6.033 Spring 2018

Lecture #11

- **Reliable Transport**
- **Window-based Congestion Control**

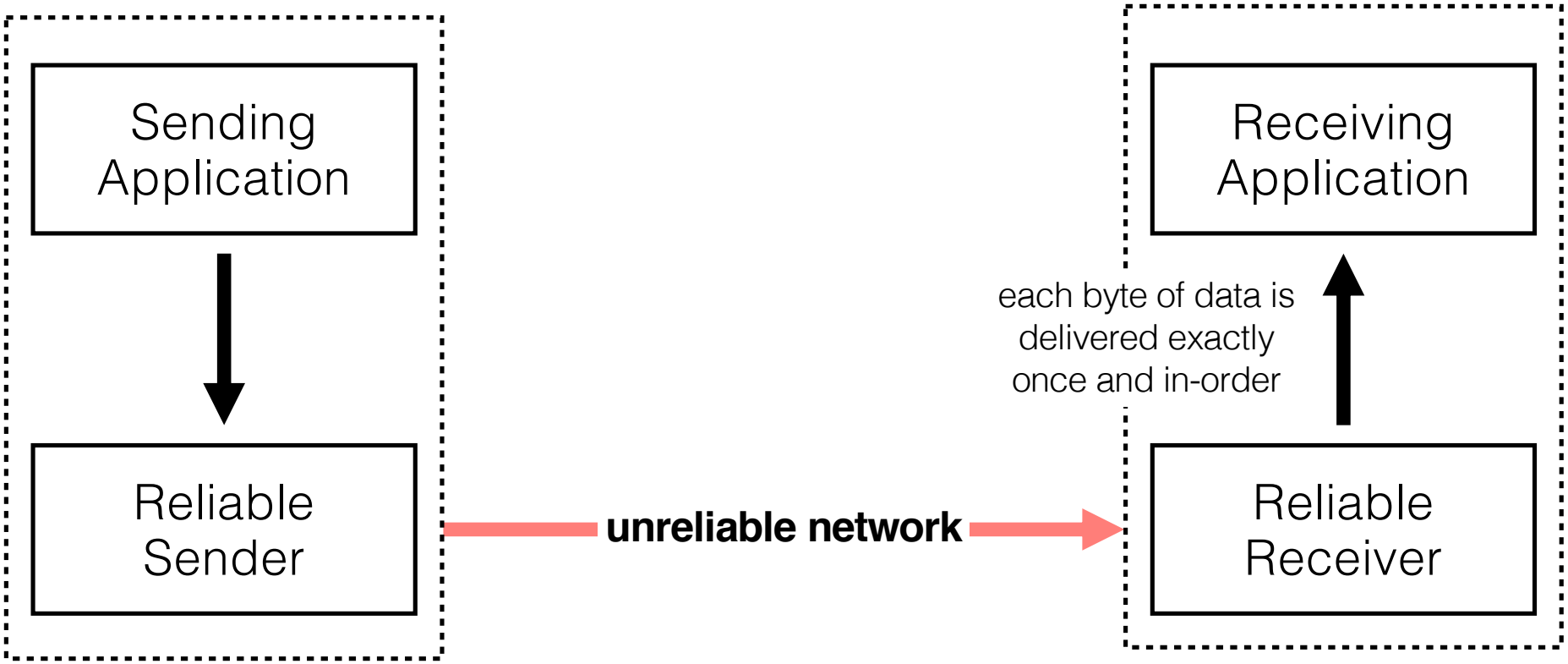
Internet of Problems

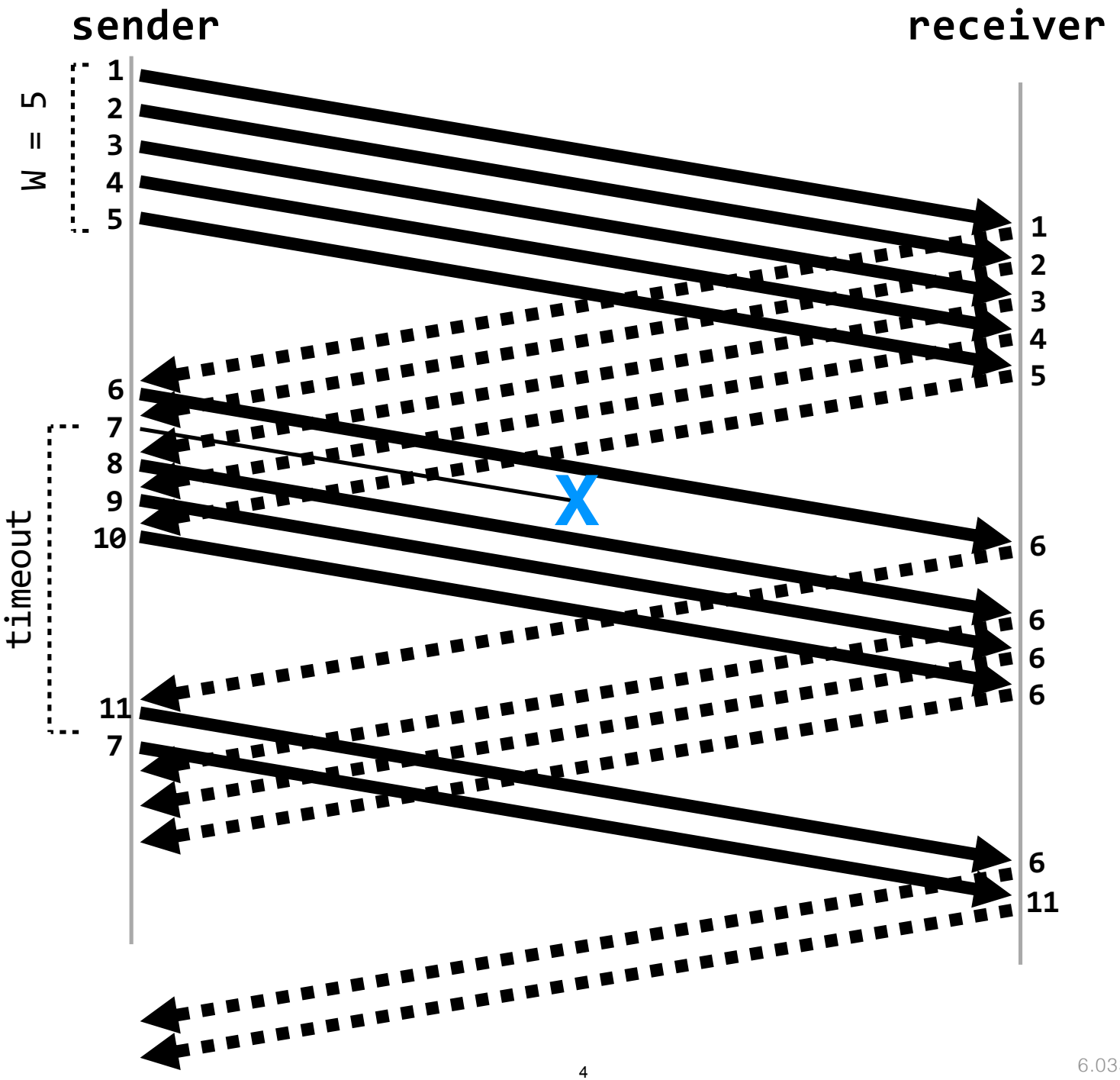
How do we **route** (and address) scalably, while dealing with issues of policy and economy? → **BGP**

How do we **transport** data scalably, while dealing with varying application demands? → **TCP**

How do we **adapt** new applications and technologies to an inflexible architecture?

