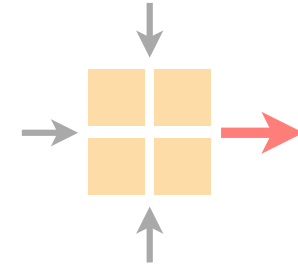


# Communication Networks

Spring 2022



Tibor Schneider

Tobias Bühler

<https://comm-net.ethz.ch/>

ETH Zürich

May 19 2022

## Reminder: no exercise session next week

No exercise session on Thursday (holidays)

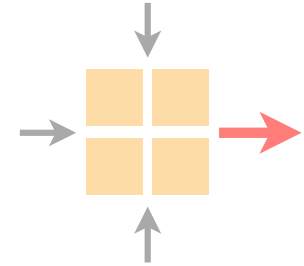
Instead a Q&A session on Tuesday (24.05)

ETA F 5 (Paul Scherrer lecture hall) 4-6 pm

We will offer Zoom calls for remote participants

# Communication Networks

## Exercise 11

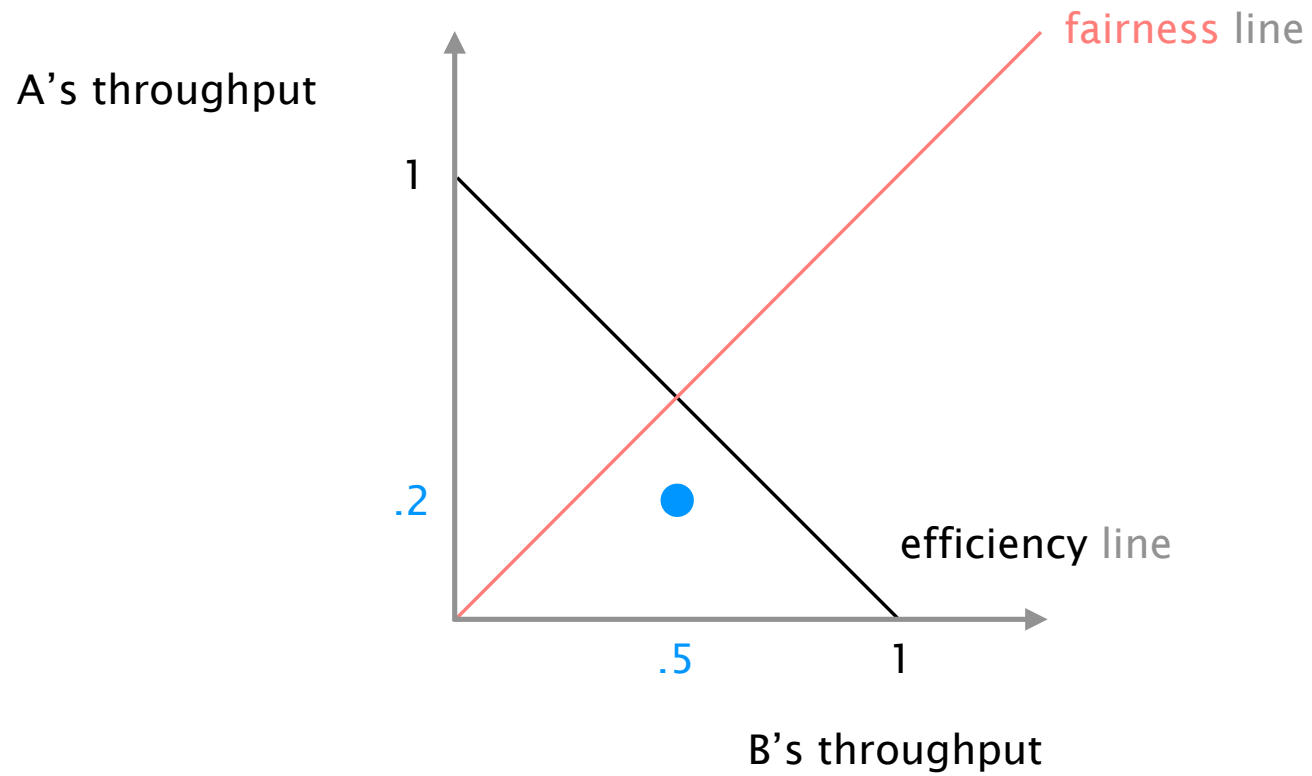


Overview current assignment

Transport project (with demo)

