Computer Networks I

Error Detection

(Parity check and Internet checksum)

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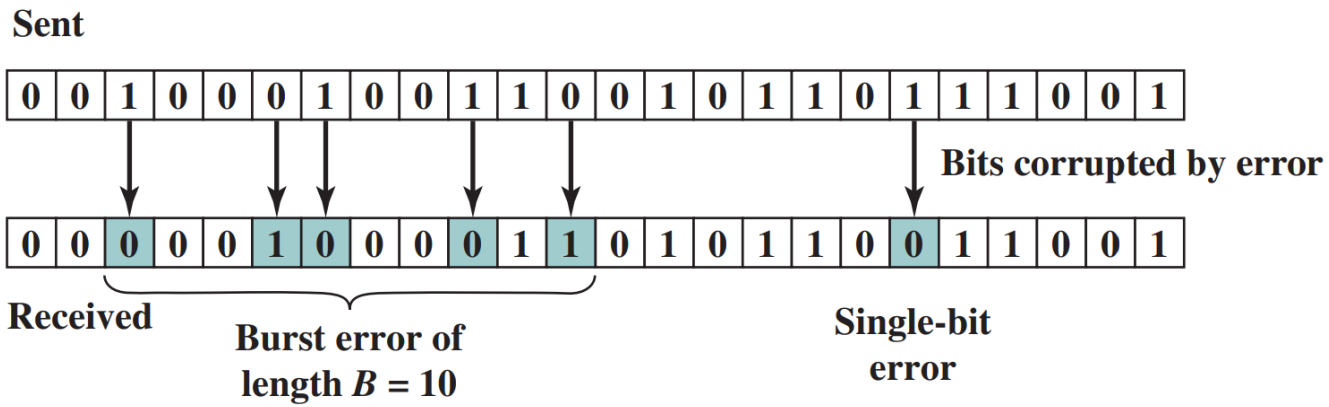
Types of Errors

- An error occurs when a bit is altered between transmission and reception

- Types of errors:
  - Single bit errors
  - Burst errors

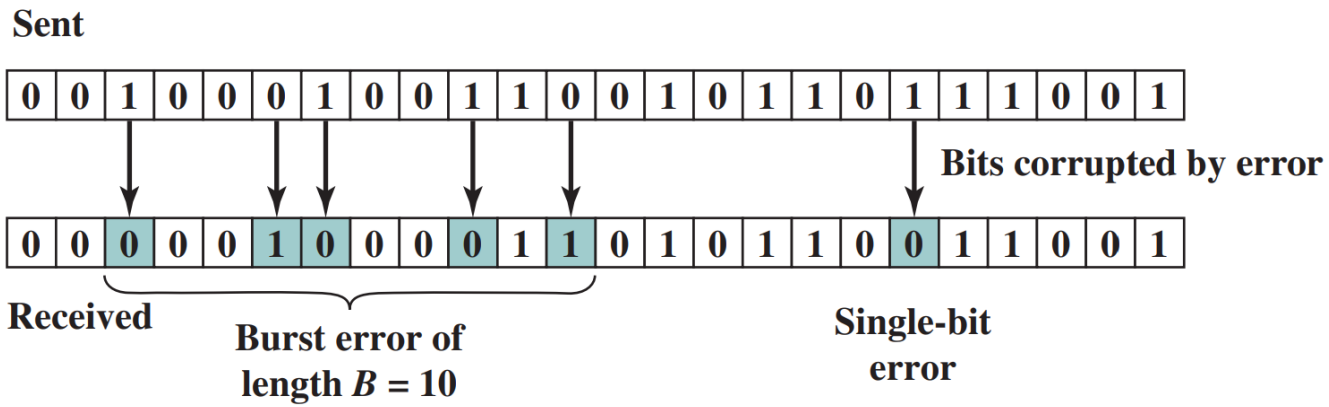
Types of Errors

- Single bit error:
  - Isolated error that alters one bit but does not affect nearby bits
  - Can occur in presence of white noise