Reliable Transport




sender
receiver
W = 5
timeout
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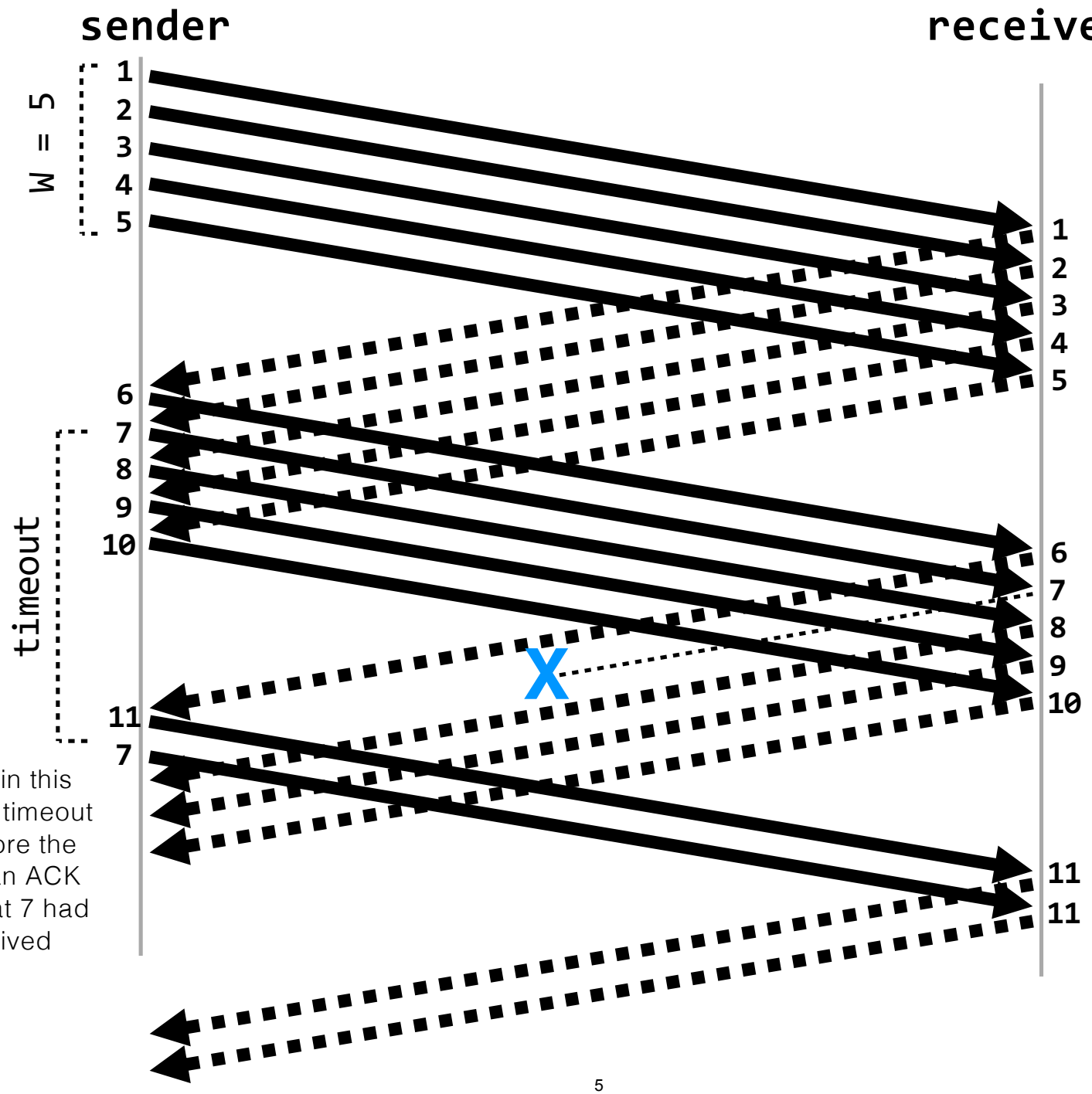
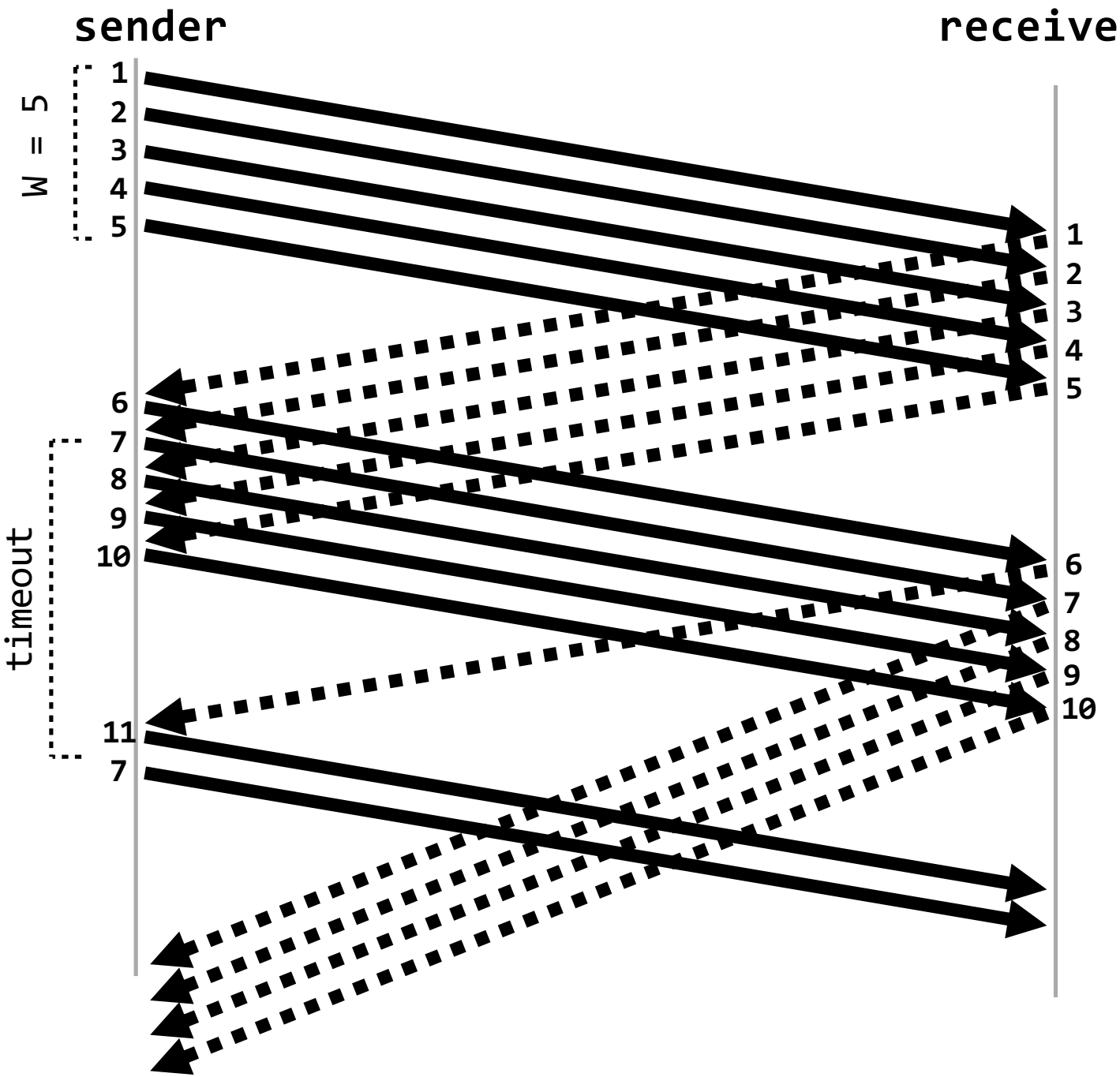


