

# Communication Networks

Spring 2017



Tobias Bühler, TA

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

ETH Zürich (D-ITET)

May, 22 2017

**This week on**  
**Communication Networks**

# Exercise session

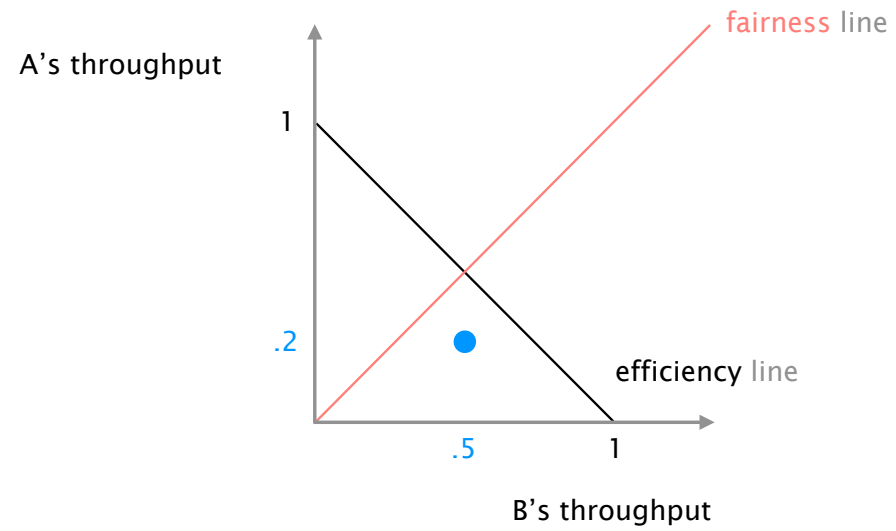
