Veri İletişimi ve Bilgisayar Ağları
BLM3051

Dr. Öğr. Üyesi Furkan ÇAKMAK

Ders Bilgilendirme Formu – Haftalık Konular

Week #	Date	Subjects
1	20.02.2025	Veri İletişimine Giriş, Mimari Modeller
2	27.02.2025	OSI Referans Modeli, Katmanları, Fonksiyonları
3	06.03.2025	Fiziksel Katman, Sinyalleşme
4	13.03.2025	Paralel ve Seri İletişim, Haberleşme Ortamları ve Teknik Özellikleri, Multiplexing (TDM, FDM)
5	20.03.2025	Hata Tespiti ve Düzeltme Yöntemleri
6	27.03.2025	Veri Bağı Kontrol Teknikleri ve Akış Kontrolü
7	03.04.2025	Senkron ve Asenkron Veri Bağı Protokolleri (BSC, HDLC)
8	10.04.2025	Ara Sınav
9	17.04.2025	LAN Teknolojileri, IEEE 802.3, IEEE 802.4, 802.5, 802.11
10	24.04.2025	Geniş Alan Ağlarında Kullanılan Teknolojiler (X.25, ISDN, FR, ATM, xDSL.)
11	01.05.2025	Emek ve Dayanışma Günü
12	08.05.2025	Ağ Katmanı, Anahtarlama, Bağlantılı ve Bağlantısız Servisler, Statik ve Dinamik Routing
13	15.05.2025	Ağ Katmanında Sıkışıklık, Sebepleri ve Çözümleri, IP (Internetworking Protocol)
14	22.05.2025	ICMP, BOOTP, DHCP, Taşıma Katmanı - UDP (User Datagram Protocol), TCP (Transmisson Control Protocol)
15	29.05.2025	Öğrenci Proje Sunumları

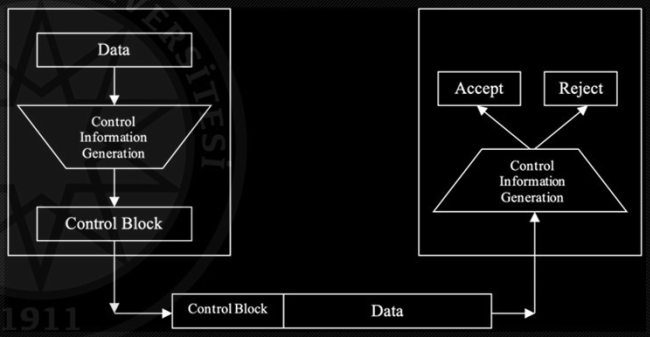
Error Detection and Correction Techniques

- Data Link Layer (in OSI model)
- Error reasons
  - Attenuation
  - Delay Distortion
    - Video + Voice
    - Problem in time sensitive conditions
  - Noise in the communication environment
    - Thermal noise
      - Random electron motion
    - Intermodulation noise
    - CrossTalk
    - Impulse Noise

Error Types

Error Detection

- Both sides have original data?
- Sending data twice?
- Control block?
  - 4 different types
    - VRC (Vertical Redundency Code)
    - LRC (Longitudial Redundency Code)
    - CRC (Cyclic Redundency Check)
    - Checksum



VRC (Vertical Redundency Code)

- Parity check
- Simple error coding technique
- The number of errors should be **odd**.
- XOR operation

	VRC	Data						
Data Sent	1	Ø	1	Ø	Ø	1	1	Ø
Data Received 1	1	Ø	1	Ø	Ø	1	1	Ø
Data Received 2	1	Ø	1	1	Ø	1	1	Ø
Data Received 3	1	Ø	1	1	Ø	1	Ø	Ø

LRC (Longitudial Redundency Code)

- LRC is 2D-VRC

	Byte 1		Byte 2		Byte 3		Byte 4		LRC
	1		Ø		1		1		1
	Ø		Ø		1		1		Ø
	Ø		1		Ø		1		Ø
	1		1		Ø		1		1
	1		Ø		1		Ø		Ø
	Ø		1		1		Ø		Ø
	1		Ø		Ø		Ø		1
VRC	Ø		1		Ø		Ø		1

CRC (Cyclic Redundency Check)

- The data to be sent is divided into a predetermined prime polynomial.
- The remainder value is added to the data to be sent as an error control code.
- The remainder zero in receiver side means that error-free transmission.
- Common polynomials used for CRC: 13-bits, 17-bits, 33-bits
  - The number of undetectable errors is almost zero
- Commonly used polynomials in CRC technique:
  - CRC-12 $x^{12}+x^{11}+x^3+x+1$
  - CRC-16 $x^{16}+x^{15}+x^2+1$
  - CRC-ITU $x^{16}+x^{12}+x^5+1$
  - CRC-32 $x^{32}+x^{26}+x^{23}+x^{22}+x^{16}+x^{12}+x^{11}+x^{10}+x^8+x^7+x^5+x^4+x^2+x+1$