notice that (in this example) the timeout expired before the sender got an ACK indicating that 7 had been received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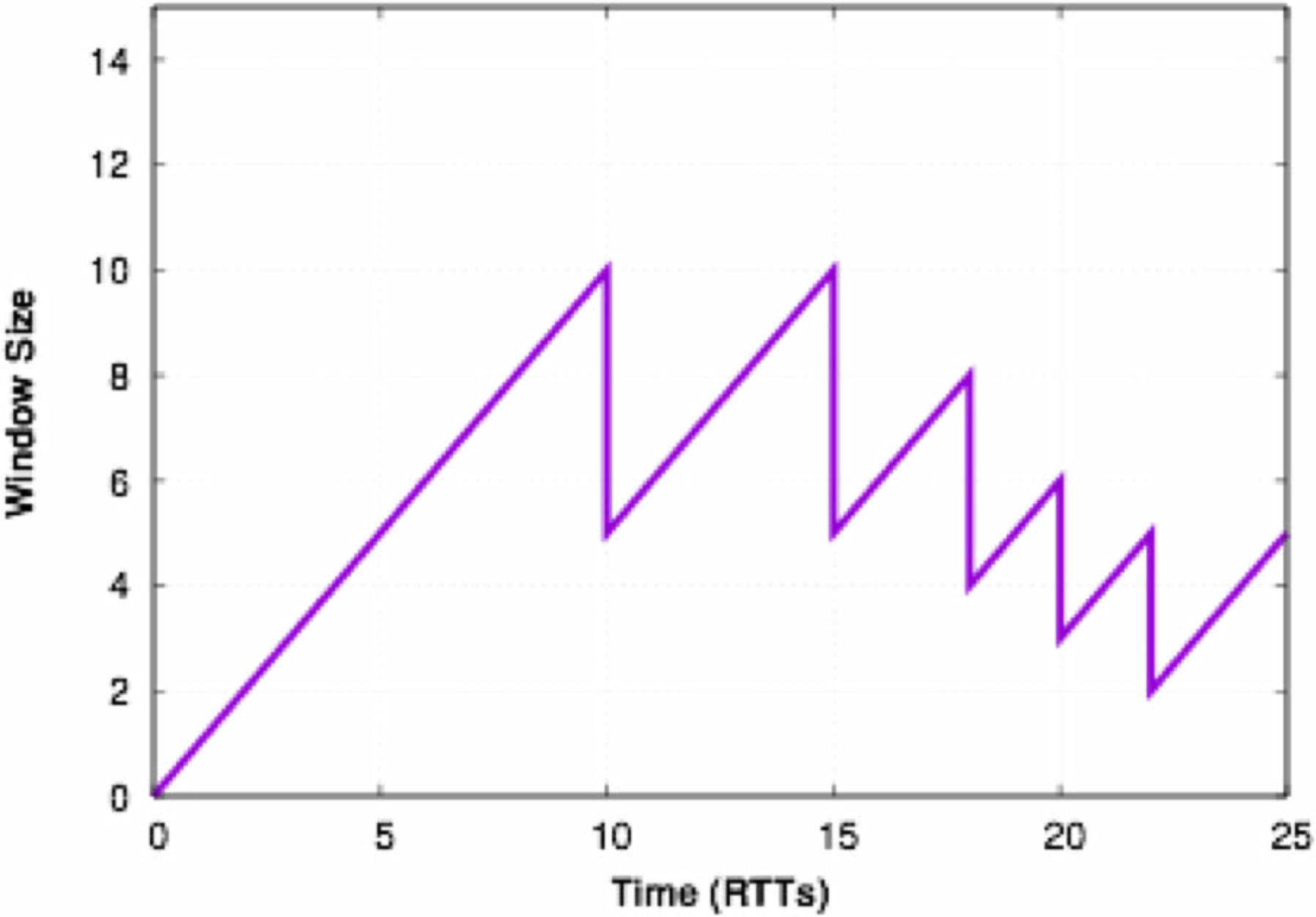
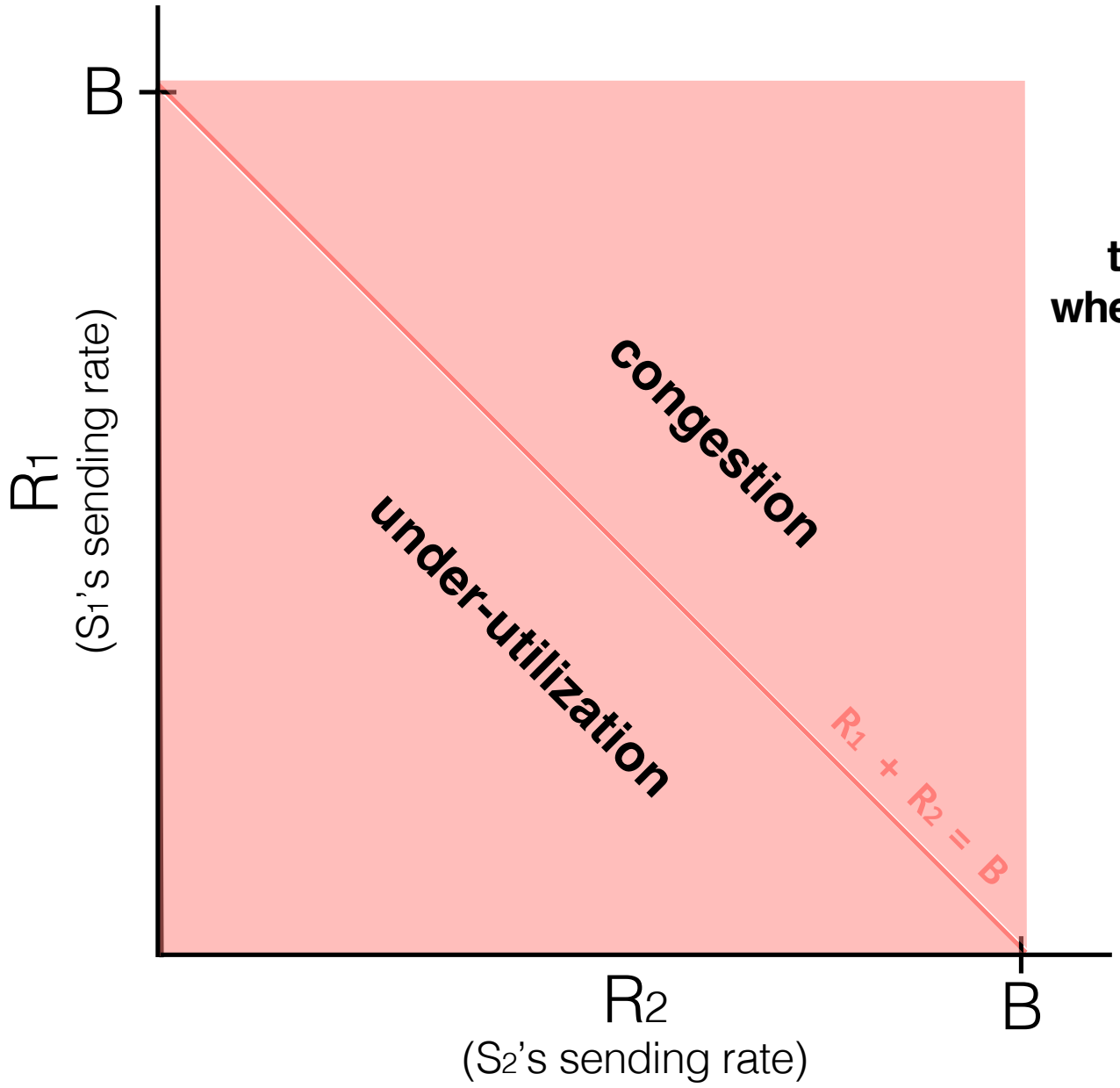
question: what is the correct value for `W`?

