Session 8B

Quality of Service (QoS)

Mouli Sankaran

Session 8B: Focus

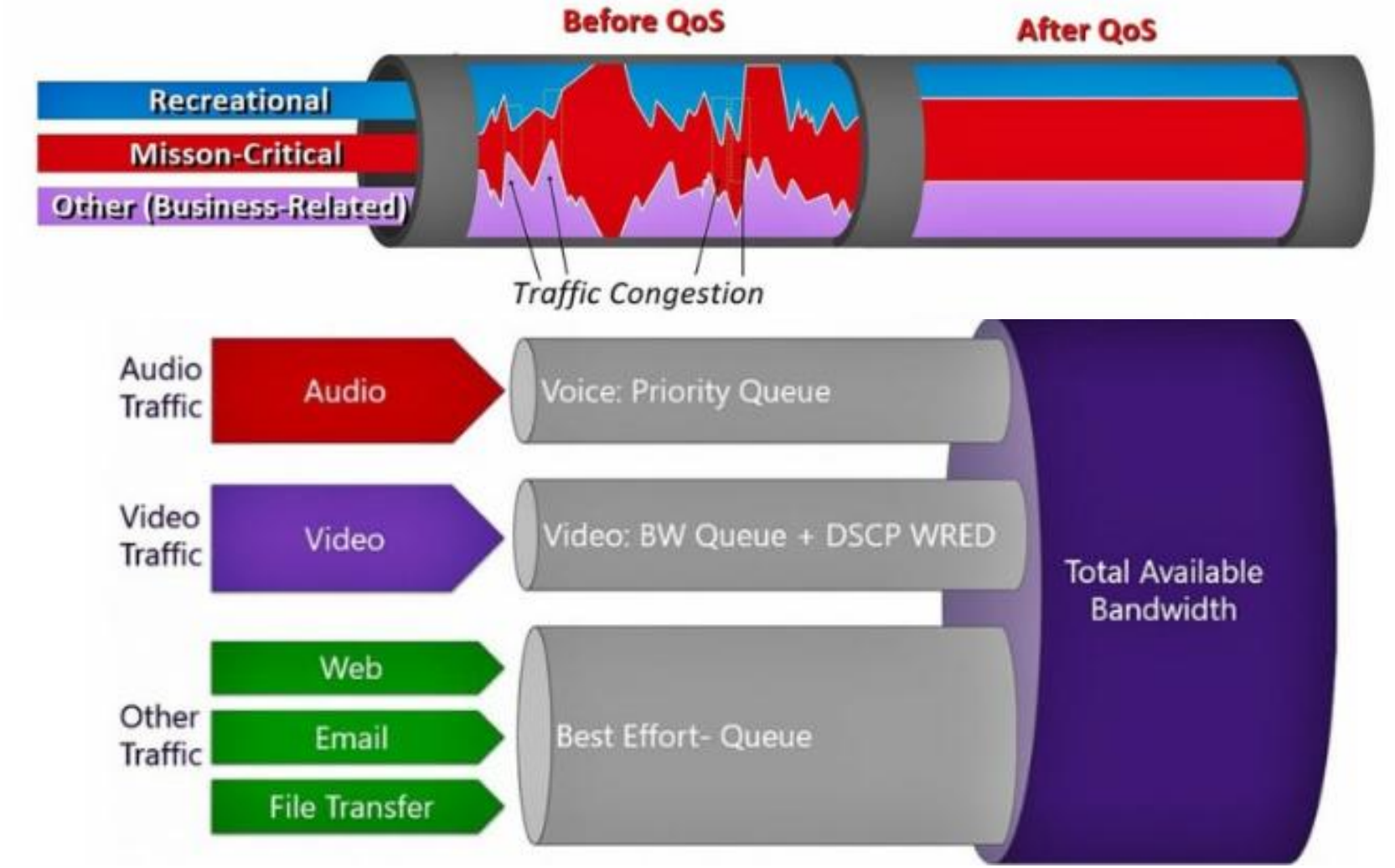
- Quality of Service (QoS)
  - Introduction
  - QoS Parameters
- QoS Tools
  - Classification and Marking,
  - Queuing and Scheduling,
  - Congestion Management.
  - Policing and Traffic Shaping
- QoS Models

Course page where the course materials will be posted as the course progresses:

Quality of Service (QoS)

What is QoS?