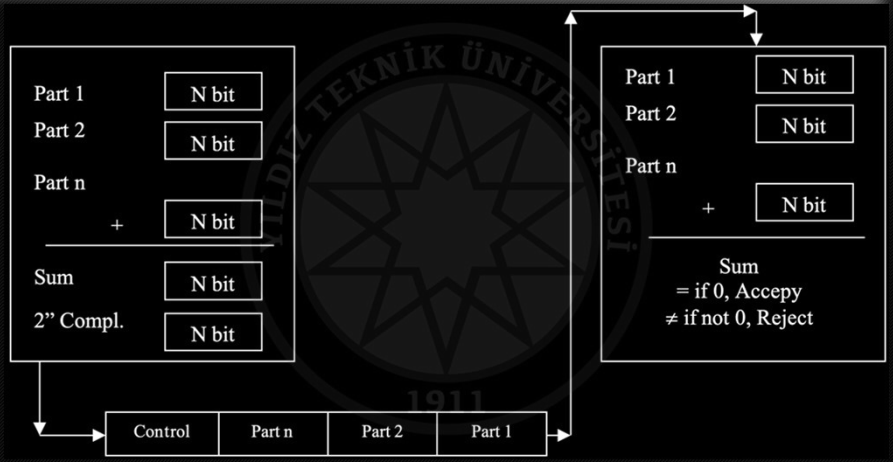
CRC (Cyclic Redundancy Check) - Example

Example: Data Sent: **100100**, polynom: $x^3 + x^2 + 1$, CRC = ?

Checksum

- The sender divides the data into N-bits parts (usually 16 bits are used).
- The parts are collected using the first complementary arithmetic.
  - In this way, a total value of only N bits is obtained.
- Calculate two's complement using summed value
  - The calculated value is added to the end of the information to be sent.
- The checksum detects all of the odd errors and most of the even numbers.
  - However, if one or more bits in a part are 0 when they are 1, but there is a 0 when 1 in another part, the error will not be understood because there will be no difference in this column sum.

Checksum - Con't



Checksum - Example

Example: Data Sent: **5A65EF7D**, Checksum = ?

Error Correction

- 2 methods
  - Send data again
  - If one bit error
    - Hamming Code / Distance

Hamming Code

- If we sent m bit data, the error occurs in 1,2,…,m bit
- Adding error-free state, the data length will be m+1
- Control block length must be $log_2(m+1) \leq \mathrm{r}$
- $m+r$ bit must be sent error-free
- So, control block length must be $log_2(m+r+1) \leq \mathrm{r}$
- (1, 2, 4, 8, 16. bits)

B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1
D_7	D_6	D_5	R_4	D_4	D_3	D_2	R_3	D_1	R_2	R_1

Hamming Code – Con't

- $R_1=B_1 \oplus B_3 \oplus B_5 \oplus B_7 \oplus B_9 \oplus B_{11}$
- $R_2=B_2 \oplus B_3 \oplus B_6 \oplus B_7 \oplus B_{10} \oplus B_{11}$
- $R_3=B_4 \oplus B_5 \oplus B_6 \oplus B_7$
- $R_4=B_8 \oplus B_9 \oplus B_{10} \oplus B_{11}$

B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1
1	0	0		1	1	0		1		

- $R_1=B_3 \oplus B_5 \oplus B_7 \oplus B_9 \oplus B_{11} = 1 \oplus 0 \oplus 1 \oplus 0 \oplus 1 = 1$
- $R_2=B_3 \oplus B_6 \oplus B_7 \oplus B_{10} \oplus B_{11} = 1 \oplus 1 \oplus 1 \oplus 0 \oplus 1 = 0$
- $R_3=B_5 \oplus B_6 \oplus B_7 = 0 \oplus 1 \oplus 1 = 0$
- $R_4=B_9 \oplus B_{10} \oplus B_{11} = 0 \oplus 0 \oplus 1 = 1$

B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1
D_7	D_6	D_5	R_4	D_4	D_3	D_2	R_3	D_1	R_2	R_1

	R_4	R_3	R_2	R_1	Info
0	0	0	0	0	Error-free
1	0	0	0	1	1. bit error
2	0	0	1	0	2. bit error
3	0	0	1	1	3. bit error
4	0	1	0	0	4. bit error
5	0	1	0	1	5. bit error
6	0	1	1	0	6. bit error
7	0	1	1	1	7. bit error
8	1	0	0	0	8. bit error
9	1	0	0	1	9. bit error
10	1	0	1	0	10. bit error
11	1	0	1	1	11. bit error

Hamming Code - Example

Example: Data Sent: **0101110**, Data with Hamming Code ?

Thank you for listening…

Dr. Öğr. Üyesi Furkan ÇAKMAK