King Fahd University of Petroleum & Minerals
College of Computer Science & Engineering

Information & Computer Science Department

ICS 343
Fundamentals of Computer Networks

Transport Layer: Congestion Control and Quality of Service

These slides are based on:

Chapter 24 Data Communications and Networking, 4th Edition

Information and Computer Science

The main focus of congestion control and quality of service is data traffic. In congestion control we try to avoid traffic congestion. In quality of service, we try to create an appropriate environment for the traffic. So, before talking about congestion control and quality of service, we discuss the data traffic itself.
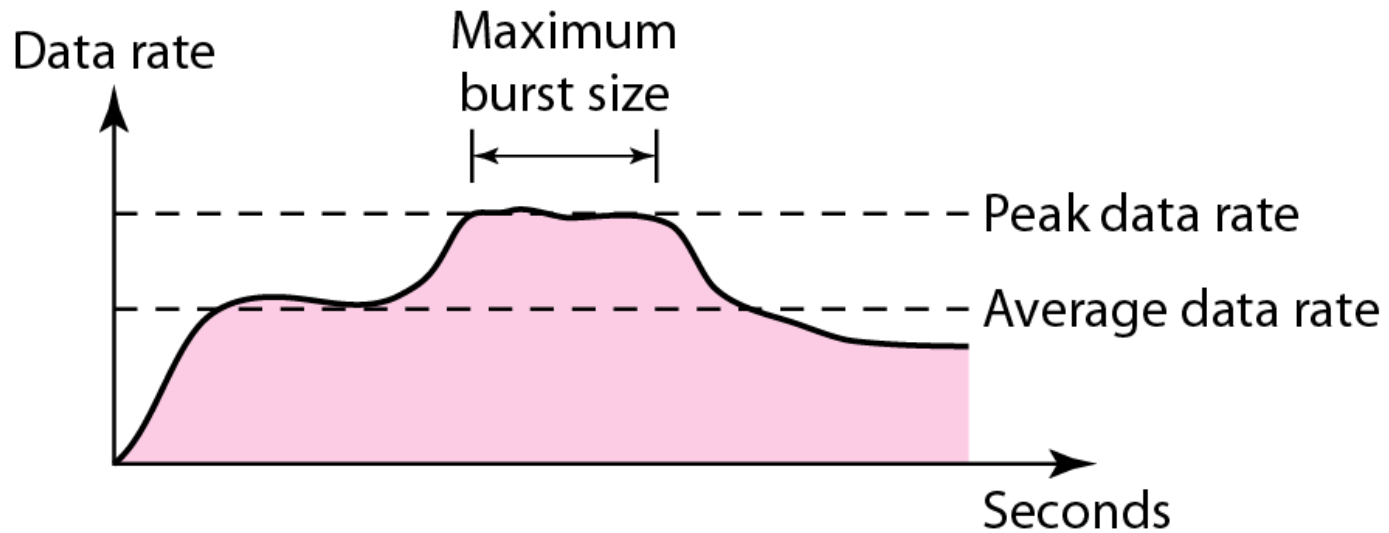
Topics discussed in this section:
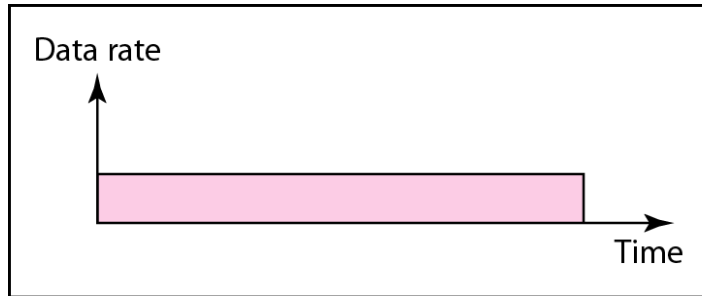**Traffic Descriptor**
Traffic Profiles

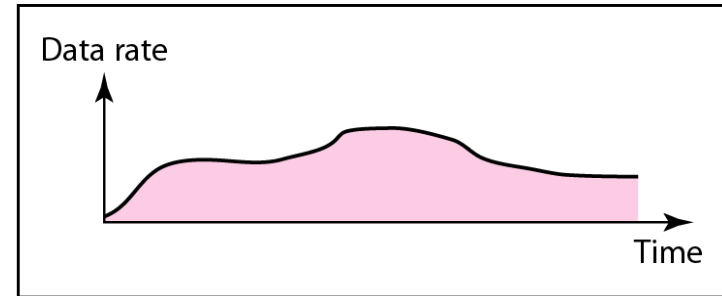Information and
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Figure 24.1 *Traffic descriptors*

