ET4254 – Communications and Networking 1

Topic 6

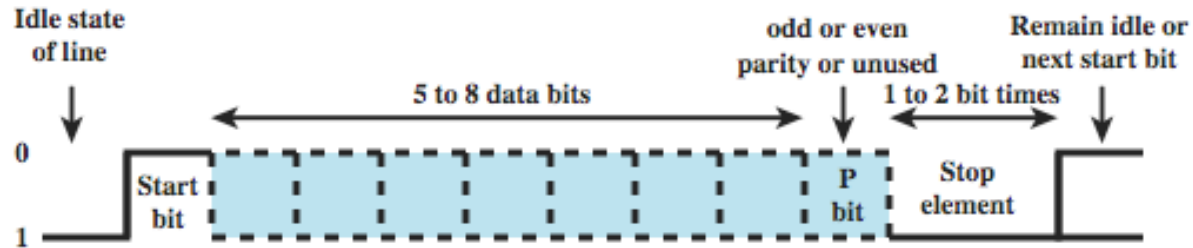### Digital Data Communications Techniques

Aims:-

- asynchronous verses synchronous transmission
- error detection and correction
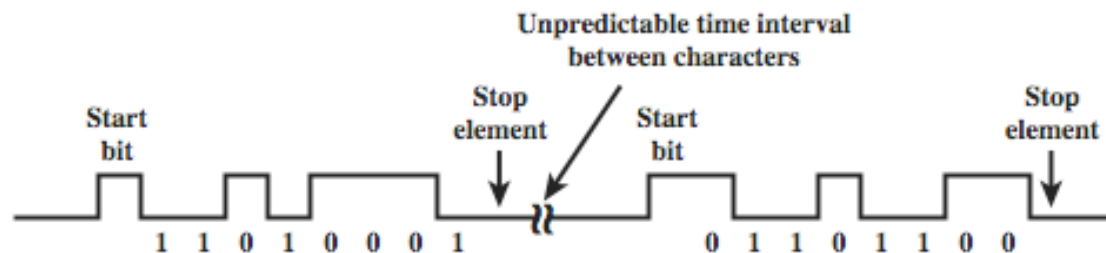- line configuration issues

Asynchronous and Synchronous Transmission

- timing problems require a mechanism to synchronize the transmitter and receiver
  - receiver samples stream at bit intervals
  - if clocks not aligned and drifting will sample at wrong time after sufficient bits are sent
- two solutions to synchronizing clocks
  - asynchronous transmission
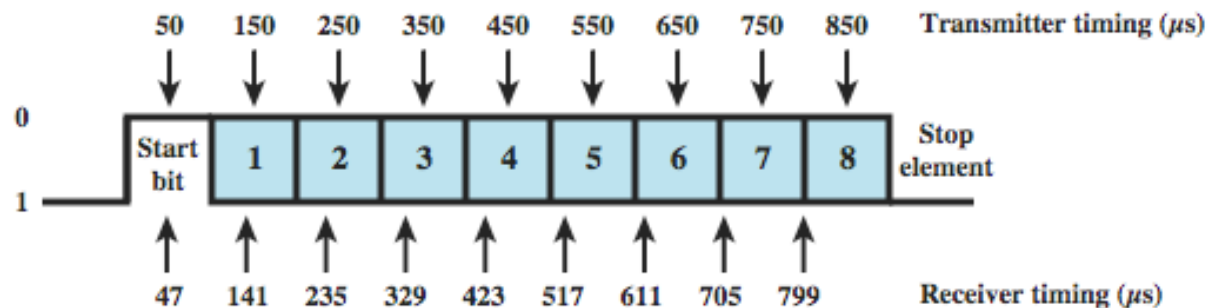 - synchronous transmission

Asynchronous Transmission

Idle state of line | odd or even parity or unused | Remain idle or next start bit

5 to 8 data bits

1 to 2 bit times

0

Start bit | P bit | Stop element

1

(a) Character format

Unpredictable time interval between characters

Start bit | Stop element | Start bit | Stop element

1 1 0 1 0 0 0 1 | 0 1 1 0 1 1 0 0

(b) 8-bit asynchronous character stream

50   150   250   350   450   550   650   750   850   Transmitter timing (μs)

0

Start bit | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Stop element

1

47   141   235   329   423   517   611   705   799   Receiver timing (μs)

