Data Communication and Computer Network

BLM3051

Dr. Öğr. Üyesi Furkan ÇAKMAK

Lecture Information Form - Weekly Subjects

BLM3051 Data Communication and Computer Network - 2

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

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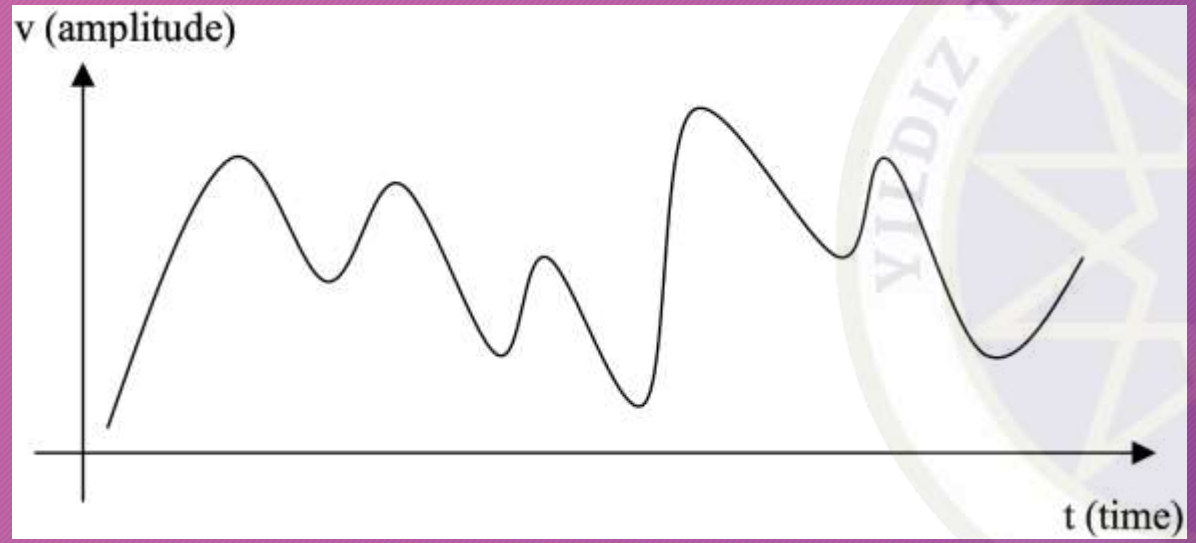
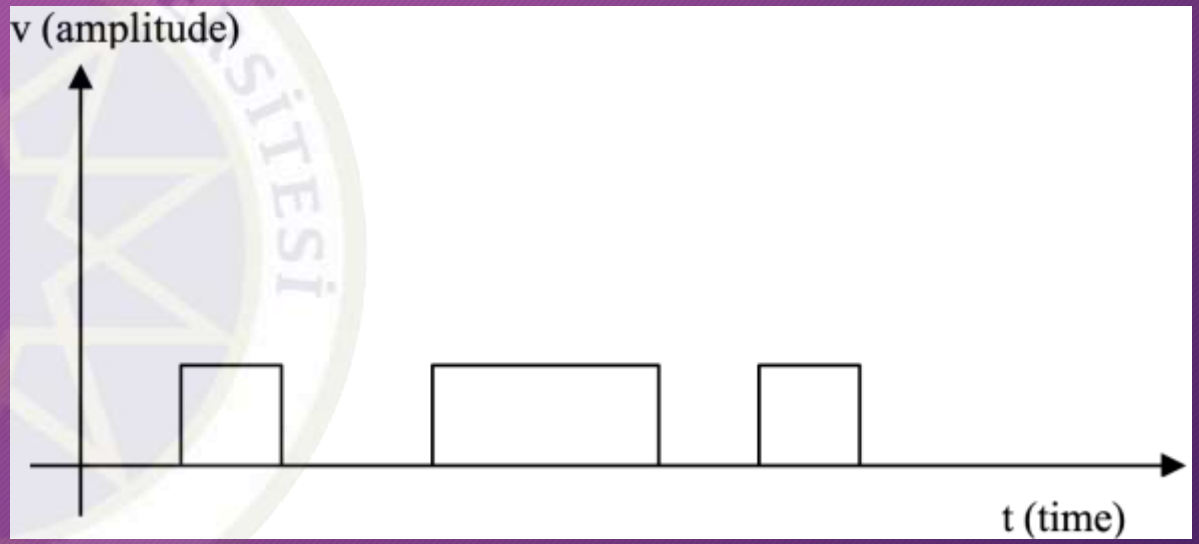
Continious - Analog

