

Data and Computer Communications

**Chapter 6 – Digital Data Communications
Techniques**

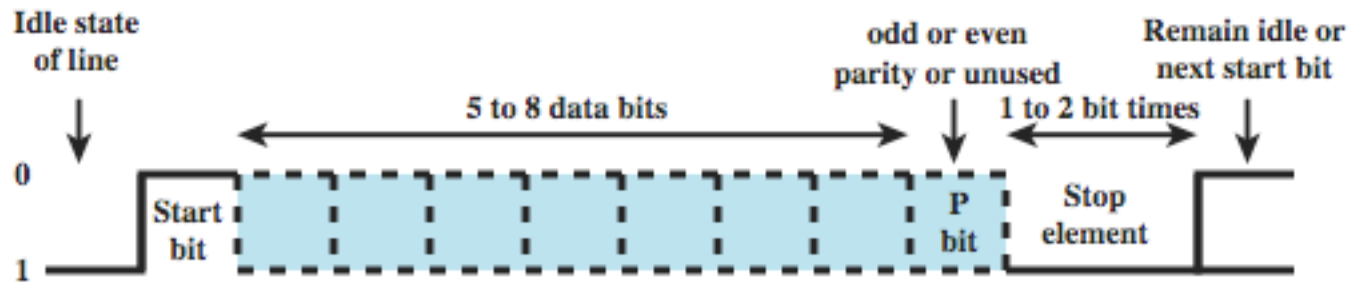
Eighth Edition

by William Stallings

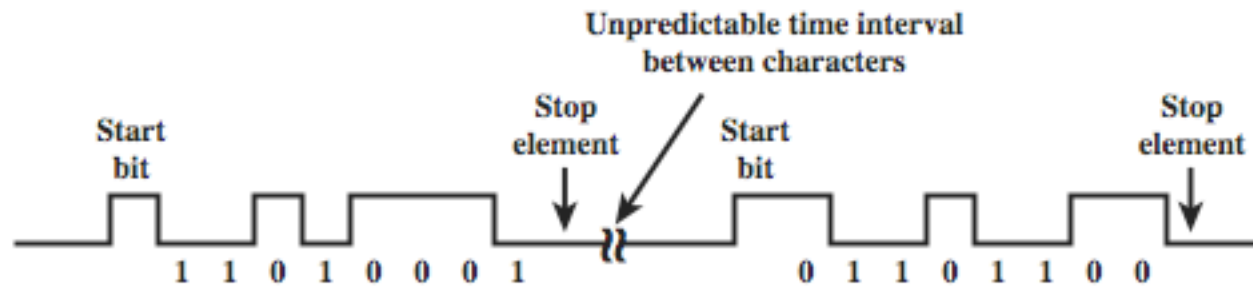
Lecture slides by Lawrie Brown

Asynchronous and Synchronous Transmission

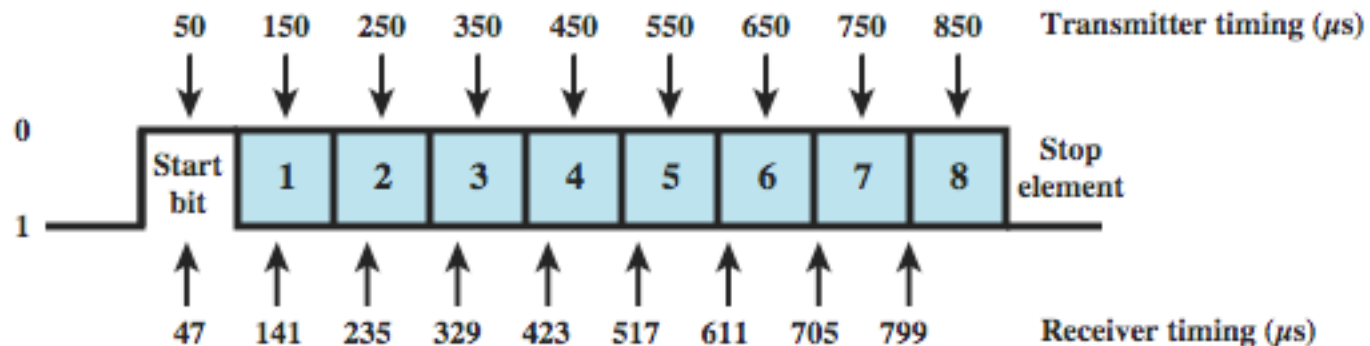
- Transmission of data requires co-operation and agreement bet. transmitter and receiver
- timing problems require a mechanism to synchronize the transmitter and receiver
 - receiver samples stream at bit intervals
 - if the two clocks are not aligned and drifting, receiver will sample at wrong time after sufficient bits are sent
- two solutions to synchronizing clocks
 - asynchronous transmission
 - synchronous transmission



