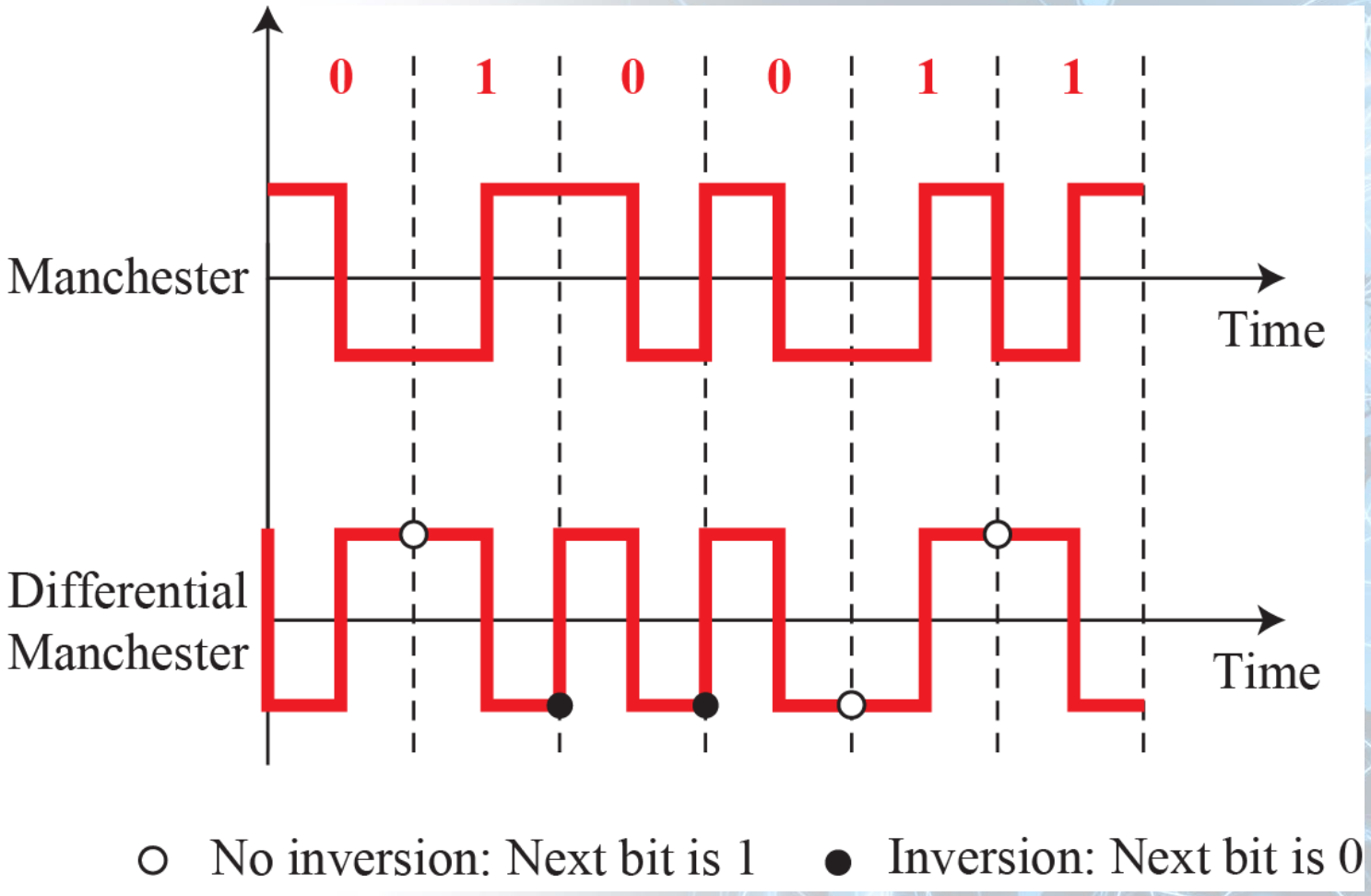
Line Coding Schemes

- We can roughly divide line coding schemes into five broad categories

Line Coding Schemes



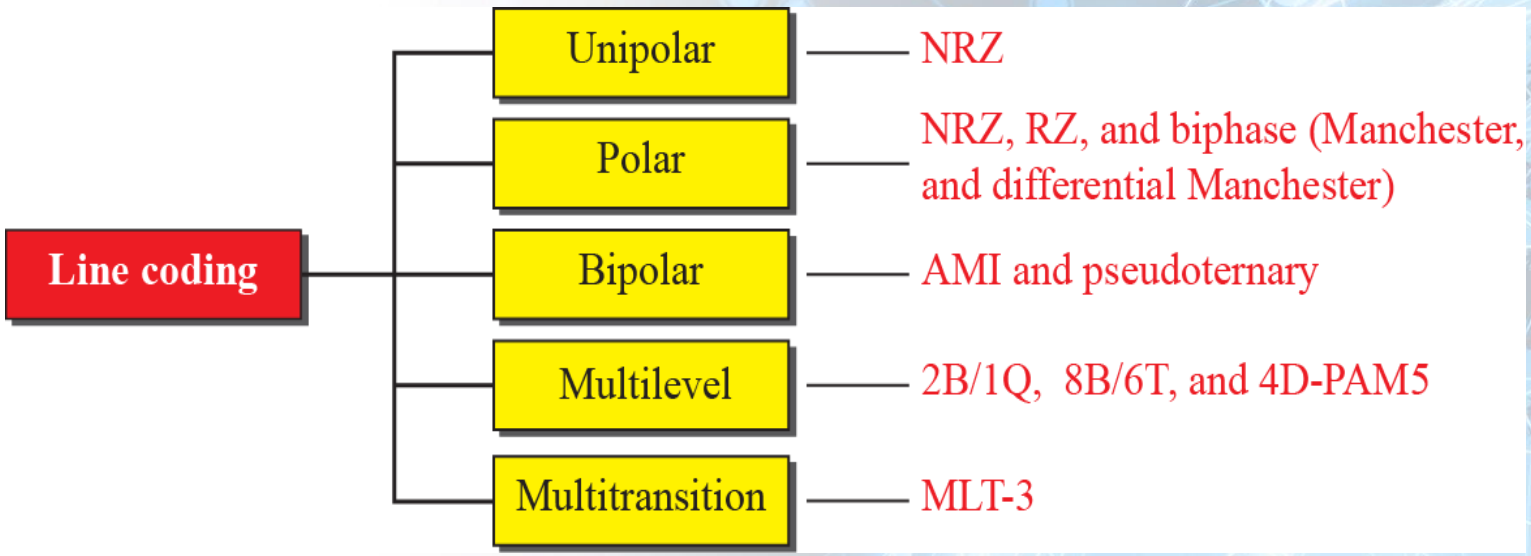
Polar Biphase



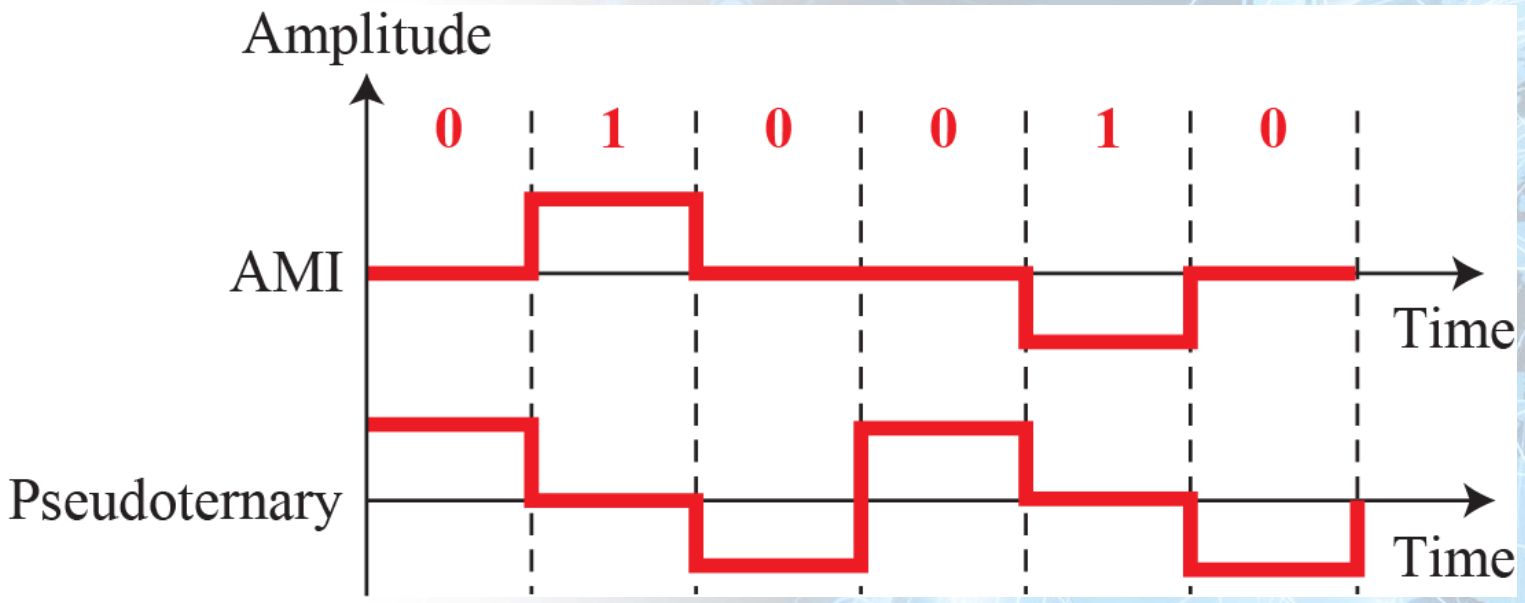
Line Coding Schemes

- We can roughly divide line coding schemes into five broad categories

Line Coding Schemes