(c) Effect of timing error

Asynchronous - Behavior

- simple

- cheap

- overhead of 2 or 3 bits per char (~20%)

- good for data with large gaps (keyboard)

Synchronous Transmission

- block of data transmitted sent as a frame
- clocks must be synchronized
  - can use separate clock line
  - or embed clock signal in data
- need to indicate start and end of block
  - use preamble and postamble
- more efficient (lower overhead) than async

8-bit flag	Control fields	Data Field	Control fields	8-bit flag

Types of Error

- an error occurs when a bit is altered between transmission and reception
- single bit errors
  - only one bit altered
  - caused by white noise
- burst errors
  - contiguous sequence of B bits in which first last and any number of intermediate bits in error
  - caused by impulse noise or by fading in wireless
  - effect greater at higher data rates

Error Detection

- will have errors
- detect using error-detecting code
- added by transmitter
- recalculated and checked by receiver
- still chance of undetected error
- parity
  - parity bit set so character has even (even parity) or odd (odd parity) number of ones
 - even number of bit errors goes undetected

Error Detection Process
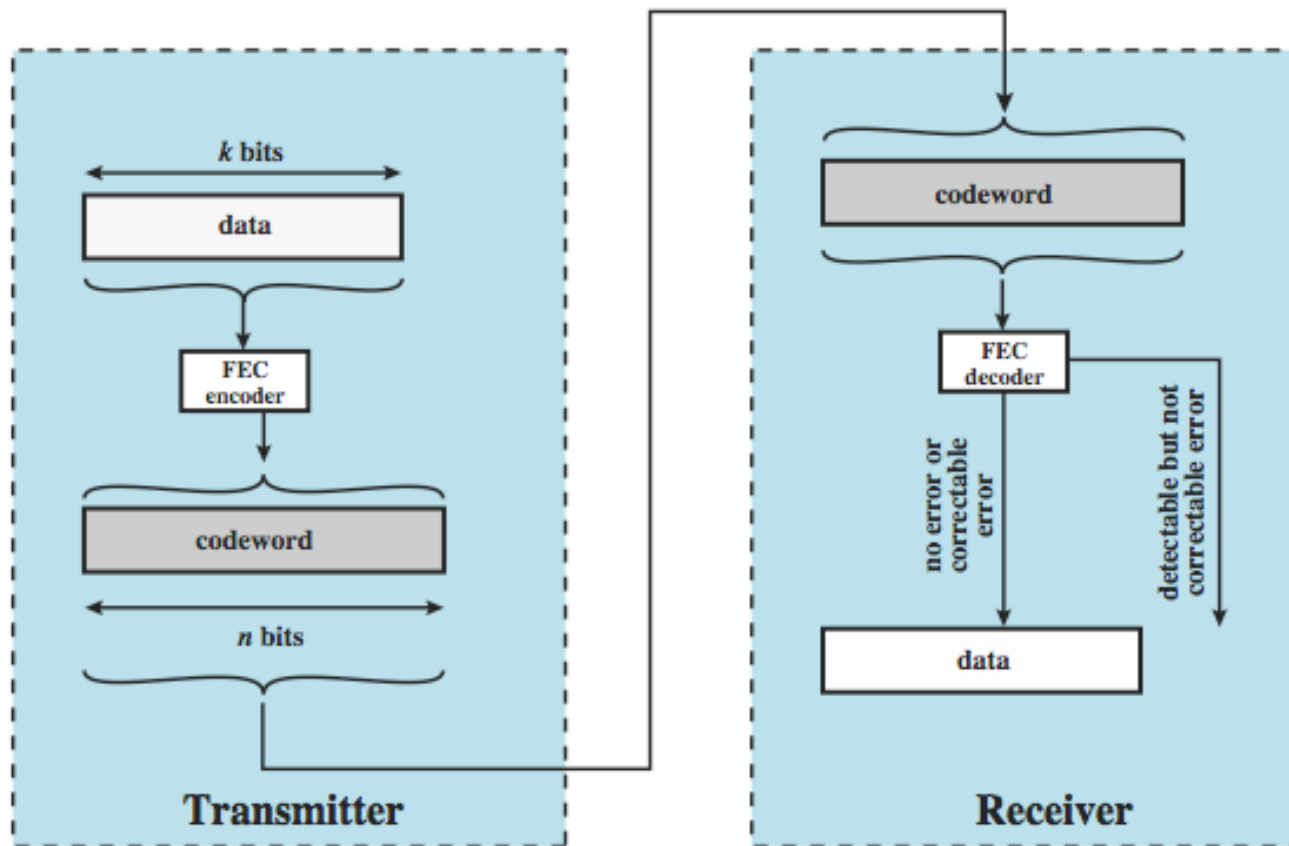
Cyclic Redundancy Check