(a) Character format



(b) 8-bit asynchronous character stream



(c) Effect of timing error

Asynchronous Transmission

- Send one character at a time
 - each character begins with a start bit to alert the receiver
 - receiver samples each bit in the character
 - the data bits are usually followed by a parity bit
 - the final element is a *stop element*
 - the stop element is the same as the idle state
- Characteristics
 - simple
 - cheap
 - overhead of 2 or 3 bits per char (~20%)
 - good for data with large gaps (keyboard)

Synchronous Transmission

- block of data transmitted 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

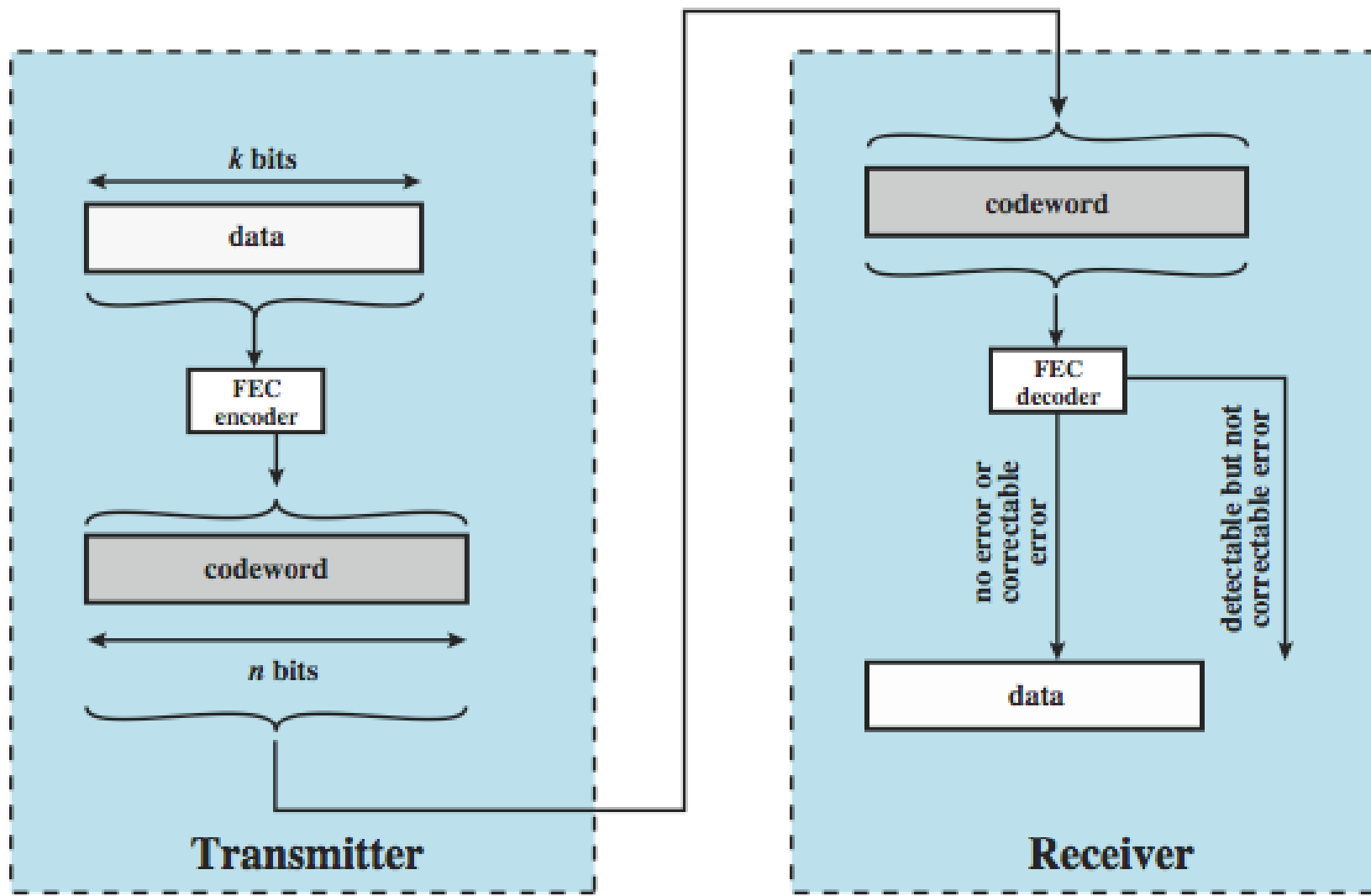


Types of Error

- 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

- there will be errors introduced by the tx. system
- Error detection done using error-detecting code
- function of data bits, calculated by transmitter and appended to the frame
- recalculated and checked by receiver
- still chance of undetected error
- Error detection using parity
 - parity bit set so character has even (even parity) or odd (odd parity) number of ones
 - even number of bit errors goes undetected