Source:



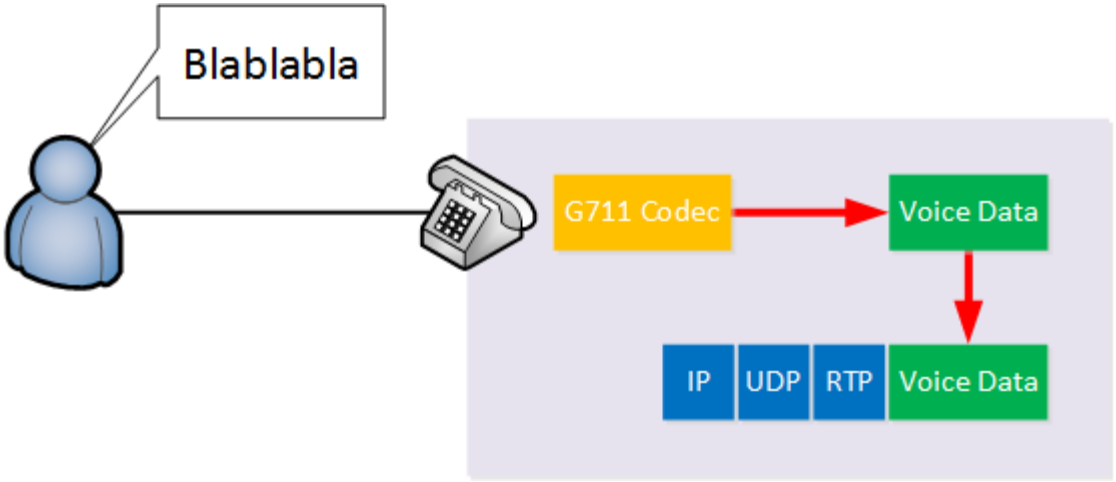
QoS: Introduction

- Quality of Service (QoS) refers to a set of technologies and techniques that help networks **prioritize important traffic**, control delay, reduce packet loss, and improve overall application performance.
- QoS ensures that critical applications get the network resources they need, even during congestion.
- Congestion can happen when network links are oversubscribed.
- Real-time applications (like VoIP) degrade significantly if packets are delayed or lost.
- Different types of traffic have different network requirements:
  - **Voice** needs low latency and low **jitter**.
  - **Video** needs high bandwidth and some tolerance for jitter.
  - **Email** or web browsing is tolerant to delays, but not to loss.

Jitter: Variation in delay

Example: Voice Data Processing

Source



- Codec processes the analog sound and converts it into a digital signal.
- The analog sound is digitized for a certain time period which is usually 20 ms.
- With the G711 codec, each 20 ms of audio is 160 bytes of data.
- The IP phone will then create a new IP packet with an UDP and RTP (Realtime Transport Protocol) headers, adds the voice data to it and forwards the IP packet to the destination.

QoS Parameters

Parameter	Description
Bandwidth	Maximum rate of data transfer over a network path
Latency (Delay)	Time taken for a packet to travel from source to destination
Jitter	Variation in delay for packet delivery
Packet Loss	Packets that are dropped and never reach their destination

