Data Communications and Networking Fourth Edition

Forouzan

Chapter 24

Congestion Control and Quality of Service

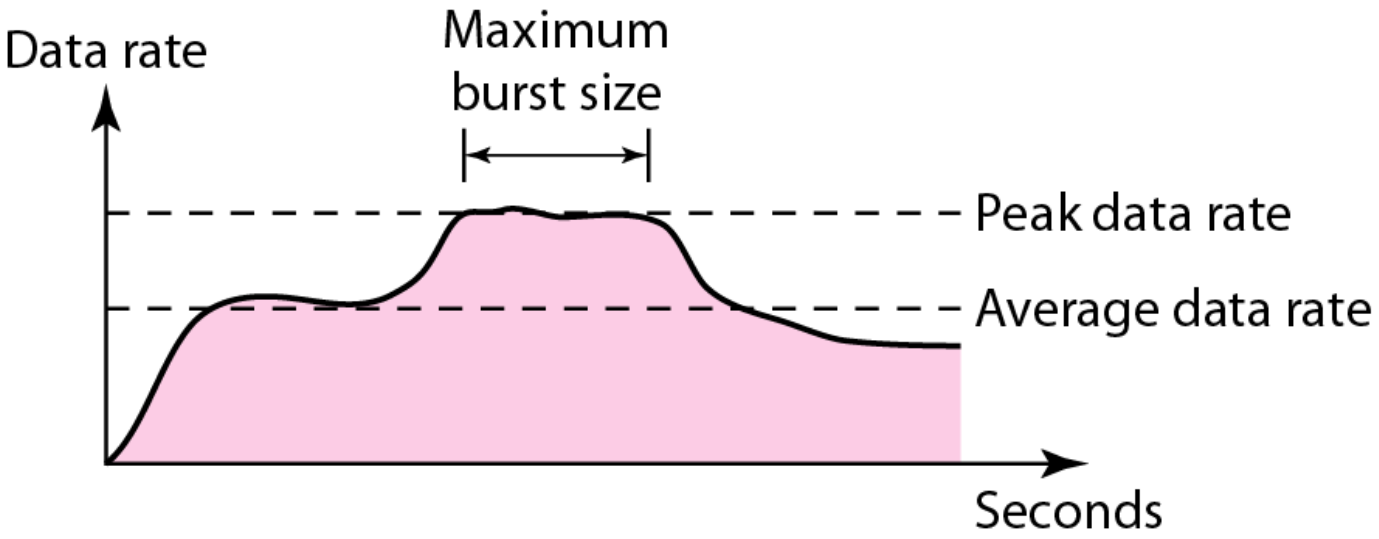
24-1 DATA TRAFFIC

- ✓ 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

Figure 24.1 *Traffic descriptors*

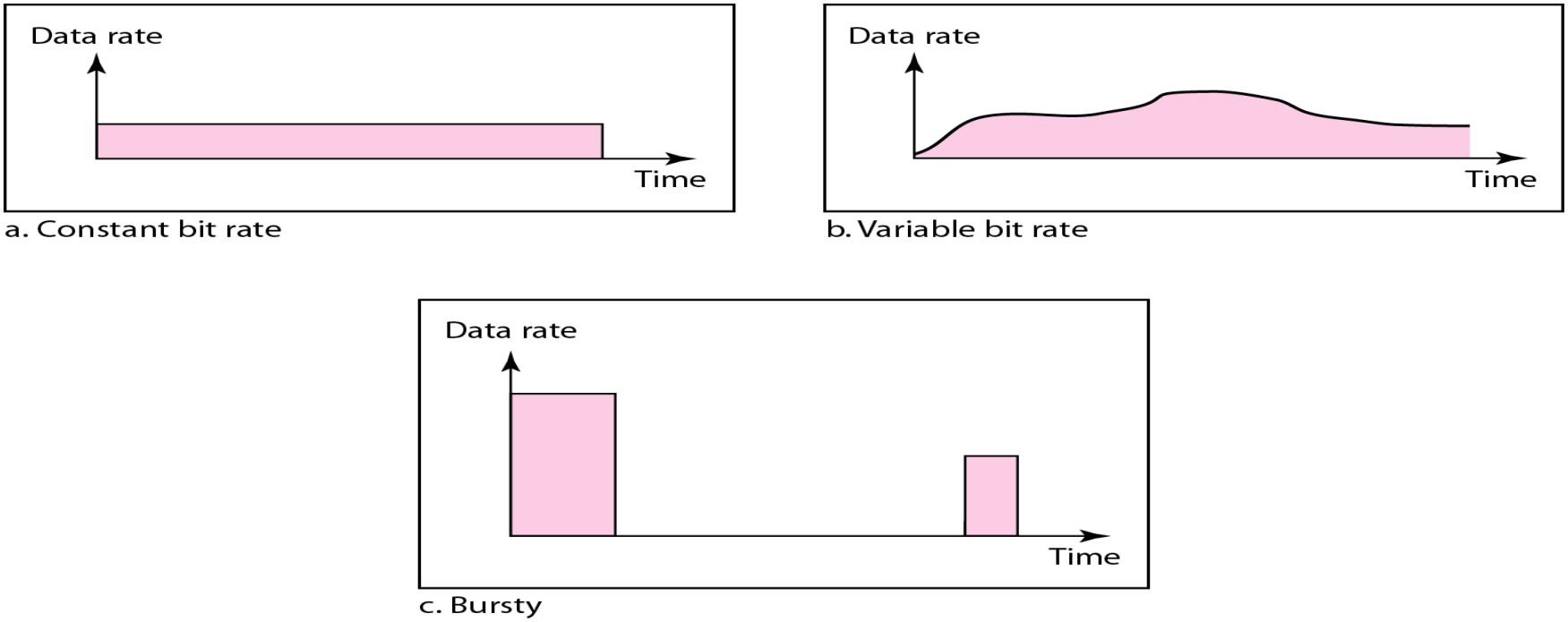


- ✓ The average data rate is the number of bits sent during a period of time:

Average data rate = amount of data / time

- ✓ **Peak** data rate defines the maximum data rate of the traffic.
- ✓ **Maximum burst size** normally refers to the **maximum length of time** the traffic is generated at the peak rate.

Figure 24.2 *Three traffic profiles*



- ✓ Constant-bit-rate (CBR): or a fixed-rate, traffic model has a data rate that does not change.
- ✓ Variable-bit-rate (VBR): the rate of the data flow changes in time.
- ✓ **Bursty data:** the data rate changes suddenly in a very short time

24-2 CONGESTION

- ✓ **What is Congestion?** Congestion happens when too many packets are sent into a network, exceeding its capacity to handle them.
- ✓ **What is Congestion Control?** It involves methods to manage traffic and prevent the network from getting overloaded.

Topics discussed in this section:

Network Performance

Figure 24.3 *Queues in a router*

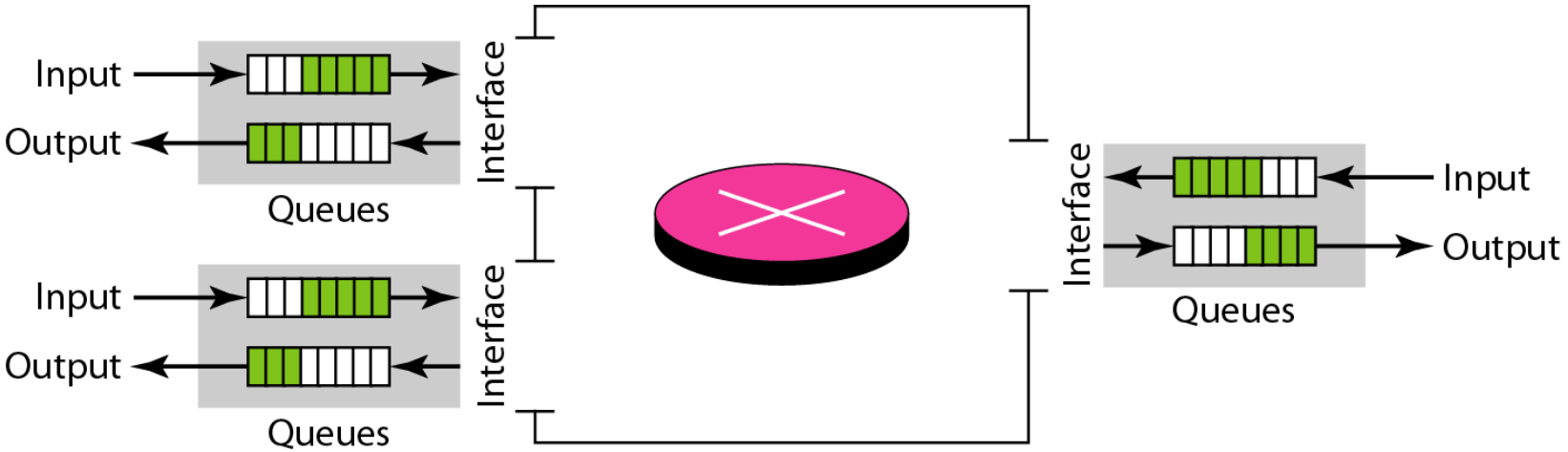
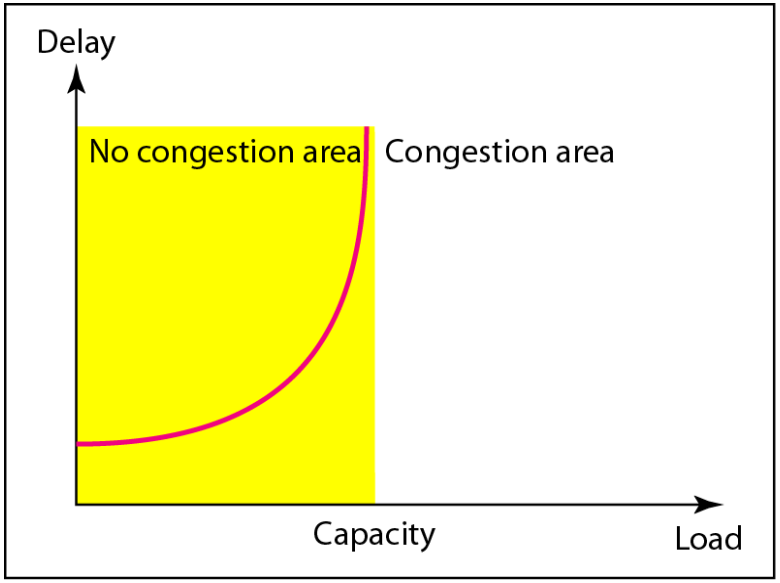
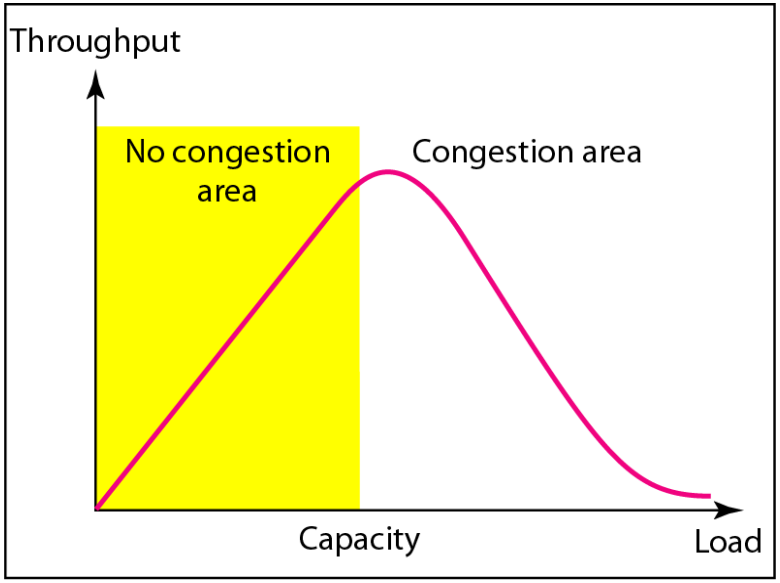


Figure *Packet delay and throughput as functions of load*



a. Delay as a function of load



b. Throughput as a function of load

24-3 CONGESTION CONTROL

- ✓ Congestion control refers to techniques and mechanisms that can either prevent congestion, before it happens, or remove congestion, after it has happened.
- ✓ Two broad categories of congestion control mechanisms:
  - ✓ 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*

