

Data Link Control

BLM3051
Data
Communication
Week 6

- Basic tasks of the data link layer:
 - Framing and determining of start and end points to ensure synchronization
 - Flow control
 - Error control / Retransmission
 - Addressing
 - Line discipline / Link management

Furkan Çakmak

Enq/Ack (Enquiry/Acknowledgement)

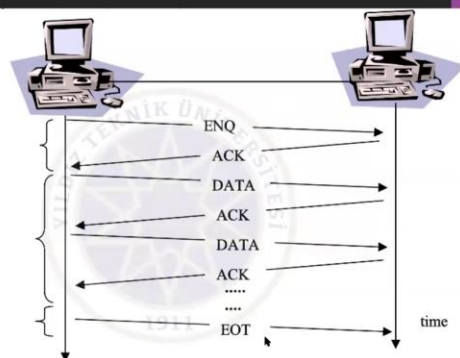
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- Point to point (in WANs)
- Units are expected to have equal properties

Furkan Çakmak

Enq

- Point to point
 - Units are expected to have equal properties
- Establishment of connection
- Data transferring
- Termination of connection



Furkan Çakmak

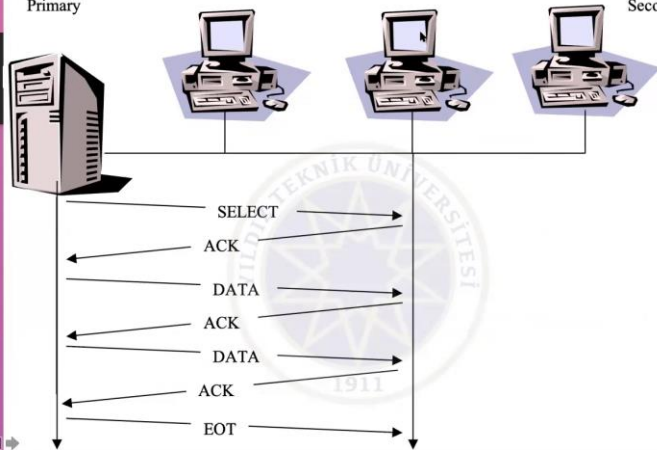
Poll/Select Connection Management

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- Multi-point (in LANs)

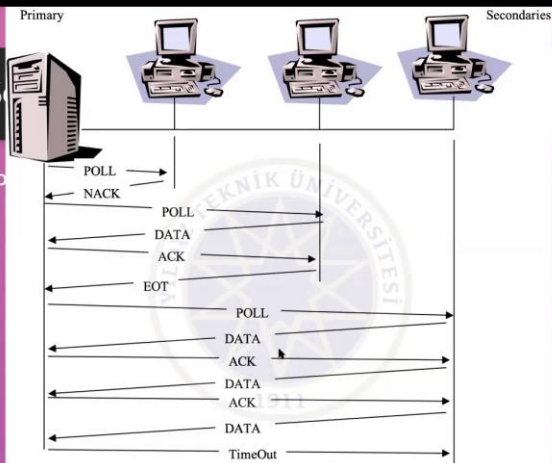


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Poll/S

- Multi-p



Flow Control

- Overwhelm
- Buffer
- There are two basic techniques:

Stop & Wait

- ACK is required for every transfer.
- Pros:
 - Packages consist of smaller pieces
 - Effective use of buffers
 - Medium is busy for a shorter time
 - Error probability decreases
 - Error control processing times are shortened.
 - Wait time may be shorter for other devices in LANs.

Stop & Wait - Line Utilization (U) Rate

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Communication
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- t_{frame} : Transmission time of a single frame
- t_{prop} : The time it takes from the sender to the receiver
- t_{ack} : The time it takes for all bits of the ACK to exit the receiver
- $T_F = t_{\text{frame}} + t_{\text{prop}} + t_{\text{ack}} + t_{\text{prop}}$
- $T_F = t_{\text{frame}} + 2t_{\text{prop}}$
- $U = \frac{t_{\text{frame}}}{t_{\text{frame}} + 2t_{\text{prop}}}$
- $a = \frac{t_{\text{prop}}}{t_{\text{frame}}} \Rightarrow U = \frac{1}{1+2a}$
- $t_{\text{prop}} = \frac{\text{distance}}{\text{velocity}} = \frac{d}{v}$ and $t_{\text{frame}} = \frac{\text{frameSize}}{\text{dataRate}} = \frac{L}{R}$