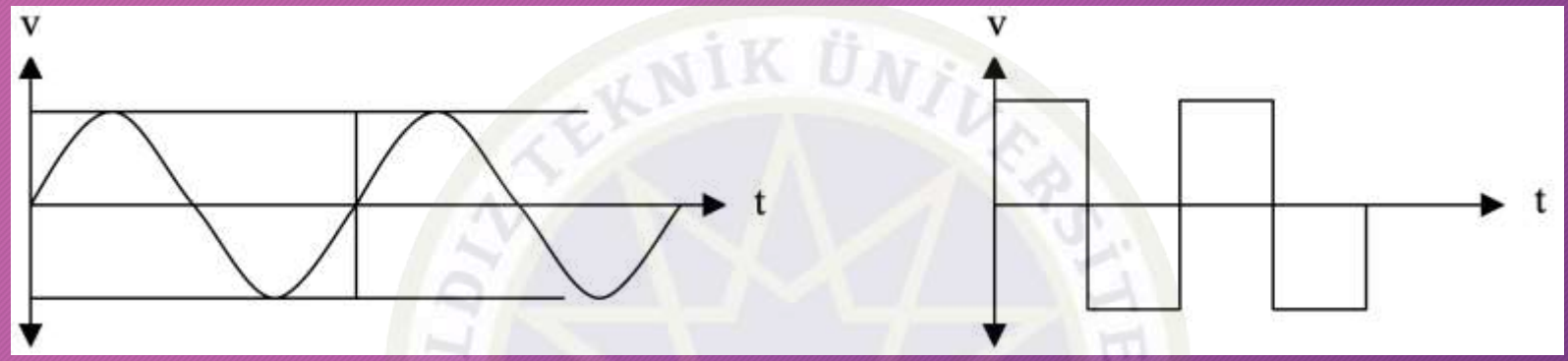


Discrete - Digital

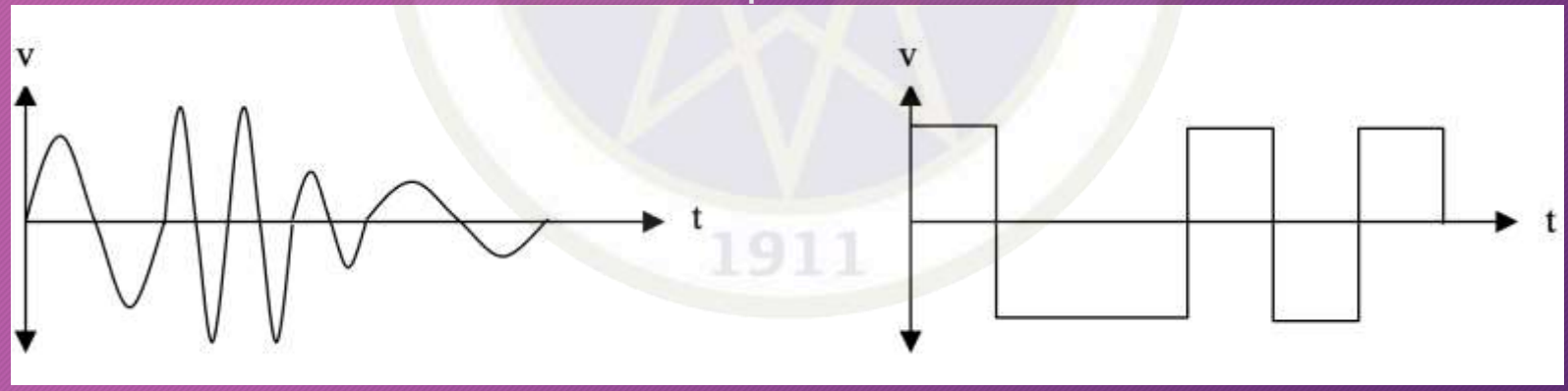


Signals – Con’t

Periodic



Non-periodic



Analog Signals

Simple Analog Signals

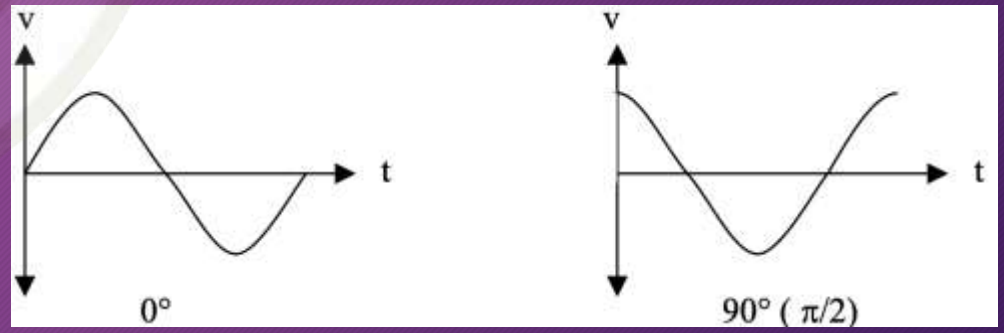
$$f(t) = A\sin(2\pi ft + \phi)$$

Complex Analogue Signals

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

- v – Amplitude
  - Volt - V
  - Amper - A
  - Watt-W
- f – Frequency
  - Cycle
  - Hertz - Hz
- ϕ - Phase
  - Degree - °
  - Radian - π

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

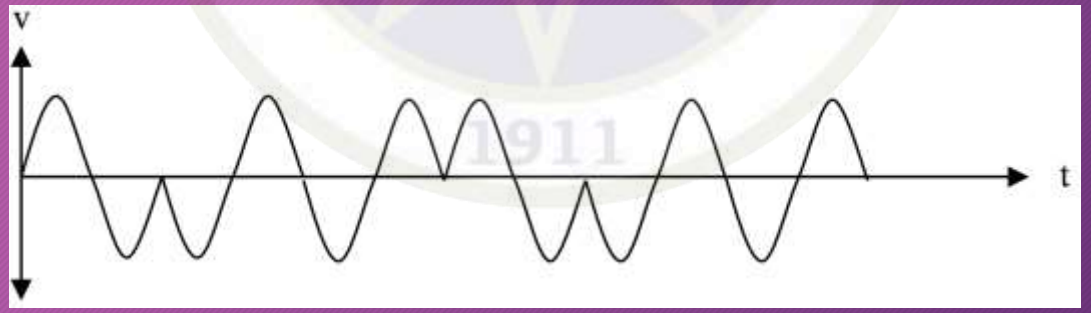


Analog Signals – Con't

Frequency Change

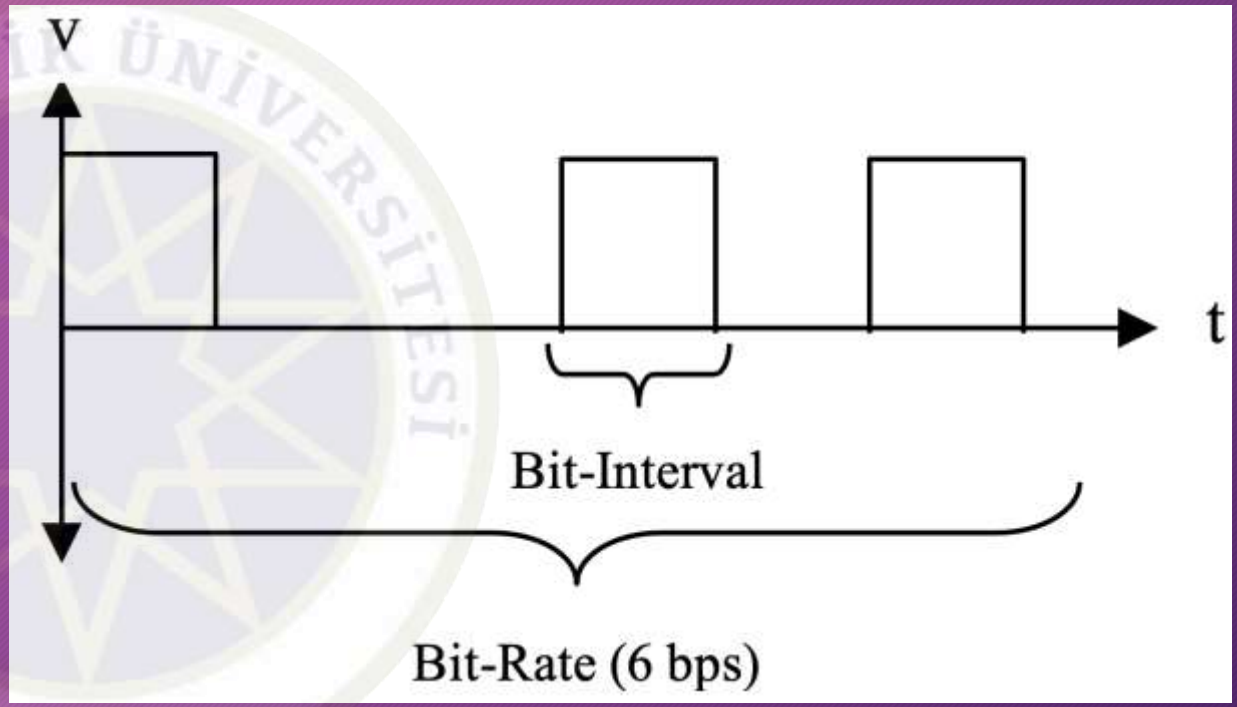
Amplitude Change

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

- Distortion
  - Attenuation
    - dB
    - Solution: Amplifying
      - Analog?
  - 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