Theoretical

TCP Congestion  
Control

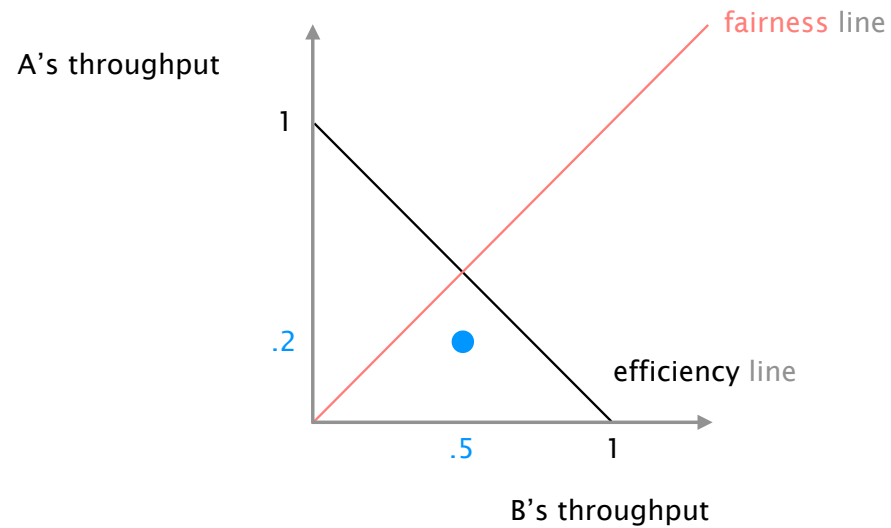
Practical

Reliable Transport  
group project

# Fairness – are you getting a fair share?



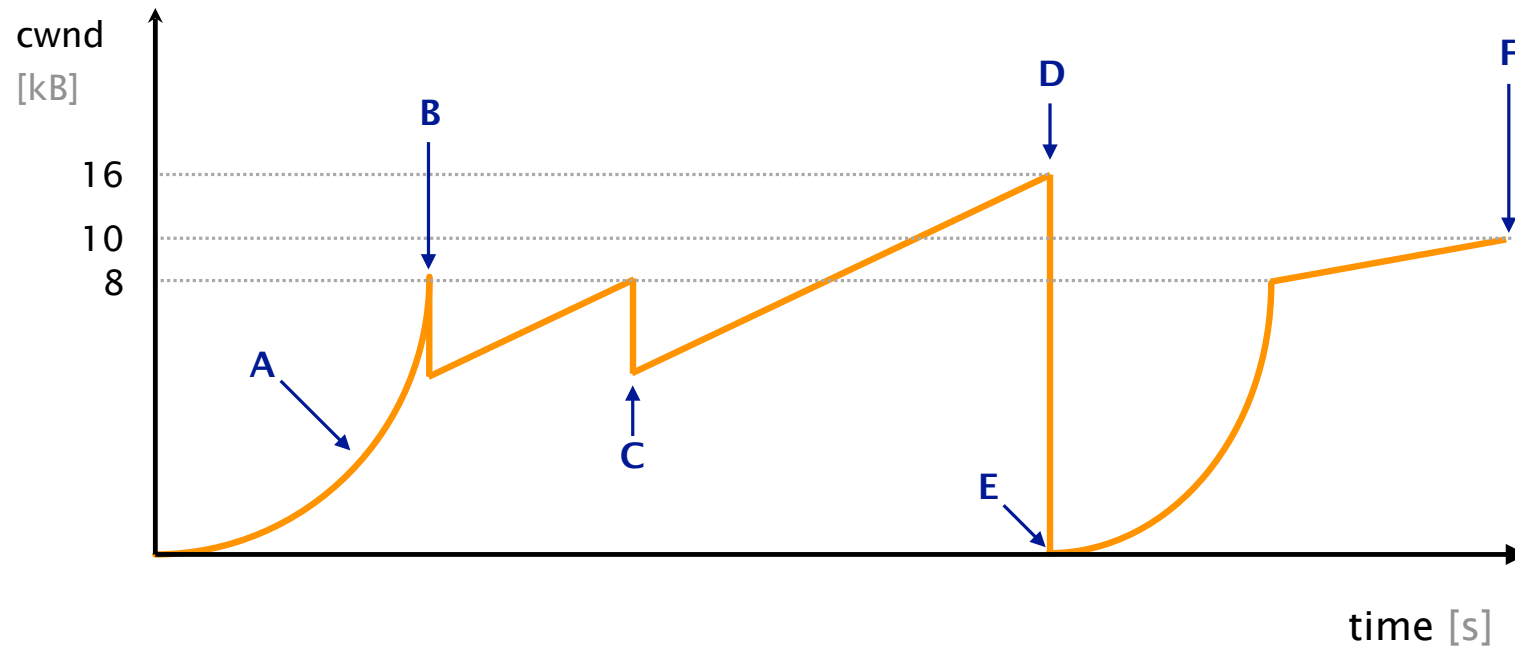
# Fairness – are you getting a fair share?