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Stop & Wait - Line Utilization (U) Rate - Con't

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Communication
Week 6

- Example:
 - Data communication is made between two points at a distance of 1000 km ($d = 1000 \text{ km} = 10^6 \text{ m}$) at a speed of 155.52 Mbps ($R = 155.52 \cdot 10^6 \text{ bit/sec}$).
 - The transmission speed of the line is 200.000.000 m/sec ($V = 2 \cdot 10^8 \text{ m/sec}$).
 - Frame size is 424 bits ($L = 424 \text{ bit}$).
 - What is the Line Utilization (U) in Stop & Wait Flow Control mode?
- Answer
 - $a = \frac{t_{\text{prop}}}{t_{\text{frame}}} \Rightarrow U = \frac{1}{1+2a}$
 - $t_{\text{prop}} = \frac{\text{distance}}{\text{velocity}} = \frac{d}{v}$ and $t_{\text{frame}} = \frac{\text{frameSize}}{\text{dataRate}} = \frac{L}{R}$

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Sliding Window

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Communication
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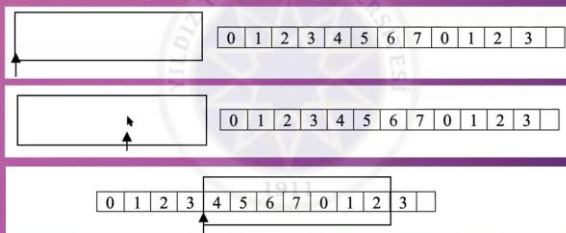
- U rate is low in Stop & Wait
- The sender sends a certain amount of data to the receiver without ACK data.
- Frames are transmitted in convoys.
- The receiver can send ACK data for several frames.
- Frame number is necessary
 - n-bit $\Rightarrow 2^n$ frame
- Piggy backing

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Sliding Window - Sender Side

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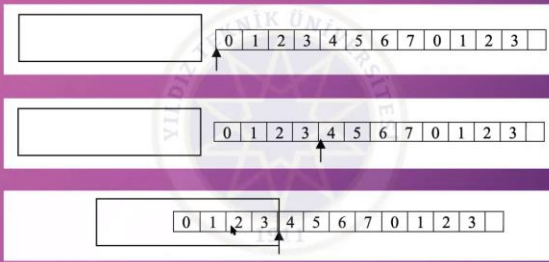
- Window size: $2^n - 1$
 - Example: If frame sequence number bit length is $n=3$, windows size is $2^3 - 1 = 7$



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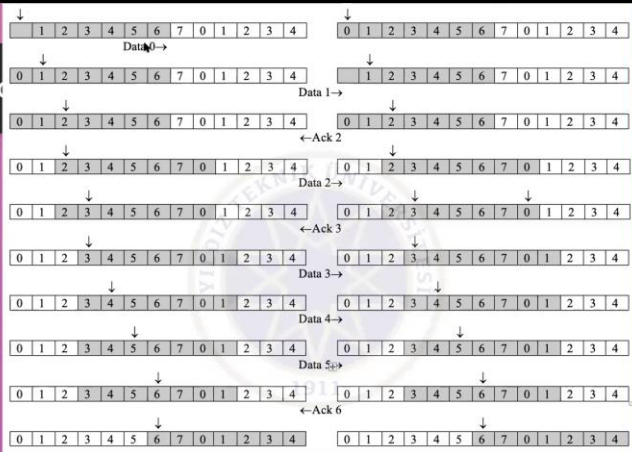
Sliding Window - Receiver Side