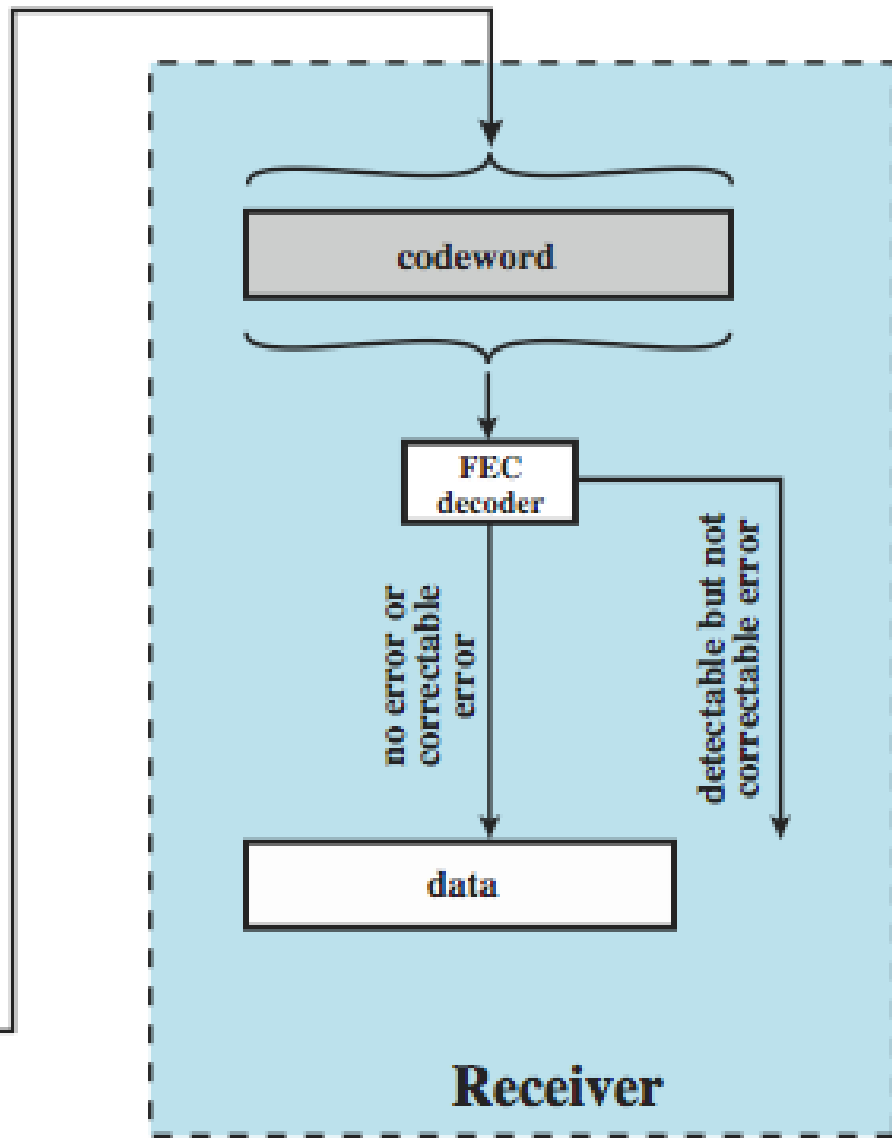
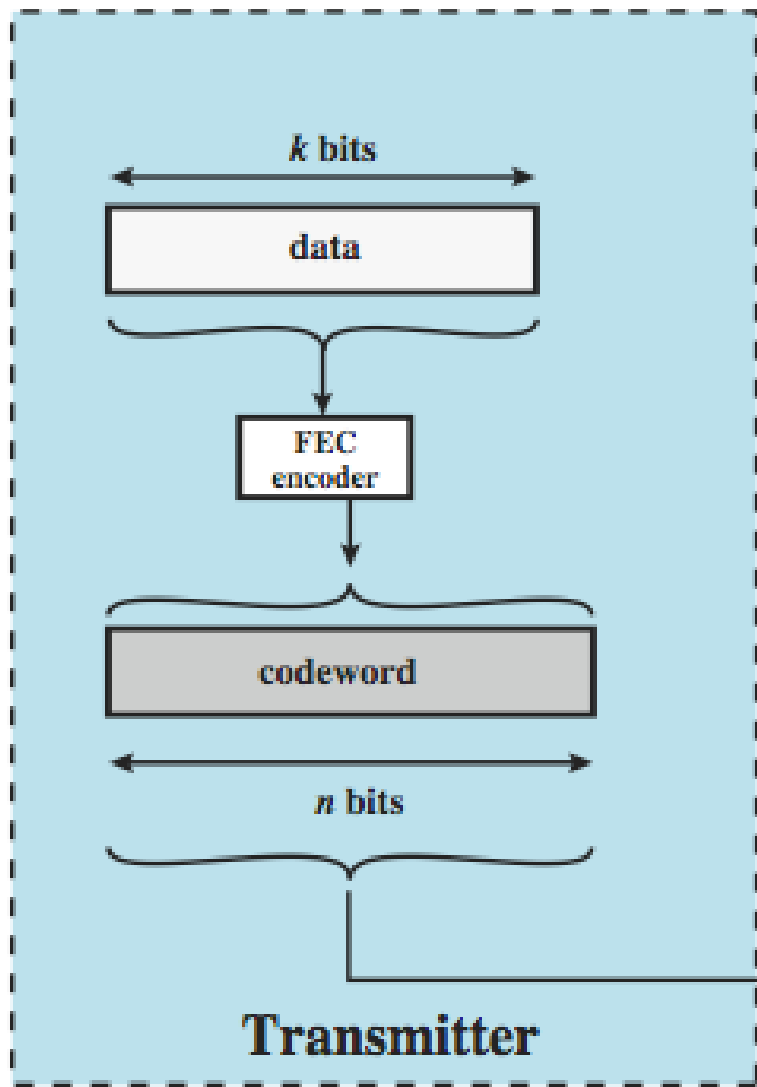