Data Carrying Capacity

- **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

$$data_{vel} = 2Hlog_2V \ \ bit/sec$$

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

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

Data Carrying Capacity – Con't

- Shannon-Hartley
  - Data velocity with noise

$$data_{vel} = Hlog_2(1 + \frac{S}{N})\ bit/sec$$

- 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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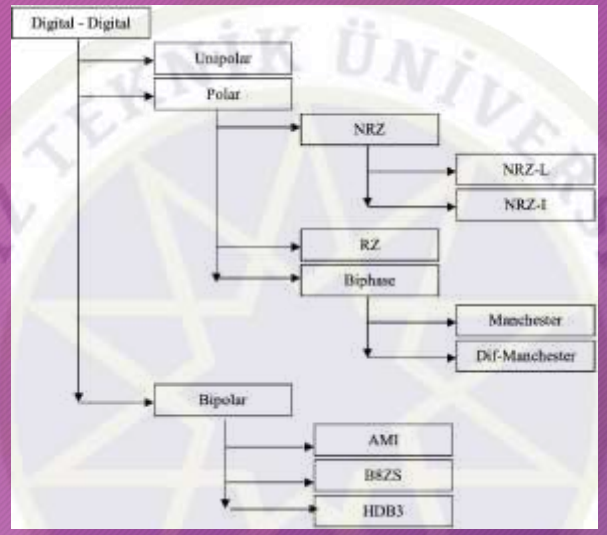
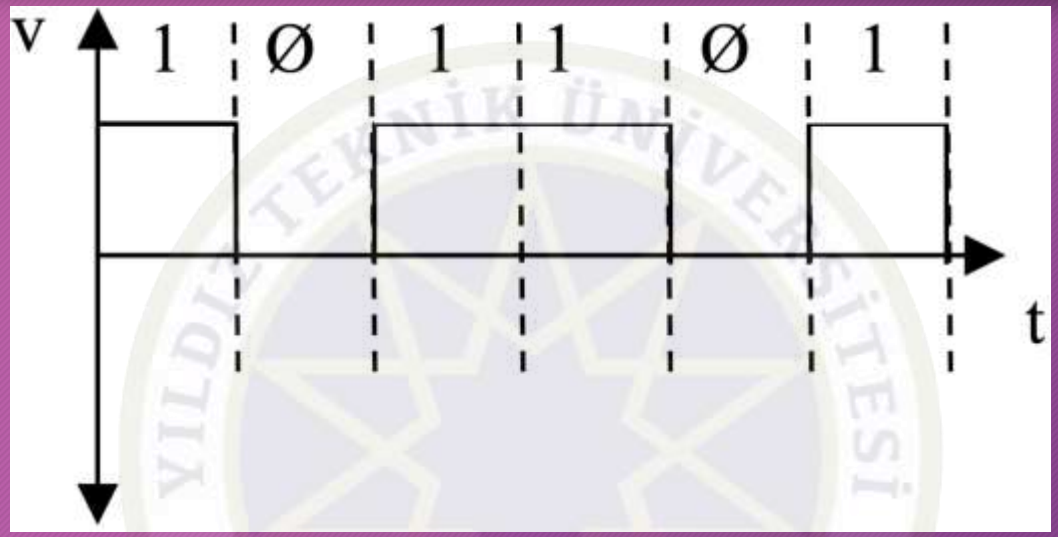
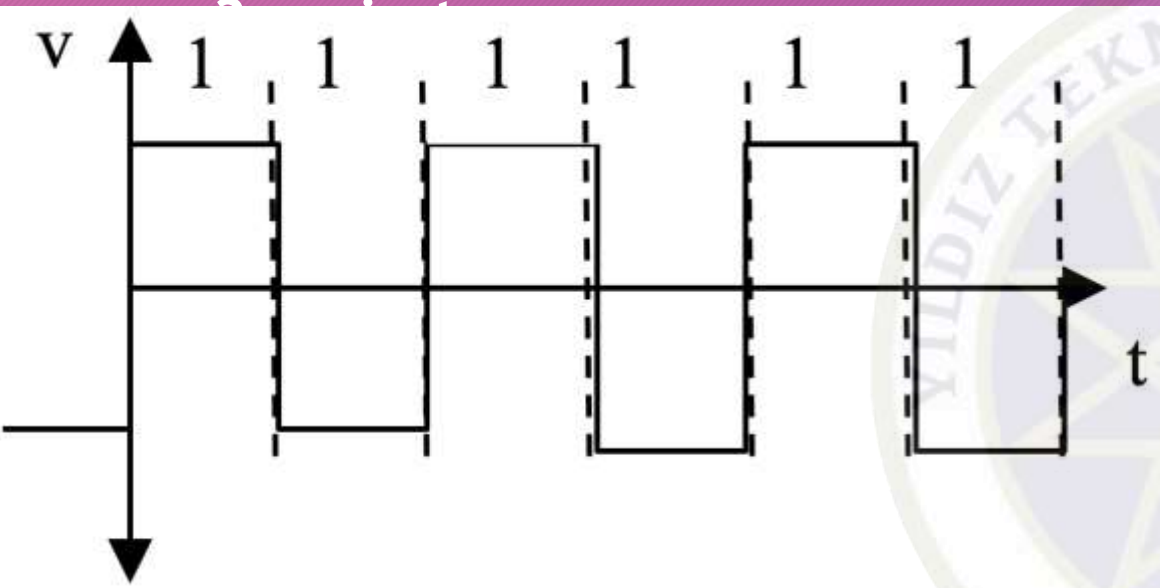