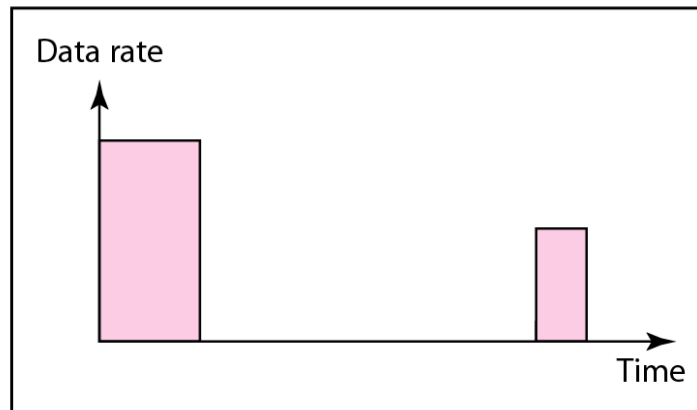**Figure 24.2** *Three traffic profiles*

a. Constant bit rate

b. Variable bit rate

c. Bursty

Congestion in a network may occur if the load on the network—the number of packets sent to the network—is greater than the capacity of the network—the number of packets a network can handle. Congestion control refers to the mechanisms and techniques to control the congestion and keep the load below the capacity.

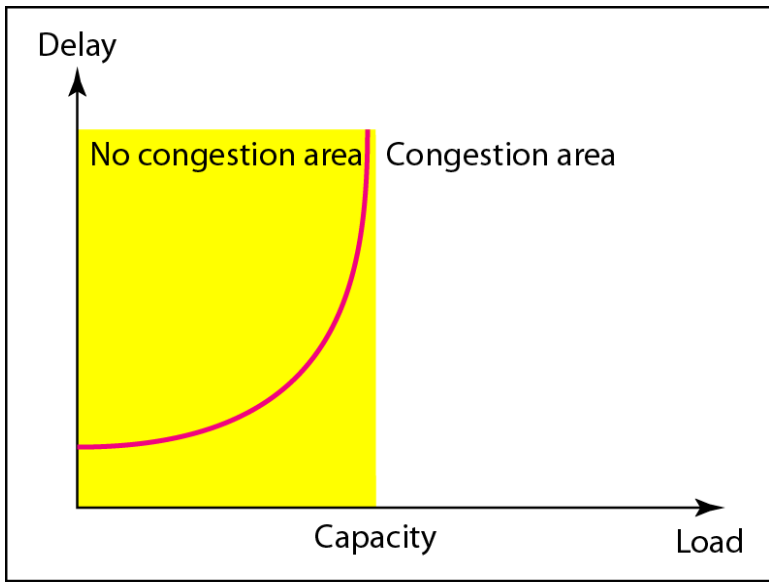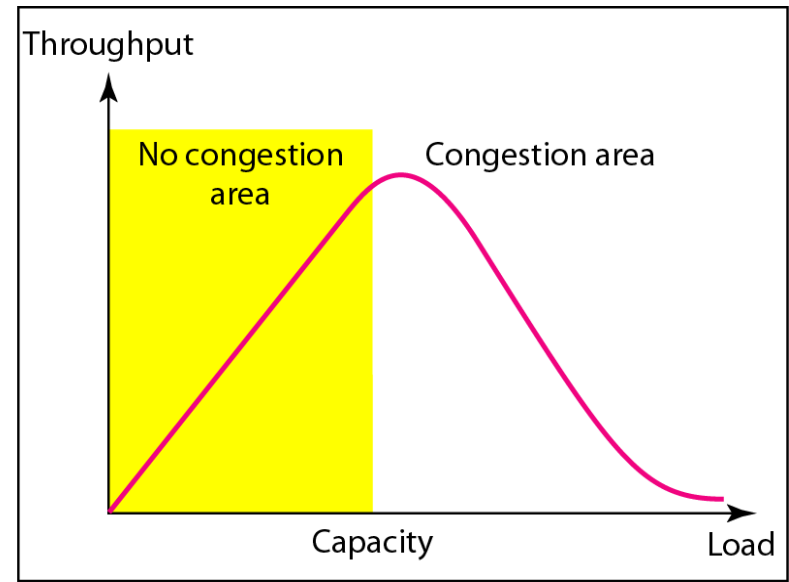**Topics discussed in this section:**
Network Performance