too small → underutilized network
too large → congestion

question: how can a single reliable sender, using a sliding-window protocol, set its window size to maximize utilization — but prevent congestion and unfairness — given that there are many other end points using the network, all with different, changing demands?

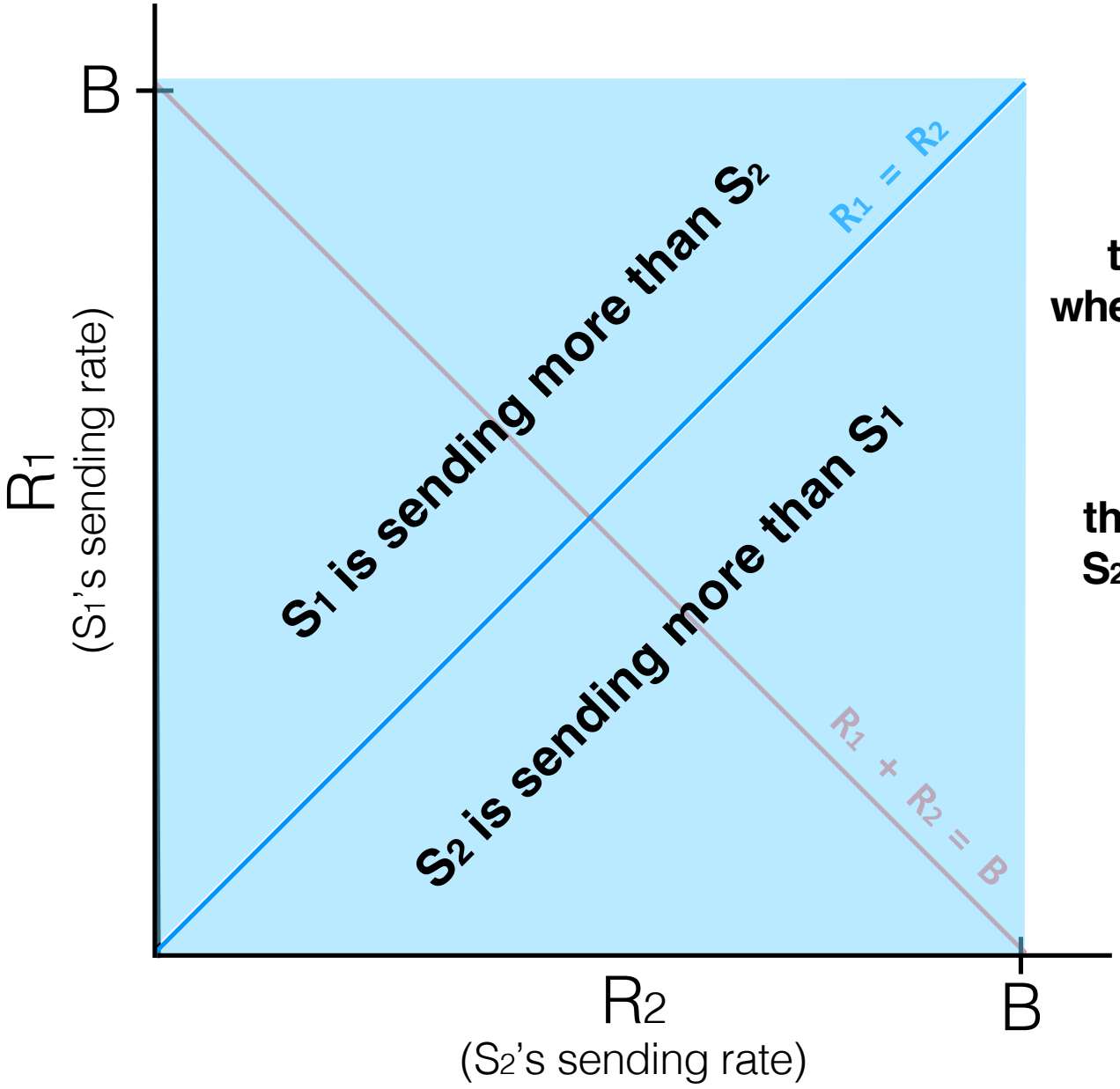
AIMD





efficiency
(utilization)

the network is fully utilized when the bottleneck link is "full"



