SET 4573: Data Communication and Switching System

Chapter 3: Data Communication Basic

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Asynchronous and Synchronous Transmission

- Synchronization is to synchronize the transmitter and receiver
  - receiver samples data stream at bit intervals
  - the clocks has to be aligned so that the sampling is done at the correct time
- Two solutions to synchronizing clocks
  - asynchronous transmission
  - synchronous transmission

Asynchronous Transmission

- Simple and cheap method of transmission
- Every character is sent with overhead of 2 or 3 bits (start, parity and stop bit)
- ~20% loss due to overhead

Synchronous Transmission

- block of data transmitted sent as a frame/packet
- clocks must be synchronized
  - using separate clock line or
  - embedded clock signal in the data sent
- indication for the start and end of block
  - use preamble and postamble (flag and control fields)
- more efficient (lower overhead) than asynchronous transmission

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

Error in Transmission

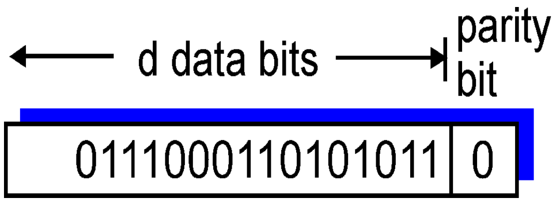
- an error occurs when a bit is altered between transmission and reception process
  - e.g. from ‘1’ to ‘0’ or vice versa
- single bit errors
  - only one bit altered
- burst errors
  - sequence of several bits in error
  - mostly occur at higher data rates

Error Detection

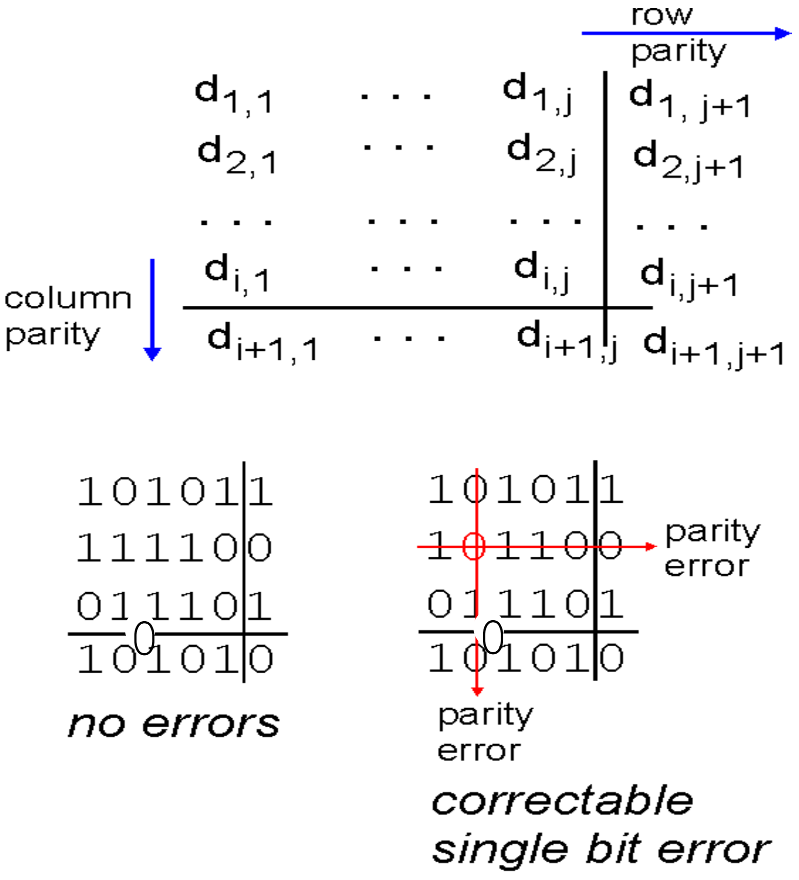
- detect using error-detecting code
- added by transmitter
- recalculated and checked by receiver
- example
  - parity
    - parity bit is set so character has even (even parity) or odd (odd parity) number of ‘1’
    - even number of bit errors cannot be detected
  - Cyclic Redundancy Check (CRC)
    - check a block number of bits

Parity Checking

Single bit parity:
Detect single bit error

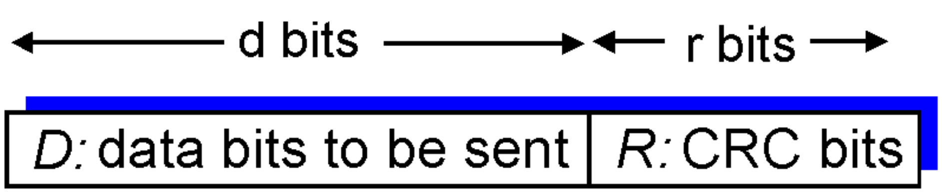


Two Dimensional Bit Parity:
Detect & correct single bit error



Cyclic Redundancy Check

- for a block of *d* bits, transmitter generates an *r* bit of CRC bit
- transmits *(d+r)* bits which is exactly divisible by a pre-determined number, G (r+1 bits)
- receiver divides the frame by G (modulo 2)
  - if no remainder, no error detected



