

Data Communication and Computer Network BLM3051

Dr. Öğr. Üyesi Furkan ÇAKMAK



Lecture Information Form - Weekly Subjects

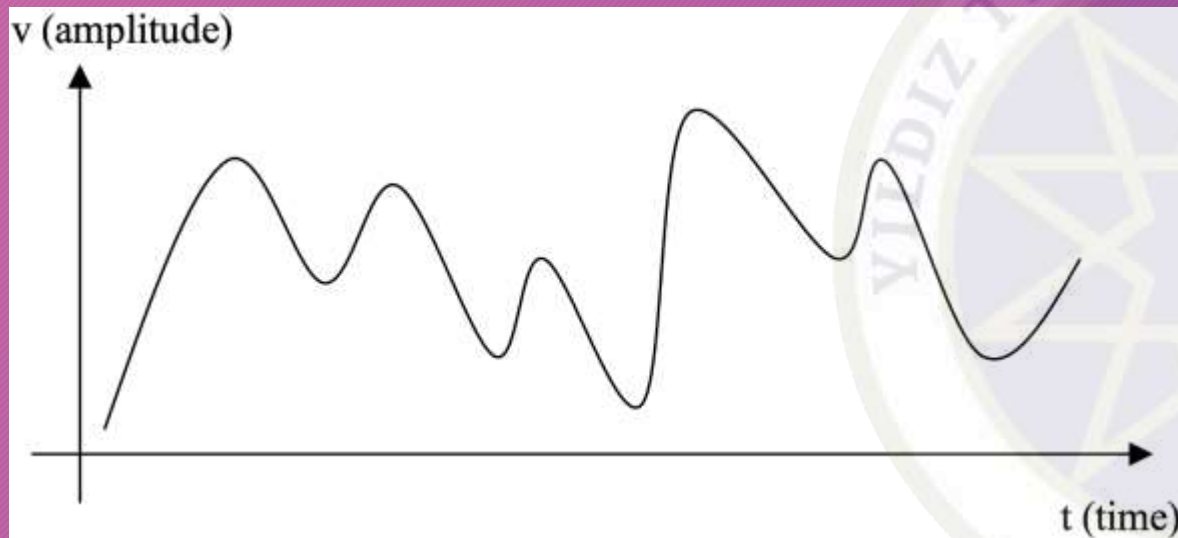
Hafta	Tarih	Konular
1	20.02.2024	Introduction to Data Communication Standards Used on Data Communication, Architectural models
2	27.02.2024	OSI Reference Model , Layers and Their Functions, Signaling and Signal Encoding
3	05.03.2024	Parallel and Serial Transmission, Communication Media and Their Technical Specs., Multiplexing (TDM, FDM)
4	12.03.2024	Error Detection and Error Correction Techniques, Data Link Control Techniques, Flow Control
5	19.03.2024	Asynchronous and Synchronous Data Link Protocols (BSC, HDLC)
6	26.03.2024	LAN Technologies Continued, IEEE 802.4, 802.5, 802.11
7	02.04.2024	Connectionless and Connection Oriented Services, Switching
8	09.04.2024	Tatil - Ramazan Bayramı Arifesi
9	16.04.2024	1. Ara Sınav
10	23.04.2024	Tatil - 23 Nisan Ulusal Egemenlik ve Çocuk Bayramı
11	30.04.2024	Static and Dynamic Routing, Congestion in the Network Layer, Its Causes and Solutions
12	07.05.2024	IP (Internetworking Protocol), ICMP, BOOTP, DHCP
13	14.05.2024	2. Ara Sınav
14	21.05.2024	UDP (User Datagram Protocol), TCP (Transmisson Control Protocol)

OSI Reference Model - Reminding

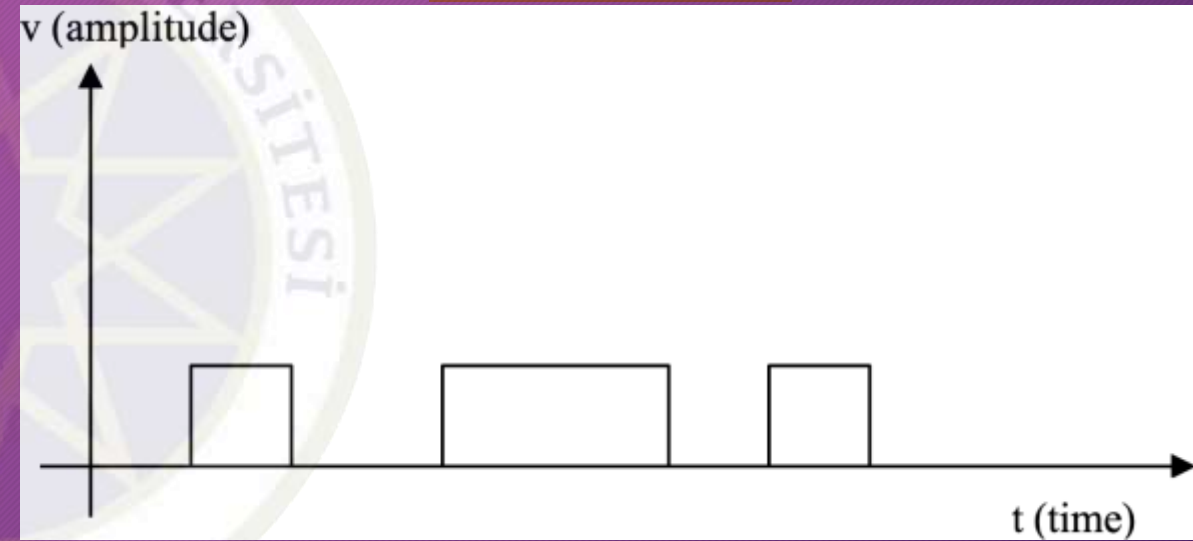
7	Application Layer
6	Presentation Layer
5	Session Layer
4	Transport Layer
3	Network Layer
2	Data Link Layer
1	Physical Layer