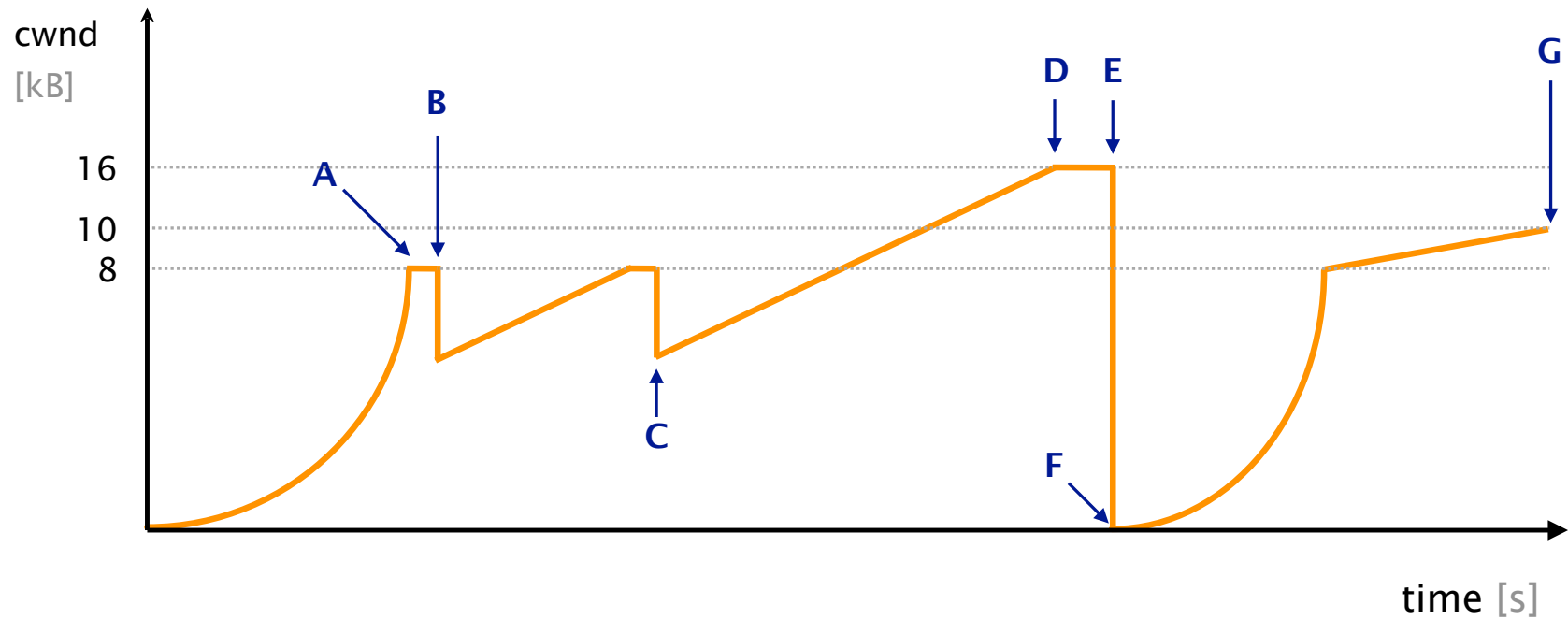
Time to solve the assignment/ask questions