- one of most common and powerful checks

- for block of k bits transmitter generates an n bit frame check sequence (FCS)

- transmits $k+n$ bits which is exactly divisible by some number

- receiver divides frame by that number

  - if no remainder, assume no error

  - for math, see Stallings chapter 6

Error Correction

- correction of detected errors usually requires data block to be retransmitted
- not appropriate for wireless applications
  - bit error rate is high causing lots of retransmissions
  - when propagation delay long (satellite) compared with frame transmission time, resulting in retransmission of frame in error plus many subsequent frames
- instead need to correct errors on basis of bits received
- error correction provides this

Error Correction Process
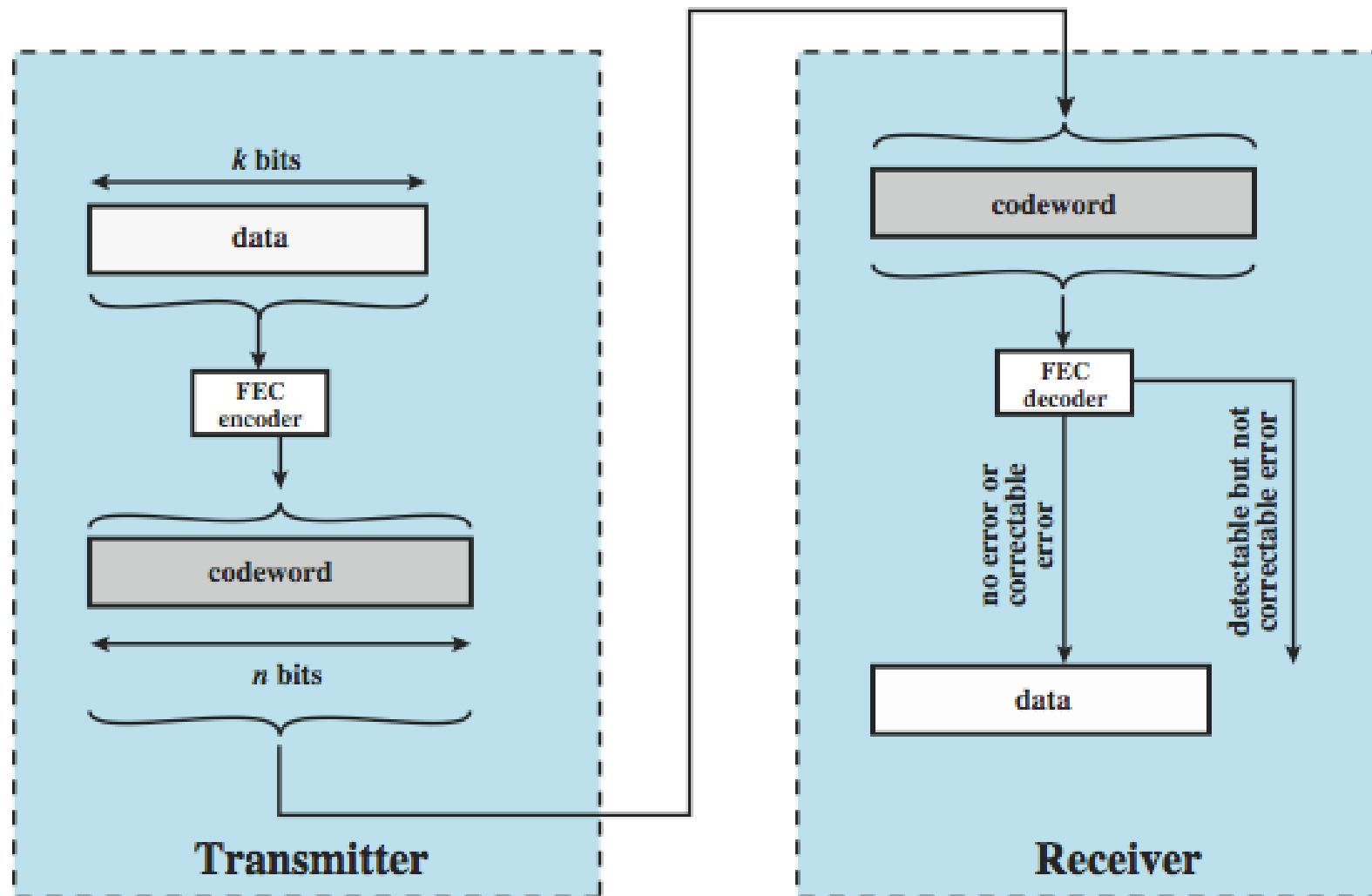
How Error Correction Works