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Communication
Week 6



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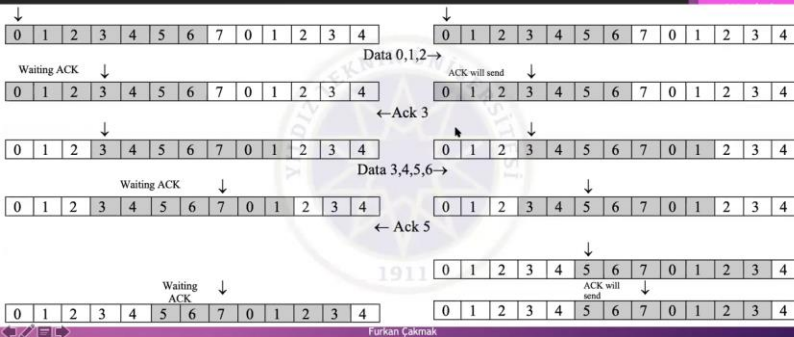
Slide



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Communication
Week 6

Sliding Window - Both Side Example

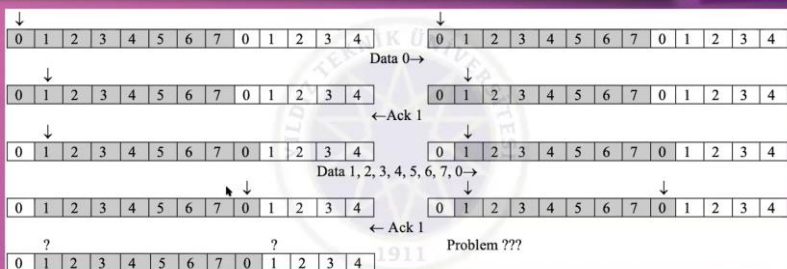
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Sliding Window - Window Size $2^n - 1$

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Sliding Window - Line Utilization (U) Rate

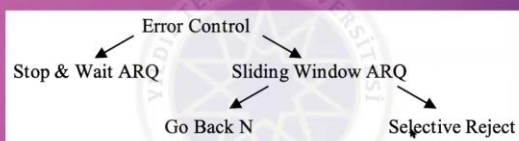
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- In Stop & Wait $a = \frac{t_{prop}}{t_{frame}}$
- In Sliding Windows $t_{frame} = 1 \Rightarrow a = t_{prop}$
- If w (window size) $\geq (2a + 1)$
 - $U = \%100$
- If $w < (2a + 1)$
 - $U = \frac{w}{2a + 1}$
- $U = \begin{cases} 1 & w \geq 2a + 1 \\ \frac{w}{2a + 1} & w < 2a + 1 \end{cases}$

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Error Control, Automatic Repeat reQuest (ARQ)

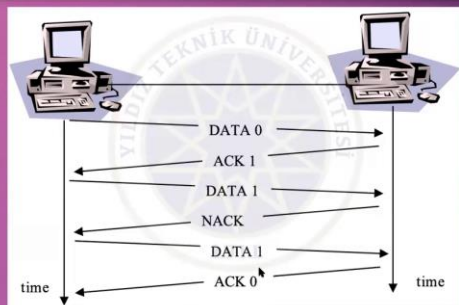
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Communication
Week 6



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Stop & Wait ARQ

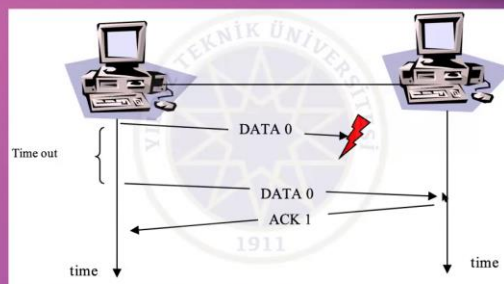
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Communication
Week 6



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Stop & Wait ARQ

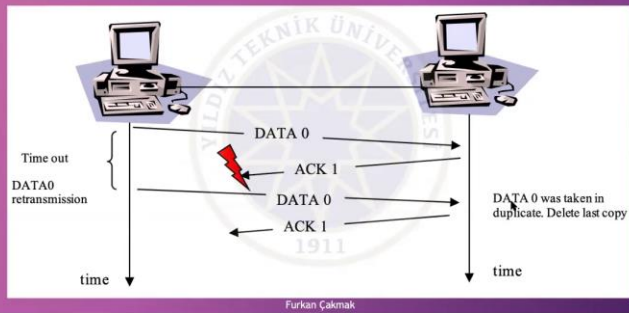
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Communication
Week 6