Signals

Continuous - Analog

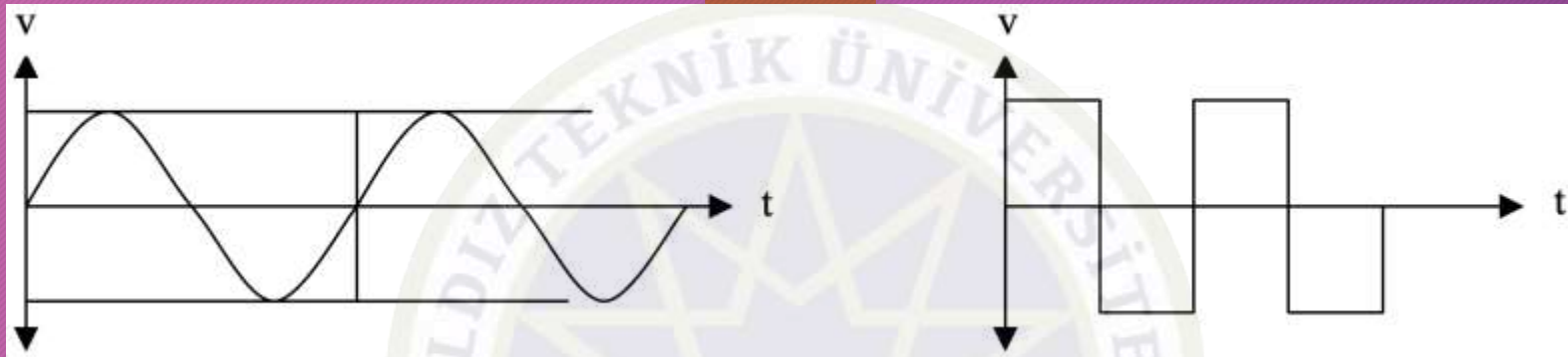


Discrete - Digital

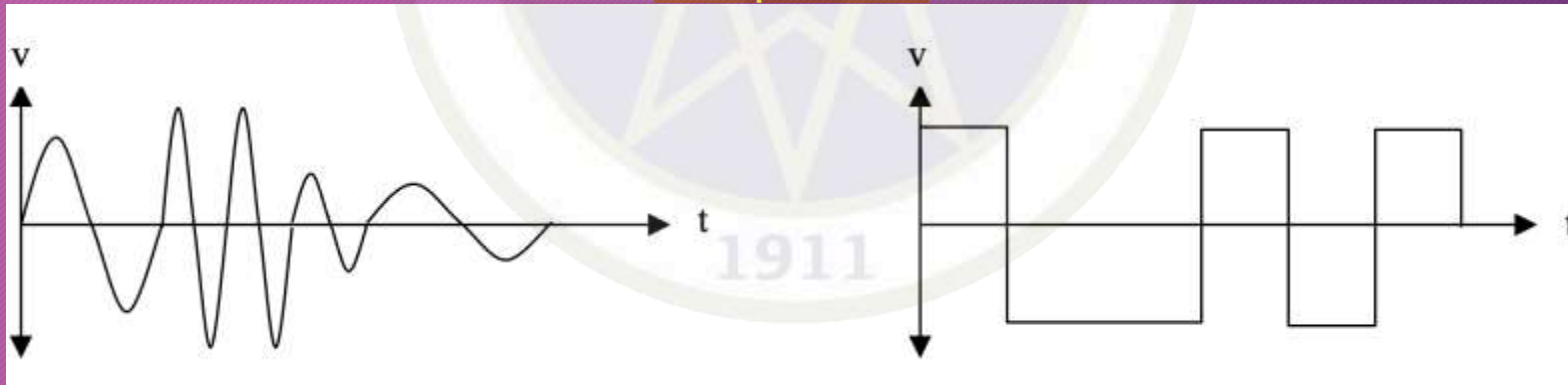


Signals - Con't

Periodic



Non-periodic



Analog Signals

Simple Analog Signals

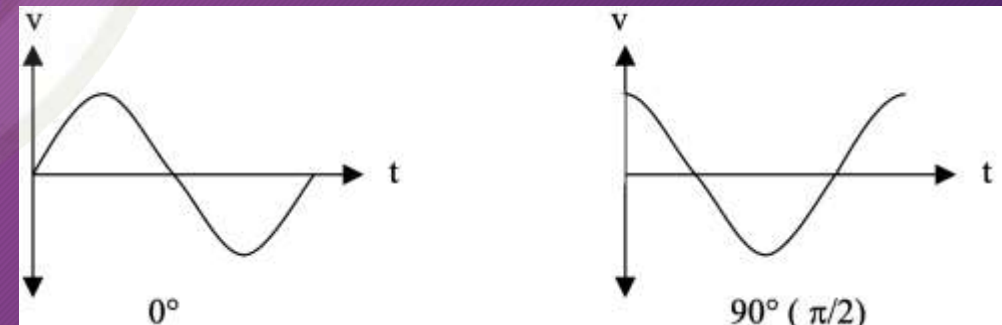
$$f(t) = A \sin(2\pi f t + \phi)$$

Complex Analogue Signals

$$f(t) = \sum_{n=1,3,5..}^{\infty} \frac{1}{n} \sin(2\pi n f t)$$

- v - Amplitude
 - Volt - V
 - Amper - A
 - Watt-W
- f - Frequency
 - Cycle
 - Hertz - Hz
- ϕ - Phase
 - Degree - $^{\circ}$
 - Radian - π

Frequency	Time
Hz	sec (second)
KHz	msec (milli second)
MHz	μ sec (micro second)
GHz	nsec (nano second)
THz	psec (pico second)



Analog Signals - Con't

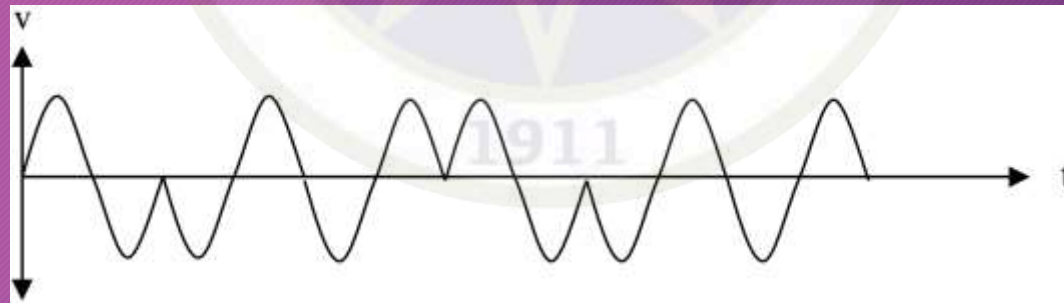
Frequency Change



Amplitude Change

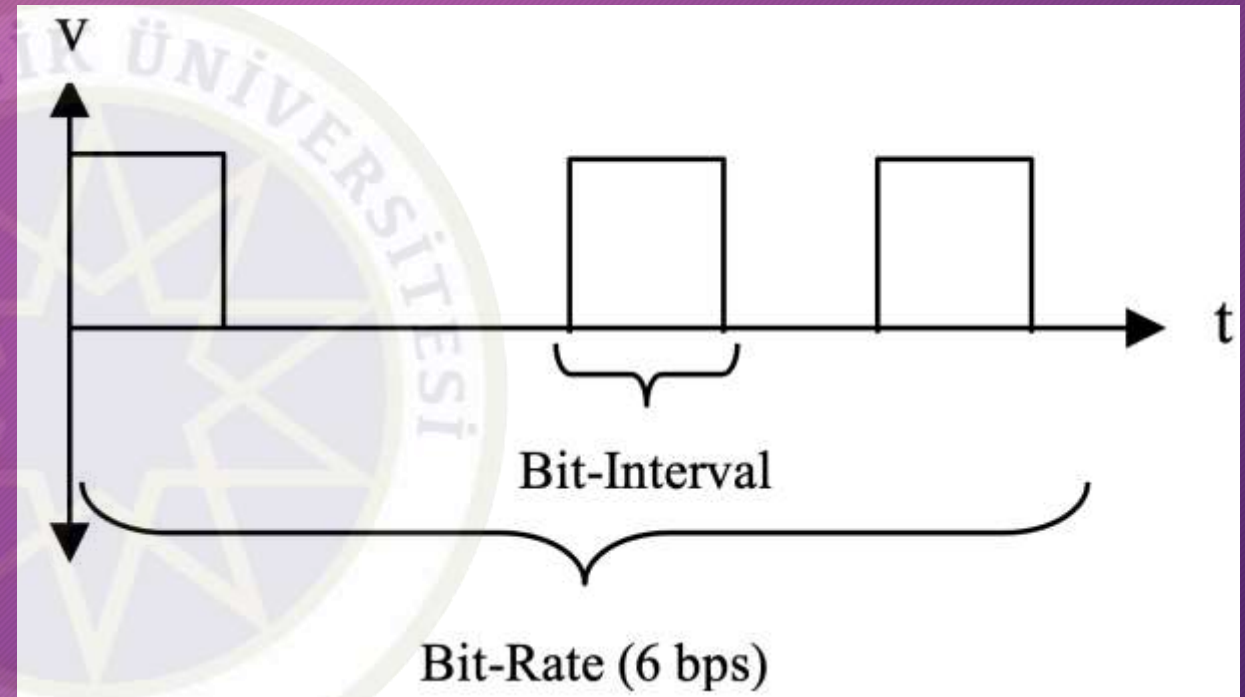


Phase Change



Digital Signals

- Non-periodic
- Bit-rate
 - The number of bits transferred in one second
- Bit-interval
 - The time it takes to transmit one bit (in seconds)



Elements that Negatively Affect Communication

iletişimi olumsuz etkileyen unsurlar

Distortion

• Attenuation

- dB
- Solution: Amplifying
- Analog?