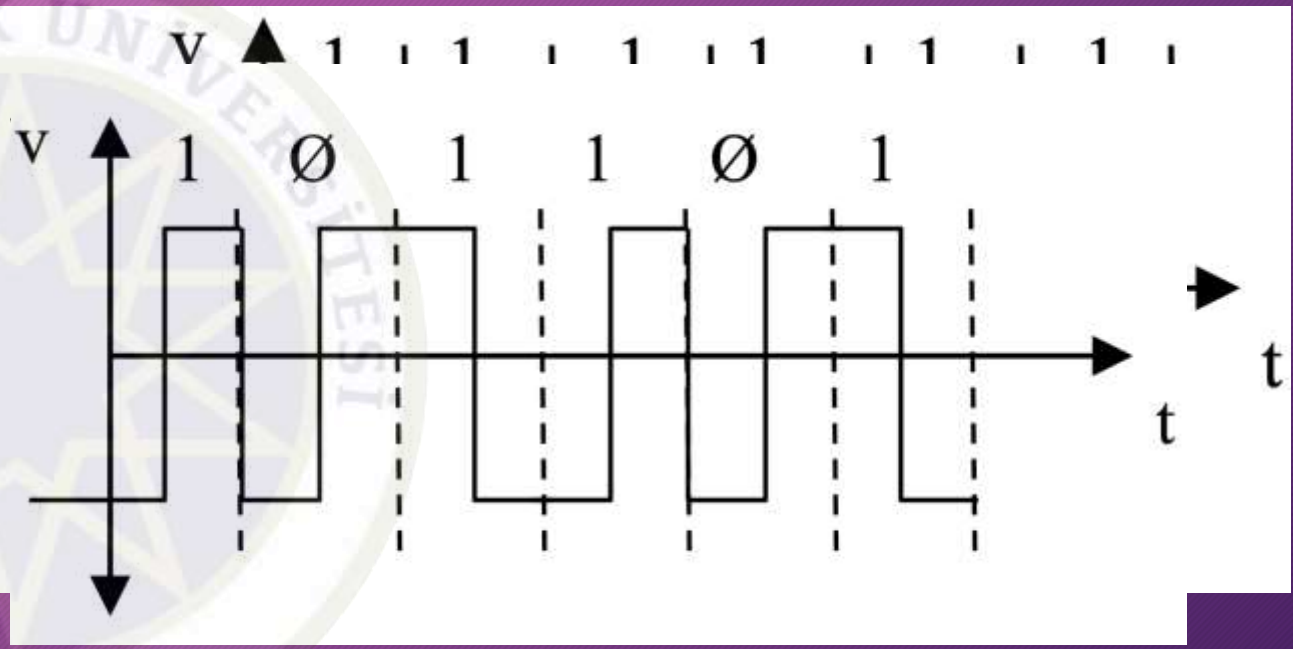
Digital2Digital – Unipolar Coding



- 2 main problems;
  - DC Component
  - Synchronization

Digital2Digital – Polar Coding





+	Ø	Ø	Ø	Ø

→

If the number of 1s transferred after the last conversion is odd

+	Ø	Ø	Ø	+

-	Ø	Ø	Ø	Ø

→

-	Ø	Ø	Ø	-

+	Ø	Ø	Ø	Ø

→

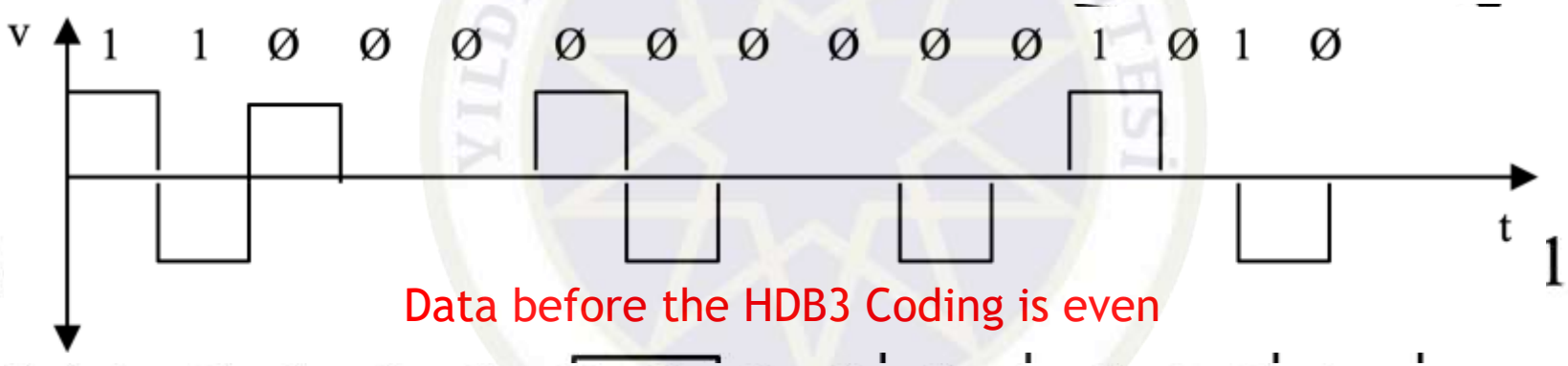
+	-	Ø	Ø	-

If the number of 1s transferred after the last conversion is even