- adds redundancy to transmitted message
- can deduce original despite some errors
- eg. block error correction code
    - map k bit input onto an n bit codeword
    - each distinctly different
    - if get error assume codeword sent was closest to that received
- for math, see Stallings chapter 6
- means have reduced effective data rate

Line Configuration - Topology

- physical arrangement of stations on medium
    - point to point - two stations
        - *such as between two routers / computers*
    - multi point - multiple stations
        - *traditionally mainframe computer and terminals*
        - *now typically a local area network (LAN)*

Line Configuration - Topology

(a) Point-to-point

Host (primary)

Terminals (secondaries)

(b) Multipoint
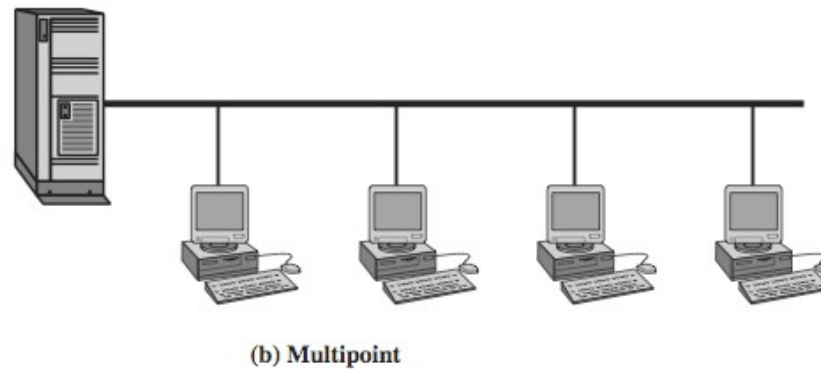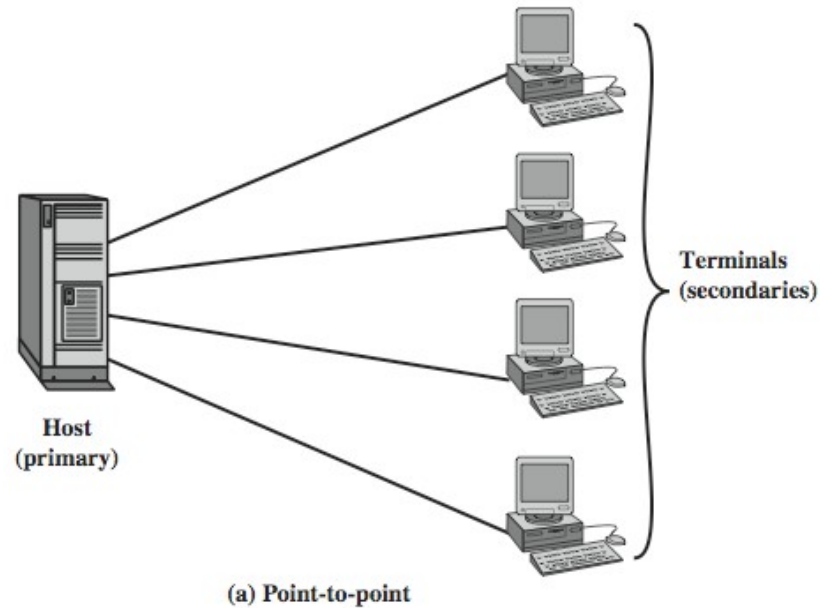
Line Configuration - Duplex

- classify data exchange as half or full duplex
- half duplex (two-way alternate)
  - only one station may transmit at a time
  - requires one data path
- full duplex (two-way simultaneous)
  - simultaneous transmission and reception between two stations
  - requires two data paths
    - *separate media or frequencies used for each direction*
  - or echo canceling

Summary

- asynchronous verses synchronous transmission
- error detection and correction
- line configuration issues