→ Gõzüm
amplifier

• Noise

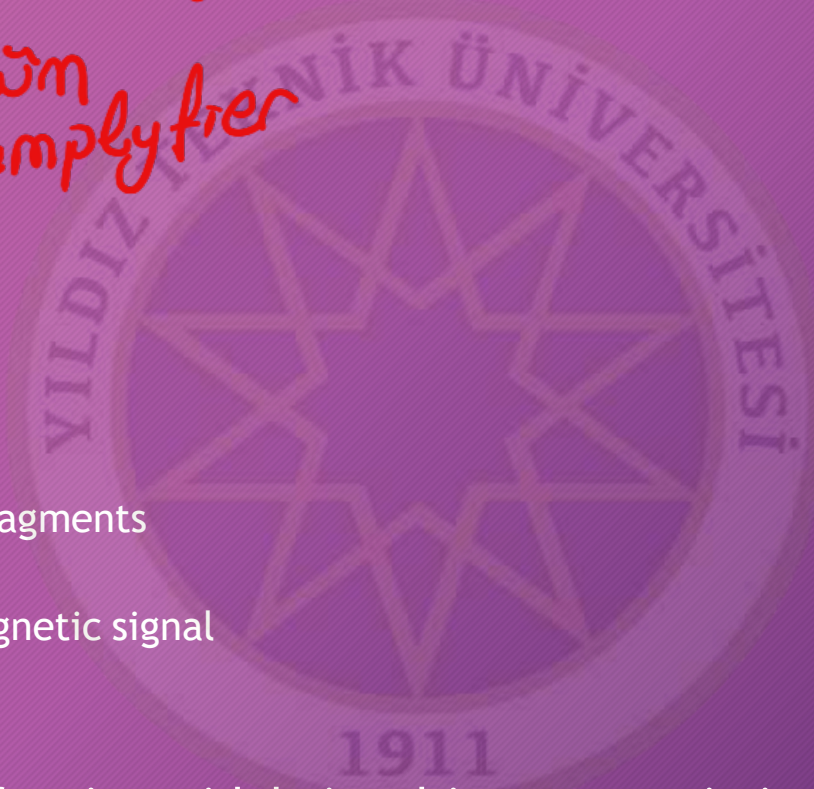
- Even Idle mode
- Thermal noise
 - Motion of atomic fragments
- Impulse noise
 - Random electromagnetic signal

• Cross talk

• Delay

- Propagation: Velocity of a sinusoidal signal in a transmission line

→ iletim hattında bir sinüsoidal



Sinyalin iletim hızı

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Data

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Data Carrying Capacity

Veri taşıma kapasitesi

- Nyquist Theorem**

- The amount of data that can be sent per unit time
- H: Band width
- V: Number of discrete voltages
- Not consider the noise ★

$$data_{vel} = 2H \log_2 V \text{ bit/sec}$$

iletim kanalının birim
zaman başına taşıyabi-
leceği veri miktarı

- Noise (dB)** (Sinyal gürültü oranı)

- Signal strength (sent): S
- Strength of the current noise: N

$$SNR = 10 \log_{10} \frac{S}{N} \text{ dB}$$

Data Carrying Capacity - Con't

→ gürültülü kanalda veri hızı

- Shannon-Hartley
 - Data velocity with noise

$$data_{vel} = H \log_2 \left(1 + \frac{S}{N} \right) \text{ bit/sec}$$

- First, the highest data rate to be achieved is found according to the Shannon-Hartley formula.
- Then, according to the Nyquist formula, how many discrete voltage levels can be used in this bandwidth is determined.

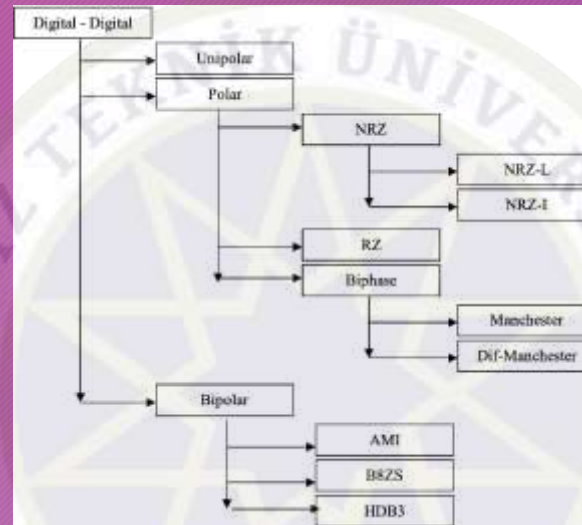
Coding of Signals

- **Digital - Digital**
 - Computer - Printer
- **Analog - Digital**
 - Microphone - Computer
- **Digital - Analog**
 - Computer - Communication Lines
- **Analog - Analog**
 - Radio - Radio Signal Lines



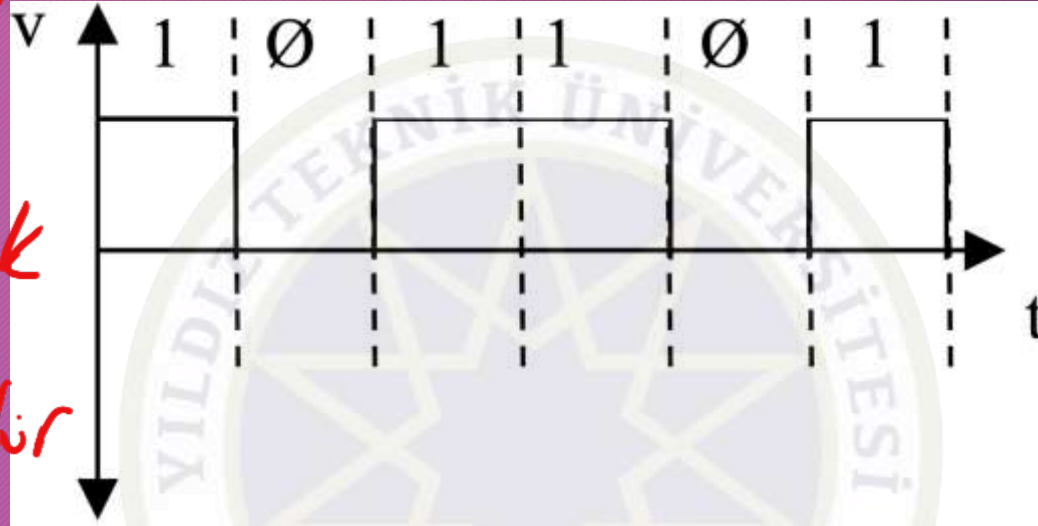
Digital - Digital Coding

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Digital2Digital - Unipolar Coding

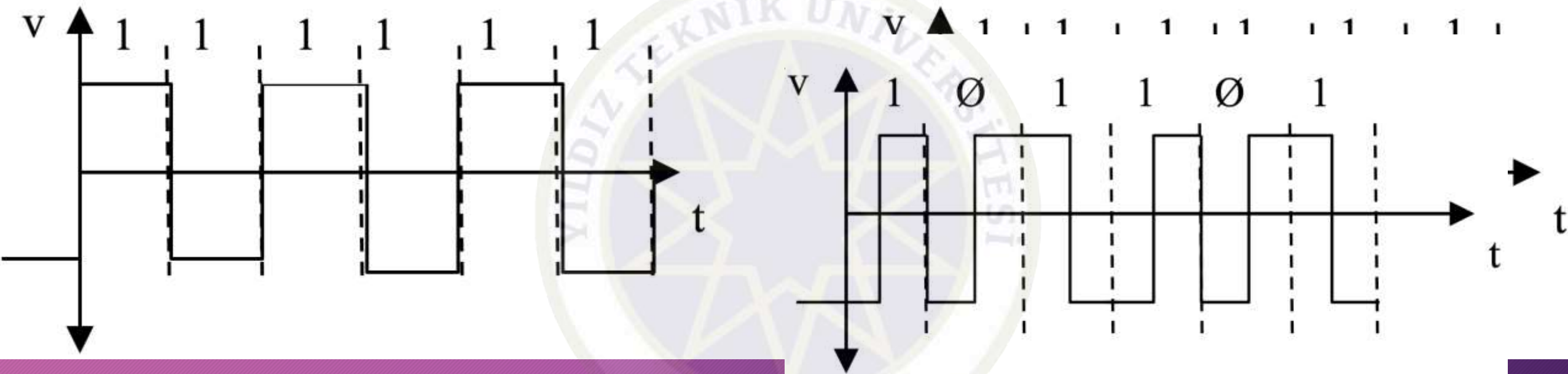
Dijital sinyallerin sadece tek bir polariteyi (genellikle pozitif) kullanarak ifade edildiği bir kodlama türüdür