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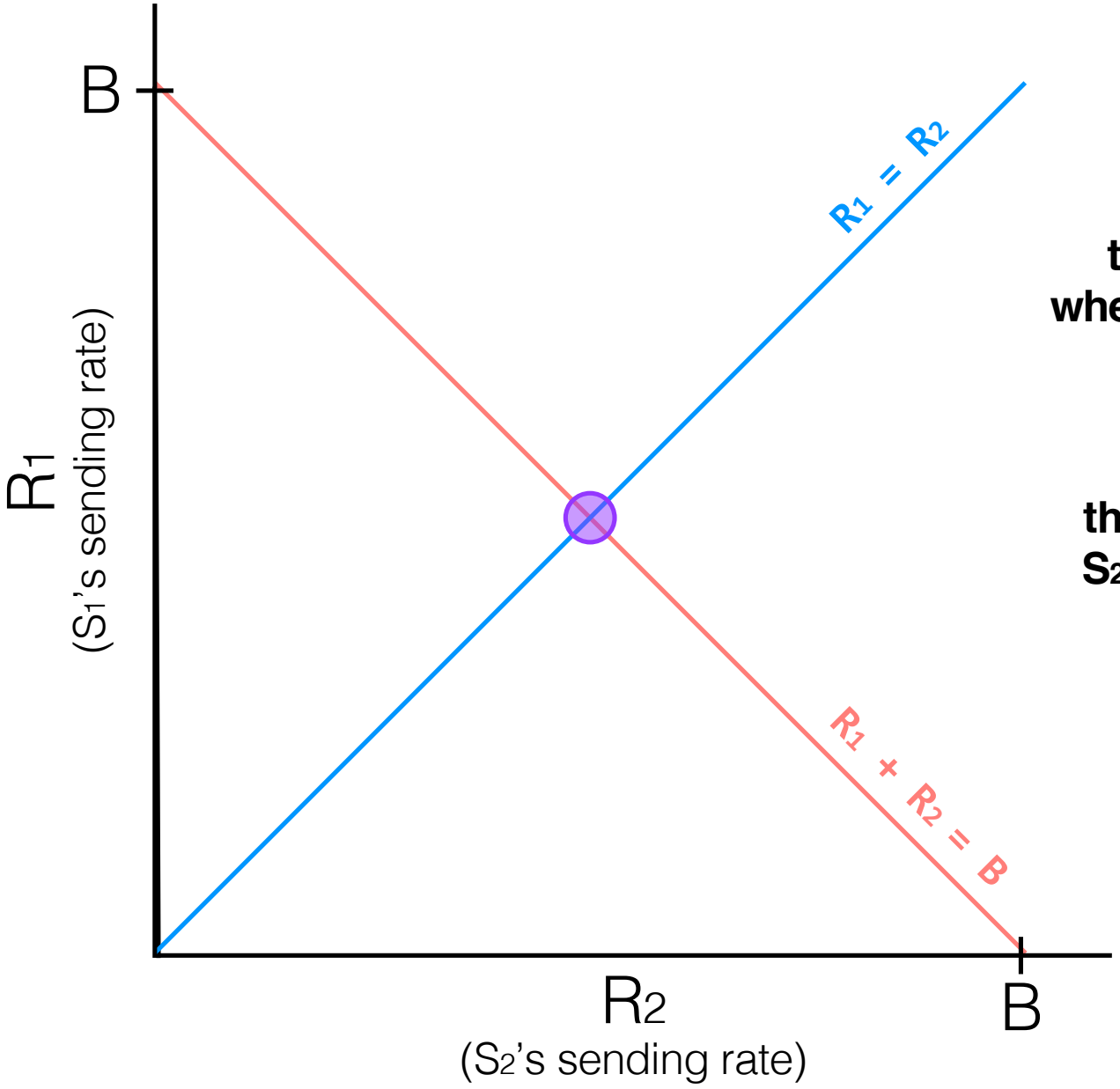
fairness

the network is fair when S_1 and S_2 are sending at the same rate



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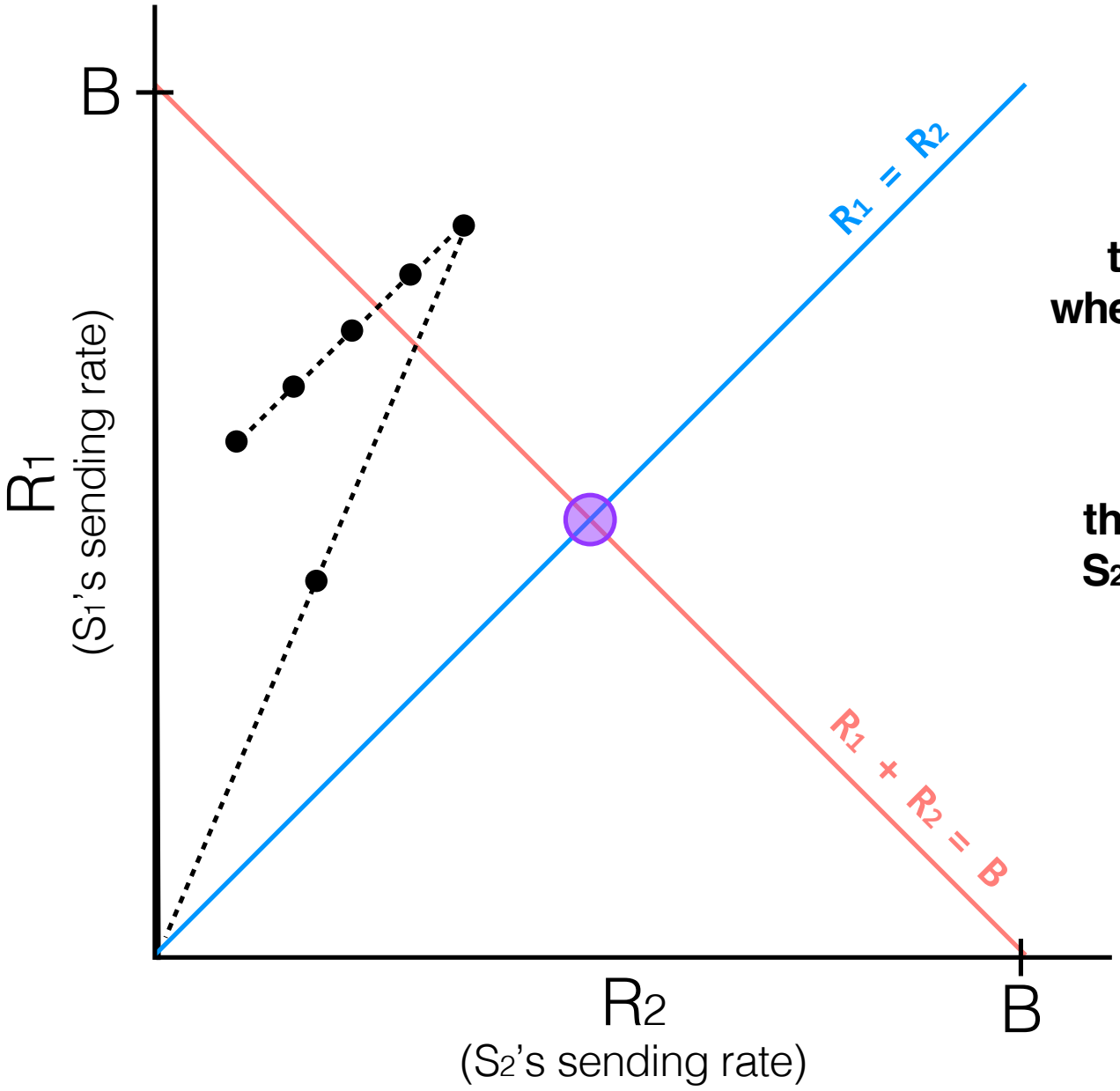