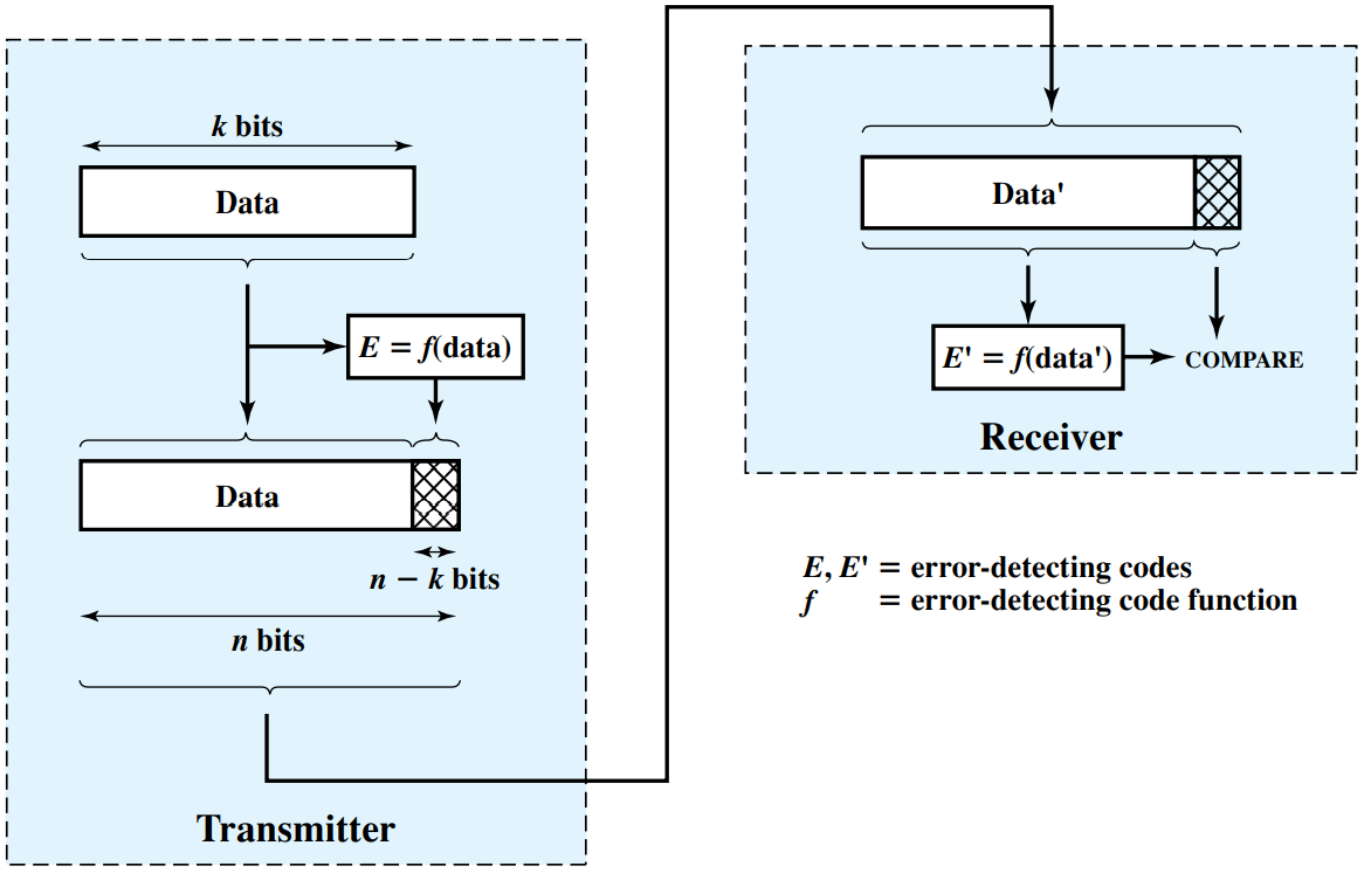


Types of Errors

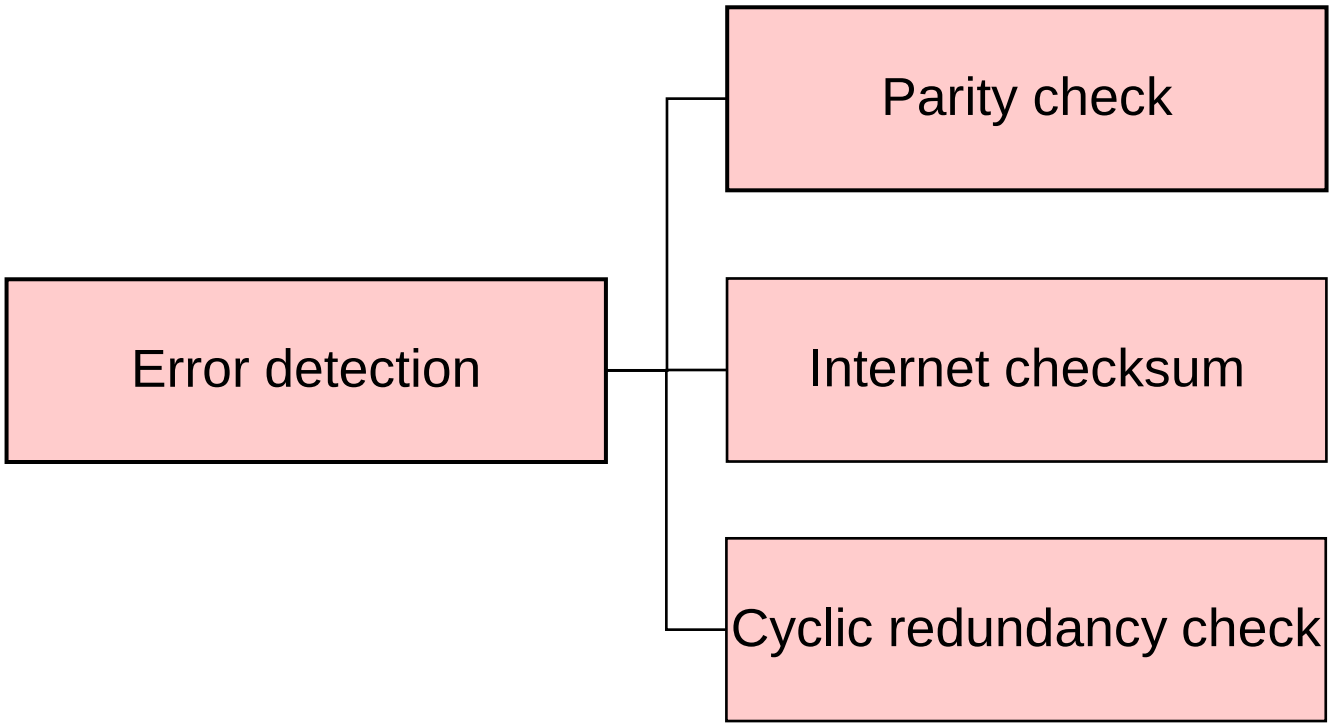
- Burst error:
  - Contiguous sequence of B bits in which the first and last bits and any number of intermediate bits are received in error
  - Can occur due to impulse noise or fading in wireless environment
  - Effects are greater at higher data rates