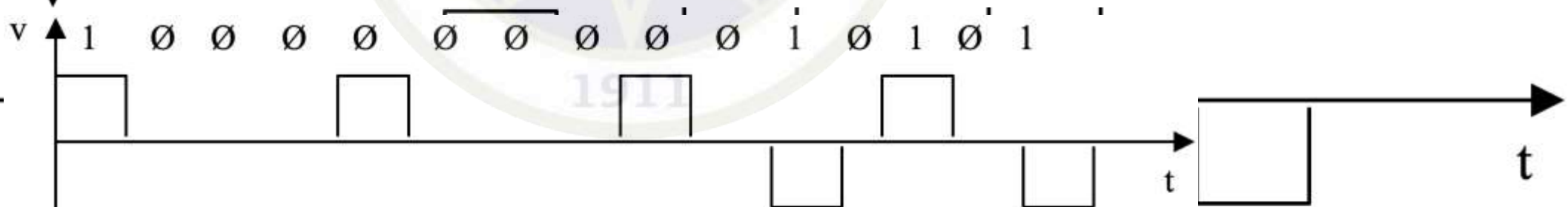
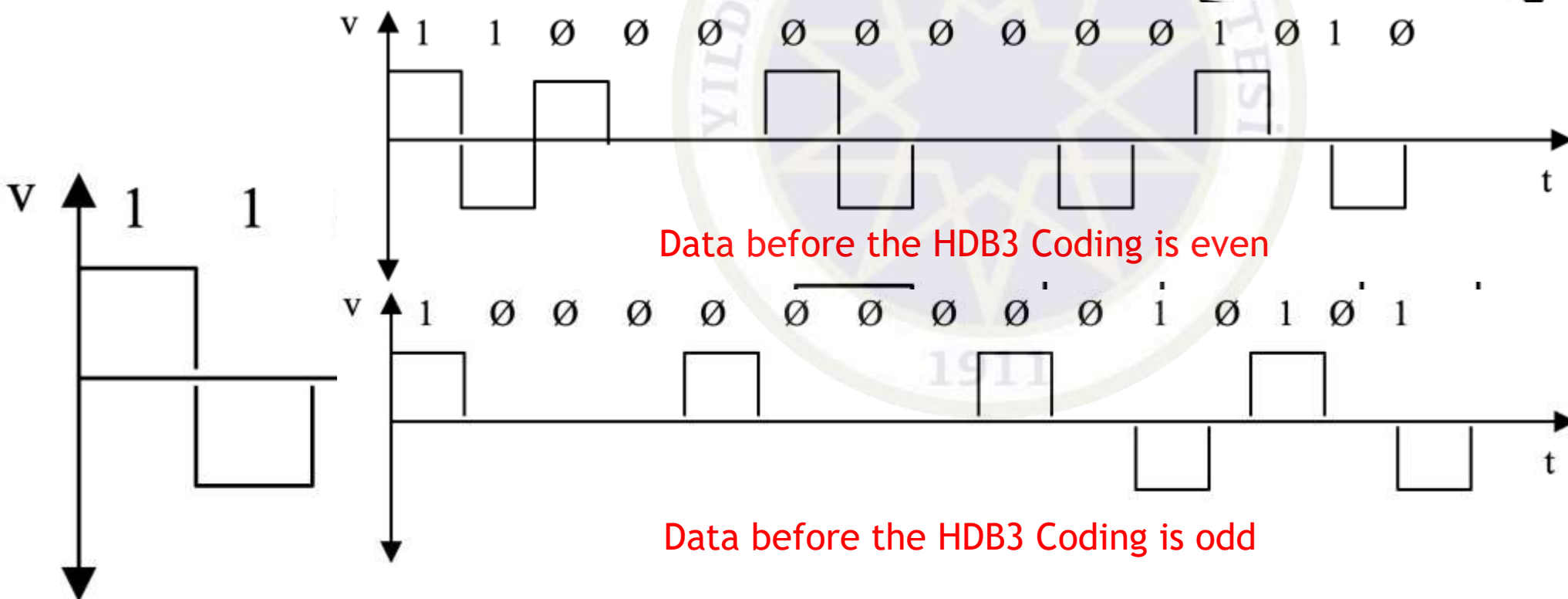
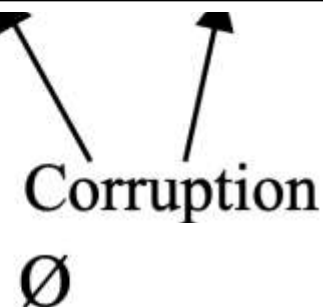
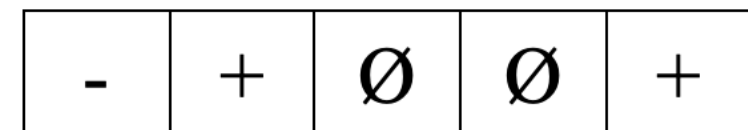
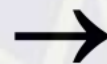
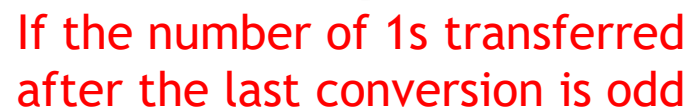
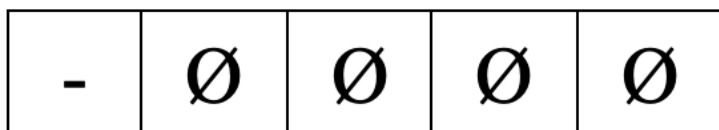