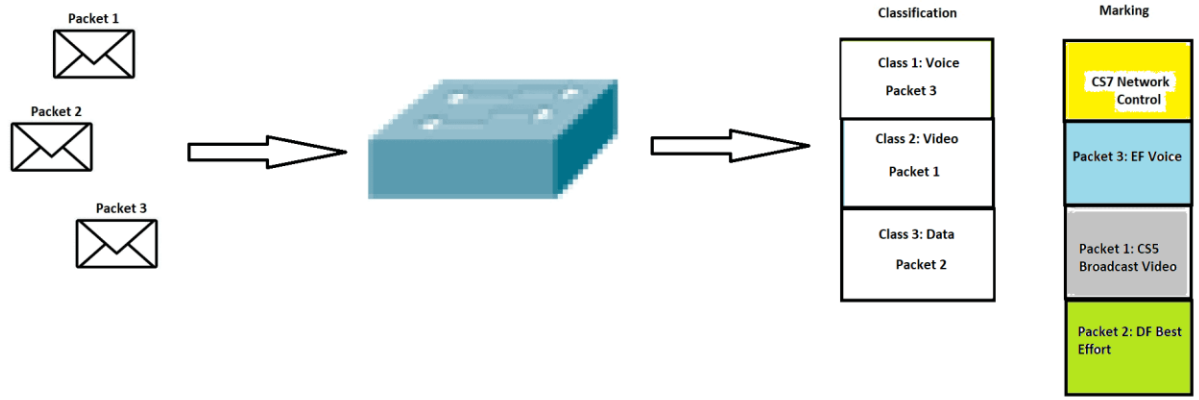
QoS tries to optimize these metrics according to application needs.

QoS Tools

QoS Tools

- Some of the QoS tools are:
  A. Classification and Marking,
  B. Queuing and Scheduling,
  C. Congestion Management.
  D. Policing and Traffic Shaping

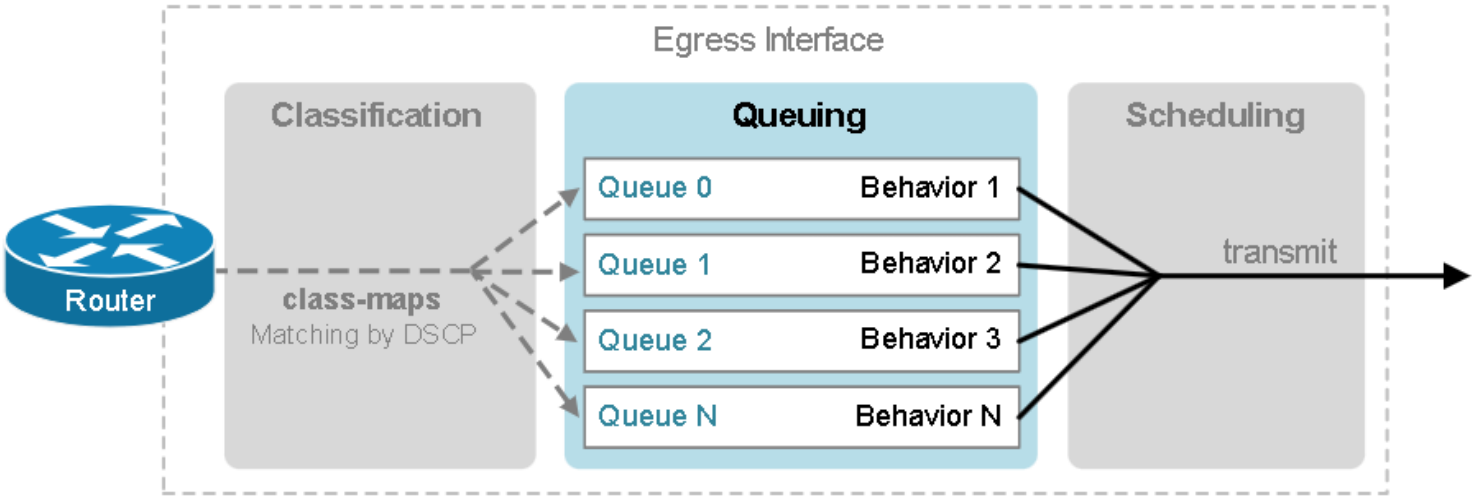
A. Classification and Marking



a) Classification and Marking

- **Classification**: Identifying and separating traffic into categories.
- **Marking**: Tagging packets based on priority levels.
- Common fields used:
  - **IP Precedence** (older)
  - **DSCP** (Differentiated Services Code Point) in IP header
  - **802.1p** tags for Ethernet frames