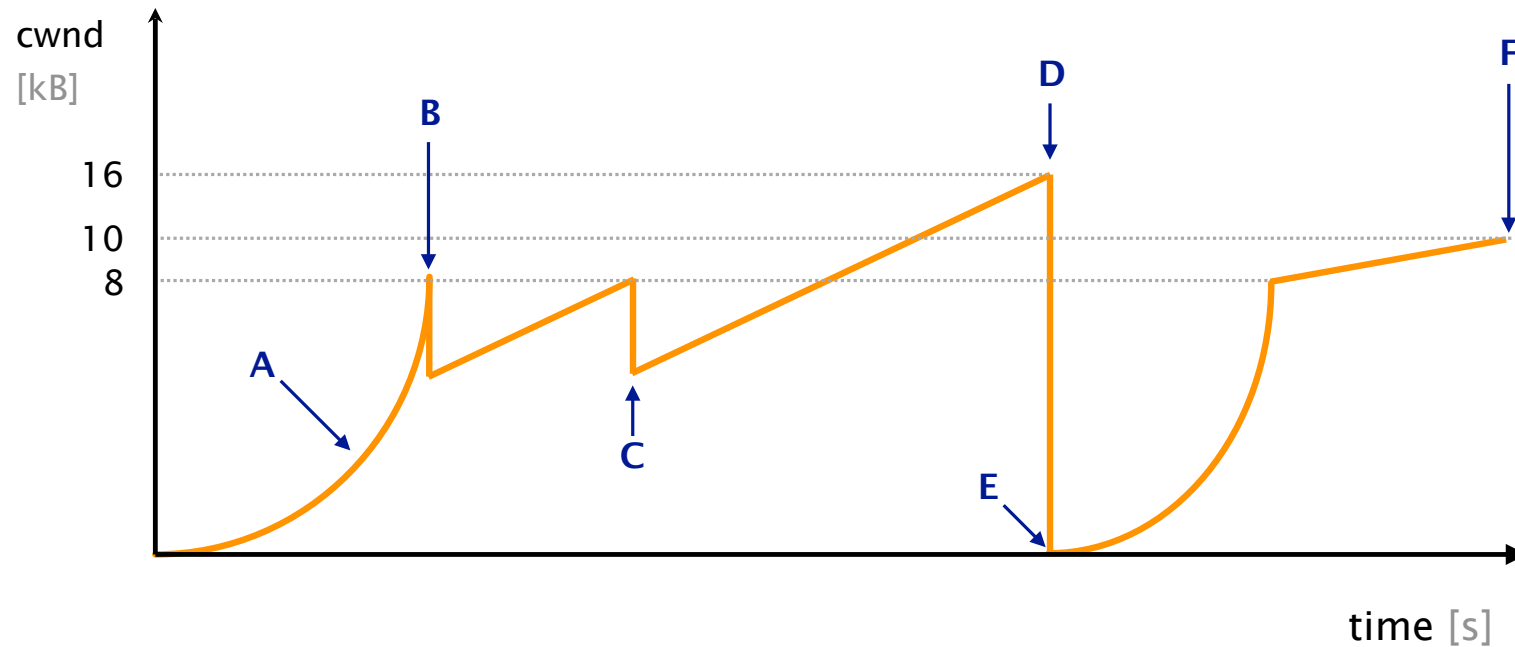
**a) Additive Increase  
Multiplicative Decrease (AIMD)**

**b) Multiplicative Increase  
Additive Decrease (MIAD)**

# TCP Congestion Window evolution



# TCP Congestion Window evolution



Describe the observed events

Compute elapsed time between events

# Exercise session

Theoretical

TCP Congestion  
Control

Practical

Reliable Transport  
group project



# Sequence number overflow

NBITS

maximum

overflow

application  
examples

# Sequence number overflow

NBITS controls the maximum sequence number

maximum assuming NBITS=3:  $2^{\text{NBITS}} - 1 = 7$

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

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

# Retransmission after timeout

best approach

also accepted

# Retransmission after timeout

best approach      retransmission in order: 6, 7, 0, 1

also accepted      random retransmission order: 0, 1, 6, 7

# Packet reordering

data segment

ACKs

# Packet reordering

data segment

for question 3.2 and 3.3, the receiver should handle packet reordering. **Goal:** delivered in correct order

ACKs

ACKs are cumulative! Reordered (old) ACKs should be ignored. **Example:** received ACKs: 4, 4, 3, 4

3 should not increase/reset duplicate counter (Q 3.2)

## 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

# 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

important:

sender window is not moved

**Next week** on  
Communication Networks

**Monday:** DNS, Web, CDNs & exam briefing

**Tuesday:** last exercise session

**Thursday:** ICMP, NAT, SDN & recap

**Sunday:** deadline - Reliable Transport group project

# Communication Networks

Spring 2017



Tobias Bühler, TA

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

ETH Zürich (D-ITET)

May, 22 2017