Modulation
(An Overview)

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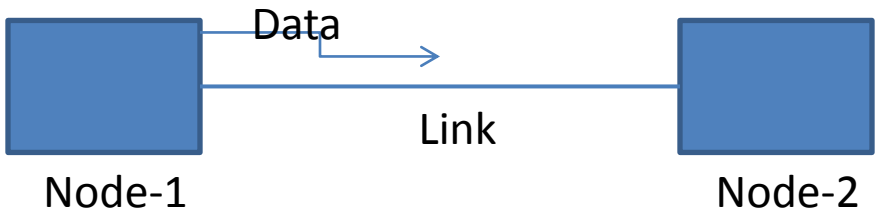
Recap

what is band width efficiency ????

- Nodes generate data (bits: 1's and 0's)
- Links carry signals in the form of electromagnetic waves
- Learnt some theory: Signals and bandwidth, Shannon Theorem, goals of modulation
- Ready for: Converting data into signals



Two approaches to Modulation

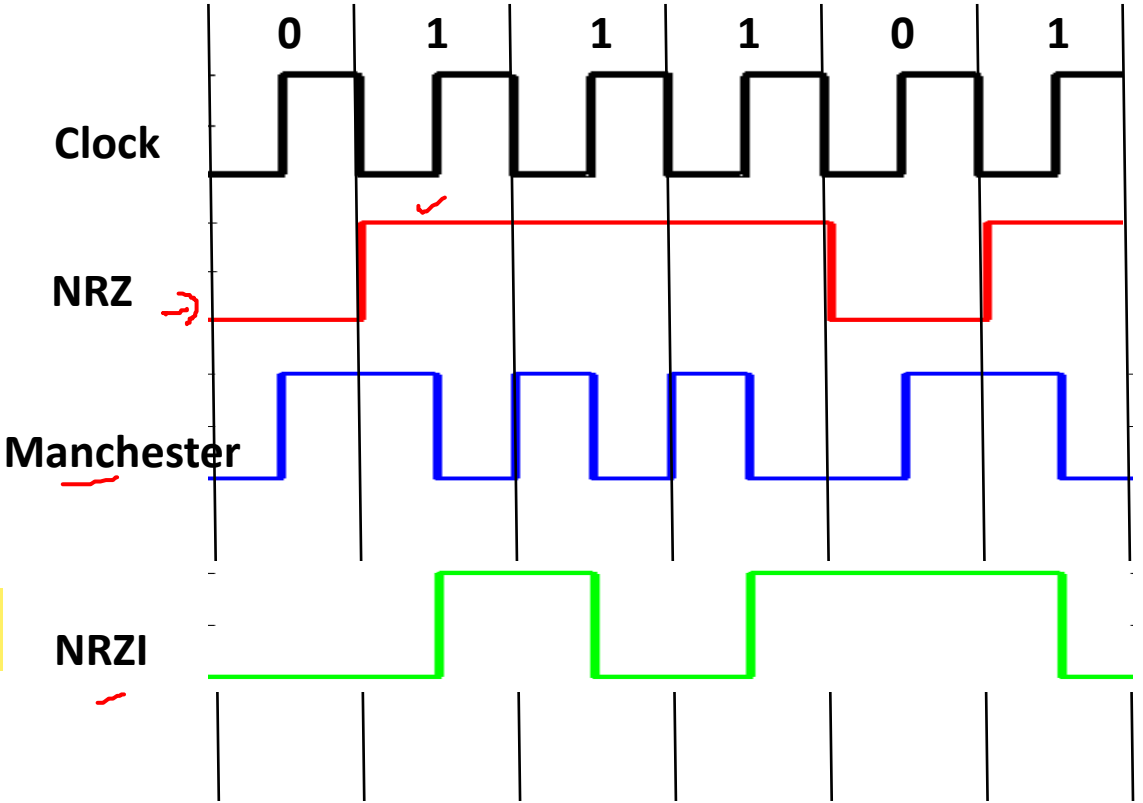
- Line Encoding (also called Digital Baseband Modulation)
  - Used in Ethernet, FDDI (fiber optics)

- Passband Modulation
  - Used in Wireless, ADSL

Asymmetric Digital Subscribed Line

Line Encoding

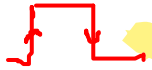
- Convert bits to “high” and “low” signals (voltage or power levels)
- Uses: Ethernet and FDDI
- Advantages: Quite simple



Limitations of Line Codes

data rate ↓ lower BW

- Bandwidth of line-coded signals is rather large (due to abrupt changes in signal) → Bandwidth of link (physical media) needs to be large



sudden changes produce high freq components

ideally u dont want abrupt changes in signals

  - Alternatively if the link bandwidth is fixed, these signals undergo more distortion

ampl ↓ freq ↑

- Presence of DC component hinders transmission

voltage staying same for long time introduces DC component.