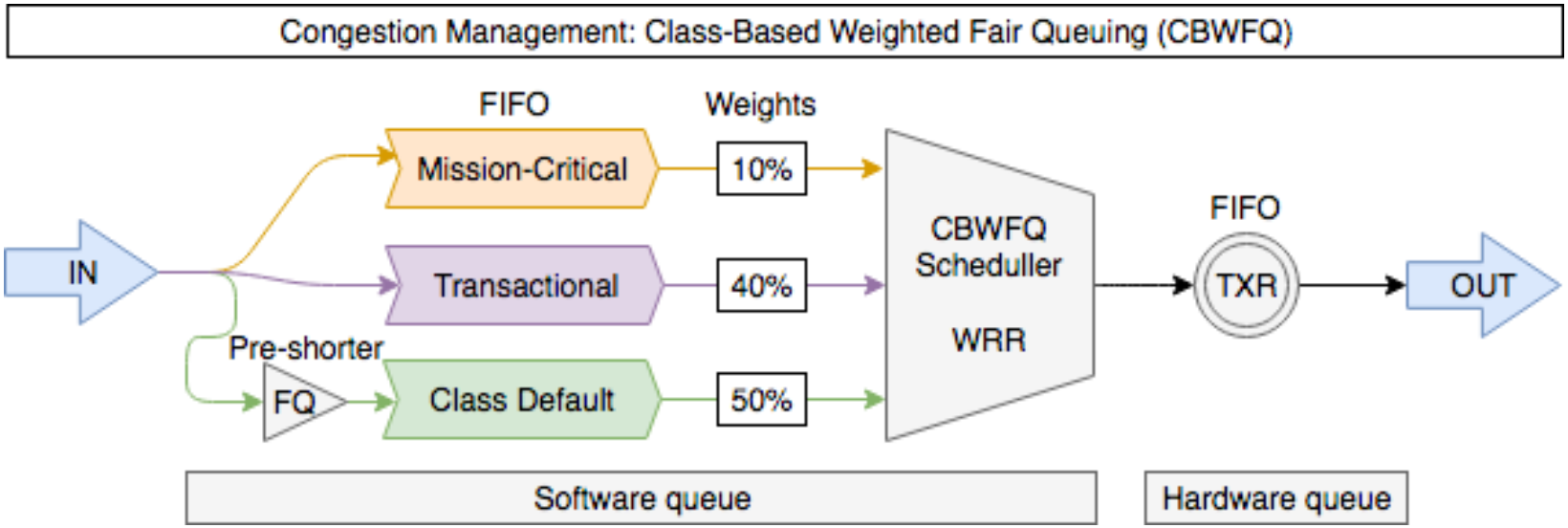
B. Queuing and Scheduling



b) Queuing and Scheduling

- Packets are placed into **queues** based on their classification.
- **Scheduling algorithms** determine the order in which packets are transmitted:
  - **First-In-First-Out (FIFO)** (default but not QoS-friendly)
  - **Priority Queuing (PQ)**: Highest priority queues first
  - **Weighted Fair Queuing (WFQ)**: Fair bandwidth division based on weights
  - **Class-Based Weighted Fair Queuing (CBWFQ)**: More flexible control