-	Ø	Ø	Ø	Ø

→

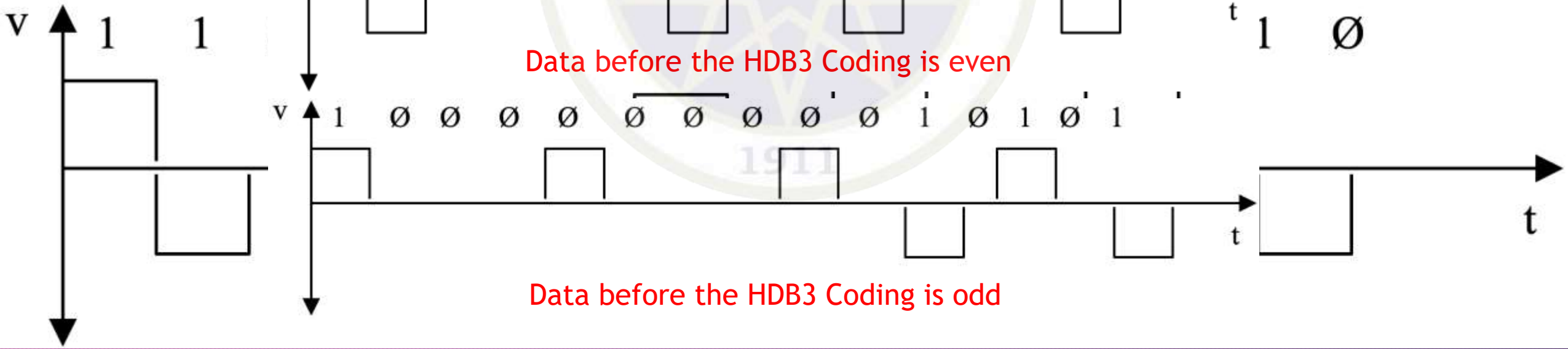
-	+	Ø	Ø	+



Corruption

1 Ø

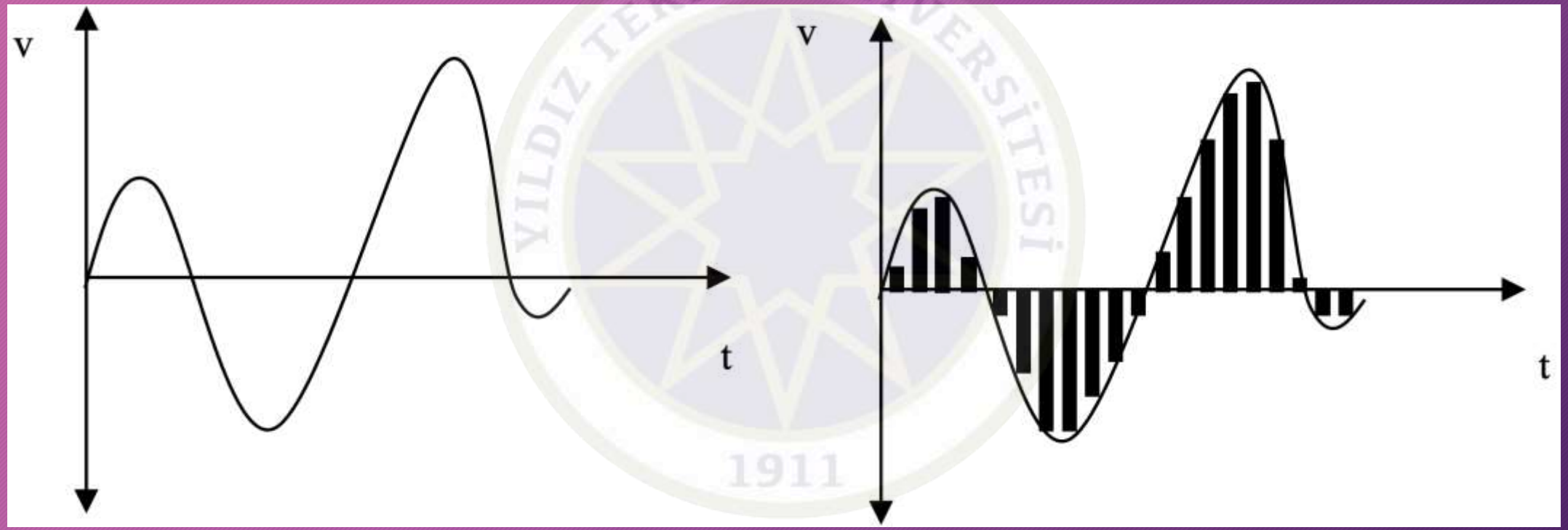
Data before the HDB3 Coding is even



Data before the HDB3 Coding is odd

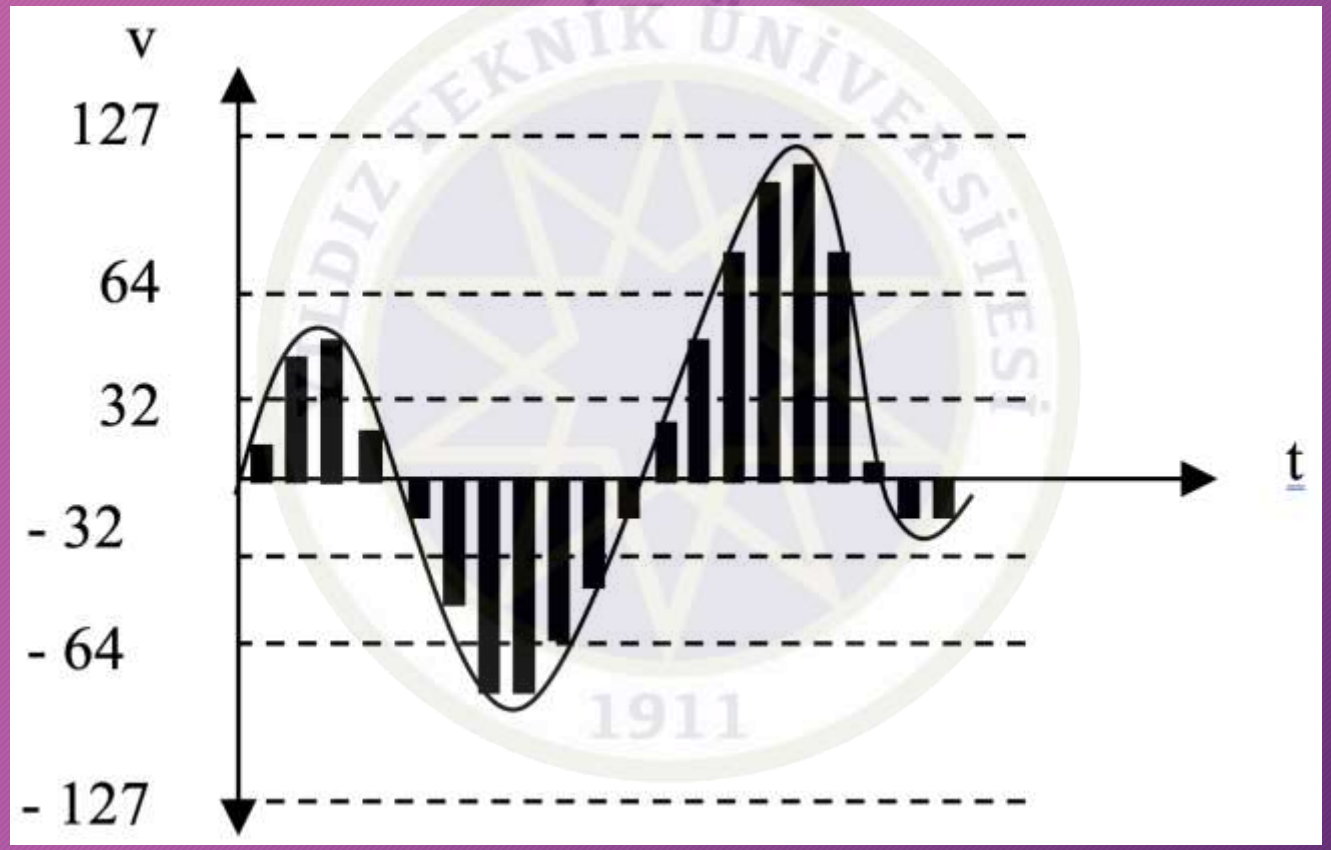
Analog – Digital Coding

PAM (Pulse Amplitude Modulation)

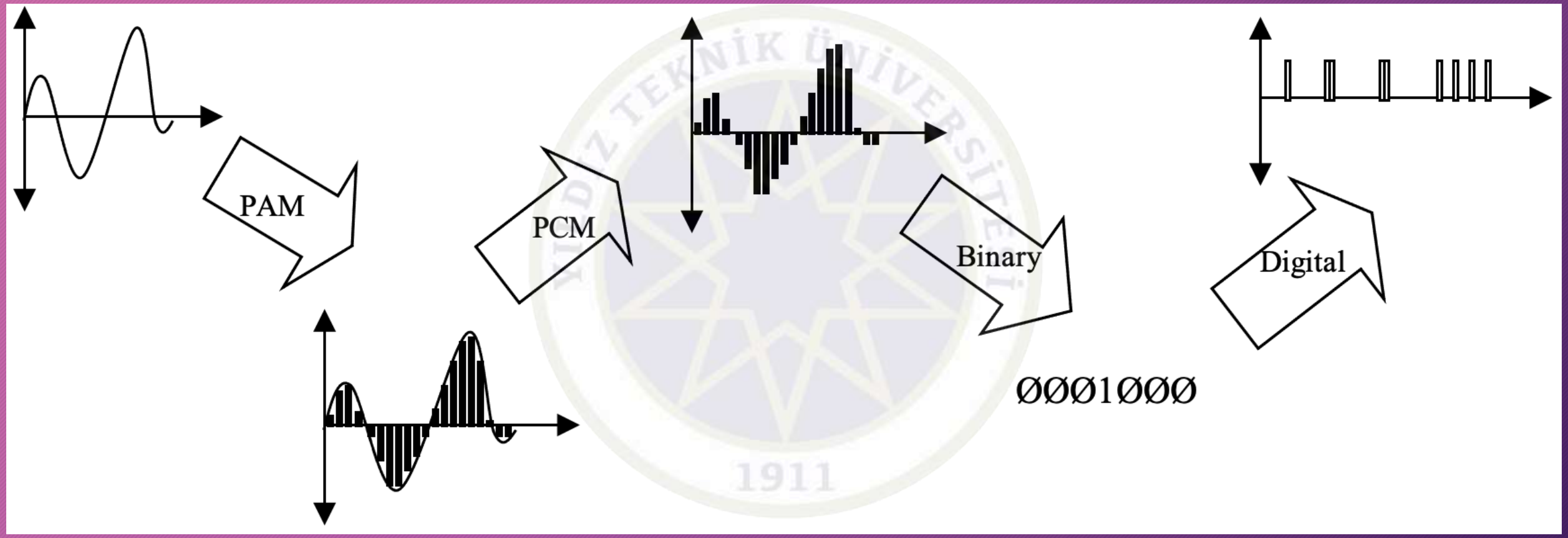


Analog – Digital Coding – Con’t

PCM (Pulse Code Modulation)