# Task 11.1: Fairness



Compare slides 04b page 52+

## Task 11.2: Congestion Window

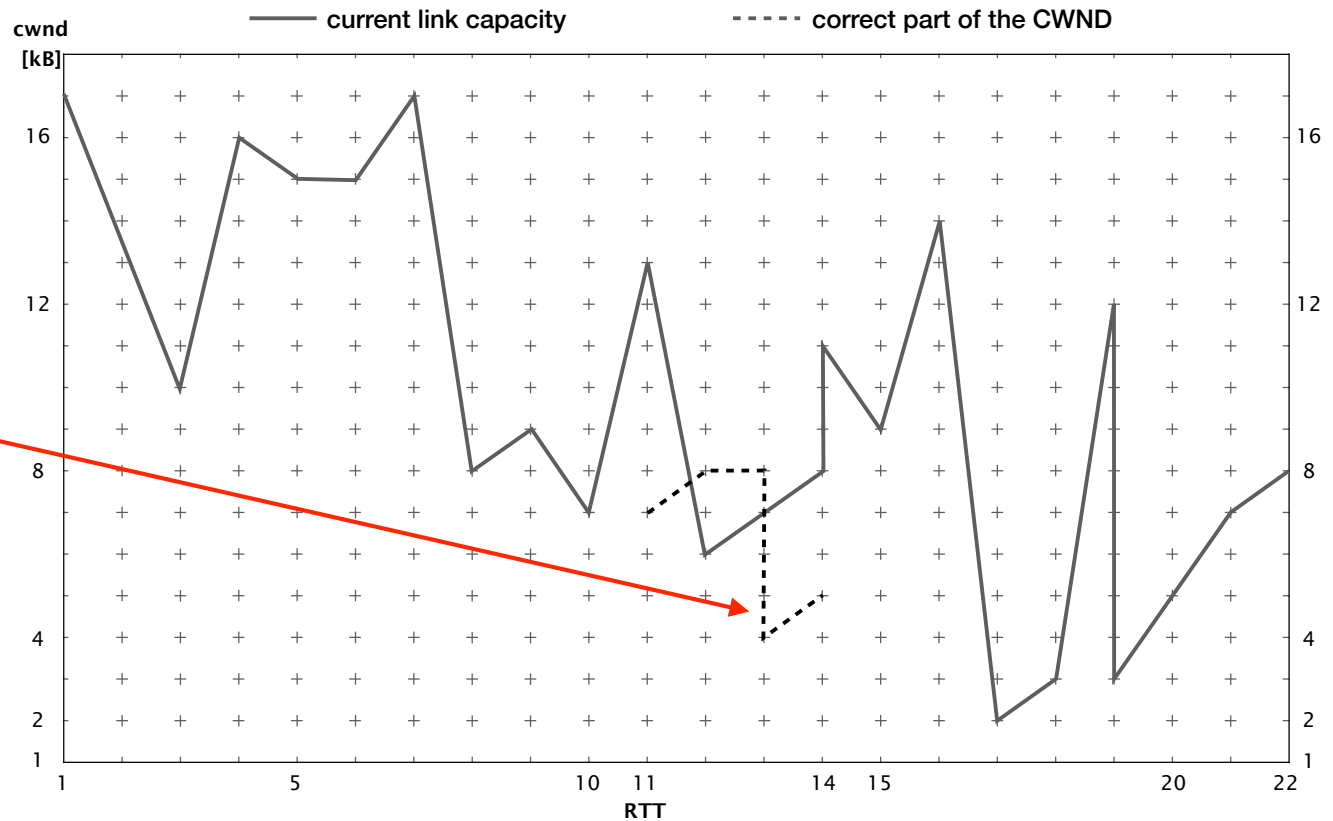


Hint: TCP performs a Three-Way-Handshake at the beginning

# Task 11.3: Drawing practice (Exam 2018)