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Figure 24.3 *Queues in a router*
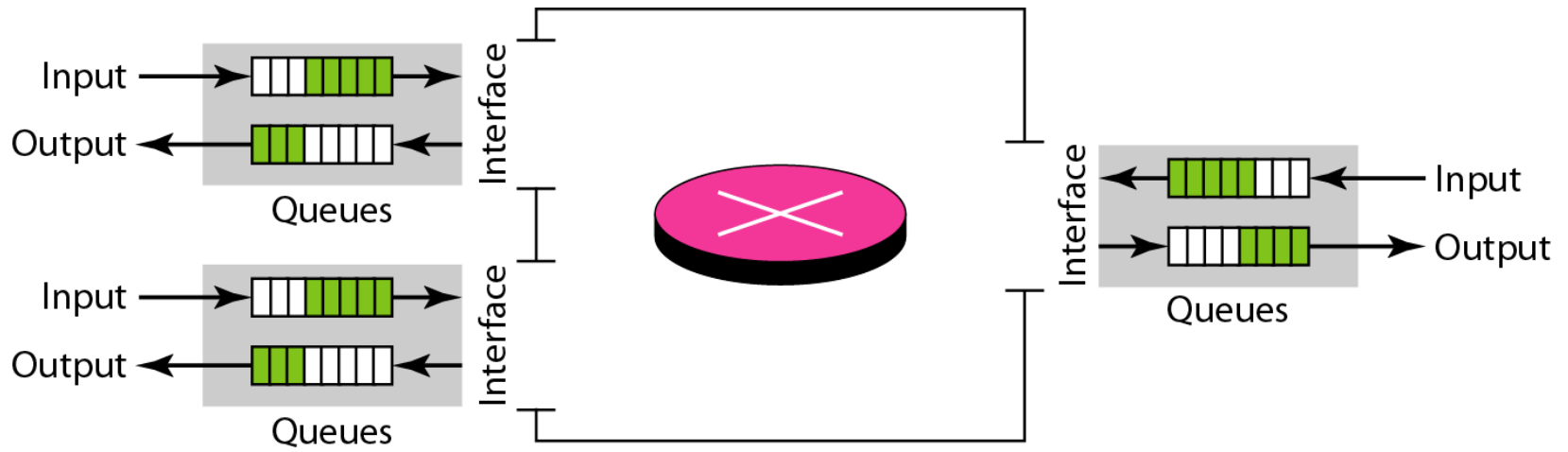
a. Delay as a function of load

b. Throughput as a function of load

Congestion control refers to techniques and mechanisms that can either prevent congestion, before it happens, or remove congestion, after it has happened. In general, we can divide congestion control mechanisms into two broad categories: open-loop congestion control (prevention) and closed-loop congestion control (removal).

