3. Data Link Layer

Wednesday, February 17, 2021 9:21 AM

Link layer:
- Data unit: frame
- Packet from network is encapsulated with header and tailer into frame
- MAC addresses
- Channel access if shared medium

Services
1. Flow control
2. Error detection
3. Error correction
4. Half- and full-duplex communication

Implemented in the adaptor or Network interface card (NIC) (hw+sw)

Why error detection and correction?
- No completely reliable channel
- Corrupted due to noise
- Mechanism at receiver end to ensure data received is correct (and identify the error)

Errors:
- Single-bit: only one bit in the data unit is changed
- Multi-bit: two or more non-consecutive bits in the data are changed
- Burst: 2 or more consecutive bits are changed (no guarantee to detect this sort of error)

Easy mechanism to detect single- and multi-bit error

10110	11110	Second bit is corrupted

Error control:

Error detection codes:
- **Block code**: divide total data stream into multiple blocks. (eg. 4 bits in each block; same sized block). Encoder processes block by block. [add parity bit with the help of the encoder]
- Convolutional code: process bit-by-bit. Every bit converted to two bits. [CRC, Checksum].

Parity bit, hamming code

Block code:

1. FEC: forward error correction [data link]
2. ARQ: automatic repeat request [transport]

FEC [parity, checksum]
Sender appends parity bit
Receiver uses parity bit to detect error

Example: even parity encoder

Block of message -> 1 even parity bit -> code word

Message	parity
0101	0
0111	1

Receiver: checker: ensure data not corrupted

01010	Accepted
01011	Rejects entire block and transmitter should resend the block

Only detects error, not its position

ARQ: gives acknowledgement for every data
If acknowledged, transmitter sends next block
- Time and bandwidth wasted

Flow control:
1. Feedback-based
2. Rate-based

Redundancy
Divide data into multiple blocks
1. Parity bit
2. Redundancy bit

K bits --> encoder --> N bits
N = K+p(parity bits)

Each k bits are mapped to n bits
2^n code words possible
Bandwidth overloaded with redundant data

Syndrome(?) value=0, no error
No way to detect every possible error

Parity check:

- Performance:

Error detection capability - 1 bit

10101	1	00101	1	Correctly discard
		01101	1	Wrongly accept (2bit)
		10101	0	Wrongly discard (parity bit)

Horizontal/vertical parity check:
Row/column parity check

1011	0110	0001	1110

Even parity for row AND cloumn

1	0	1	1	**1**
0	1	1	0	**0**
0	0	0	1	**1**
1	1	1	0	**1**
0	**0**	**1**	**0**	***1***

Max. 3 digit error detection
Code word:

10111	01100	00011	11101	00101

1	0	1	1	**1**
0	**0**	1	0	**0//error**
0	0	0	1	**1**
1	1	1	0	**1**
0	**0//error**	**1**	**0**	***1***

Message is discarded

1	0	1	1	**1**
0	**0**	**0**	0	**0**
0	0	0	1	**1**
1	1	1	0	**1**
0	**0 //error**	**1 //error**	**0**	***1***

1	0	1	**0**	**1//error**
0	**0**	**0**	0	**0**

0	0	0	1	**1**
1	1	1	0	**1**
0	**0//error**	**1//error**	**0//error**	**1**

1	1	1	0	**1**
0	0	0	0	**0**
0	0	0	1	**1**
1	1	1	0	**1**
0	**0**	**1//error**	**0**	***1***

Message wrongly accepted