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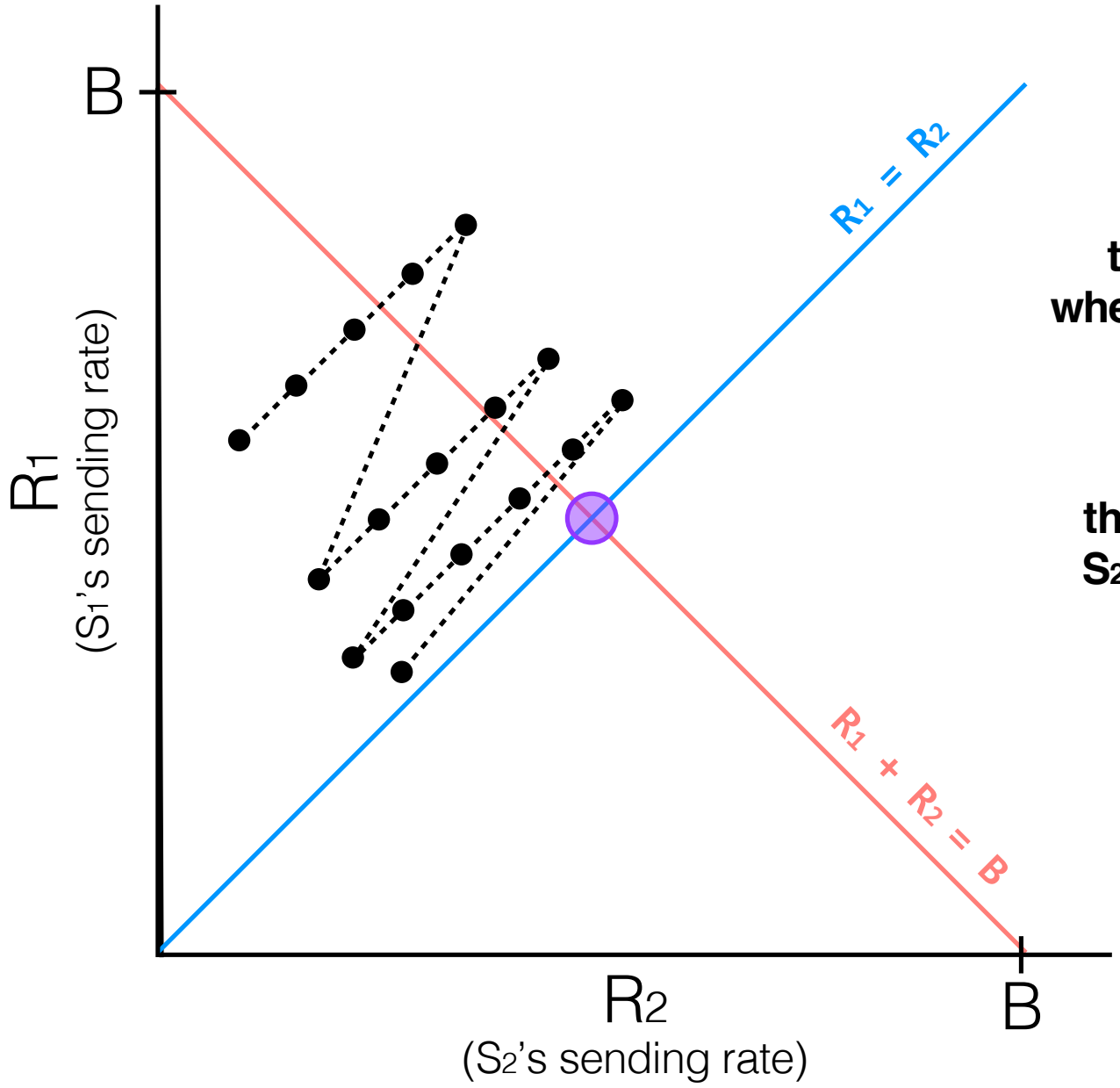


efficiency
(utilization)