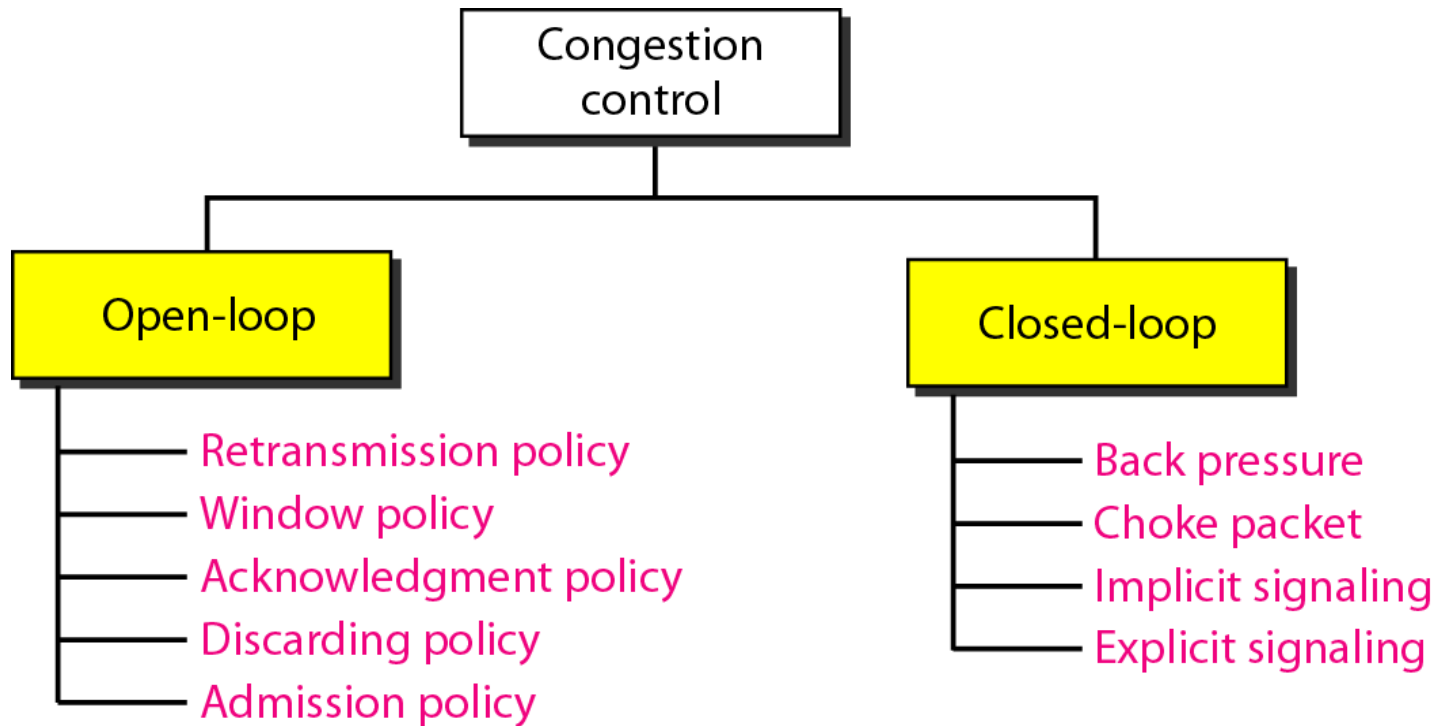**Topics discussed in this section:**

Open-Loop Congestion Control
Closed-Loop Congestion Control

Figure 24.5 *Congestion control categories*

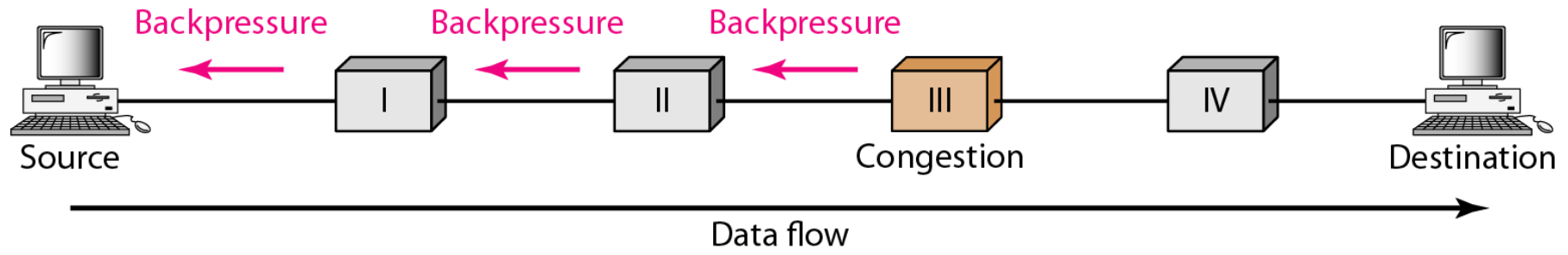**Figure 24.6** *Backpressure method for alleviating congestion*

Figure 24.7 *Choke packet*
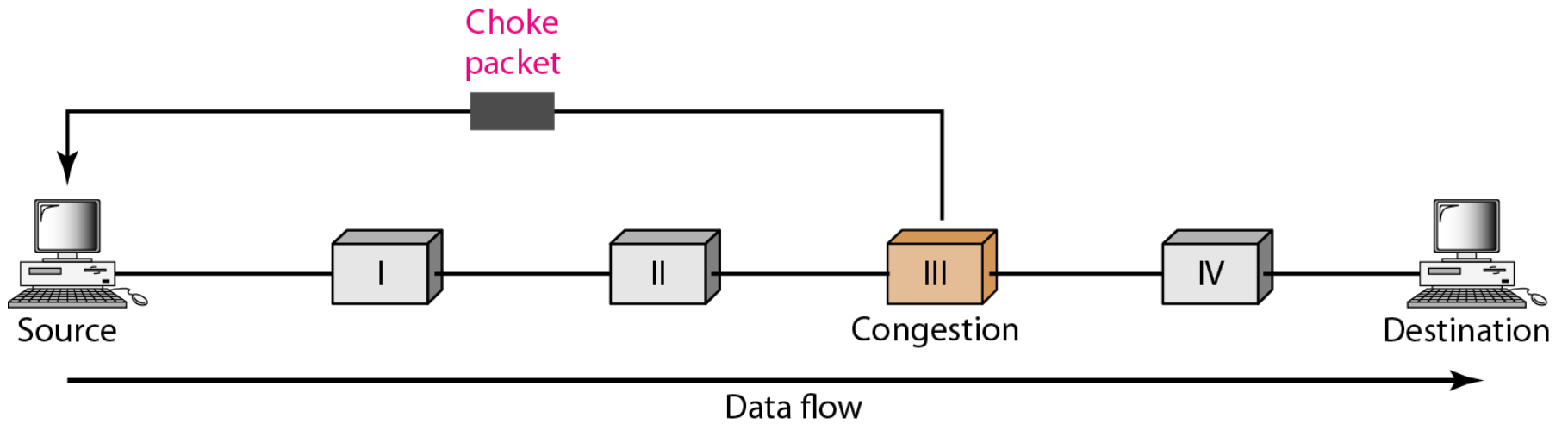
To better understand the concept of congestion control, let us give an example in TCP .

