Computer Networks WS12/13
Q&A Session

CRC checksums

- CRC checksums: Please calculate the CRC *R of D = 0101 1100 1010 0111 1110 1111.* *Please use the 4 bit generator G = 1001*

- *Please note, R is always of polynom-length (=if G has 4 bit, R is 3 bit long).*

$$G = 1 \cdot x^3 + 0 \cdot x^2 + 0 \cdot x^1 + 1 \cdot x^0$$

CRC Checksums

```
010111001010011111101111000
 1001
 001010
   1001
   001101
     1001
     01000
      1001
      0001100
         1001
         01011
          1001
          001011
            1001
            001011
              1001
              001010
                1001
                001111
                  1001
                  01101
                   1001
                   01001
                    1001
                    0000
```

```
010111001010011111101110000
 1001
 001010
   1001
   001101
     1001
     01000
      1001
      0001100
         1001
         01011
          1001
          001011
            1001
            001011
              1001
              001010
                1001
                001111
                  1001
                  01101
                   1001
                   01000
                    1001
                     001000
                       1001
                       0001
```

IP Subnetting

A provider has been assigned the network 128.30.0.0/17 and wants to divide it among four customers. Customers A and B need to accomodate 5,000 hosts each, Customer C needs to accomodate 7,000 hosts each, and Customer D needs to accomodate 9,000 hosts each. Can the provider fulfill these requirements?

Subnet calculations (Example)

- Given network: 128.30.0.0/17
- Wanted: Four sub networks
- First step: Find new subnet mask
  - To address four networks we need at least two bits ($2^2 = 4$).
  - The new subnet mask is 17+2 = 19
- Second step: Find new network addresses (see next slide)
- Third step: Calculate data for new networks

Subnet calculations (example)

New netmask: 19 (= 255.255.224.0)
11111111.11111111.11100000.00000000

=> New network 1: 128.30.0.0/19 (← this is the network address)
10000000.00011110.00000000.00000000

=> New network 2: 128.30.32.0/19
10000000.00011110.00100000.00000000

=> New network 3: 128.30.64.0/19
10000000.00011110.01000000.00000000

=> New network 4: 128.30.96.0/19
10000000.00011110.01100000.00000000

Number of hosts: 2^13 – 2 = 8,190: Customer D can not be accomodated! Only can support 8,190 hosts!

Subnet calculation (another example)

- A provider has been assigned the network 128.30.0.0/22 and wants to divide it to accommodate two customers: Customer A has 100 hosts and Customer B has 255 hosts. The remainder should be partitioned in blocks as large as possible. Please fill the following table with the data of the resulting sub networks.

Subnet No.	Network Address	Netmask	Host Range	No. of Hosts
1 Cust. A	128.30.0.0/25	255.255.255.128	128.30.0.1 – 128.30.0.126	126
2 Cust B	128.30.2.0/23	255.255.254.0	128.30.2.1 – 128.30.3.254	510
3 (free)	128.30.0.128/25	255.255.255.128	128.30.0.128 – 128.30.0.254	126
4 (free)	128.30.1.0/24	255.255.224.0	128.30.1.1 – 128.30.1.254	254

More examples:

https://learningnetwork.cisco.com/servlet/JiveServlet/download/19306
1-46962/Subnetting.pdf

IP Fragmentation

- A datagram of 1400 bytes (including 20 bytes IP header) needs to be sent over a 620 byte MTU.
- Payload = 1380 bytes

Datagram No.	Length	Frag. Flag	Offset = (MTU-Header / 8)
1	620 (**600**+20)	1	0
2	620 (**600**+20)	1	75
3	200 (**180**+20)	0	150
4			

TCP Sequence Numbers

- Used for reliable data transfer: Want to acknowledge reception of packets by „naming“ them
- Simple case: “Stop-and-wait“ protocols
  - Send a packet and wait for ACK before sending next packet
- More efficient: “pipelined” protocols
  - Go-Back-N and Selective Repeat

TCP Sequence Numbers (cont.)