yerini polar ve bipolar kodlama türüne bırakmalıdır

- 2 main problems;
 - DC Component
 - Synchronization

Digital2Digital - Polar Coding

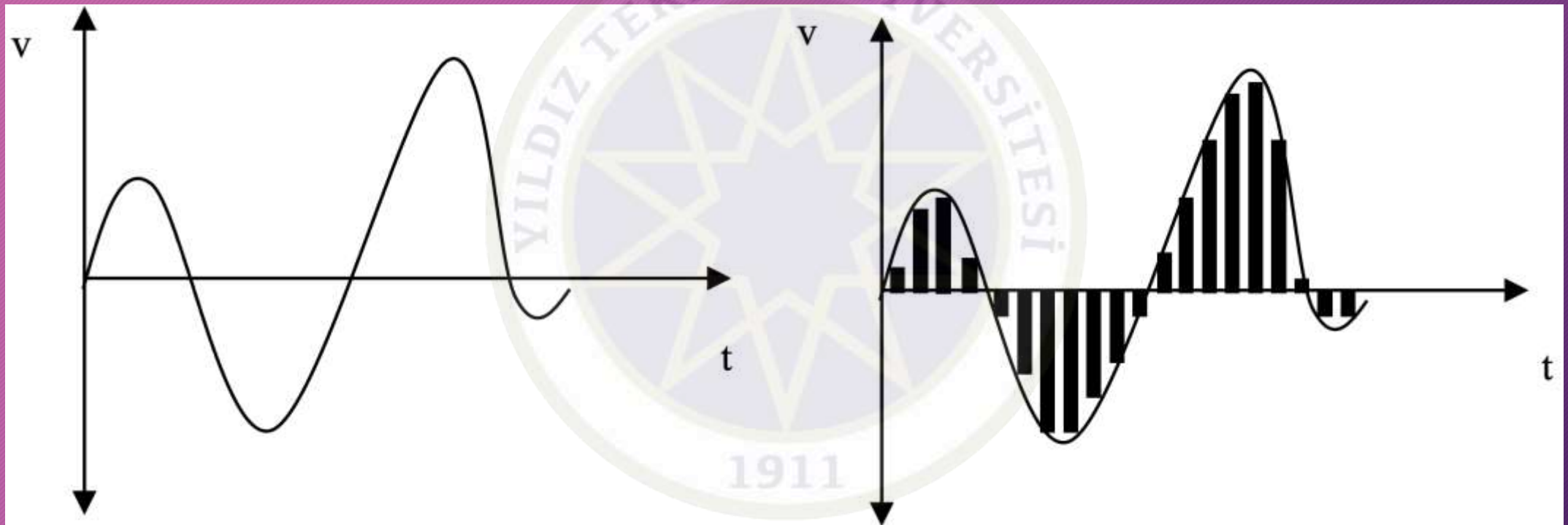




Data before the HDB3 Coding is odd

Analog - Digital Coding

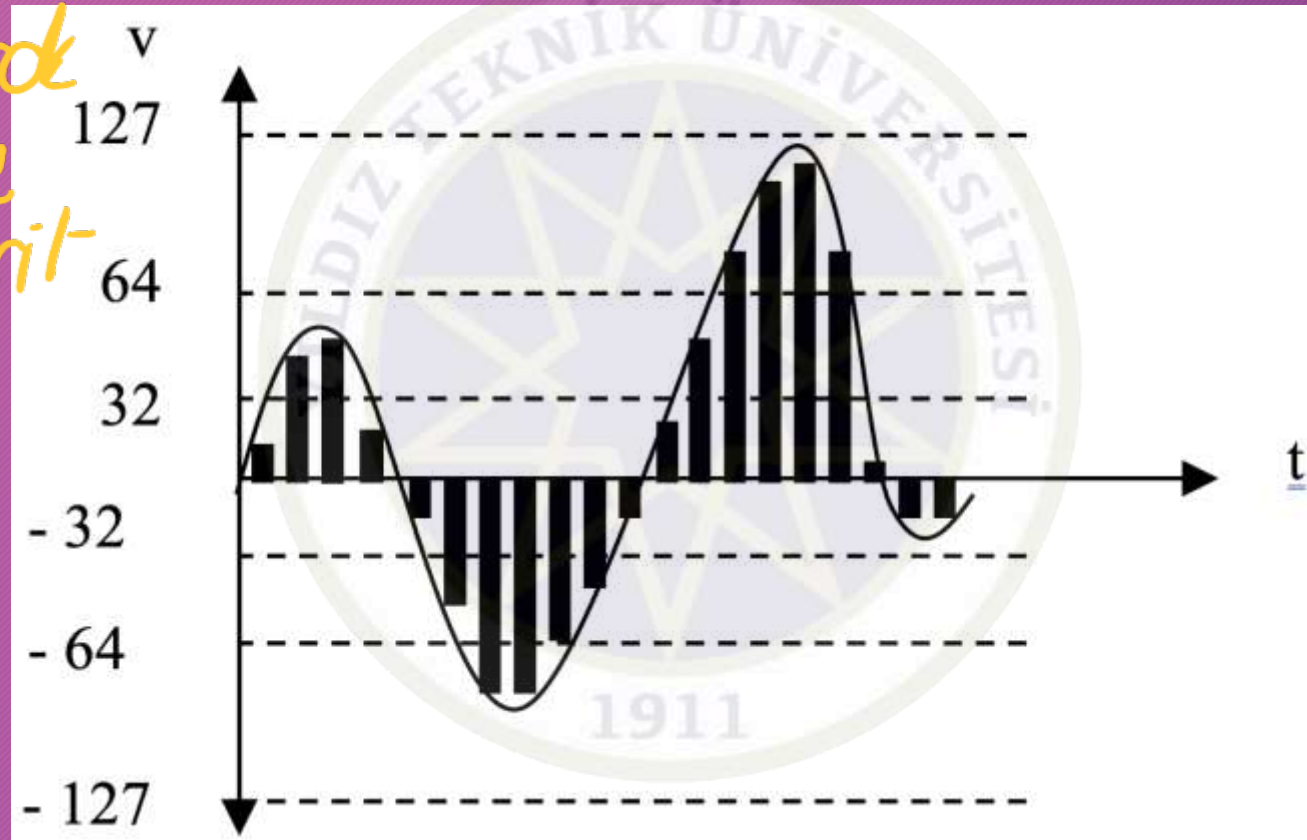
PAM (Pulse Amplitude Modulation)



Analog - Digital Coding - Con't

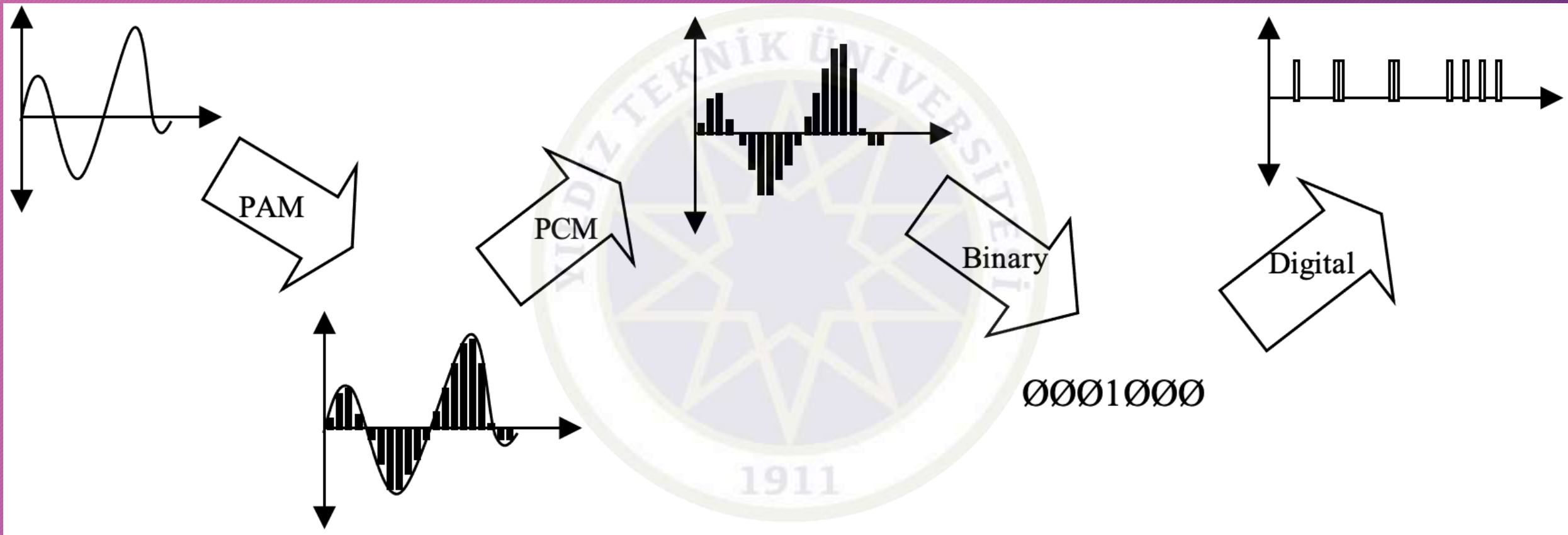
Burda sinyalin
PCM k klorode
nasil dijitalize
edildigi gosterit-
mistir

PCM (Pulse Code Modulation)