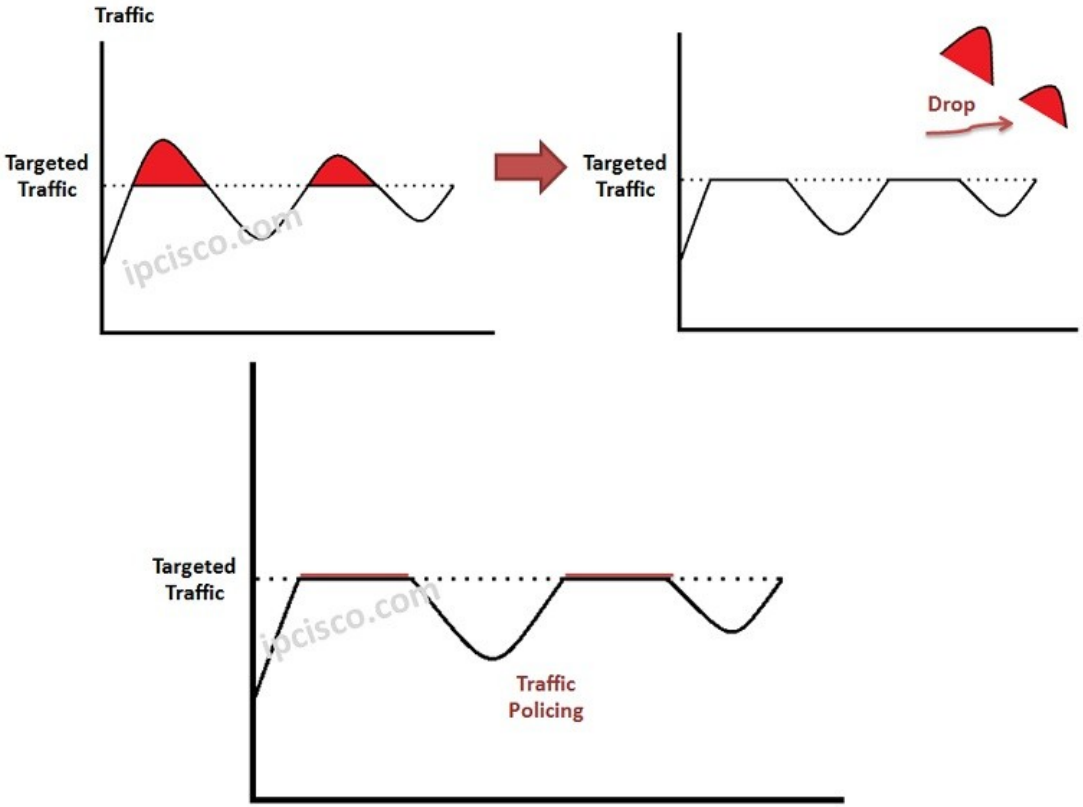
C. Congestion Management



c) Congestion Management

- Techniques to **control** or **avoid** congestion:
  - **Tail Drop**: Simply drops packets when queue is full (causes TCP global synchronization problems)
  - **Random Early Detection (RED)**: Proactively drops packets to avoid full queues

D. Policing and Traffic Shaping



d) Policing and Shaping

- **Policing**: Enforces a bandwidth limit by dropping or remarking packets exceeding the rate.
- **Shaping**: Buffers excess traffic and sends it at a controlled rate.

QoS Models

There are three major architectures or philosophies for applying QoS across networks:

Model	Description
Best Effort	No QoS; all traffic treated equally
Integrated Services (IntServ)	Provides per-flow resource reservation using **RSVP** (Resource Reservation Protocol)
Differentiated Services (DiffServ)	Traffic is classified and treated based on **DSCP** markings; scalable and widely used

DiffServ is the dominant model used in most enterprise and service provider networks.