<u>Go-back-N: big picture:</u>

- Sender can have up to N unacked packets in pipeline
- Rcvr only sends cumulative acks
  - Doesn't ack packet if there's a gap
- Sender has timer for oldest unacked packet
  - If timer expires, retransmit all unacked packets

<u>Selective Repeat: big pic</u>

- Sender can have up to N unacked packets in pipeline
- Rcvr acks individual packets
- Sender maintains timer for each unacked packet
  - When timer expires, retransmit only unack packet

TCP Sequence Numbers (cont.)

- http://media.pearsoncmg.com/aw/aw_kurose_network_2/applets/go-back-n/go-back-n.html
- http://media.pearsoncmg.com/aw/aw_kurose_network_3/applets/SelectRepeat/SR.html

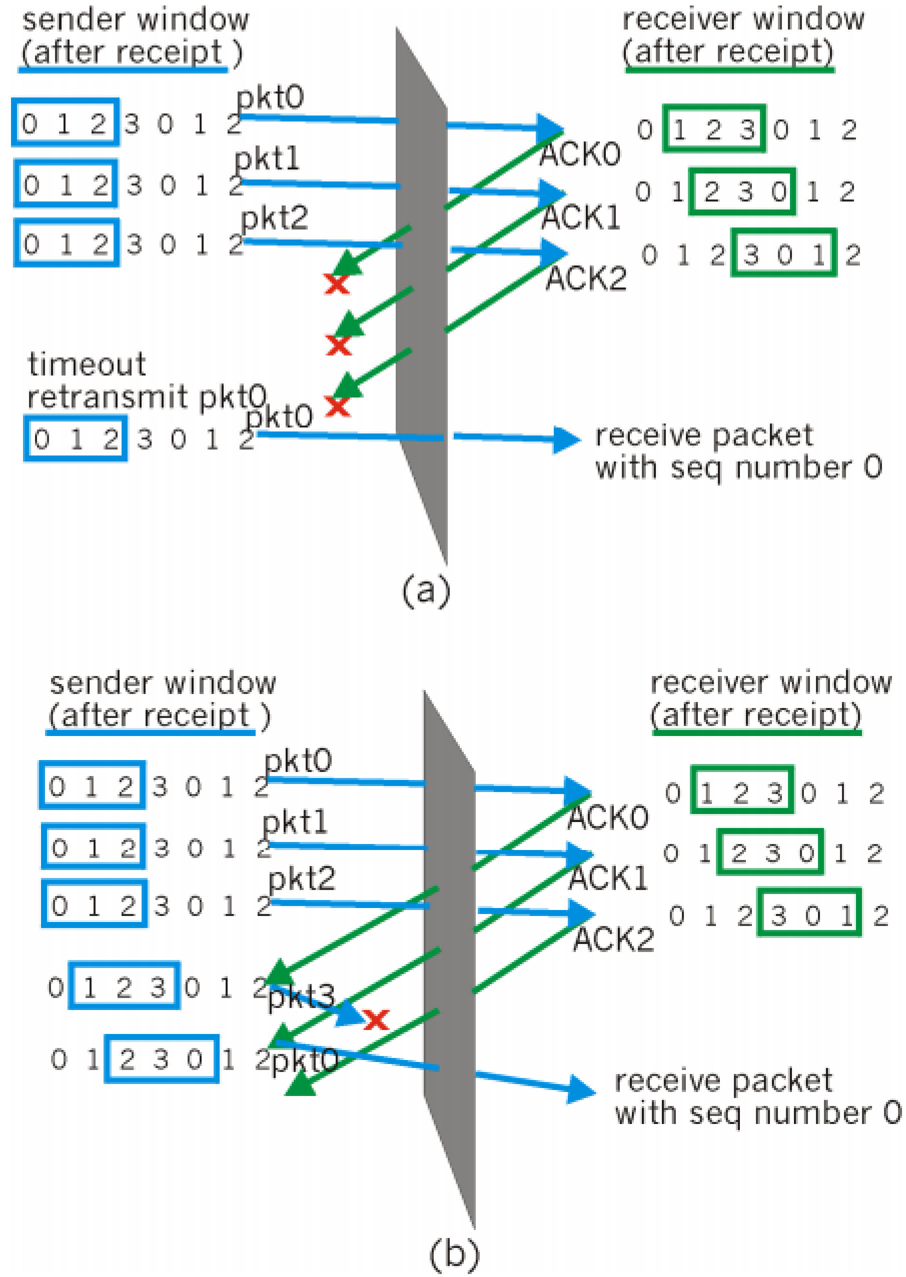
Go-Back-N and Selective Repeat

- Main difference:
  - Go-Back-N: Cumulative ACKs
  - May require retransmission of multiple packets if timeout
  - Selective Repeat: Individual Packets get retransmitted

Selective repeat: dilemma

Example:

- seq #'s: 0, 1, 2, 3
- window size=3



- receiver sees no difference in two scenarios!
- incorrectly passes duplicate data as new in (a)

Notice: Window size should be not too large, e.g. ½ of sequence range.