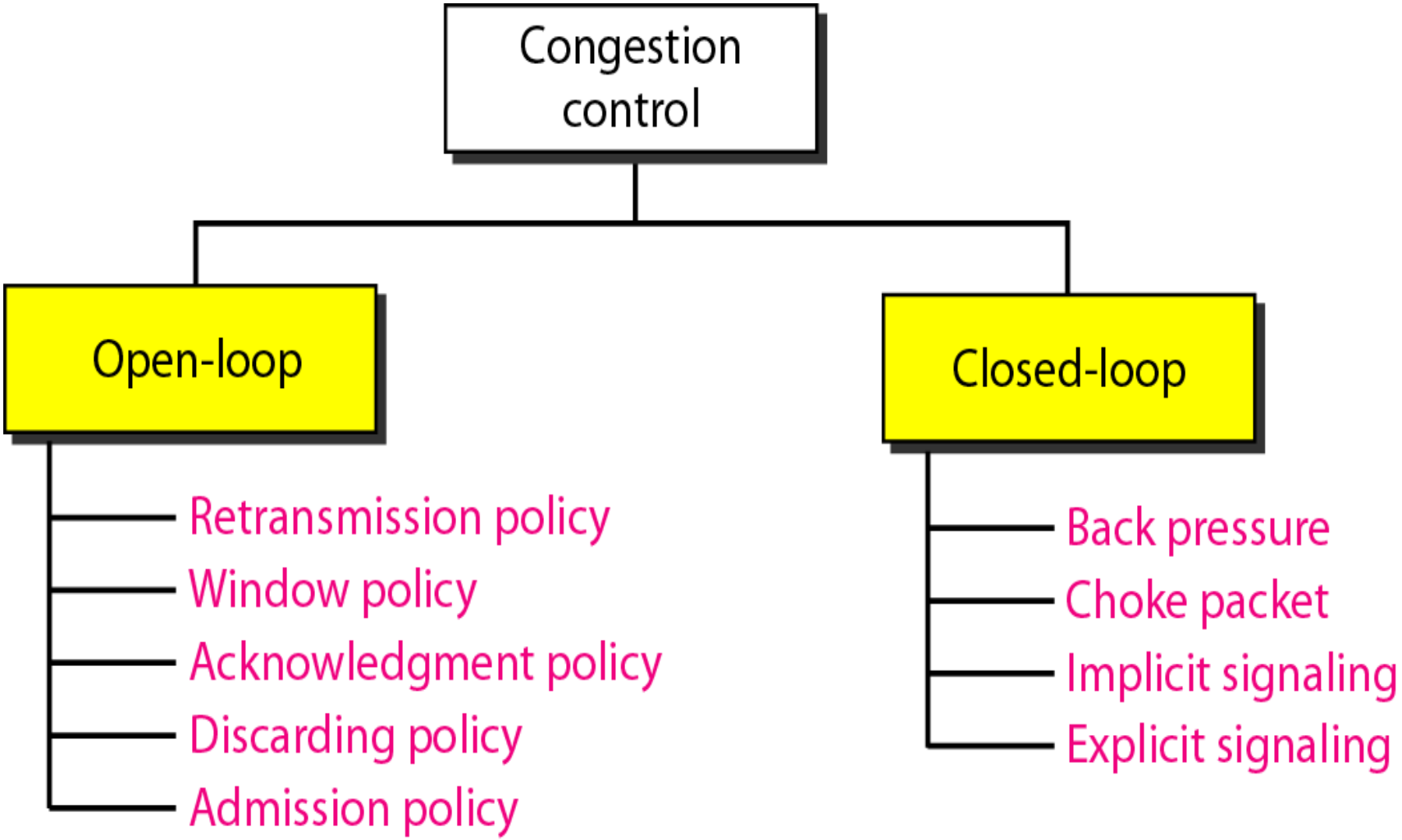
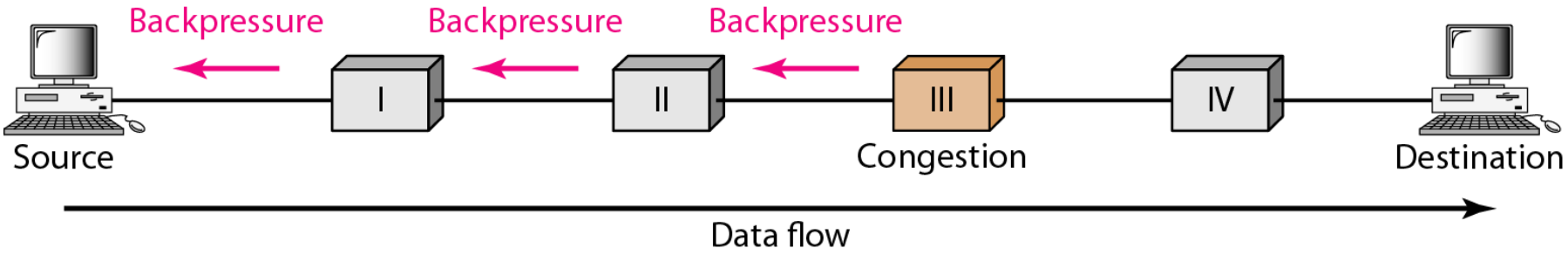
