Modulation and Encoding

- Modulation
  - Amplitude
    - Two amplitudes to represent a 0 and 1
  - phase
    - Two phases to represent a 0 and 1
  - Frequency
    - Two frequencies to represent a 0 and 1

amplitude modulation

frequency modulation

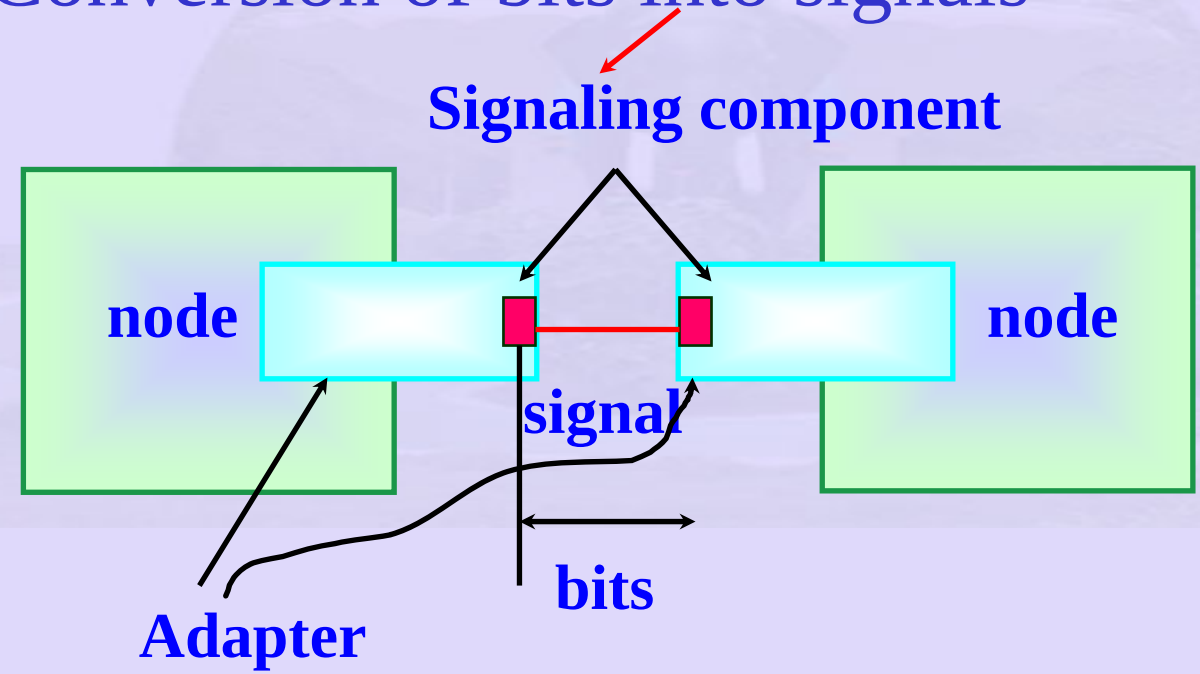
phase modulation

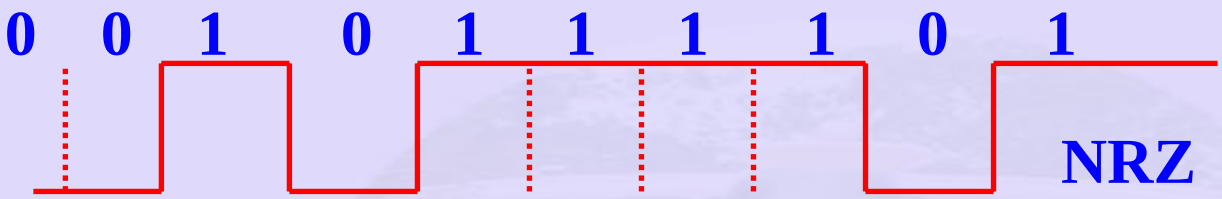
Modulation and Encoding

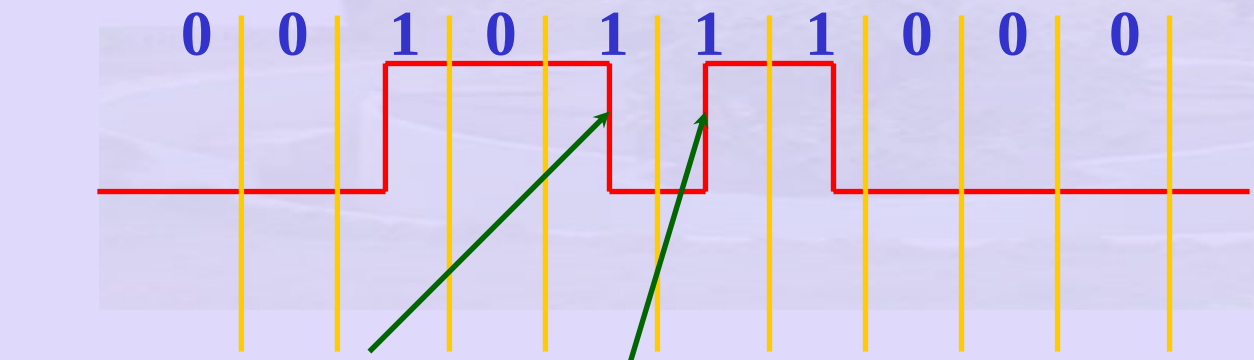
- Encoding
  - Required for clock recovery
  - A long sequence of 1s/0s can lead to clock wander
  - Receiver should be able synchronise
    - NRZ, NRZI, Manchester Encoding, Differential Manchester Encoding