Error Detection



Error Detection



Parity Check

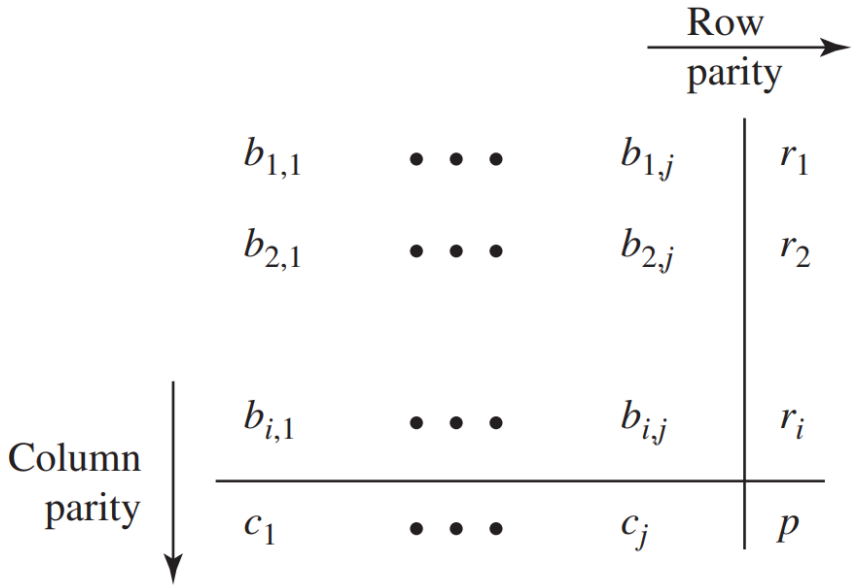
- The simplest error detecting scheme is to append a parity bit to the end of a block of data
  - Even parity: Total number of ones will be even
  - Odd parity: Total number of ones will be odd
- Any odd number of bit errors is detected

