

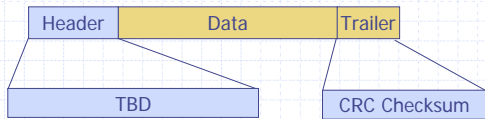
ECE453 – Introduction to Computer Networks

Lecture 5 – Data Link Protocols (II)

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Elementary Data Link Protocols

- ◆ An Unrestricted Simplex Protocol
- ◆ A Simplex Stop-and-Wait Protocol
- ◆ A Simplex Protocol for a Noisy Channel



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Unrestricted Simplex Protocol – the Utopia

- ◆ Both the transmitting and receiving network layers are always ready
- ◆ Infinite buffer space is available
- ◆ The communication channel between the data link layers never damages or loses frames
- ◆ Data are transmitted in one direction only
- ◆ Processing time can be ignored

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Unrestricted Simplex Protocol

```
void sender1 (void)
{
    frame s;
    packet buffer;

    while (true) {
        from_network_layer(&buffer);
        s.info = buffer;
        to_physical_layer(&s);
    }
}
```

```
void receiver1 (void)
{
    frame r;
    event_type event;

    while (true) {
        wait_for_event(&event);
        from_physical_layer(&r);
        to_network_layer(&r.info);
    }
}
```

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Simplex Stop-and-Wait Protocol - Assumptions

- ◆ ~~Both the transmitting and receiving network layers are always ready~~
- ◆ ~~Infinite buffer space is available~~
- ◆ The communication channel between the data link layers never damages or loses frames
- ◆ Data are transmitted in one direction only
- ◆ Processing time can be ignored

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Simplex Stop-and-Wait Protocol

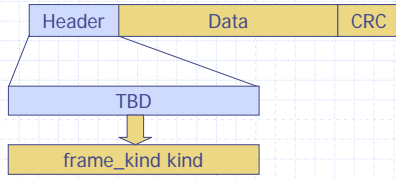
```
void sender2 (void)
{
    frame s;
    packet buffer;
    event_type event;

    while (true) {
        from_network_layer(&buffer);
        s.info = buffer;
        to_physical_layer(&s);
        wait_for_event(&event);
    }
}
```

```
void receiver2 (void)
{
    frame r, s;
    event_type event;

    while (true) {
        wait_for_event(&event);
        from_physical_layer(&r);
        to_network_layer(&r.info);
        to_physical_layer(&s);
    }
}
```

Simplex Stop-and-Wait Protocol



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A Simplex Protocol for a Noisy Channel (also a Stop-and-Wait)

- ◆ ~~Both the transmitting and receiving network layers are always ready~~
- ◆ ~~Infinite buffer space is available~~
- ◆ ~~The communication channel between the data link layers never damages or loses frames~~
- ◆ Data are transmitted in one direction only
- ◆ Processing time can be ignored

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```
void sender3 (void)
{
    seq_nr next_frame_to_send;
    frame s;
    packet buffer;
    event_type event;

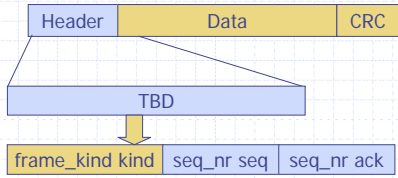
    next_frame_to_send = 0;
    from_network_layer(&buffer);
    while (true) {
        s.info = buffer;
        s.seq = next_frame_to_send;
        to_physical_layer(&s);
        start_timer(s.seq);
        wait_for_event(&event);
        if (event == frame_arrival) {
            from_physical_layer(&s);
            if (s.ack == next_frame_to_send) {
                stop_timer(s.ack);
                from_network_layer(&buffer);
                inc(next_frame_to_send);
            }
        }
    }
}
```

A Simplex Protocol for a Noisy Channel

```
void receiver3 (void)
{
    seq_nr frame_expected;
    frame r, s;
    event_type event;