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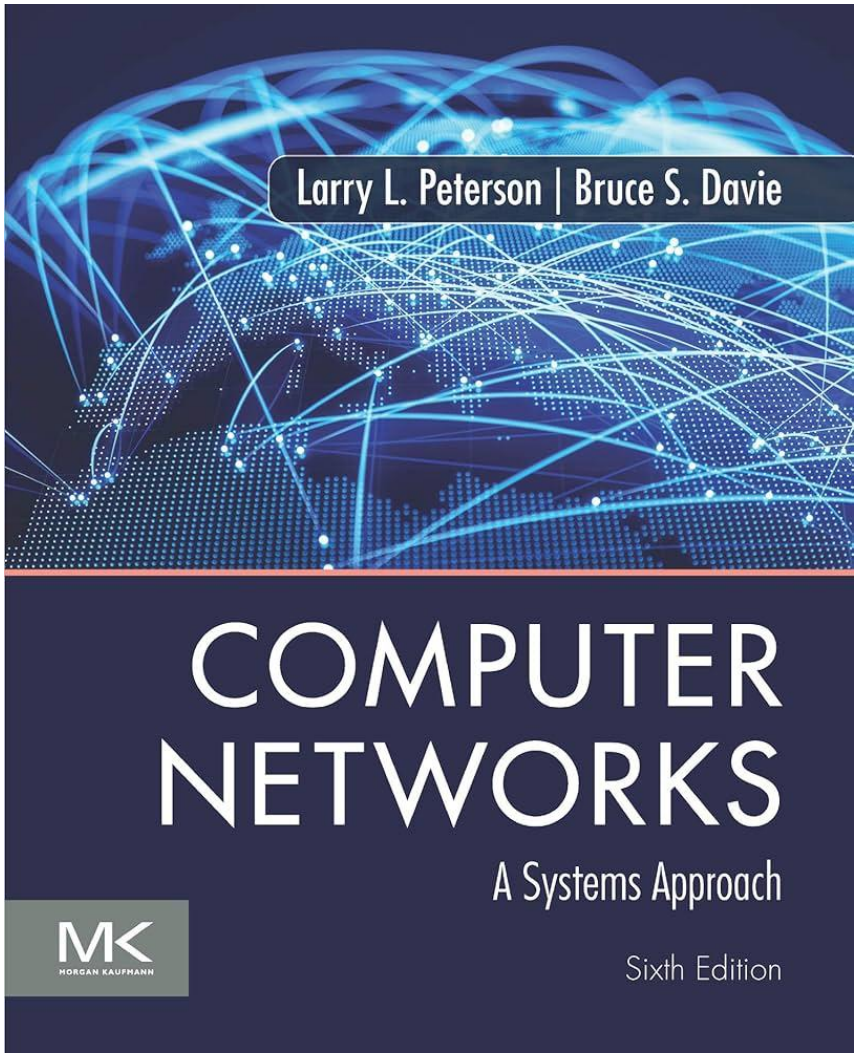
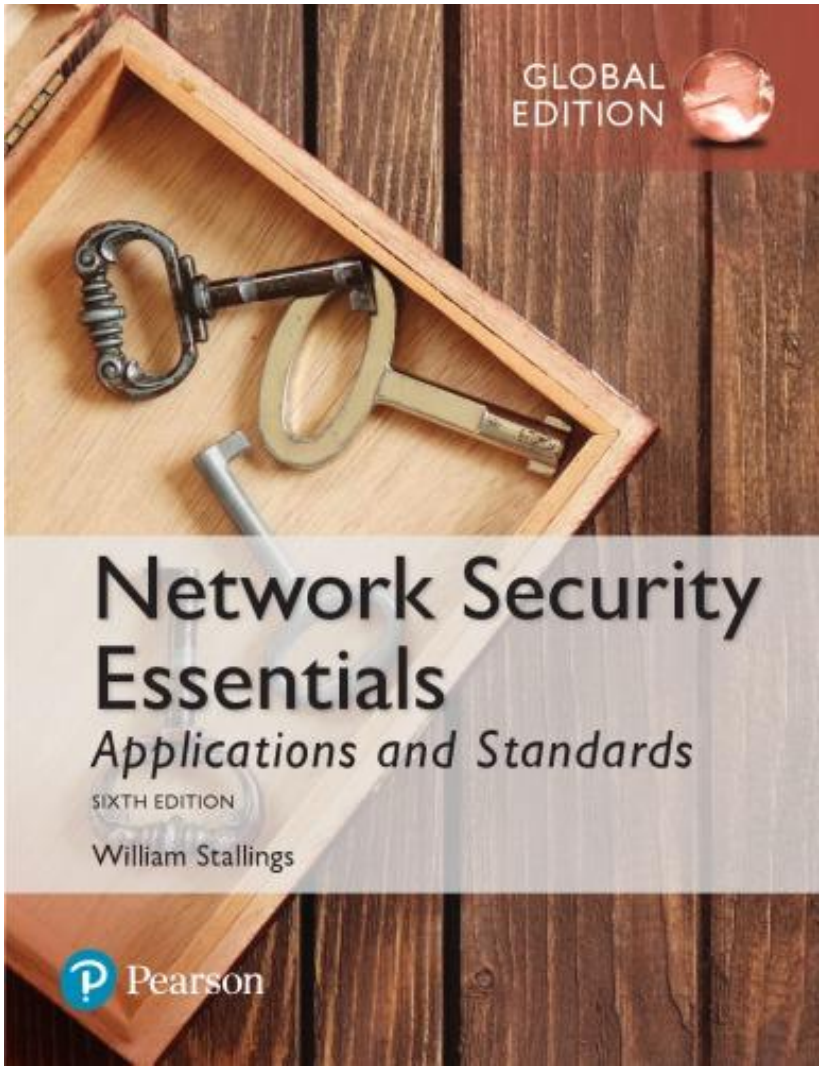
Textbooks