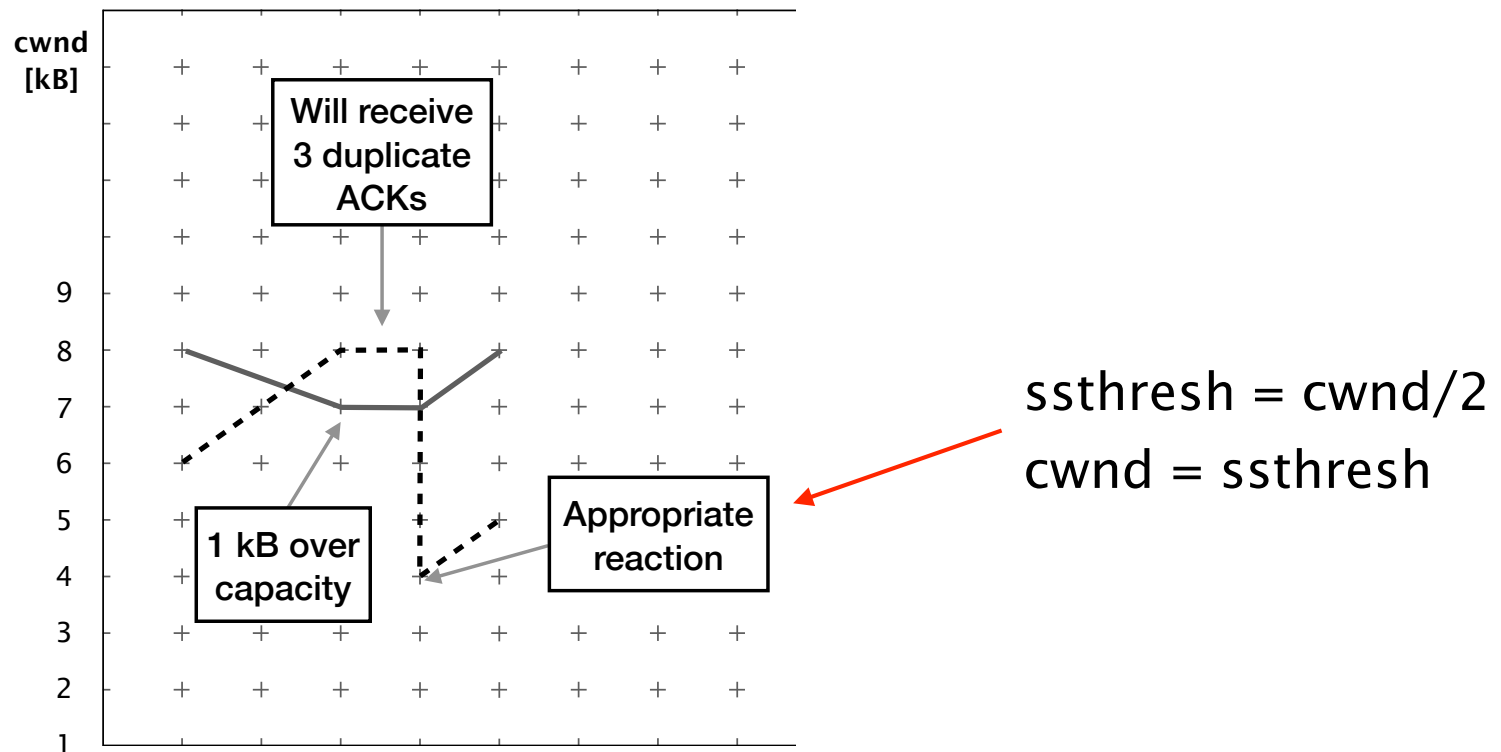
Goal: Draw the CWND given a changing link capacity

Part of the correct CWND



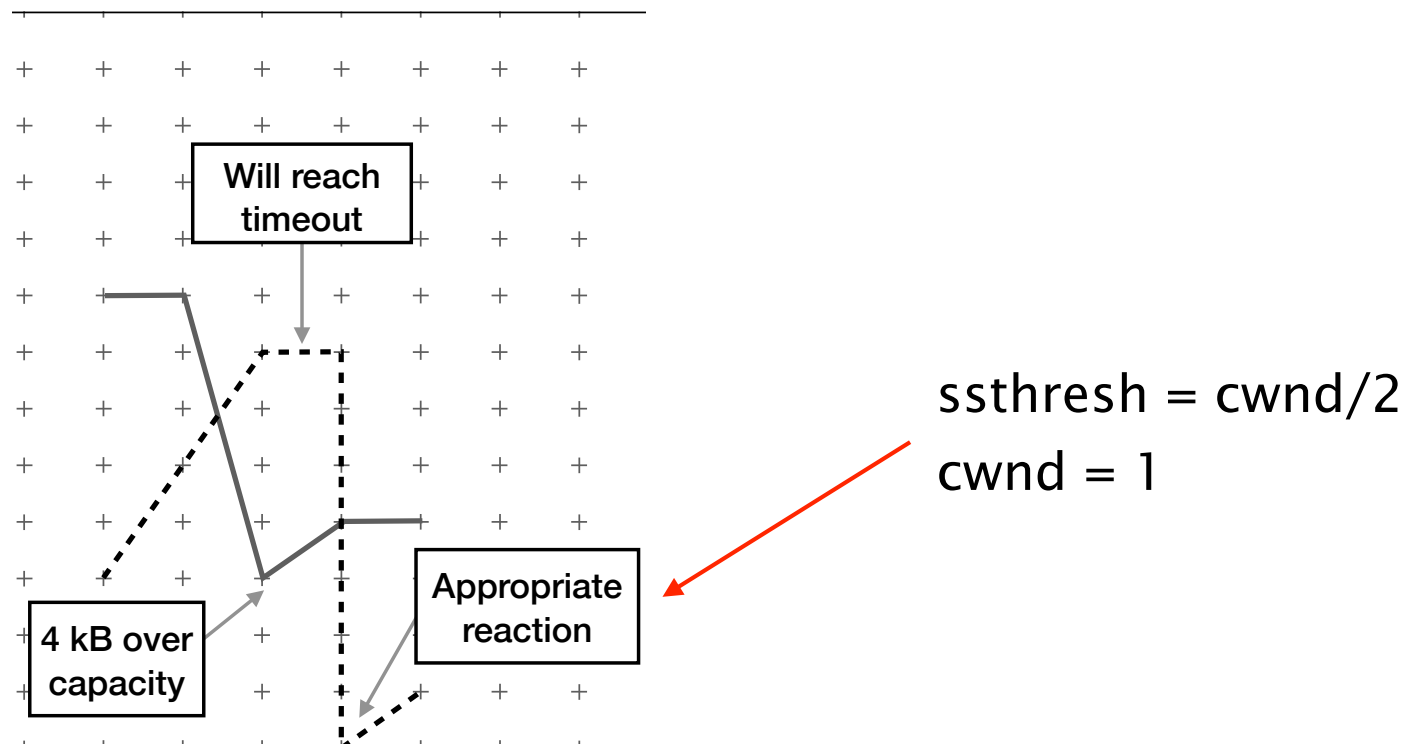
# Task 11.3: Reaction if link capacity is exceeded by at most 2kB