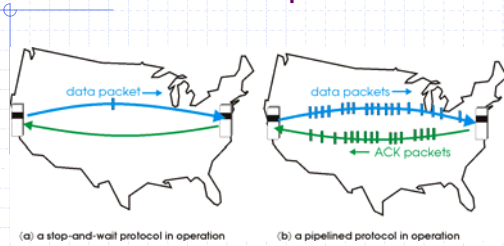
    frame_expected = 0;
    while (true) {
        wait_for_event(&event);
        if (event == frame_arrival) {
            from_physical_layer(&r);
            if (r.seq == frame_expected) {
                to_network_layer(&r.info);
                inc(frame_expected);
            }
            s.ack = 1 - frame_expected;
            to_physical_layer(&s);
        }
    }
}
```

Simplex Stop-and-Wait Protocol in Noisy Channel



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Problem with Stop-and-Wait



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Sliding Window Protocols

Assumptions

- ~~Both the transmitting and receiving network layers are always ready.~~
- ~~Infinite buffer space is available.~~
- ~~The communication channel between the data link layers never damages or loses frames.~~
- ~~Data are transmitted in one direction only.~~
- Processing time can be ignored.

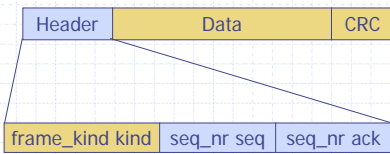
Go Back N (GBN)

Selective Repeat (SR)

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Piggybacking

- ◆ Temporarily delaying outgoing acknowledgements so that they can be hooked onto the next outgoing data frame



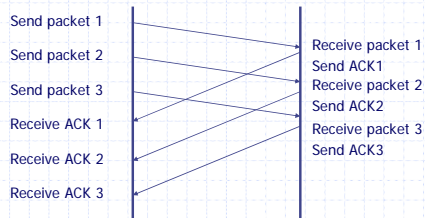
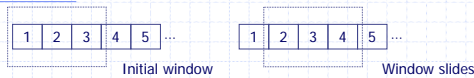
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GBN

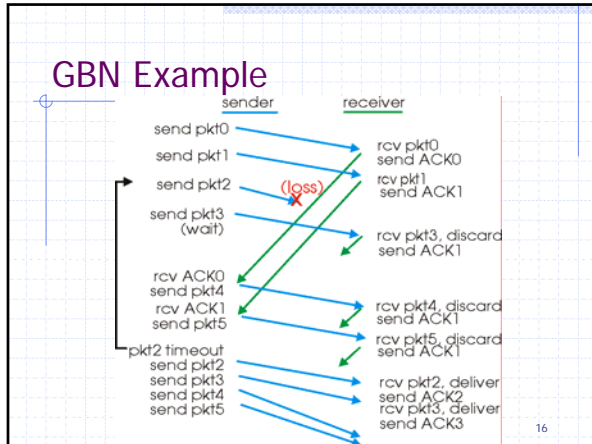
- ◆ Sender is allowed to transmit multiple packets without waiting for an acknowledgement, but is constrained to have no more than some maximum allowable number (N)
- ◆ Use **cumulative acknowledgement**
- ◆ Discard out-of-order packets, **no receiver buffering**

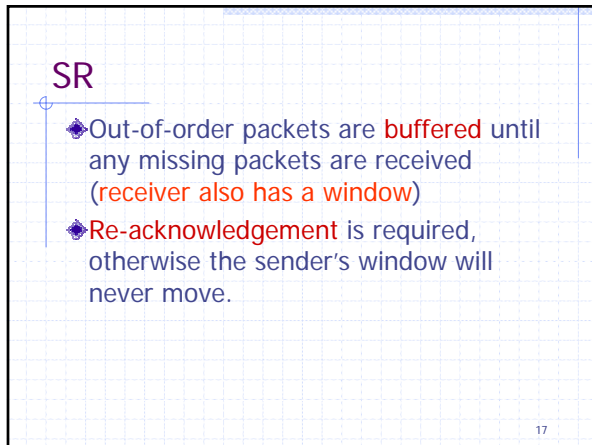
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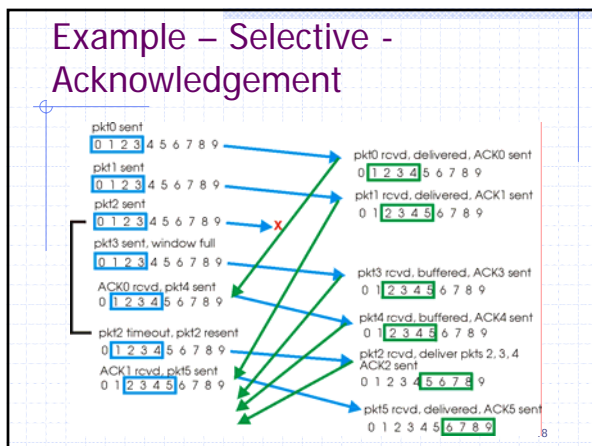
Idea Behind Sliding Window



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Summary – Reliable Data Transfer (RDT) Protocols

- ◆ Utopia
- ◆ Stop-and-wait protocol
 - Simplex stop-and-wait
 - Simplex stop-and-wait in noisy channel
- ◆ Sliding window protocols
 - Go-Back-N (GBN)
 - Selective Repeat (SR)

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