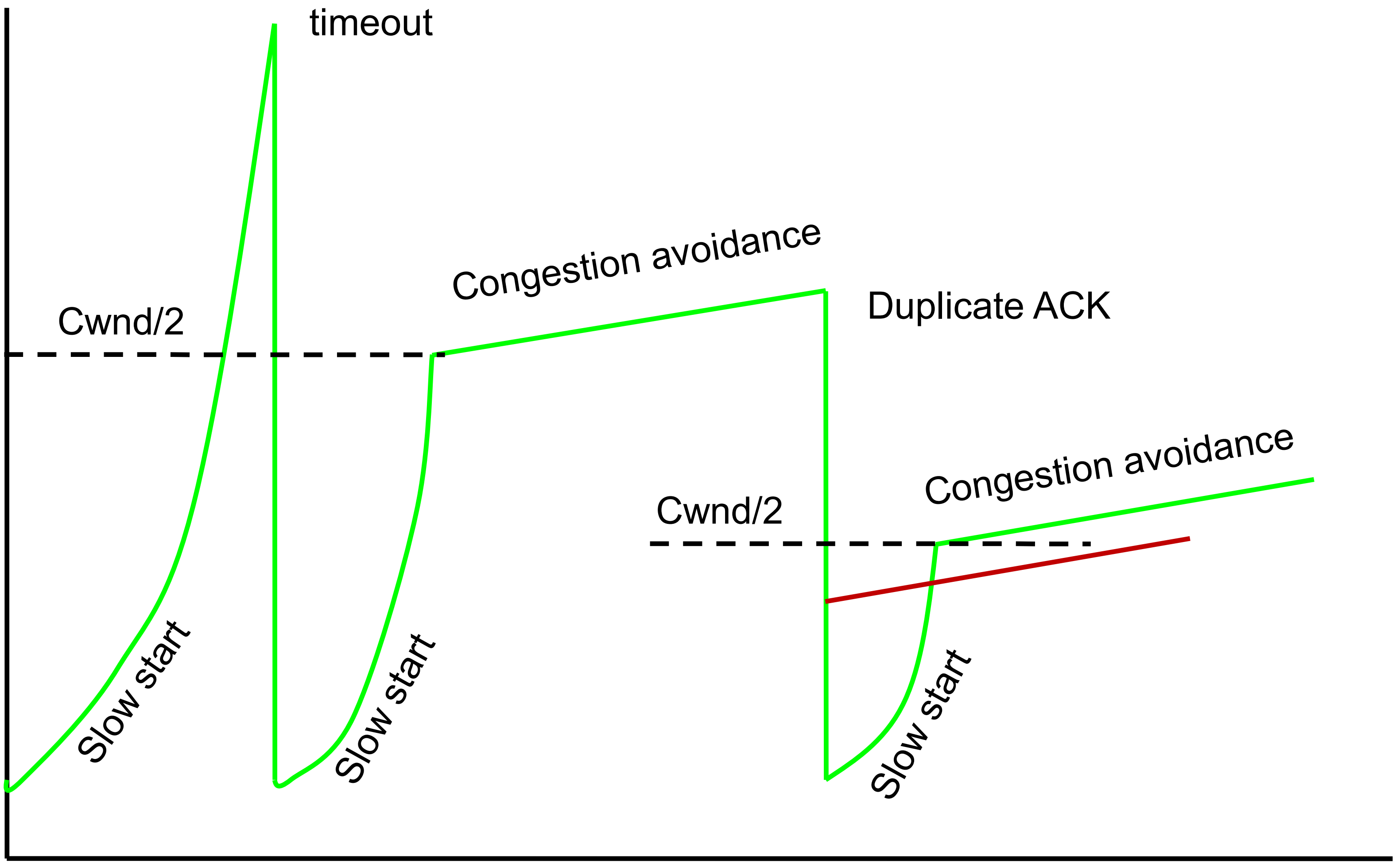
TCP Congestion Control

- Suppose that the TCP congestion window is set to 36 KB and a timeout occurs. How big will the window be if the next four transmission bursts are all successful? Assume that the maximum segment size is 1440 Bytes.

TCP sender congestion control

State	Event	TCP Sender Action	Commentary
Slow Start (SS)	ACK receipt for previously unacked data	CongWin = CongWin + MSS, If (CongWin > Threshold) set state to "Congestion Avoidance"	Resulting in a doubling of CongWin every RTT
Congestion Avoidance (CA)	ACK receipt for previously unacked data	CongWin = CongWin+MSS * (MSS/CongWin)	Additive increase, resulting in increase of CongWin by 1 MSS every RTT
SS or CA	Loss event detected by triple duplicate ACK	Threshold = CongWin/2, CongWin = Threshold, Set state to "Congestion Avoidance"	Fast recovery, implementing multiplicative decrease. CongWin will not drop below 1 MSS.
SS or CA	Timeout	Threshold = CongWin/2, CongWin = 1 MSS, Set state to "Slow Start"	Enter slow start
SS or CA	Duplicate ACK	Increment duplicate ACK count for segment being acked	CongWin and Threshold not changed

CWND Diagram



TCP Congestion Control

- When a timeout occurs:
  - CWND is set to one MSS, which is 1440 Bytes here.
  - Threshold is set to the half of the last value, which is 18KBytes
  - TCP enters the slow start phase
- The next four transmissions will exponentially increase the CWND:
  - 1 MSS 1440 Bytes
  - 2 MSS 2880 Bytes
  - 4 MSS 5760 Bytes
  - 8 MSS 11520 Bytes

Token Bucket

Consider a token bucket that is filled with a rate of 1200 tokens per minute and has a size of 600 tokens. Each bit of data consumes one token. The bucket is being filled continuously.

- What is the maximum long term average flow rate that this bucket allows?
  1200 bit/min or 20 bit/sec
- What is the maximum peak rate that this bucket allows for a one second interval?
  600 + 20 bit/sec = 620 bit
- What is the maximum burst size that this bucket allows?
  600 bit

Token Bucket

Consider a token bucket that is filled with a rate of 1200 tokens per minute and has a size of 600 tokens. Each bit of data consumes one token. The bucket is being filled continuously.

- How long would a flow of 25 bits per second conform to this bucket? Assume that the bucket is completely filled with tokens when the flow starts.

  25 bit/sec – 20 bit/sec => 5 bit/sec excess
  600 bit / 5 bit/sec = 120 sec