We assume that we would receive 3 duplicates in this case



# Task 11.3: Reaction if link capacity is exceeded by more than 2kB

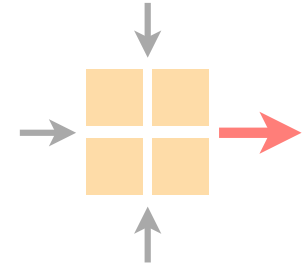
We assume that we reach a timeout





# Communication Networks

## Exercise 11



Overview current assignment

**Transport project (with demo)**

Time to solve the assignment/ask questions

# Soon the first week is already over

Part 1

20.05.2022

Complete a simple Go-Back-N implementation

Retransmit all packets after a timeout

Part 2

27.05.2022

Add support for Selective Repeat

Fast retransmission after duplicated ACKs

Part 3

03.06.2022

Add support for Selective Acknowledgements (SACK)

SACK contains blocks of correctly received segments

# Make sure that you properly handle the sequence number overflow

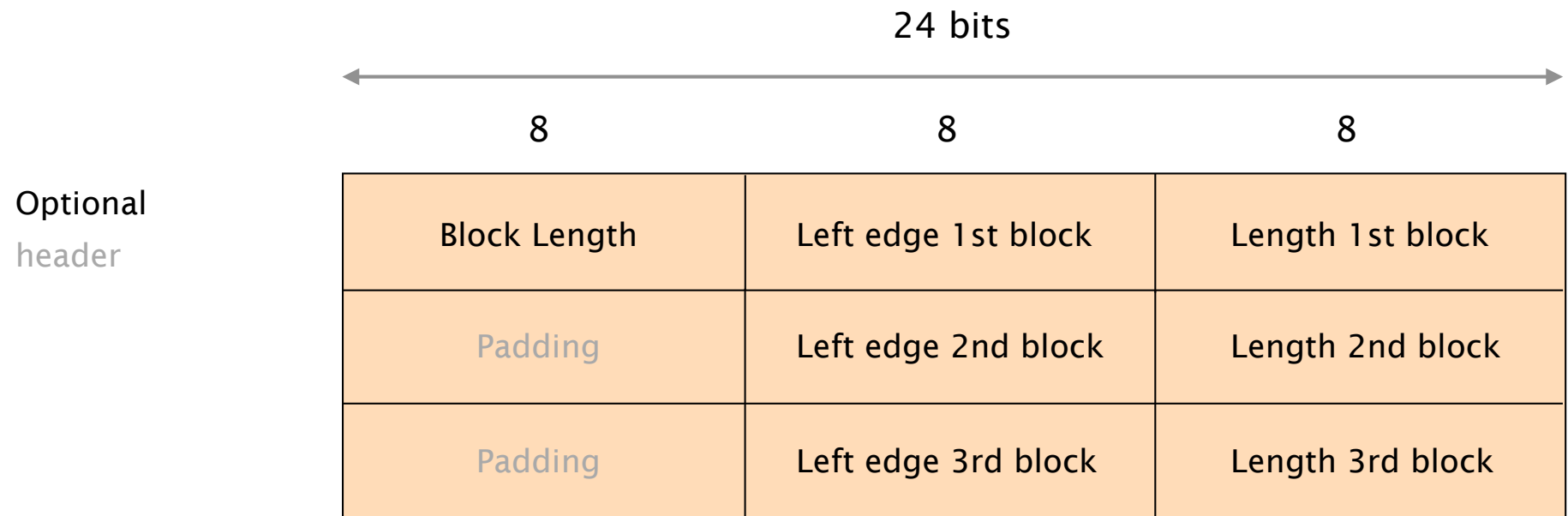
n\_bits controls the maximum sequence number