Cyclic Redundancy Check

- 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



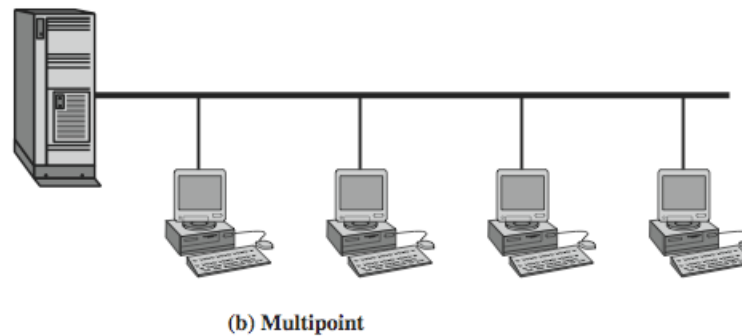
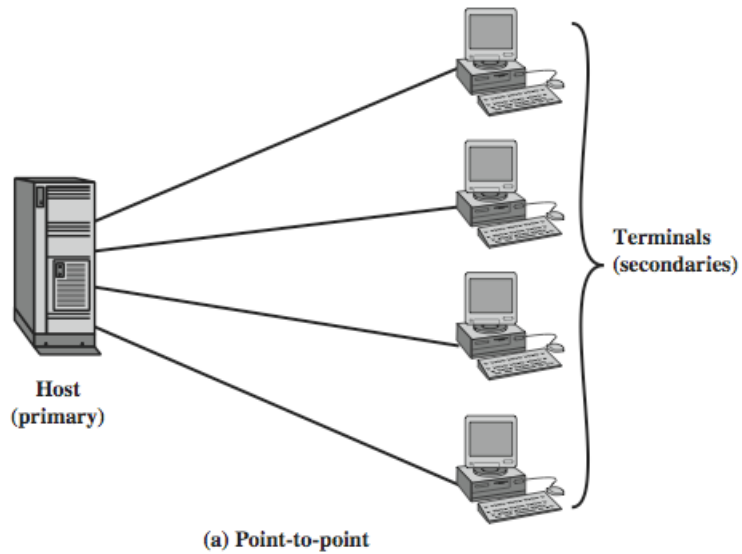
How Error Correction Works

- 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



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 versus synchronous transmission
- error detection and correction
- line configuration issues