bit pattern

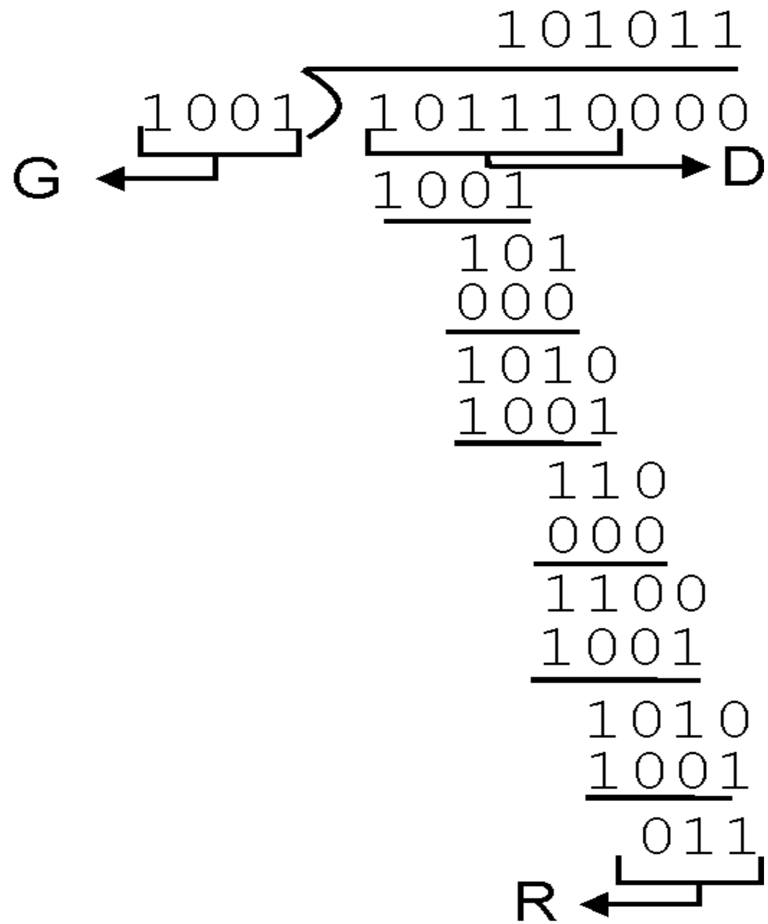
$$D * 2^r \quad XOR \quad R$$

mathematical formula

CRC Example

- Divide $D \cdot 2^r$ by G using modulo-2
- Add the remainder R to the end of the bits

$$R = \text{remainder}[\frac{D \cdot 2^r}{G}]$$



Error Control

- Detection and correction of errors
- 2 types of 'error'
  - lost frames
  - damaged frames
- Error correction
  - positive/negative acknowledgment
  - retransmission
    - after timeout
    - if negative acknowledgement

Flow Control techniques

- Stop and Wait
- Sliding Window
  - Go-back-N
  - Selective Reject

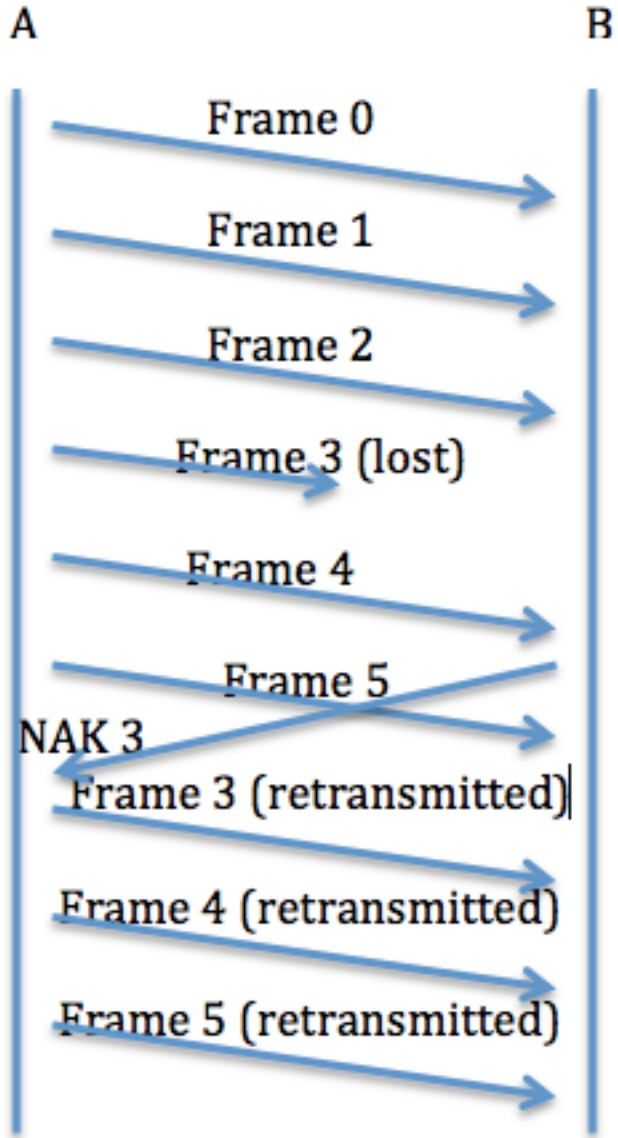
Stop and Wait

- Source transmits single frame/packet
  - wait for ACK for the frame sent
  - if ACK frame received correctly, send the next frame
  - if negative ACK frame is received, retransmit the sent frame
  - if no ACK frame received within timeout, retransmit the sent frame

Go-Back-N

- Works based on sliding window
  - send multiple number of frame simultaneously
  - the number of frames that can be sent depends on window size
  - one ACK frame can acknowledge a number of frames sent
- If negative ACK is received for a frame
  - retransmit the 'error frame(s)' and all subsequent frame(s) that have been sent

Go-Back-N Diagram



Selective Reject

- Almost the same with go-back-N
  - only rejected (error) frames are retransmitted
  - subsequent frames are accepted by the receiver and buffered and will not be retransmitted
- Minimizes retransmission
  - retransmit only the 'error/corrupted frame(s)'
- Receiver must maintain large enough buffer to store already sent frame(s)

Selective Reject-Diagram