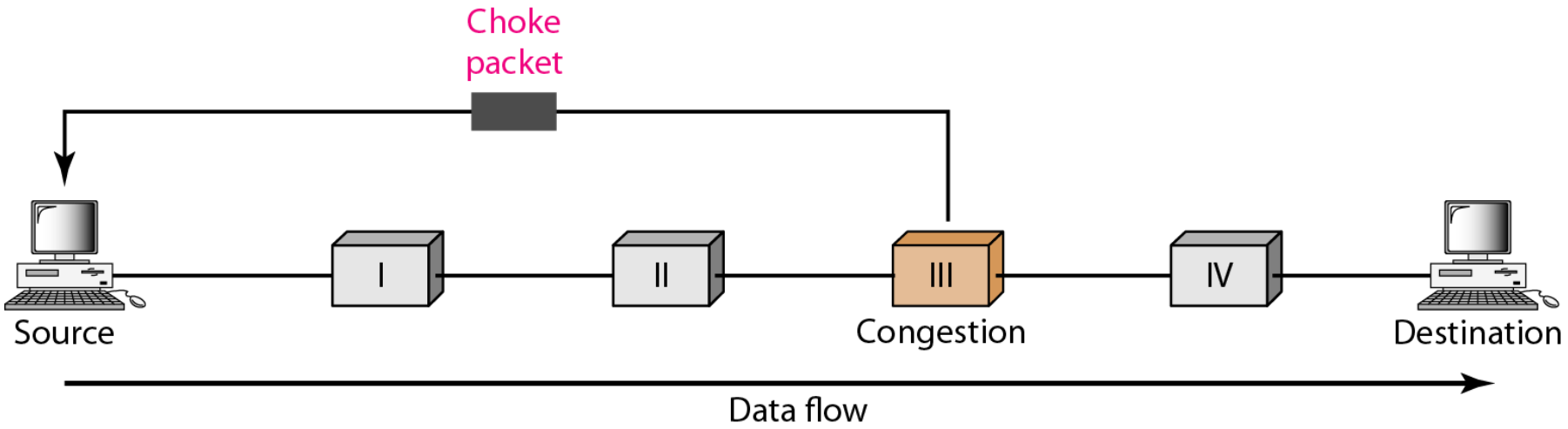