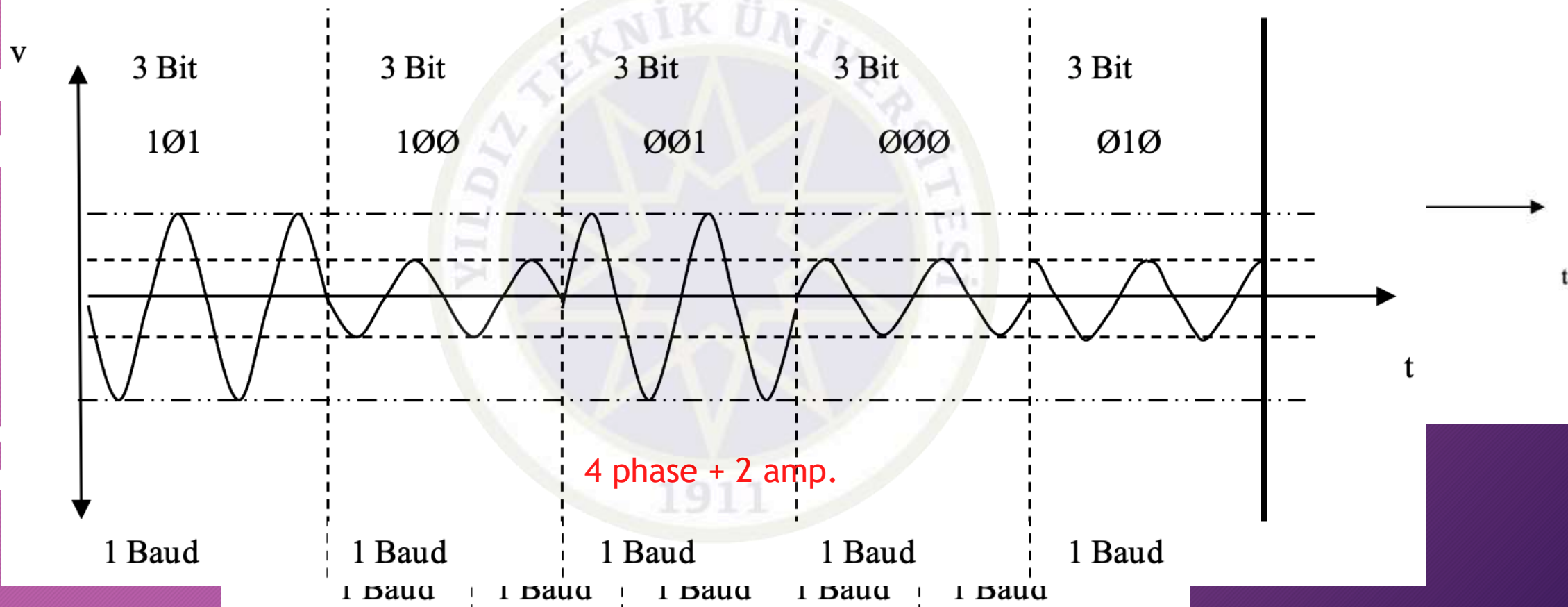
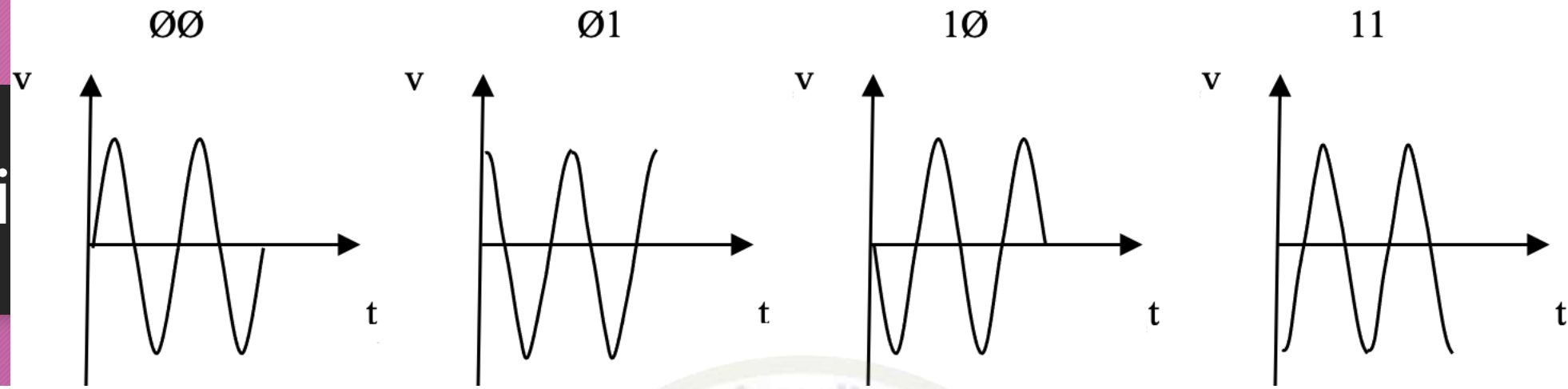
Transmission of the Analog Signal over the Digital Network

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Digi

- AS
- FS
- PS
- QA
- Mo



4 phase + 2 amp.

Analog - Digital Coding - Concepts

- Carrier Signal
- Bit and Baud Speed
 - Bit Speed \geq Baud Speed

Coding Technique	Unit	Baud Speed	Bit Speed	Bits / Baud
ASK, FSK, 2PSK	Bit	N	N	1
4PSK, 4QAM	Dibit	N	2N	2
8PSK, 8QAM	Tribit	N	3N	3
16QAM	Quadbit	N	4N	4
32QAM	Pentabit	N	5N	5
64QAM	Hexabit	N	6N	6
128QAM	Septabit	N	7N	7
256QAM	Octabit	N	8N	8

Analog - Analog Coding

Analog sinyal kodlama türleri

- AM (Amplitude Modulation)
- FM (Frequency Modulation)
- PM (Phase Modulation)

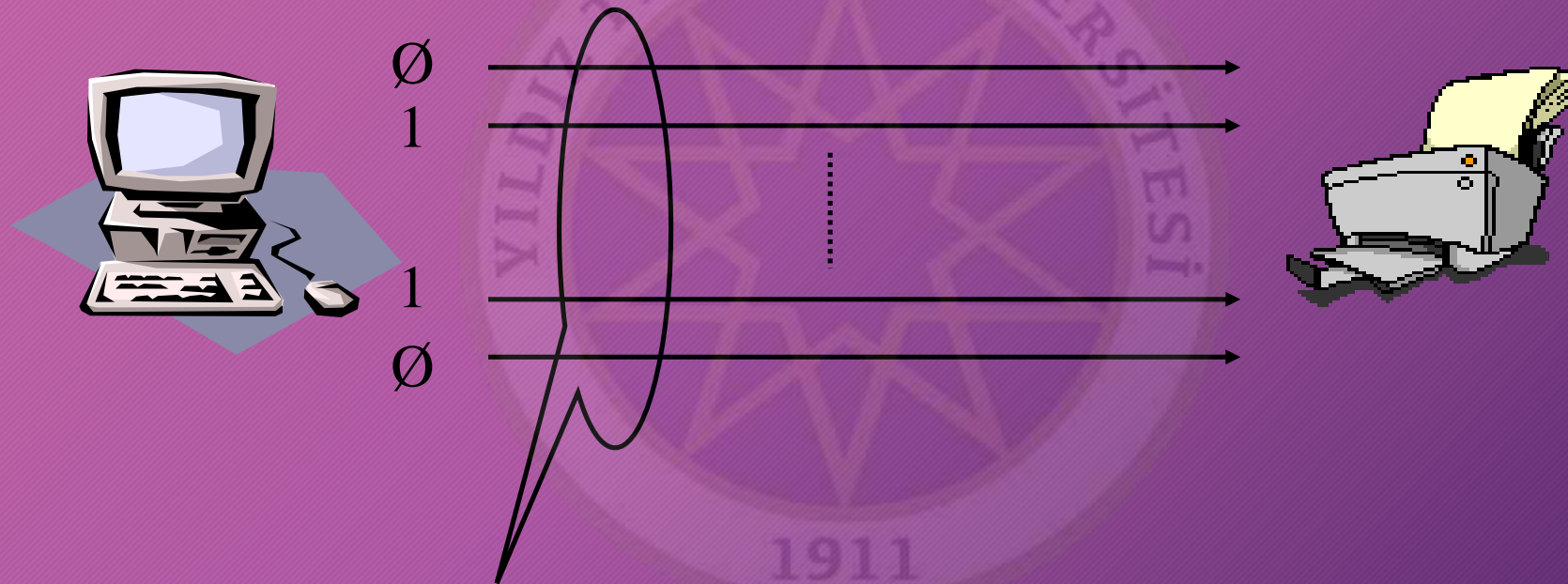
→ Bu modülasyon türünde taşıyıcı sinyalin genliği bilgiyi taşıyan sinyal ile orantılı olarak değişir

Digital Data Transmission Techniques

- Medium specs;
 - Connector type to provide mechanical connection in the transmission medium
 - Number of wires
 - Signal type
 - Purpose
 - Frequency, amplitude and phase
- Parallel Transmission
- Serial Transmission