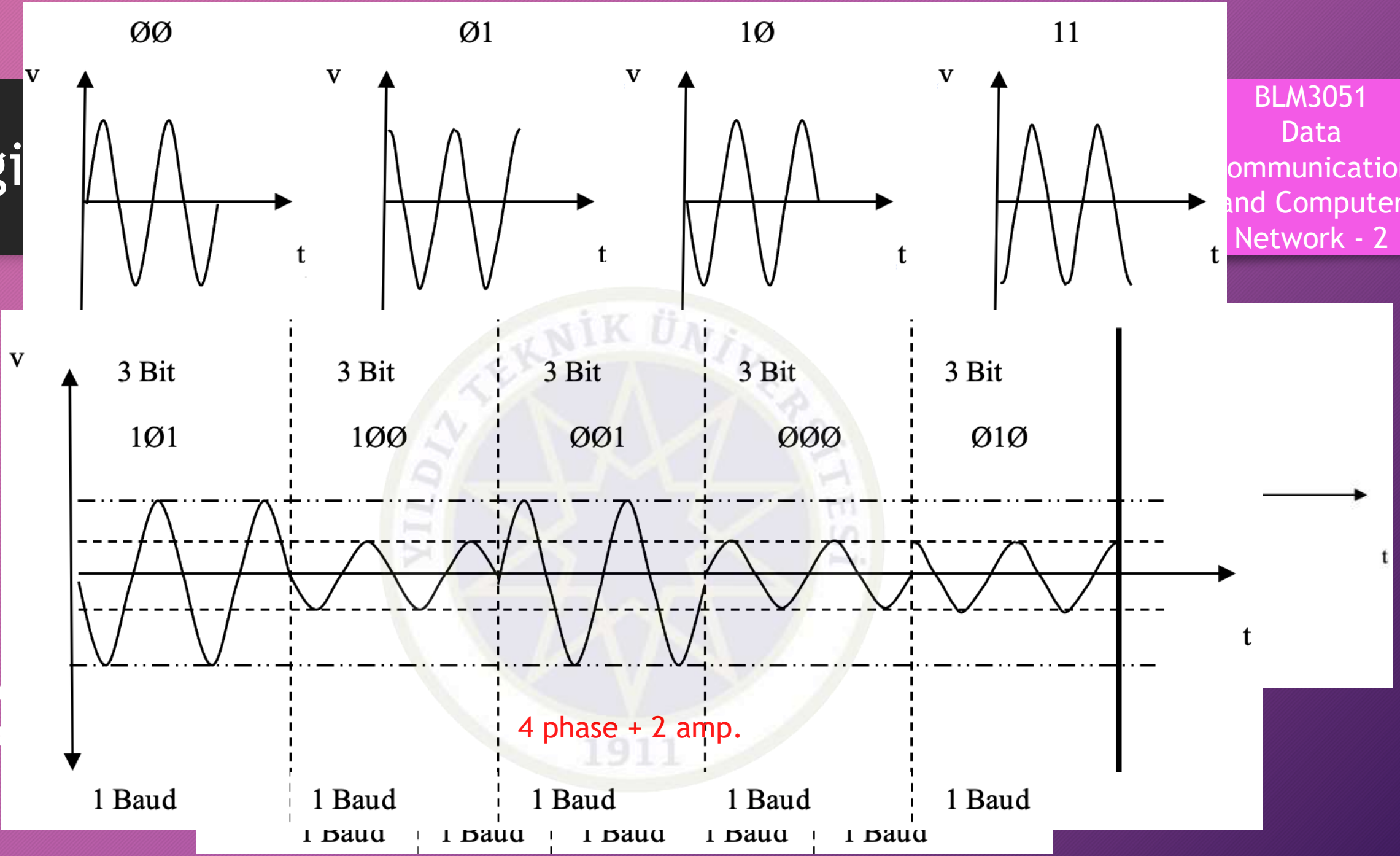


Transmission of the Analog Signal over the Digital Network



Digi

- AS
- FS
- PS
  -
- QA
  Mo
  -



Analog – Digital Coding - Concepts

- **Carrier Signal**
- Bit and Baud Speed
  - Bit Speed ≥ 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