Figure 24.6 *Backpressure method for alleviating congestion*



- ✓ The backpressure technique can be applied only to **virtual circuit networks**, in which each node knows the upstream node from which a **flow of data is corning**

Figure 24.7 *Choke packet*



- ✓ In the choke packet method, the warning is from the router, which has encountered congestion, to the source station **directly**

Implicit and Explicit Signaling

- Implicit Signaling
  - by symptoms source will identify or **assume congestion** in the network.
- **Explicit Signaling**
  - **Node will send a message** to source or destination notifying congestion in the network
  - Backward signaling
  - Forward signalling

24-4 TWO EXAMPLES

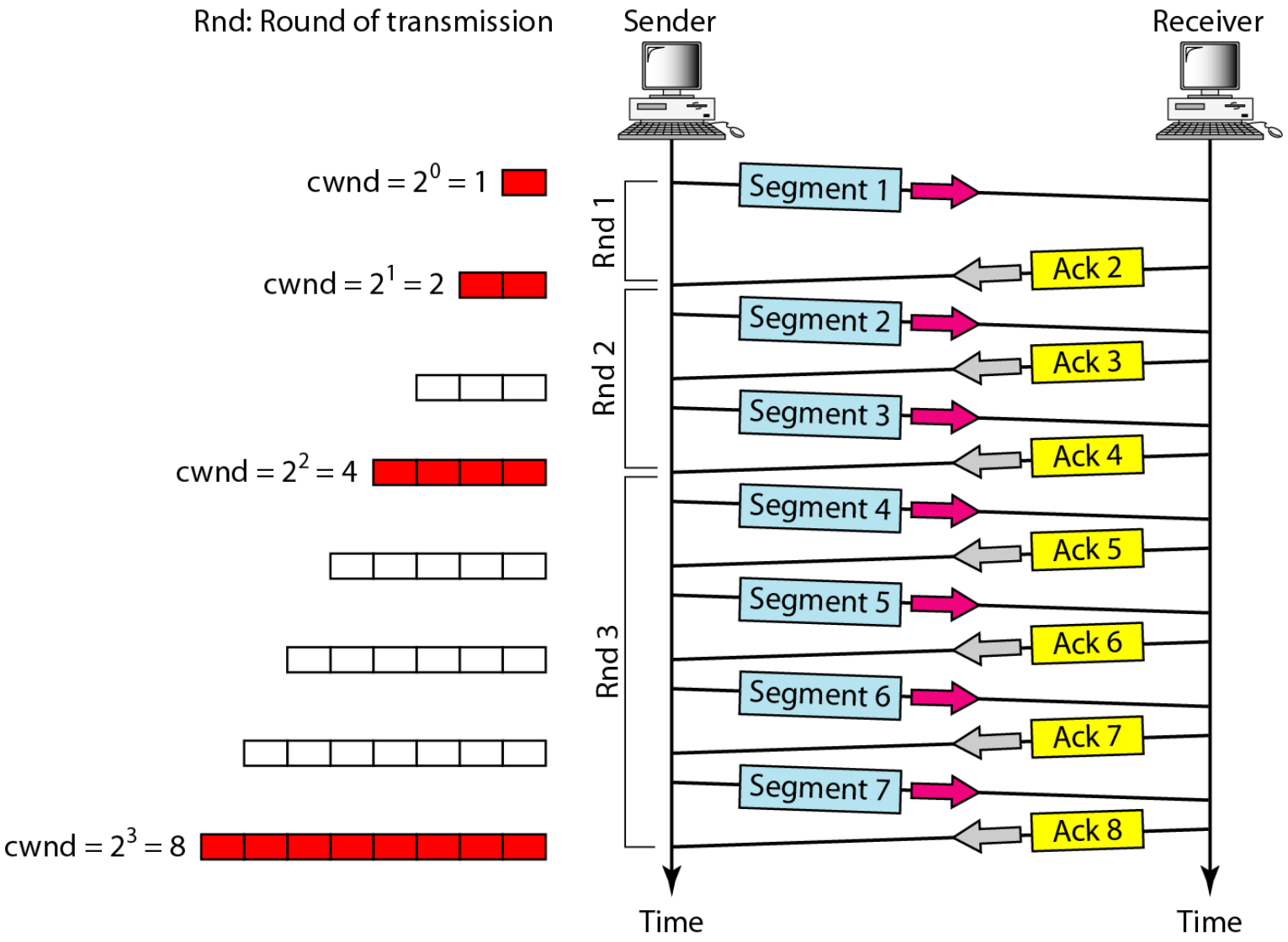
To better understand the concept of congestion control, let us give two examples: one in TCP and the other in Frame Relay.