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Stop & Wait ARQ

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Communication
Week 6



Sliding Window ARQ

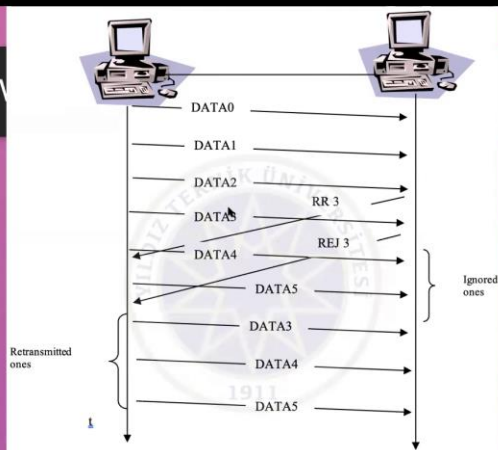
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Communication
Week 6

- There are some differences caused by the sliding window technique when the frames inside the window are sent **without a receipt**.
 - The sender continues to **store the frames in the buffer** until it receives **ACK** for the frames.
 - In the **ACK / NACK information** coming from the **receiver**, there will be a **number field** showing **which** numbered frame it is for.
- Receive Ready
 - RR 3 and RR 6 means: I have **received 3, 4, 5** numbered frames, **waiting for frame 6**.
- Each **faulty frame is immediately reported by the receiver** to the sender.
 - REJ - Reject
 - SREJ - Selective Reject
- The **sender also has a timer** in the sliding window approach.
 - Lost data frame
 - Lost acknowledge frame

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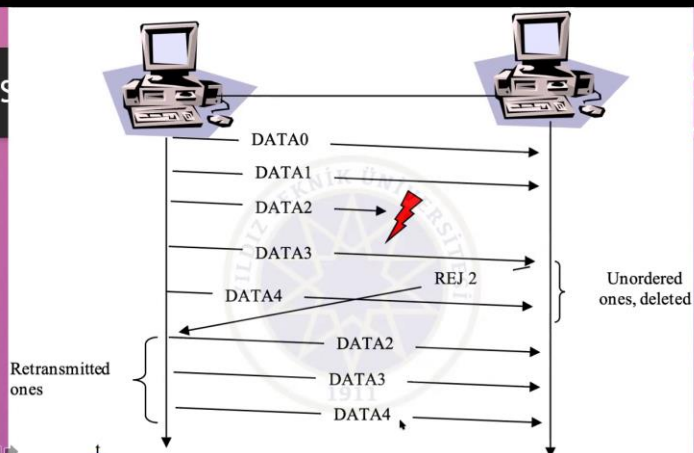
Sliding Window ARQ

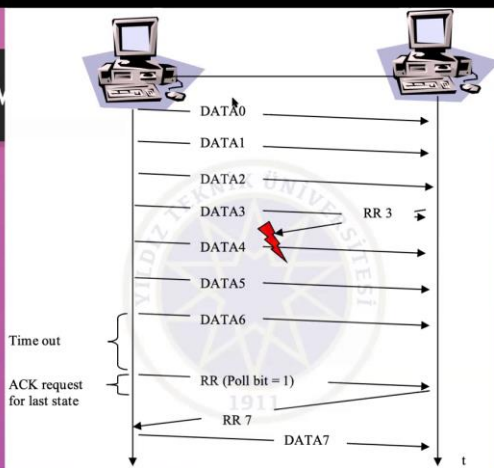
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Week 6



Sliding Window ARQ

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Week 6





Sliding Window - Selective Reject / Selective Repeat ARQ

- In this technique, the receiver will receive the frames unordered.
- Search and Sort Algorithms are necessary.
- Processing complexity increases
 - In Go Back n: $w = (2^n - 1)$
 - In Selective Reject: $w \leq (2^n + 1)/2$
- SREJ
- The receiver accepts frames without error after faulty frame.
- Frames will come in different order due to faulty frames.
 - Duplicated ones

1911

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