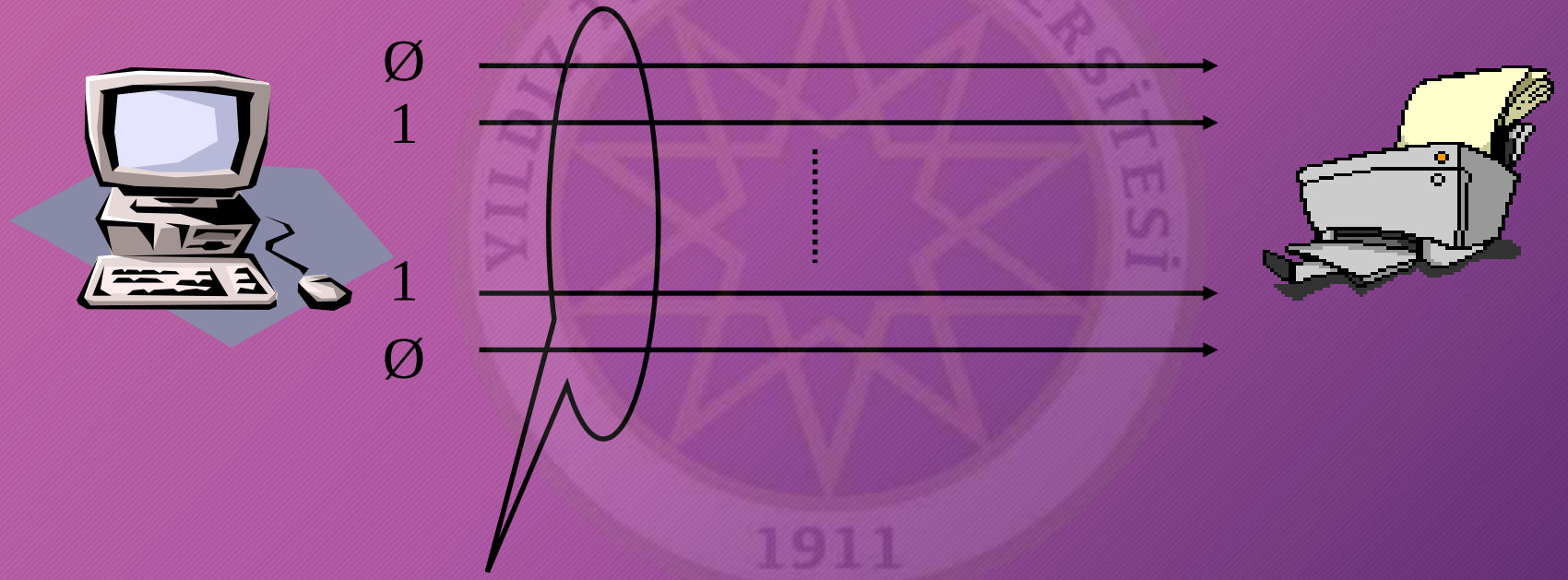
Analog – Analog Coding

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

Digital Data Transmission Techniques

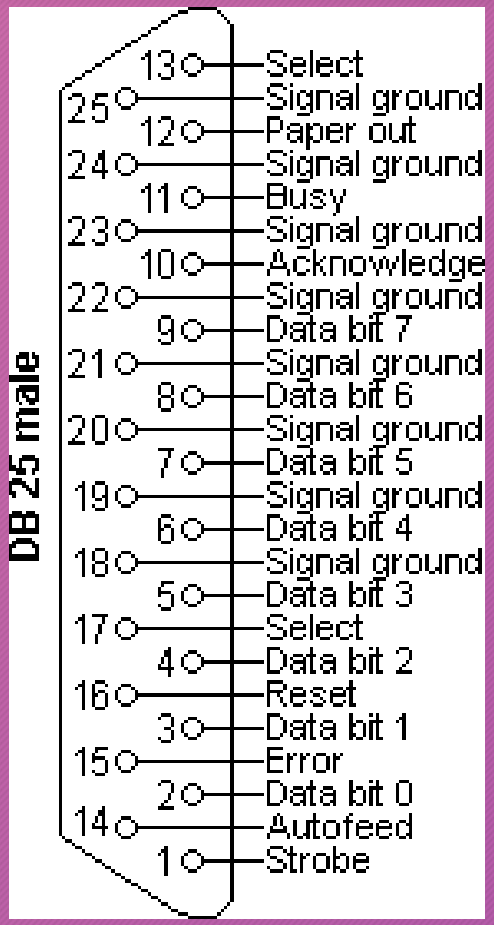
- Medium specs;
  - Connector type to provide mechanical connection in the transmission medium
  - Number of wires
    - Signal type
    - Purpose
  - Frequency, amplitude and phase
- Parallel Transmission
- Serial Transmission

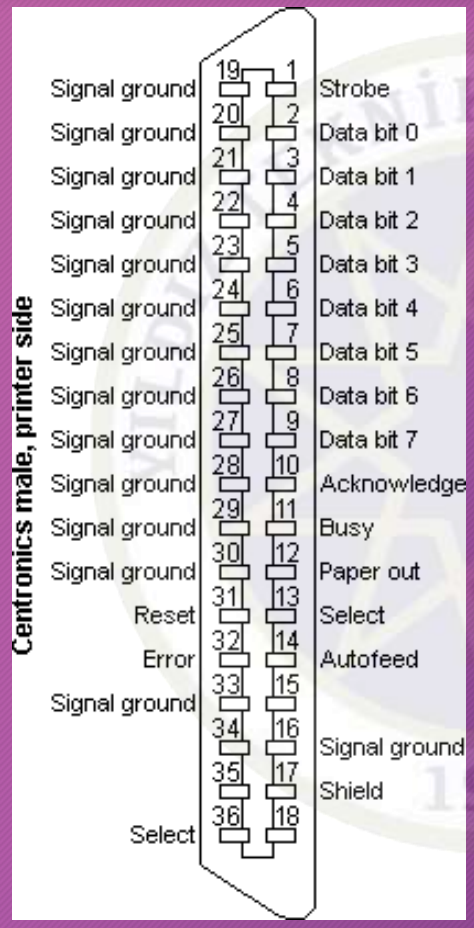
Parallel Transmission



N Wired Connection

Parallel Transmission – Con't

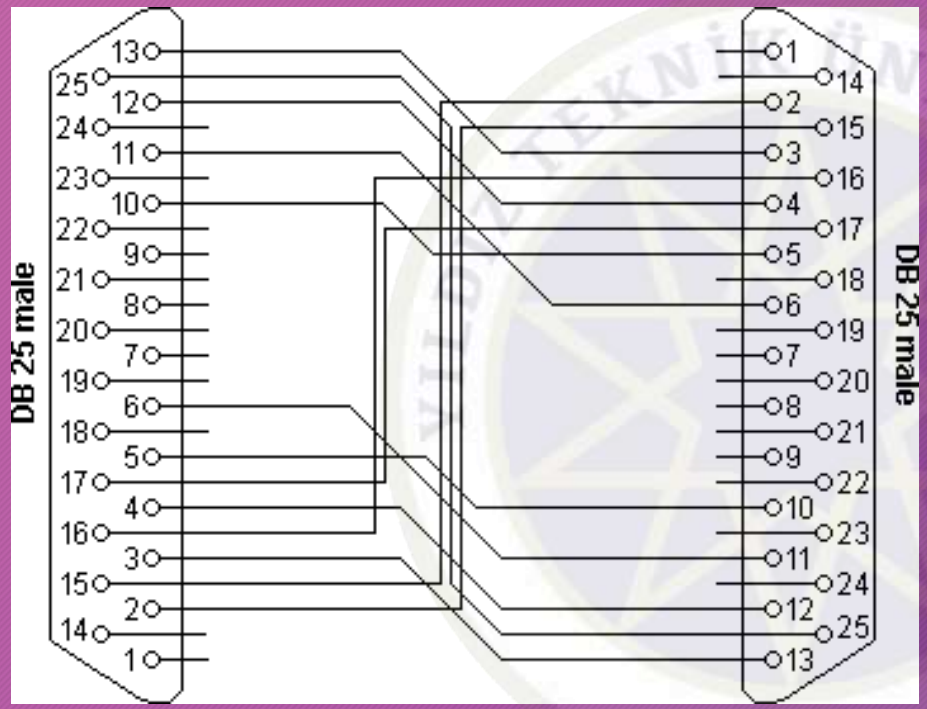




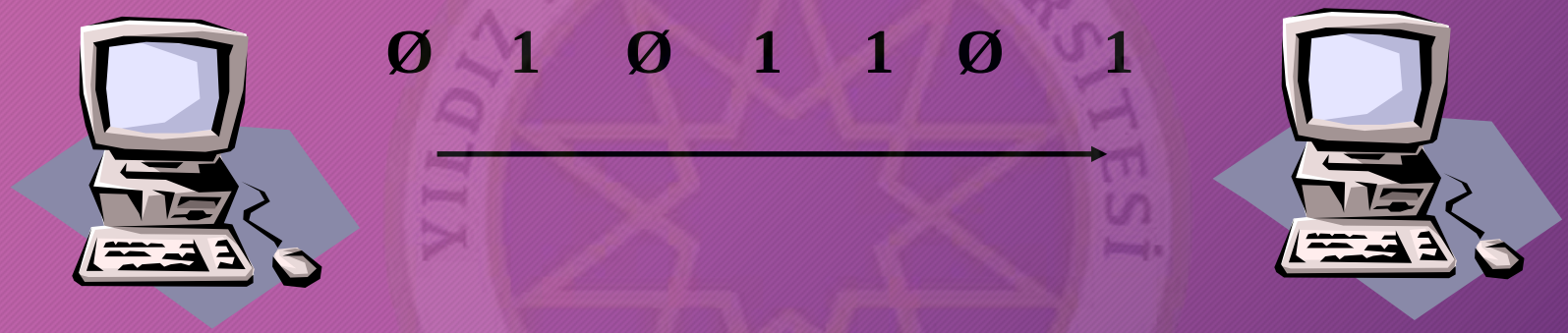
- Standard Parallel Interface
  - 155 kByte/sec
- ECP/EPP (Enhanced Parallel Port/Enhanced Capability Port)
  - 3 MByte/sec
- Maximum Cable Length: 7.5m