Topics discussed in this section:

Congestion Control in TCP

Congestion Control in Frame Relay

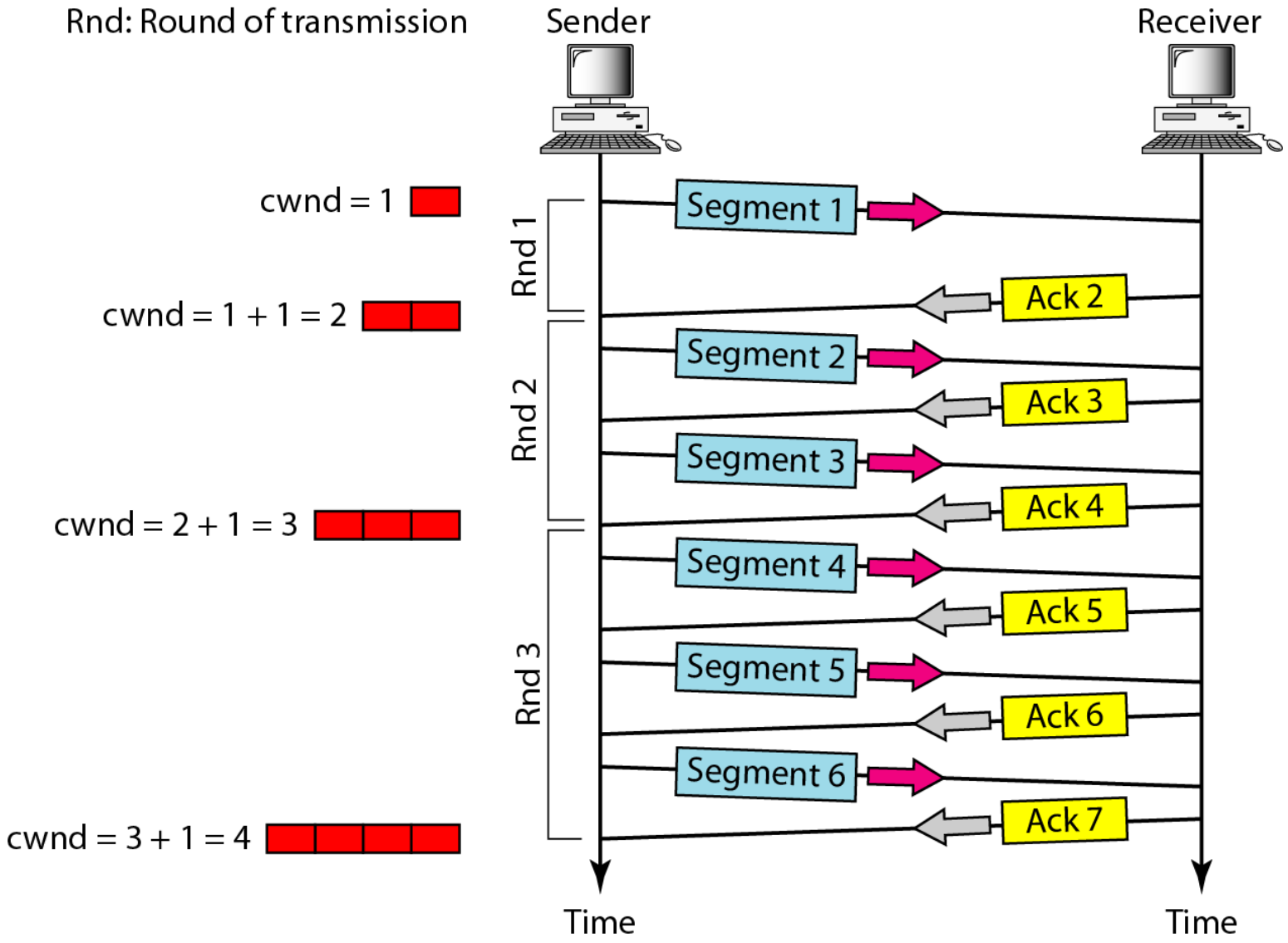
Figure 24.8 *Slow start, exponential increase*