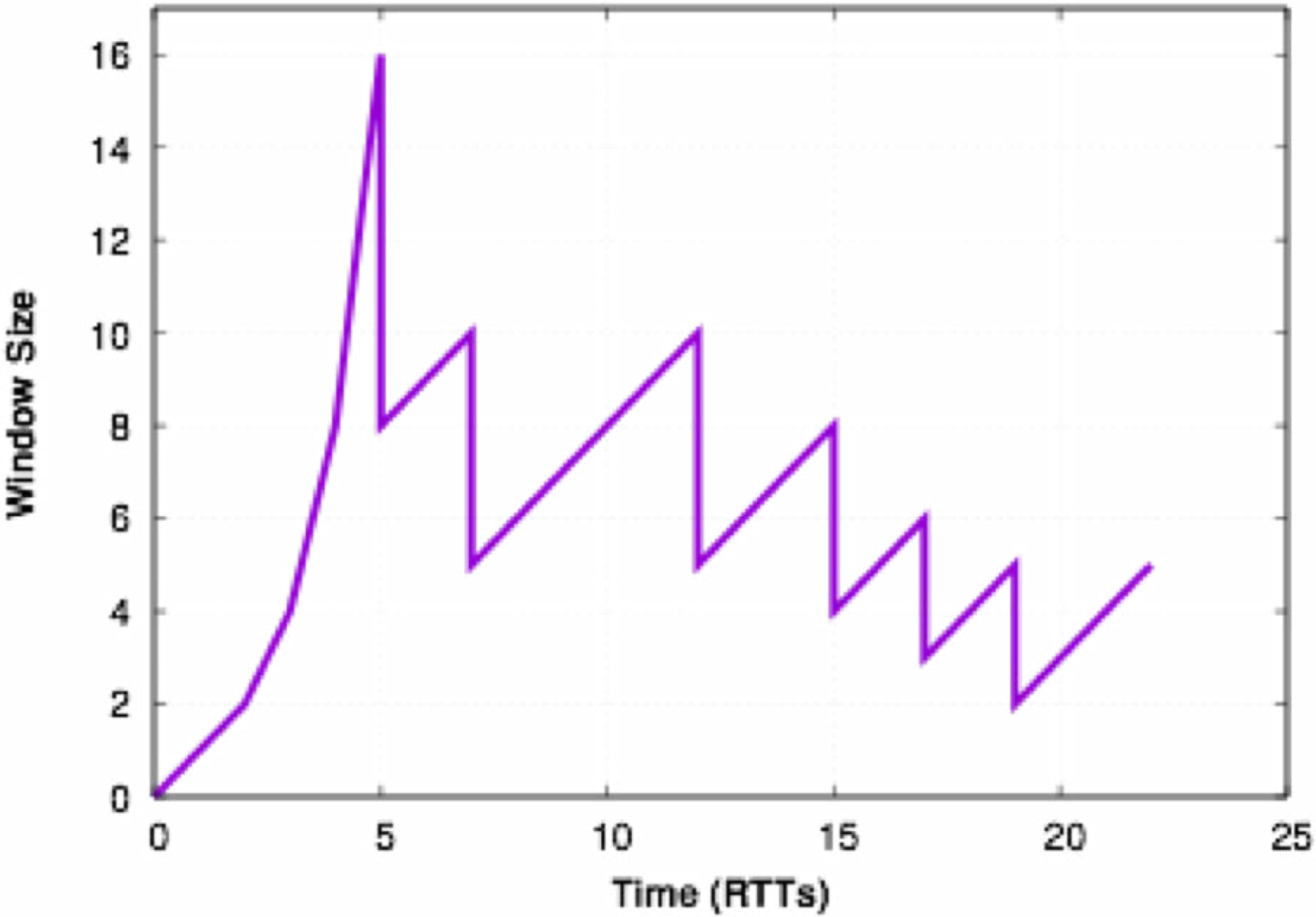
the network is fully utilized when the bottleneck link is "full"