Bipolar schemes: AMI & Pseudoternary



Multilevel: 2B1Q

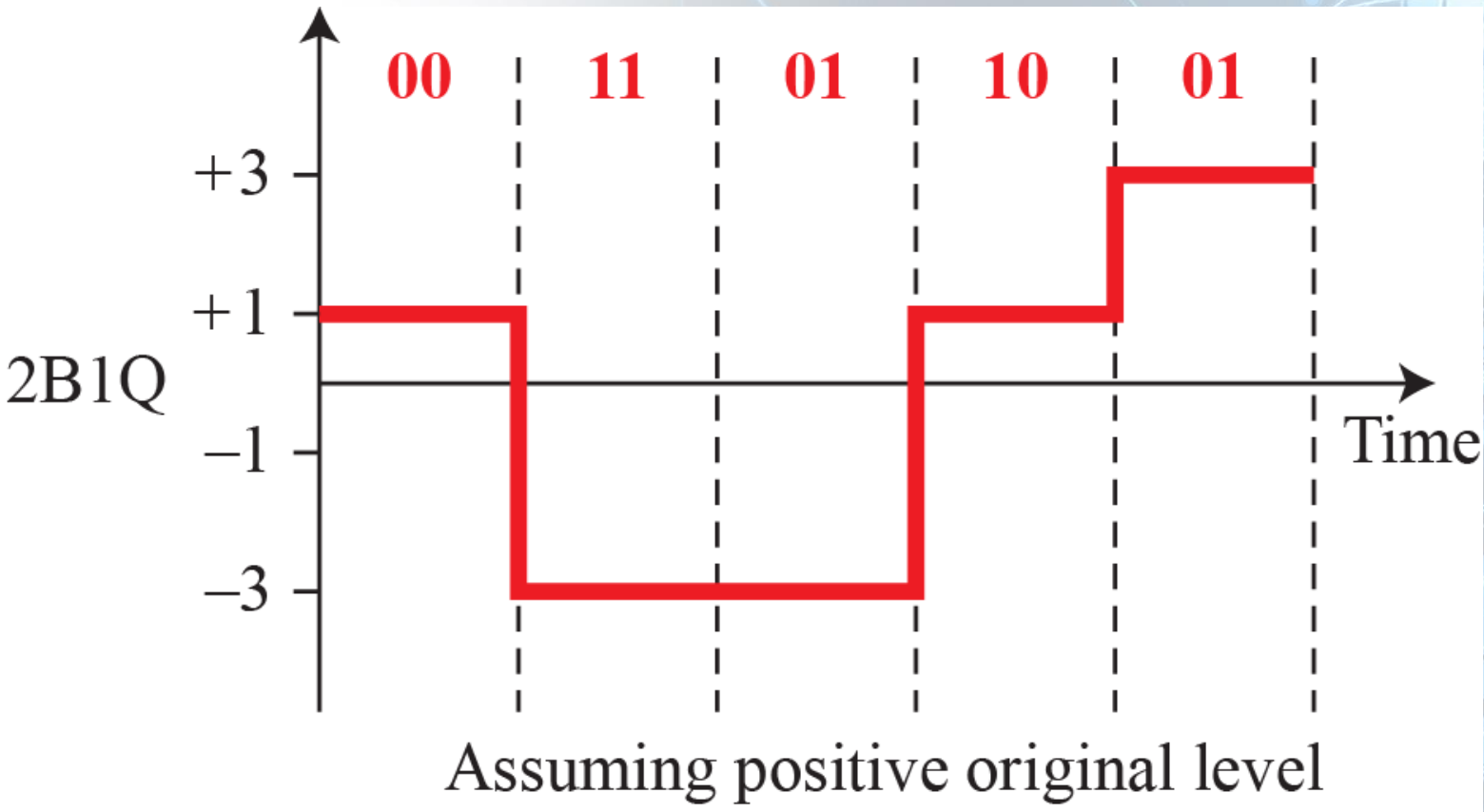


Table 4.1 : Summary of line coding schemes

Category	*Scheme*	*Bandwidth (average)*	*Characteristics*
Unipolar	NRZ	$B = N/2$	Costly, no self-synchronization if long 0s or 1s, DC
Polar	NRZ-L	$B = N/2$	No self-synchronization if long 0s or 1s, DC
	NRZ-I	$B = N/2$	No self-synchronization for long 0s, DC
	Biphase	$B = N$	Self-synchronization, no DC, high bandwidth
Bipolar	AMI	$B = N/2$	No self-synchronization for long 0s, DC
Multilevel	2B1Q	$B = N/4$	No self-synchronization for long same double bits
	8B6T	$B = 3N/4$	Self-synchronization, no DC
	4D-PAM5	$B = N/8$	Self-synchronization, no DC
Multitransition	MLT-3	$B = N/3$	No self-synchronization for long 0s