Modulation and Encoding

- Conversion of bits into signals



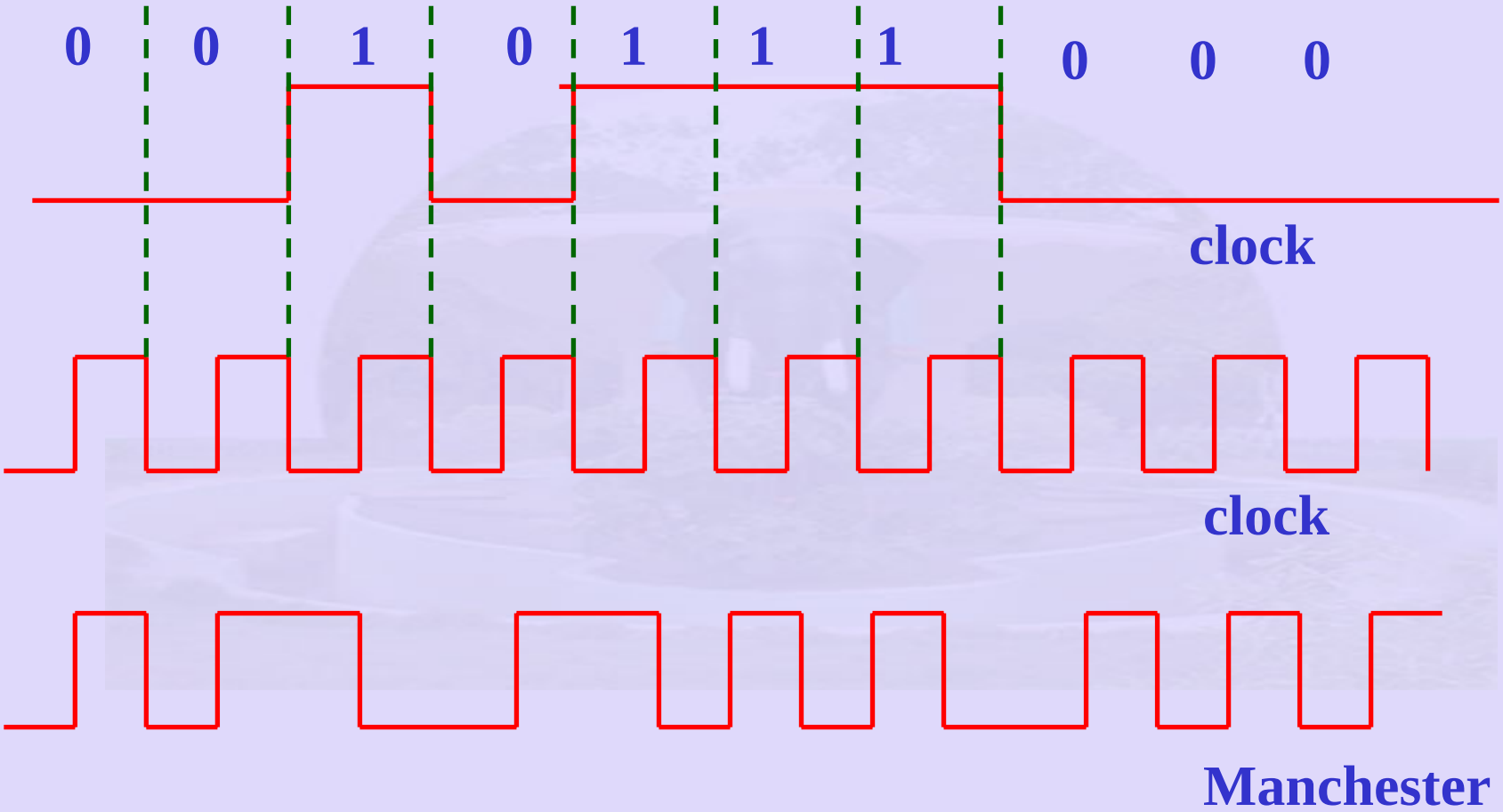




NRZI

Manchester coding: Used in Ethernet

EXOR of clock and NRZ



Physical Layer

- Xmitter/Rcvr – Trasmitter/receiver
- Amp/rep – amplifier/repeater

Physical Layer

- Mechanical:
  - connectors, cable
- Functions:
  - assign meaning to circuits
- Procedures:
  - establish / tear down connection, hand shaking
  - guided / unguided (TP / coaxial cable / fibre / radio)

Data Rate

- Baud Rate
  - Number of times the signal changes/second
- Bit Rate
  - Baud Rate*number of bits represented by sample

Data Rate

- Example: Signal takes one of 0, 1, …, 15 volts
  - BaudRate – b/s
  - Each signal value represents 4bits
  - Data Rate = b*4 bits/s
  - Greater the baudrate, greater the bandwidth required to transmit the signal
    - Shannon's theorem

Data Rate

- Nyquist rate:
  - signal passed through a low pass filter of bandwidth H recover from 2H samples.
- Clean Channel:
  - Maximum Data Rate = $2H \log_2 V$ bits/s
    - V – number of discrete lines
- Noisy channel:
  - Maximum Data Rate = $H \log_2 (1+S/N)$ bits/s
    - S/N – signal to noise ratio