Topics discussed in this section:

Congestion Control in TCP

Figure 24.8 *Slow start, exponential increase*

Rnd: Round of transmission

Sender

Receiver

$cwnd = 2^0 = 1$

$cwnd = 2^1 = 2$

$cwnd = 2^2 = 4$

$cwnd = 2^3 = 8$

Rnd 1

Rnd 2

Rnd 3

Segment 1

Ack 2

Segment 2

Ack 3

Segment 3

Ack 4

Segment 4

Ack 5

Segment 5

Ack 6

Segment 6

Ack 7

Segment 7

Ack 8

Time

Time

24.13

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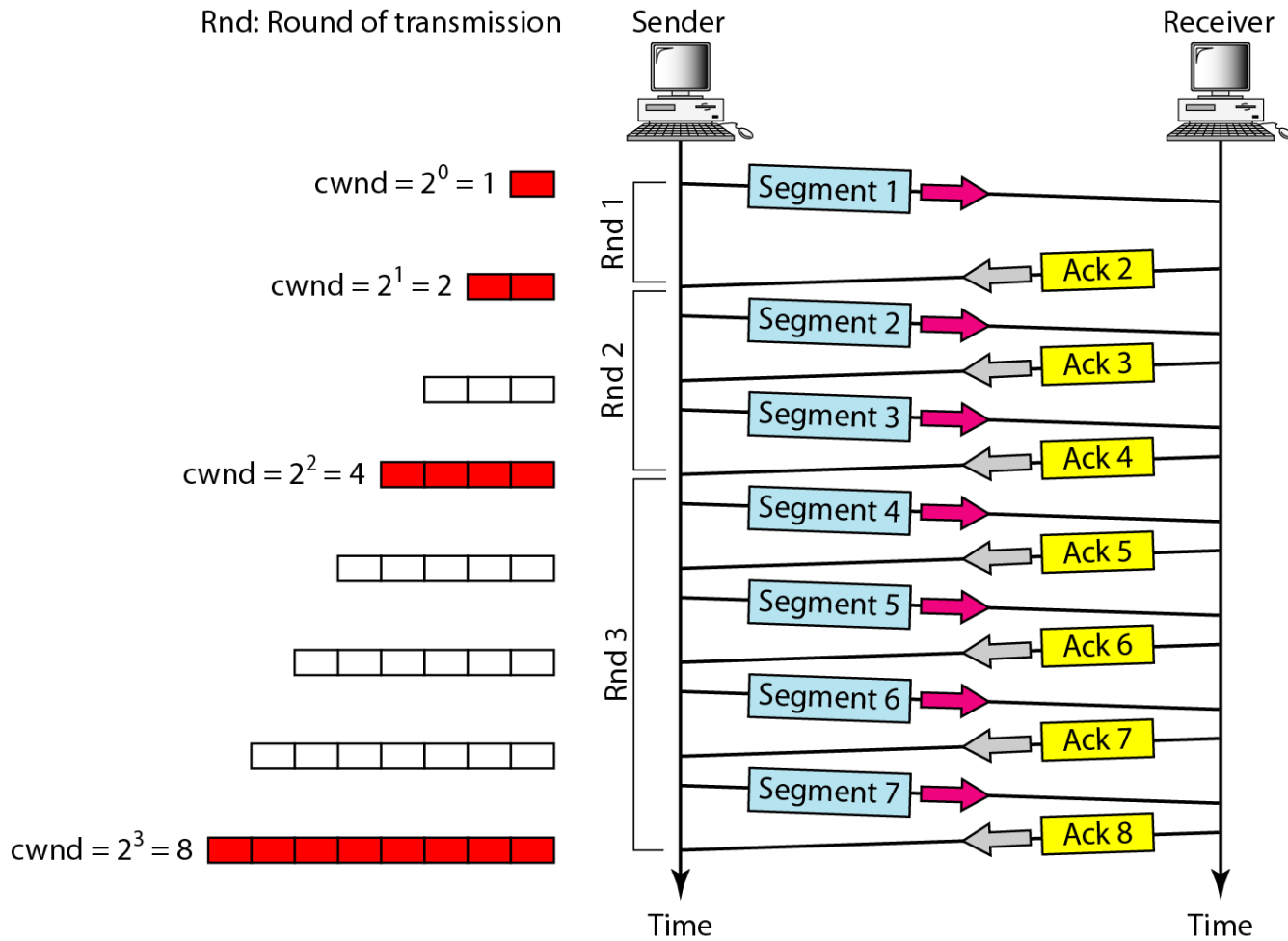
In the slow-start algorithm, the size of the congestion window increases exponentially until it reaches a threshold.