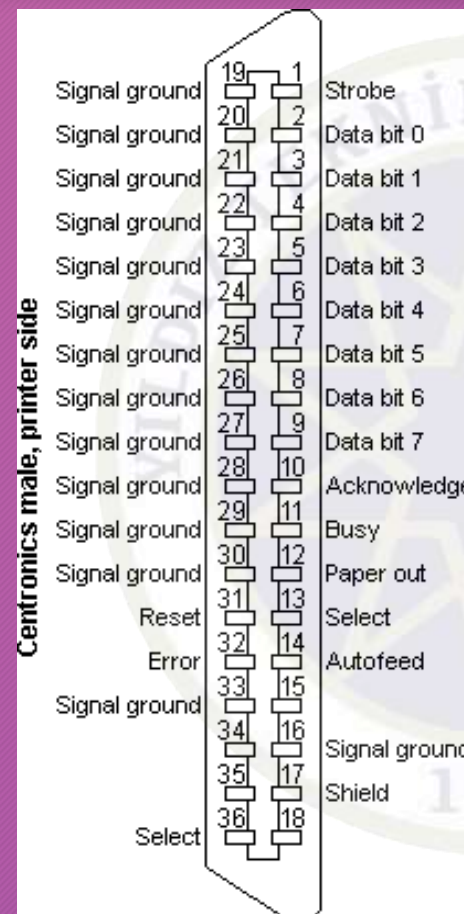
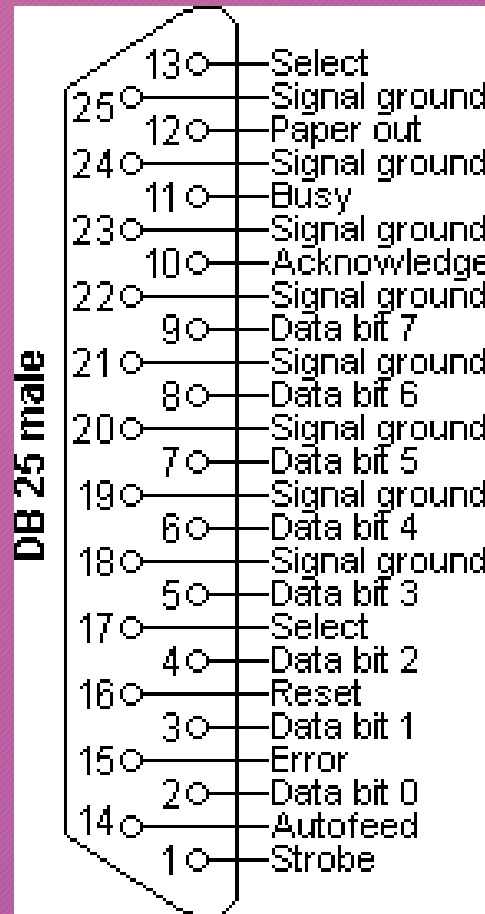


Parallel Transmission



N Wired Connection

Parallel Transmission - Con't

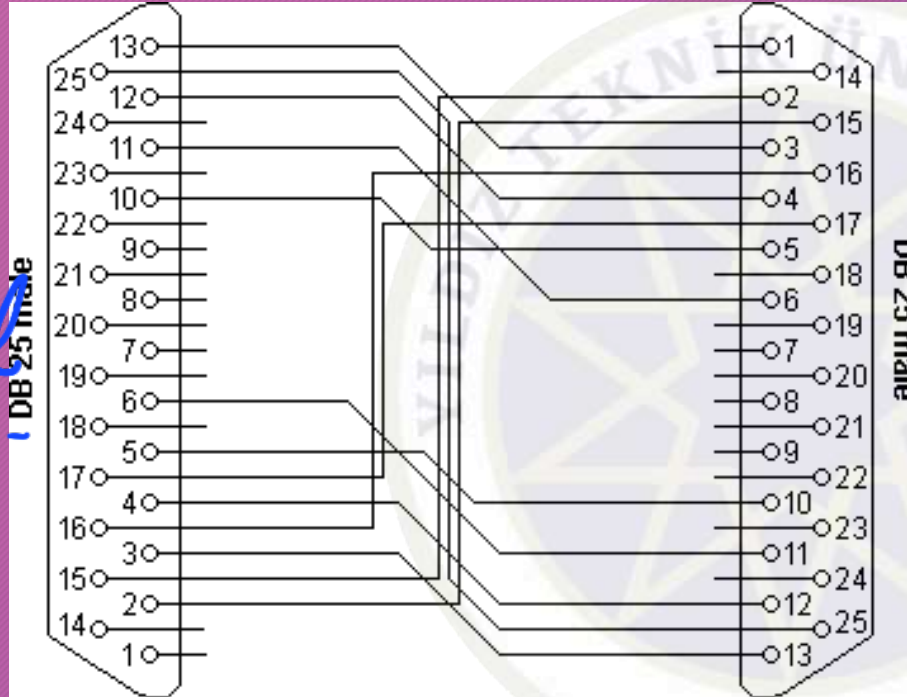


- Standard Parallel Interface
 - 155 kByte/sec
- ECP/EPP (Enhanced Parallel Port/Enhanced Capability Port)
 - 3 MByte/sec
- Maximum Cable Length: 7.5m

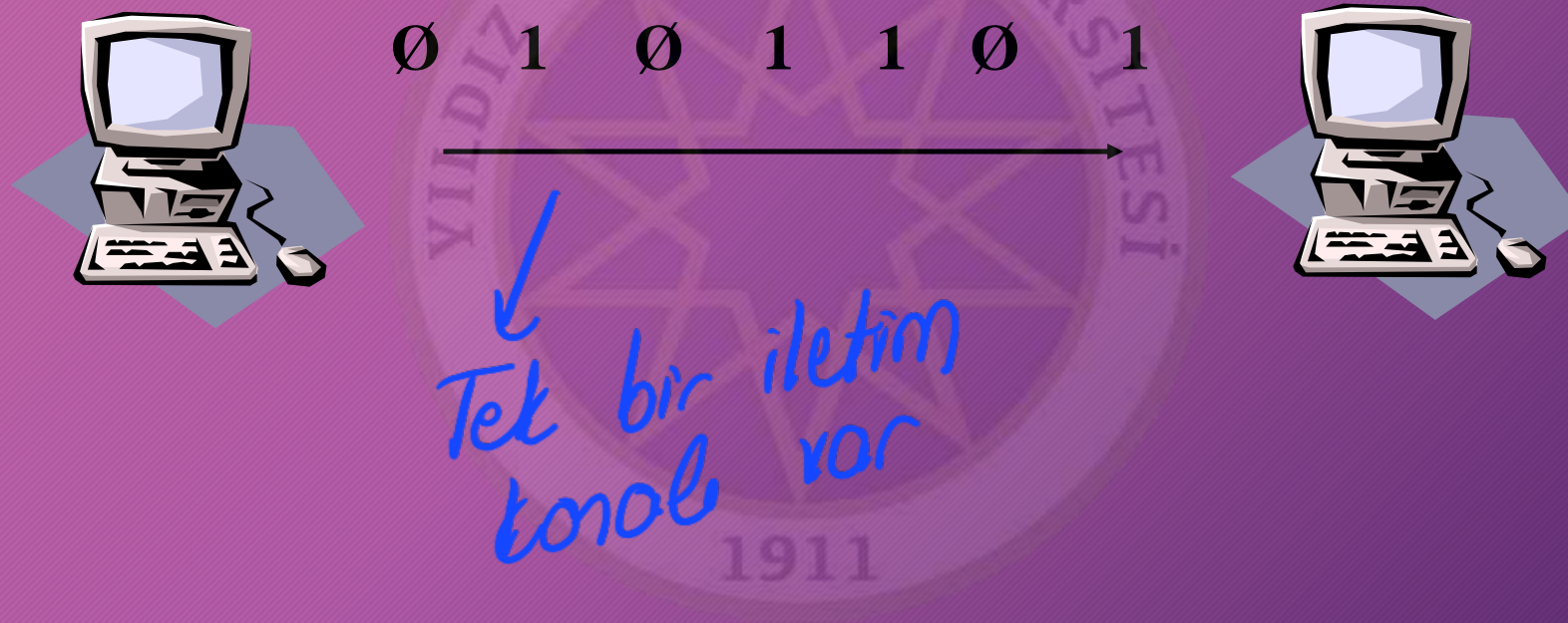
Parallel Transmission - Con't

- Laplink
- Interlink

↓
2 tane paralel
iletim tekno-
lojisi veril-
mektedir



Serial Transmission



Serial Transmission - Con't

- RS-232-C
 - 9 wires
 - RX
 - TX
 - GND
 - 6 x Flow Control Wire
 - 155 kbits/sec
 - 15 meters
 - NRZ-L
 - $(-15 \sim -5)V_{DC} \rightarrow 1$
 - $(+5 \sim +15)V_{DC} \rightarrow 0$
 - RS-422: 300 meters
- Asynchronous transmission in WAN
 - 2 wires
- Synchronous transmission in WAN
 - 4 wires

RS-232'den
farklı iletişim
mesafesidir

Asynchronous Serial Transmission

taraf lar arasında veri veris
ritmi aynı değil

Simple, Cheap

- The data arrival rhythm between the sides is not the same.
- It is not possible to tell when the incoming transmission started and when it ends
- Receiver and transmitter must agree on how long each bit will remain on the line.
- Start bit: 0, positive voltage
 - 8-N-1
 - $1 + 8 + 1 \rightarrow$ LSB
 - N: not parity bit
 - 7-E-1
 - $1 + 7 + 1$ (Even)
- Stop bit: 2-bits long