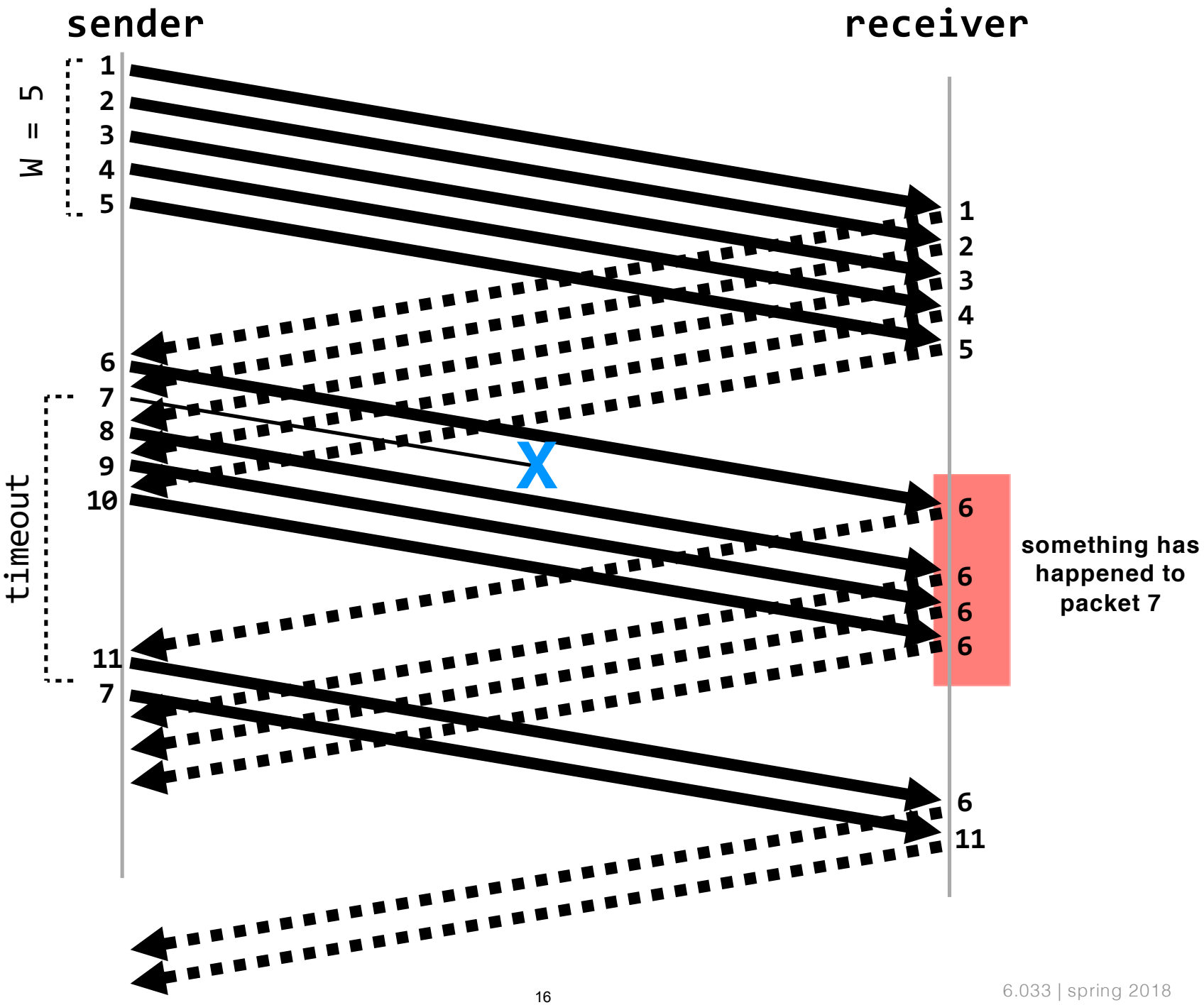
fairness

the network is fair when S_1 and S_2 are sending at the same rate

eventually, R1 and R2 will come to oscillate around the fixed point

AIMD + Slow Start

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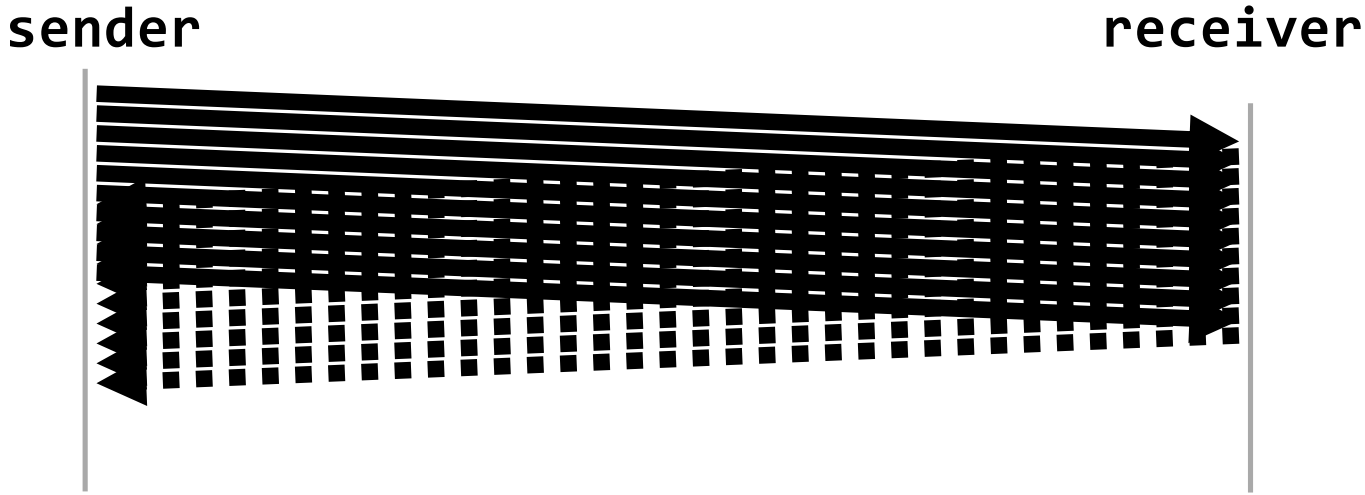
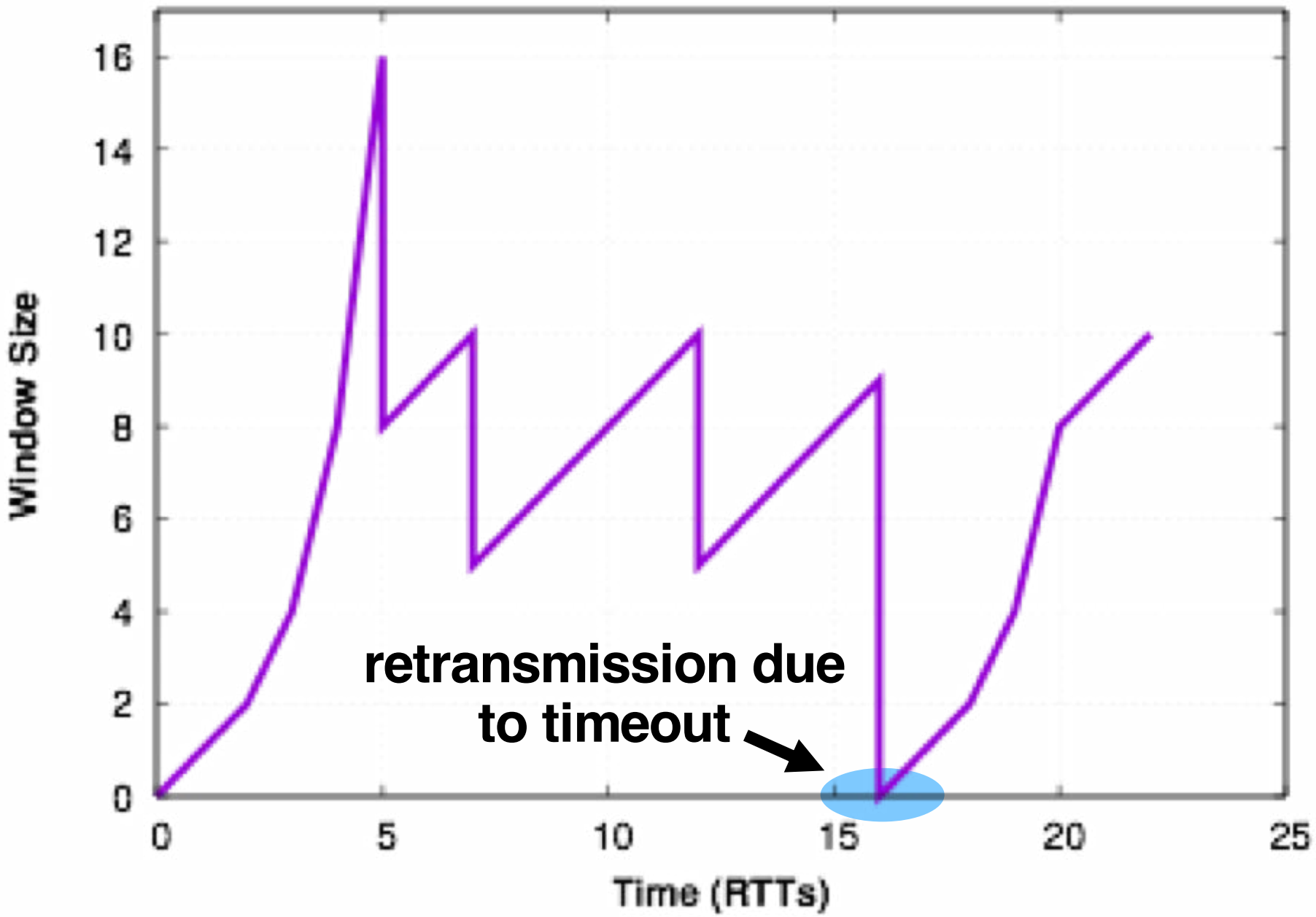
something has happened to packet 7



in practice, if a single packet is lost, the three "dup" ACKs will be received before the RTO for that packet expires

AIMD + Slow Start



- **TCP** provides **reliable transport** along with **congestion control**: senders increase their window additively until they experience loss, and then back off multiplicatively. Senders also use slow-start and fast-retransmit/fast-recovery to quickly increase the window and recover from loss.

- TCP has been a massive success, but **senders don't react to congestion until queues are already full**. Is there a better way?

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