Parity Check

- Limitation: If any even number of bits are inverted due to error, an undetected error occurs

Two-dimensional Parity Check

- 01110 01110 01000 01011



0	1	1	1	0	1
0	1	1	1	0	1
0	1	0	0	0	1
0	1	0	1	1	1
0	0	0	1	1	0

- 011101 011101 010001 010111 000110

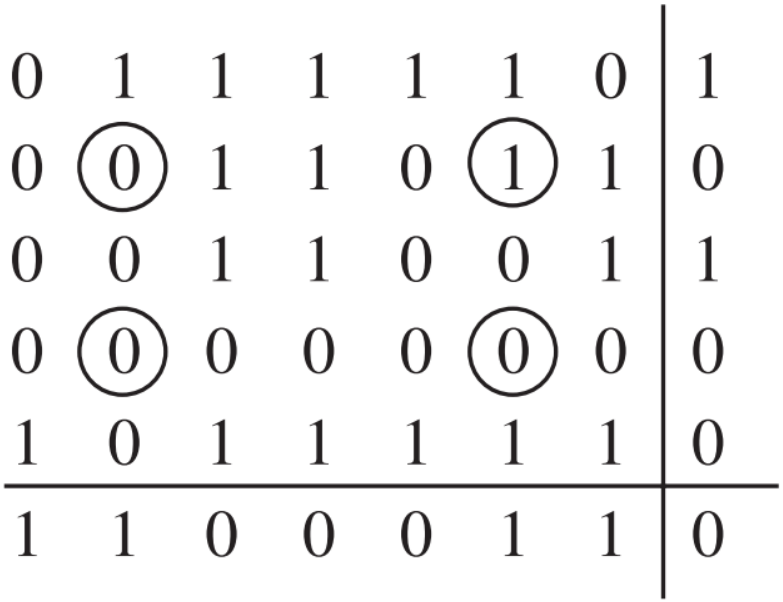
Two-dimensional Parity Check

- A single-bit error is detected and corrected
- Any odd number of bit errors is detected
- Some even number of bit errors is also detected

0	1	1	1	0	1
0	0	1	1	0	1
0	1	0	0	0	1
0	1	0	1	1	1
0	0	0	1	1	0

Two-dimensional Parity Check

- Any pattern of four errors forming a rectangle is undetectable



The Internet Checksum

- Ones-complement operation:
  - Replace 0 with 1, and 1 with 0

The Internet Checksum

- Ones-complement addition:
  - The two numbers are treated as unsigned binary integers and added
  - If there is a carry out of the leftmost bit, add 1 to the sum (end-around carry)

The Internet Checksum

- 00 01 F2 03 F4 F5 F6 F7 00 00

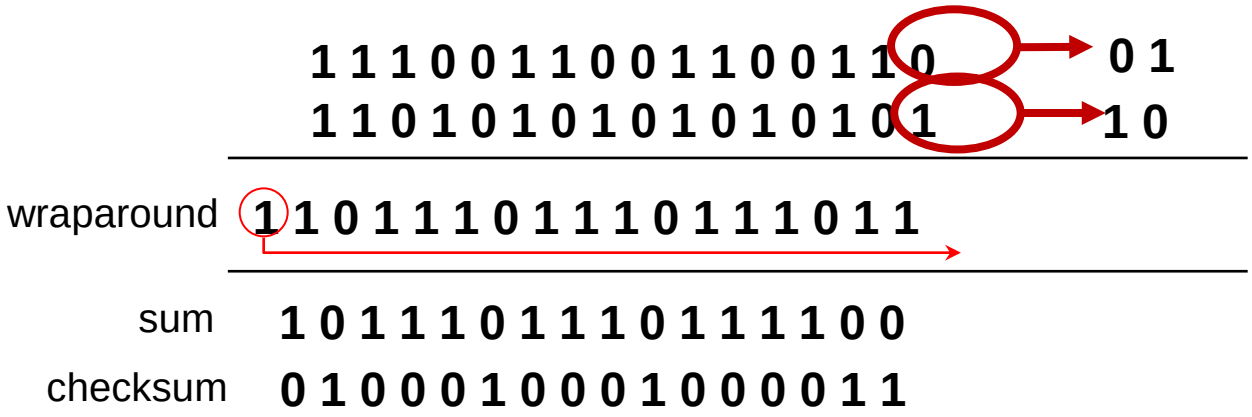
Partial sum	0001 F203 F204
Partial sum	F204 F4F5 1E6F9
Carry	E6F9 1 E6FA
Partial sum	E6FA F6F7 1DDF1
Carry	DDF1 1 DDF2
Ones complement of the result	220D