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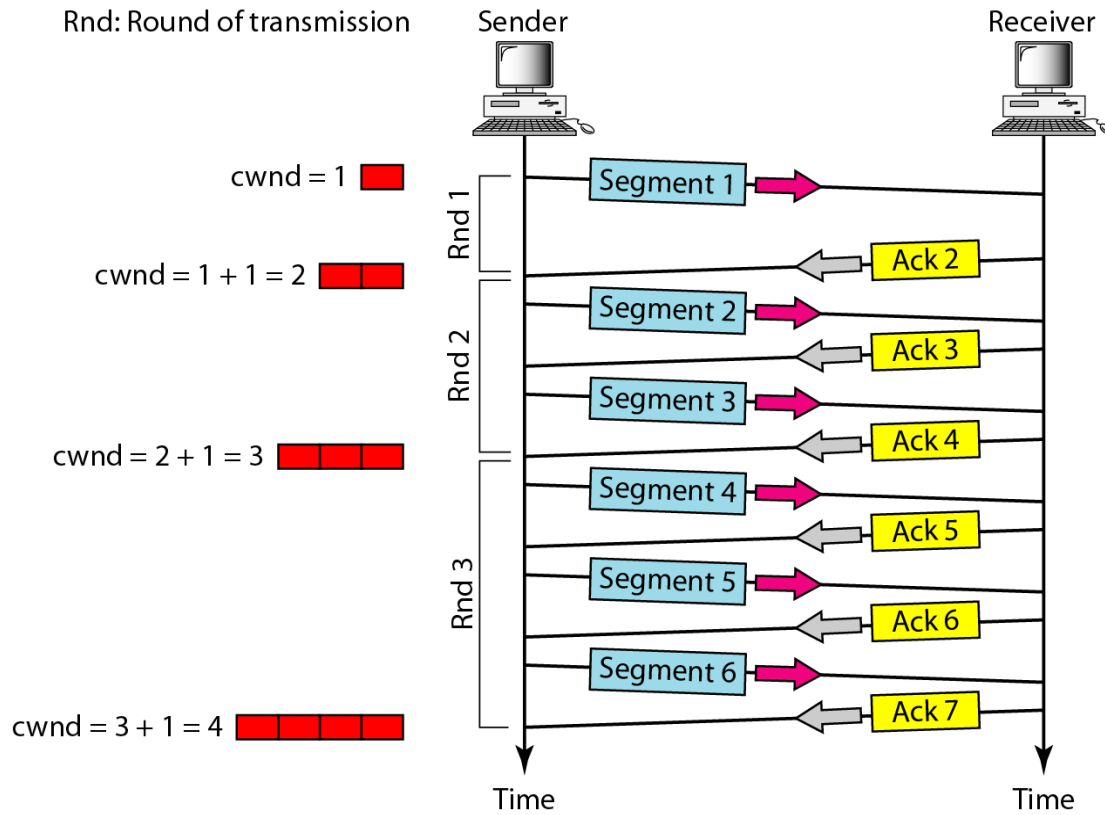**Figure 24.9** *Congestion avoidance, additive increase*

Rnd: Round of transmission

Sender

Receiver

cwnd = 1

Rnd 1
Segment 1
Ack 2

cwnd = 1 + 1 = 2

Rnd 2
Segment 2
Ack 3
Segment 3
Ack 4

cwnd = 2 + 1 = 3

Rnd 3
Segment 4
Ack 5
Segment 5
Ack 6
Segment 6
Ack 7

cwnd = 3 + 1 = 4

Time

Time

In the congestion avoidance algorithm, the size of the congestion window increases additively until congestion is detected.