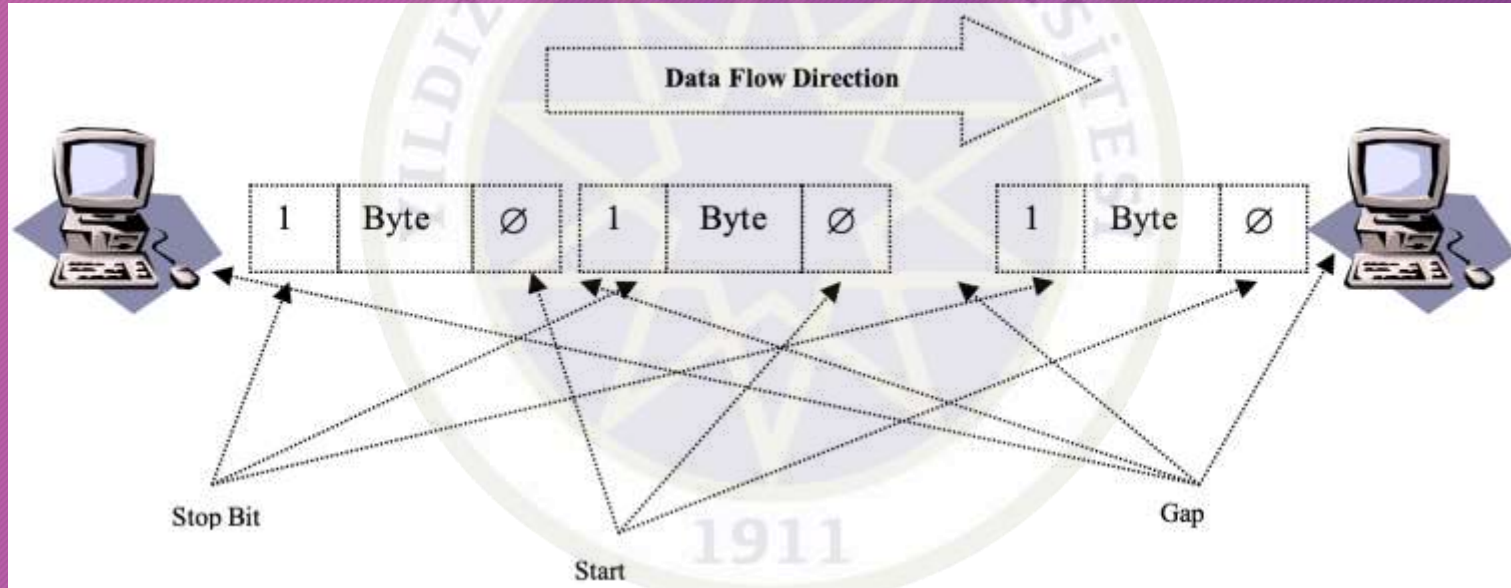
alıcı ve verici
her bitin hatta
ne kadar kalması
gerektiğini anlaşma-
lıdır

seilen iletişimin ne zaman

başladığı ve bittiği belli
değil

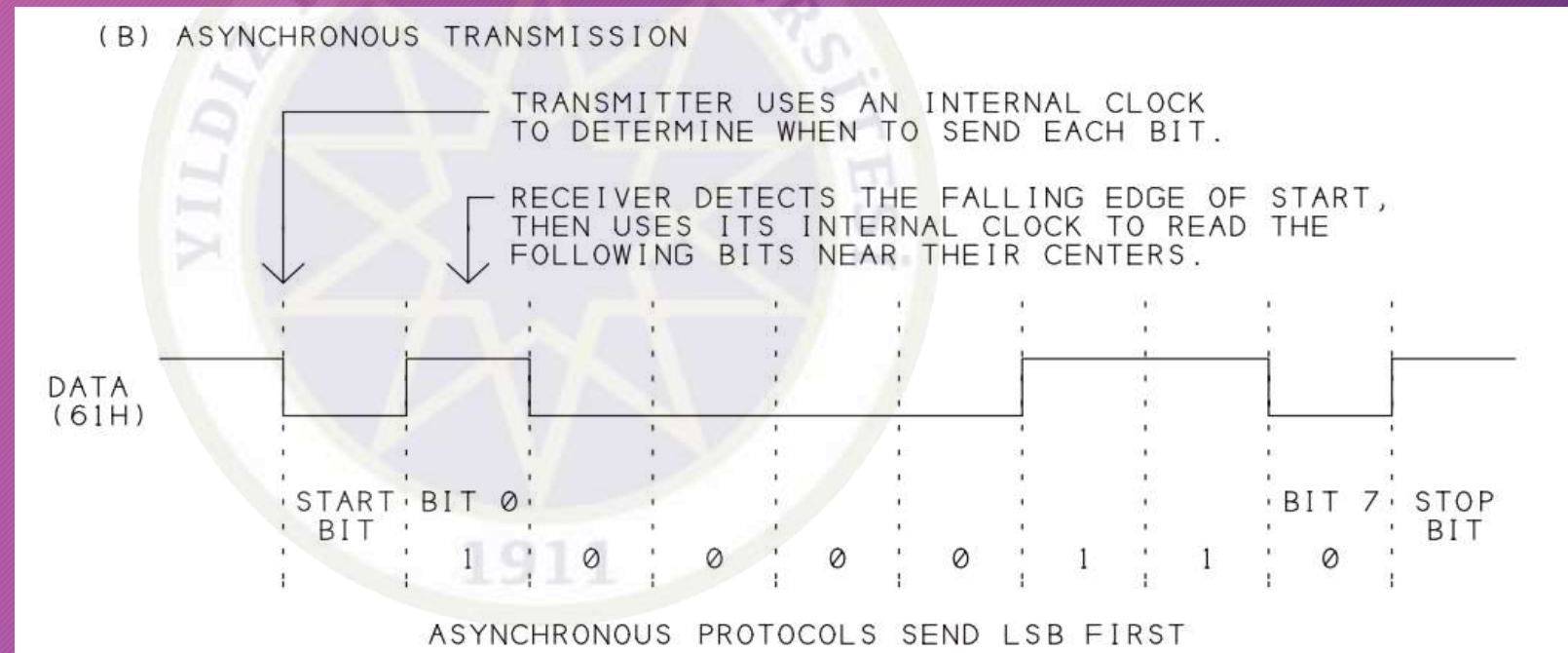
Asynchronous Serial Transmission - Con't

- Since the communication between the sender and receiver is not made simultaneously, there are **gaps** of variable duration between the bytes sent.



Asynchronous Serial Transmission - Con't

- Time skew
 - If the processing speed difference between the two sides is 5%
 - 8th -> 45%
- Dial-up
 - Carrier Signal



Synchronous Serial Transmission

- Much more big data transfer compare to Async within one transmission (>1000 byte)
- If there is no data transmission
 - A special bit sequence is sent in the line.
- In order for the information to be transferred properly, operations must be carried out depending on a common timing mark.
- Like an assembly line.
- Clock line: A different line
 - Clock pulse
 - Short distance transmissions

Asenkrona göre çok

daha fazla veri aktarımı
yapılır

Synchronous Serial Transmission - Con't

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- Logical Level Synchronization
 - Preamble Bit Array
 - Postamble Bit Array
 - Max 100 bits for control data.
 - HDLC (High Level Data Link Control)
 - 48 bits for control purposes.
 - Example
 - If we want to transfer 1000 characters in HDLC mode, how much bits send?
 - 1 character \rightarrow 8 bit
 - 1000 characters \rightarrow 1 block
 - Control data \rightarrow 48-bit
 - 1 block \rightarrow 8000 bit
 - $8000 + 48 \rightarrow 8048$ bits
 - Load of control data per bloc $\rightarrow 48 / 8048 \approx 0,6\%$

Asynchronous ST vs Synchronous ST

Synchronous	Asynchronous
<ul style="list-style-type: none">+ Much more efficient usage+ Better error control+ High transmission speed	<ul style="list-style-type: none">+ Simple+ Cheap+ Additional effort required for timing+ Limited speed– Limited error control mechanism (parity)– 20% loss due to start / end bits

Thank you for your listening.

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