Parallel Transmission – Con’t

- Laplink
- Interlink



Serial Transmission



Serial Transmission – Con't

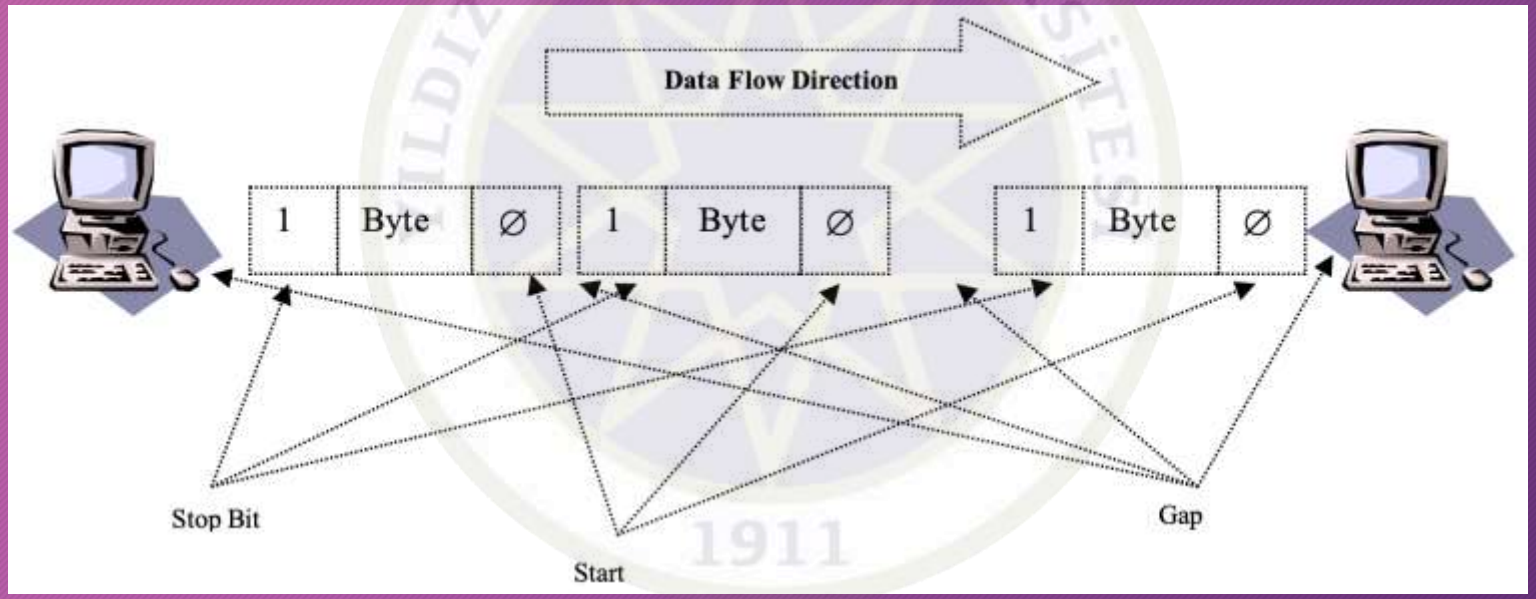
- RS-232-C
  - 9 wires
    - RX
    - TX
    - GND
    - 6 x Flow Control Wire
  - 155 kbits/sec
  - 15 meters
  - NRZ-L
    - (-15~-5)$V_{DC} \rightarrow 1$
    - (+5~+15)$V_{DC} \rightarrow Ø$
  - RS-422: 300 meters
- Asynchronous transmission in WAN
  - 2 wires
- Synchronous transmission in WAN
 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

Asynchronous Serial Transmission

- 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 -> LSB
    - N: not parity bit
  - 7-E-1
    - 1 + 7 + 1 (Even)
- Stop bit: 2-bits long

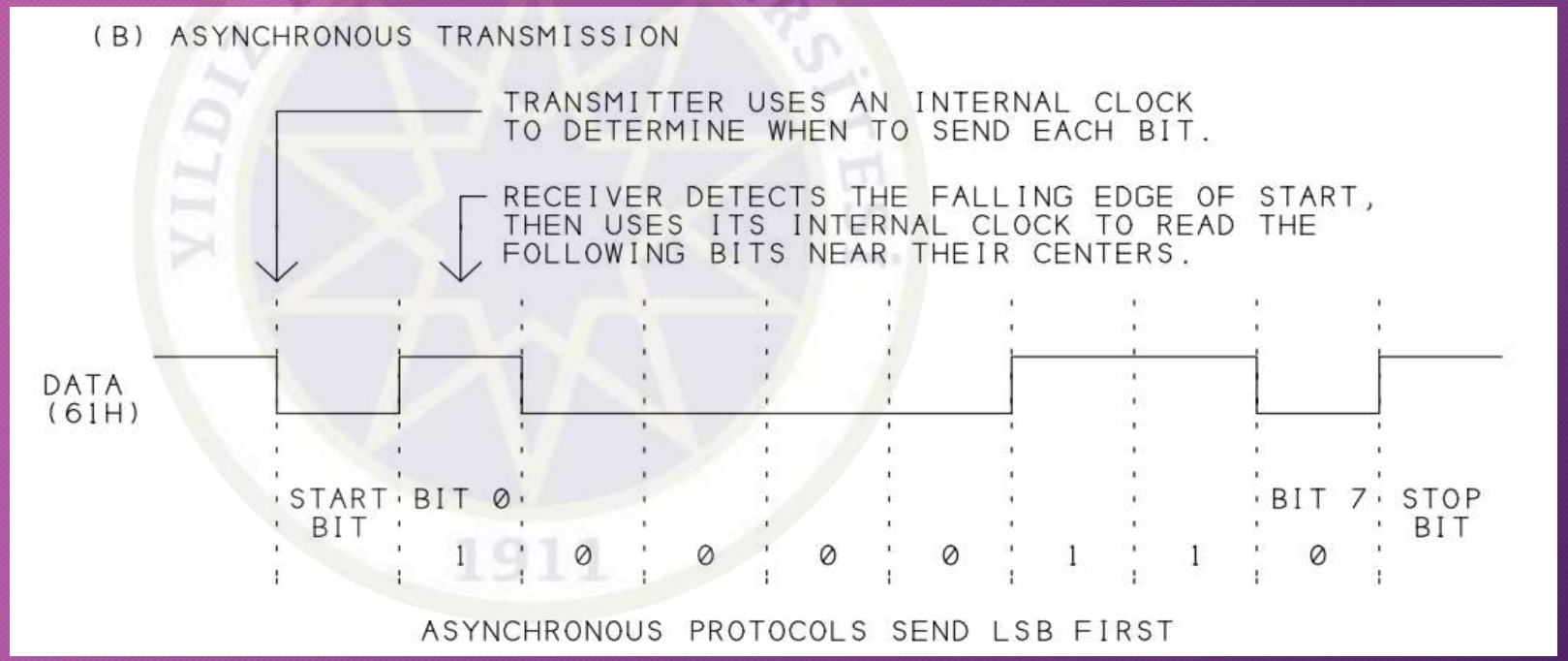
Asynchronous Serial Transmission – Con't

- 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

Synchronous Serial Transmission – Con't

- 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 → 8 bit
        - 1000 characters → 1 block
        - Control data → 48-bit
        - 1 block → 8000 bit
        - 8000 + 48 → 8048 bits
        - Load of control data per bloc → 48 / 8048 ≈ 0,6%

Asynchronous ST vs Synchronous ST

Synchronous	Asynchronous
+ Much more efficient usage + Better error control + High transmission speed	+ 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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