An implementation reacts to congestion detection in one of the following ways:

❏ **If detection is by time-out, a new slow start phase starts.**

❏ **If detection is by three ACKs, a new congestion avoidance phase starts.**
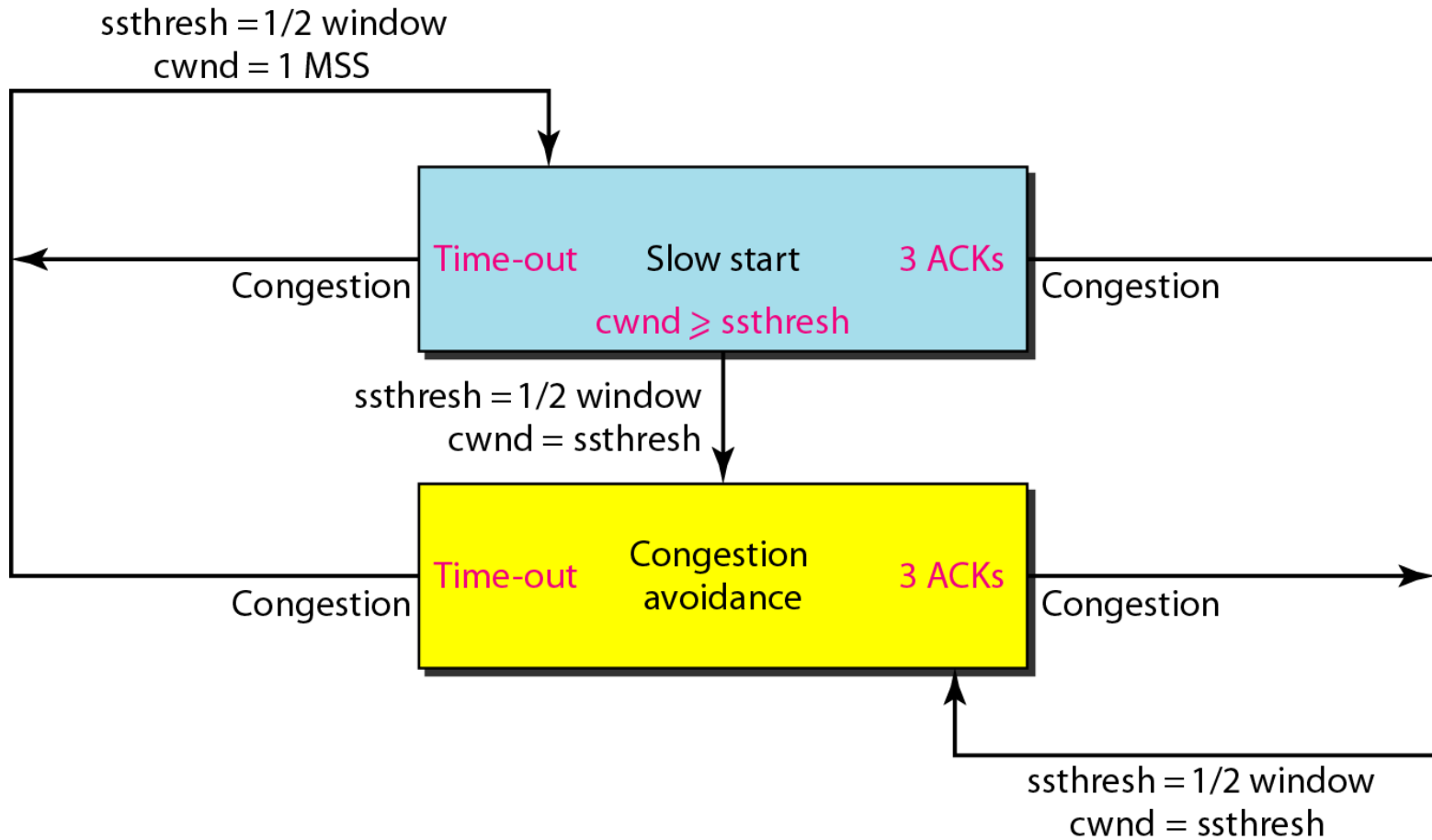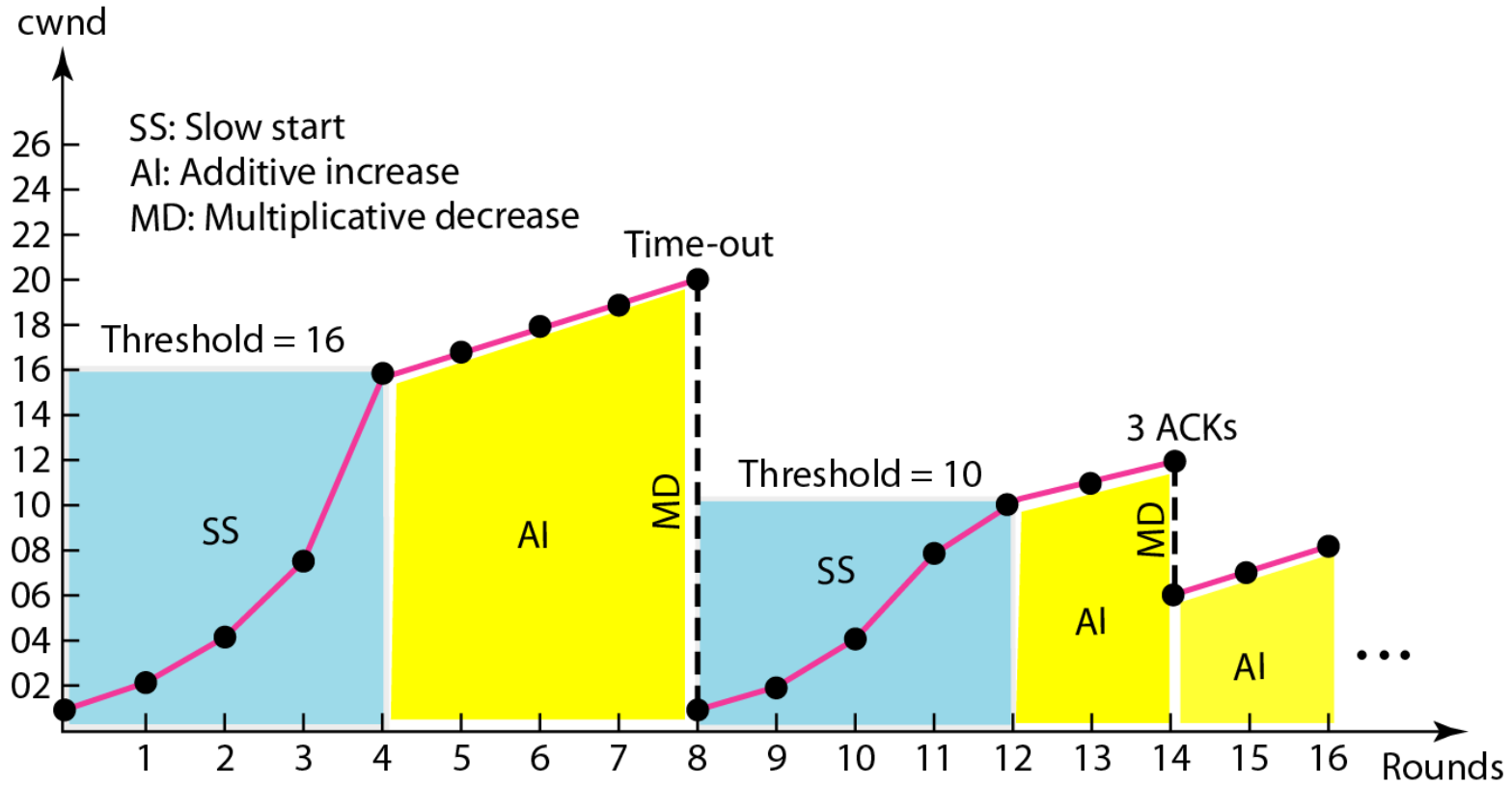
Figure 24.10 *TCP congestion policy summary*

ssthresh = 1/2 window
cwnd = 1 MSS

Time-out	Slow start	3 ACKs

cwnd ≥ ssthresh

Congestion

Congestion

ssthresh = 1/2 window
cwnd = ssthresh

Time-out	Congestion avoidance	3 ACKs

Congestion

Congestion

ssthresh = 1/2 window
cwnd = ssthresh

Figure 24.11 *Congestion example*

SS: Slow start
AI: Additive increase
MD: Multiplicative decrease

The end

Important to do at home :

 - read sections 1-4 of chapter 24 of the textbook