maximum assuming n\_bits=3:  $2^{n\_bits} - 1 = 7$

overflow ... 5, 6, 7, 0, 1, 2, ...

application examples ACK number, SACK header blocks, retransmission, ...

For SACK (third part) we need an **optional** header



Maximal 3 SACK blocks in the optional header

# SACK example - Receiver

Correctly received segments: 0, 1, 2

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, 15, 16, 17

Mandatory header:

SACK header:

# SACK example - Receiver

Correctly received segments: 0, 1, 2

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, 15, 16, 17

Mandatory header: ACK number: 3

SACK header:

# SACK example - Receiver

Correctly received segments: 0, 1, 2

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, 15, 16, 17

Mandatory header: ACK number: 3

SACK header:

#blocks	start b1	size b1
Padding	start b2	size b2
Padding	start b3	size b3

# SACK example - Receiver

Correctly received segments: 0, 1, 2

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, 15, 16, 17

Mandatory header: ACK number: 3

SACK header:

#blocks	4	2
Padding	start b2	size b2
Padding	start b3	size b3



# SACK example - Receiver

Correctly received segments: 0, 1, 2

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, 15, 16, 17

Mandatory header: ACK number: 3

SACK header:

#blocks	4	2
Padding	8	1
Padding	start b3	size b3

# SACK example - Receiver

Correctly received segments: 0, 1, 2

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, 15, 16, 17

Mandatory header: ACK number: 3

SACK header:

#blocks	4	2
Padding	8	1
Padding	10	4

# SACK example - Receiver

Correctly received segments: 0, 1, 2

no space

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, ~~15, 16, 17~~

Mandatory header: ACK number: 3

SACK header:

#blocks	4	2
Padding	8	1
Padding	10	4

# SACK example - Receiver

Correctly received segments: 0, 1, 2

Buffered out-of-order segments: 4, 5, 8, 10, 11, 12, 13, 15, 16, 17

Mandatory header: ACK number: 3

SACK header:

3	4	2
Padding	8	1
Padding	10	4

# SACK example - Sender

Receiver SACK header:

3	4	2
Padding	8	1
Padding	10	4

ACK number: 3

ACK - block 1:

block 1 - block 2:

block 2 - block 3:

after block 3:

# SACK example - Sender

Receiver SACK header:

3	4	2
Padding	8	1
Padding	10	4

ACK number: 3

ACK - block 1:

3

block 1 - block 2:

block 2 - block 3:

after block 3:

# SACK example - Sender

Receiver SACK header:

3	4	2
Padding	8	1
Padding	10	4

ACK number: 3

ACK - block 1:

3

block 1 - block 2:

6, 7

block 2 - block 3:

after block 3:

# SACK example - Sender

Receiver SACK header:

3	4	2
Padding	8	1
Padding	10	4

ACK number: 3

ACK - block 1:

3

block 1 - block 2:

6, 7

block 2 - block 3:

9

after block 3:



# SACK example - Sender

Receiver SACK header:

3	4	2
Padding	8	1
Padding	10	4

ACK number: 3

ACK - block 1:

3

block 1 - block 2:

6, 7

block 2 - block 3:

9

after block 3:

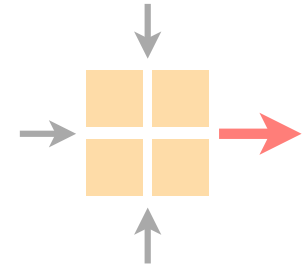
no retransmission

Demo time

Watch the live session or the recorded video!

# Communication Networks

## Exercise 11



Overview current assignment

Transport project (with demo)

**Time to solve the assignment/ask questions**