  - E.g. AC coupling via transformers not feasible

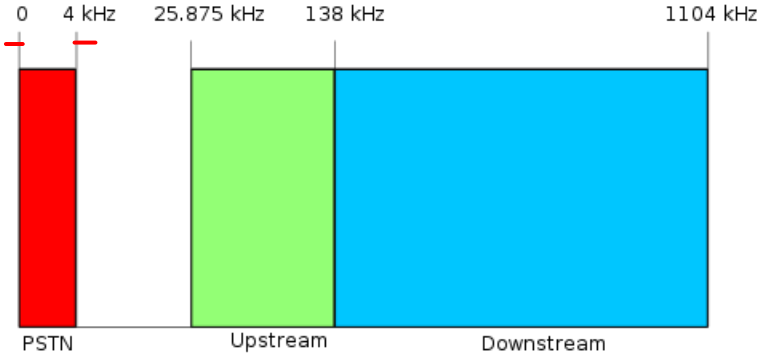
Limitations of Line Codes

- Baseband Modulation infeasible when signal has to be sent in designated spectrum band
  - E.g. WiFi (Wireless) allocated band is 2.4-2.4835Ghz.
  - ADSL: Data band can't overlap with voice band

u cannot shift the band

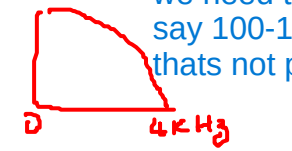
Telephone line

modem



NRZ – 2000 bps

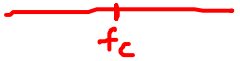
we need to shift to say 100-104, but thats not possible.



Passband Modulation

- Embed information in the amplitude, frequency or phase of a carrier signal [sinusoid: $cos(2\pi f_c t)$]
  - Carrier frequency: f_c
  - Spectrum centered around carrier frequency
- Used in Wireless and ADSL

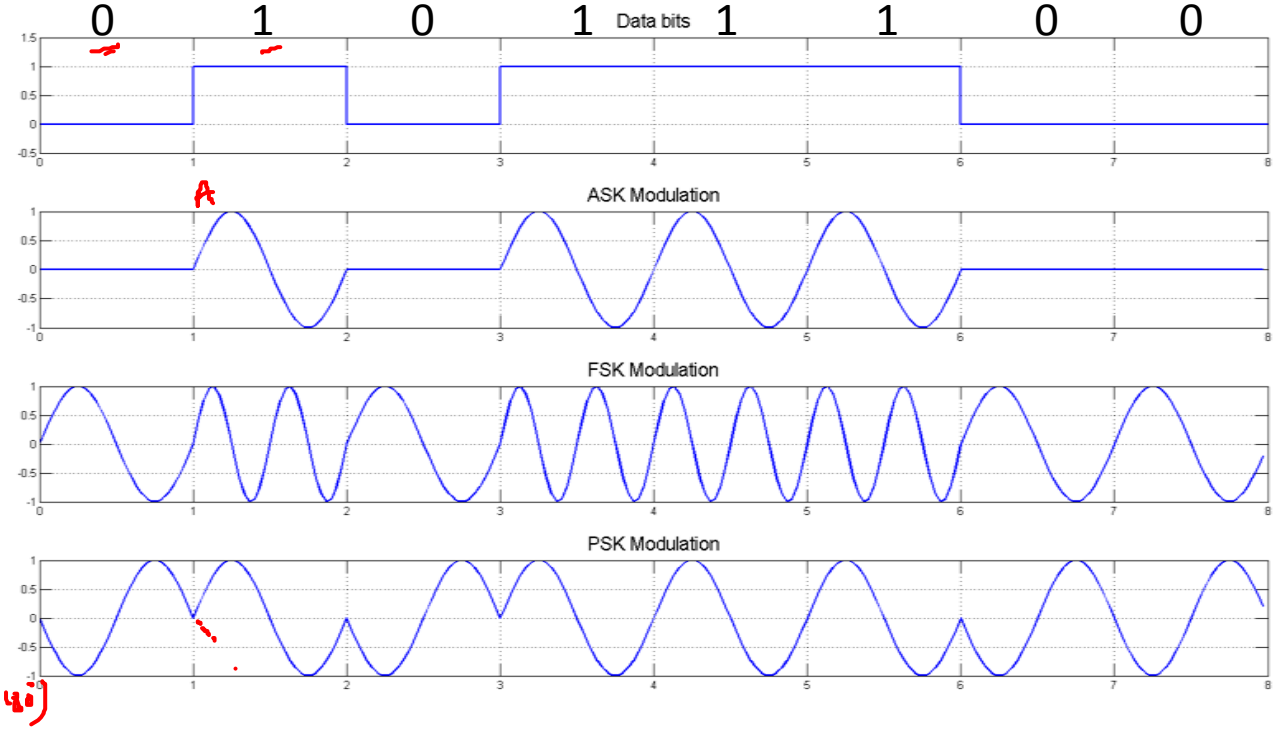
A, phase, freq.



so now we can set fc where we needed to shift , and the spectrum lies around fc.

Passband Modulation

- ASK: Amplitude Shift Keying
- BFSK: Binary Frequency Shift Keying
- BPSK: Binary Phase Shift Keying



Summary

- Two approaches towards converting bits to signals:
  - Line Coding: Not very efficient
    - Will cover a few popular line coding techniques (E.g. codes used in Ethernet)
  - Passband Modulation: Helps shift signal to desired frequency band
    - Very sophisticated techniques exist that achieve high bandwidth efficiency (not the focus of this course)