Note

In the slow-start algorithm, the size of the congestion window increases exponentially until it reaches a threshold (ssthresh is 65535).

Figure 24.9 *Congestion avoidance, additive increase*



Note

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

Note

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.**

Due to time-out

a. It sets the value of the threshold to one-half of the current window size.

b. It sets *cwnd* to the size of one segment.

c. It starts the slow-start phase again.

Due to 3 duplicate acknowledgements

a. It sets the value of the threshold to one-half of the current window size.

b. It sets *cwnd* to the value of the threshold (some implementations add three segment sizes to the threshold).

c. It starts the congestion avoidance phase.

Figure 24.10 *TCP congestion policy summary*

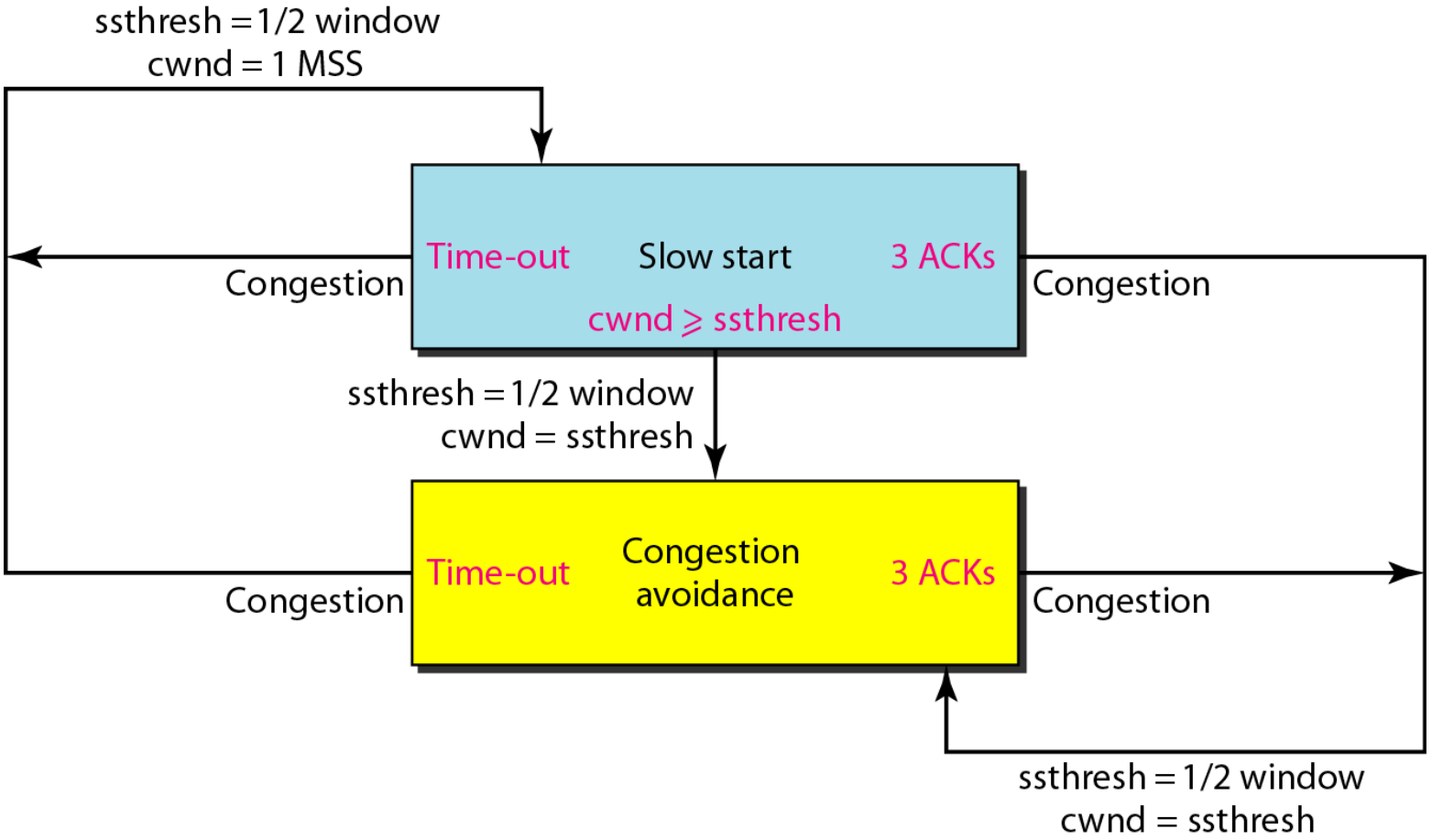
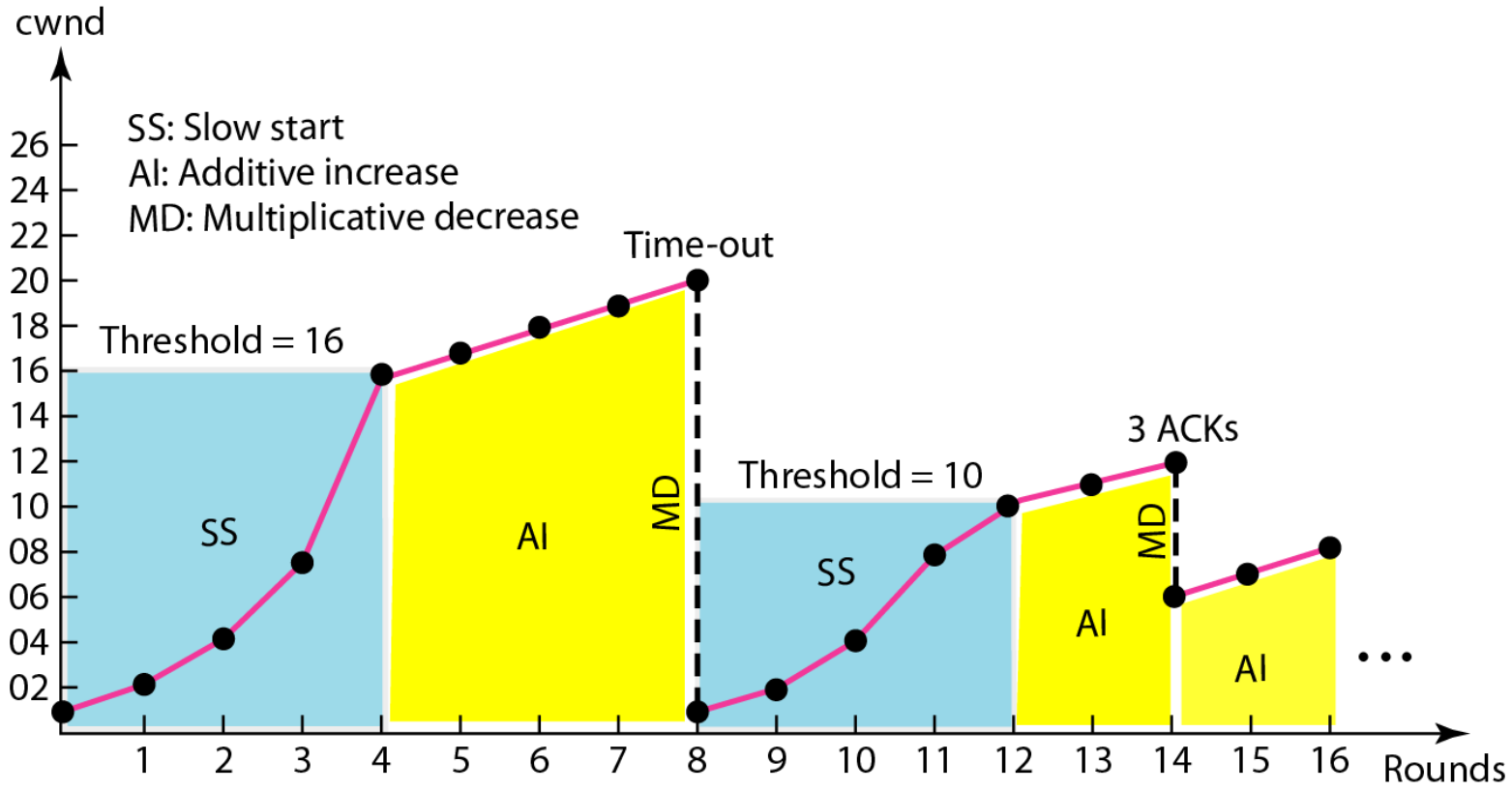


Figure 24.11 *Congestion example*



TCP Delay Modelling

- How long does it take to receive an object from a HTTP server after sending a request?
- If we ignore congestion, delay is influenced by:
  - TCP connection establishment
  - Data transmission delay
  - Slow start