FFFF
-DDF2

Partial sum	0001 F203 F204
Partial sum	F204 F4F5 1E6F9
Carry	E6F9 1 E6FA
Partial sum	E6FA F6F7 1DDF1
Carry	DDF1 1 DDF2
Partial sum	DDF2 220D FFFF

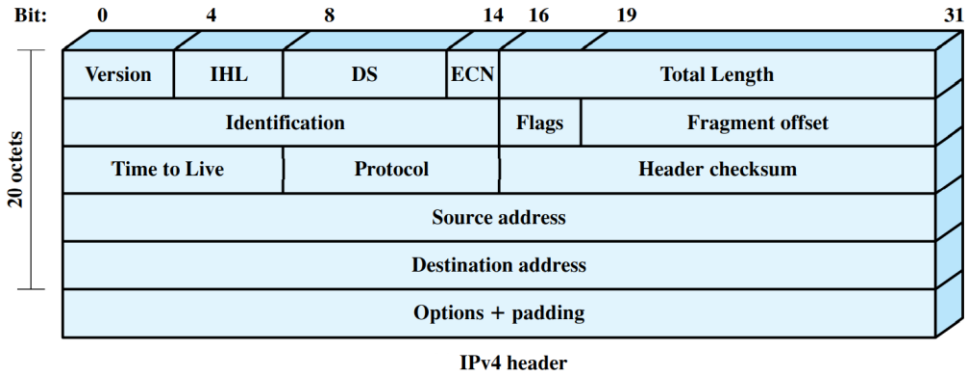
The Internet Checksum

- Provides better greater error detection capability than parity check
  - Provides weak protection

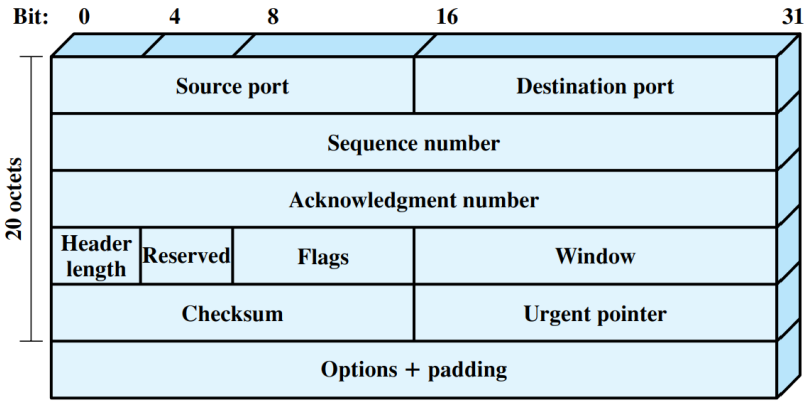


The Internet Checksum

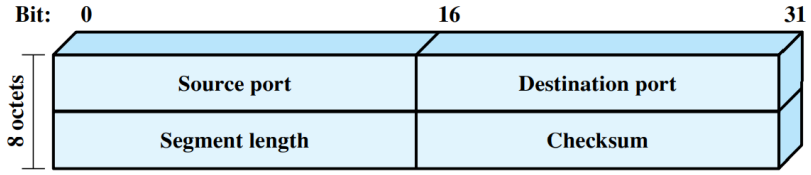
- Internet checksum is used in many Internet standard protocols, including IP, TCP, and UDP



IPv4 header



TCP header



(b) UDP header

Summary

- Different error detection techniques discussed:
  - Parity check
  - Internet checksum