Textbook 1

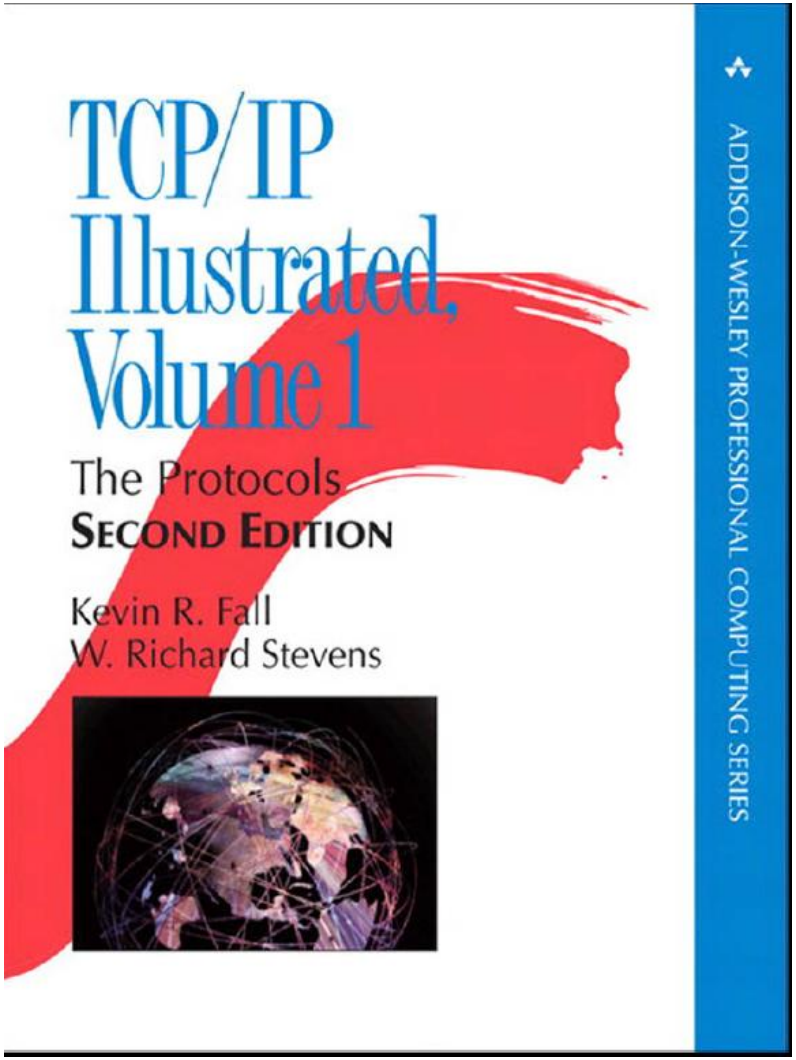


Textbook 2



References

Ref 1



Ref 2

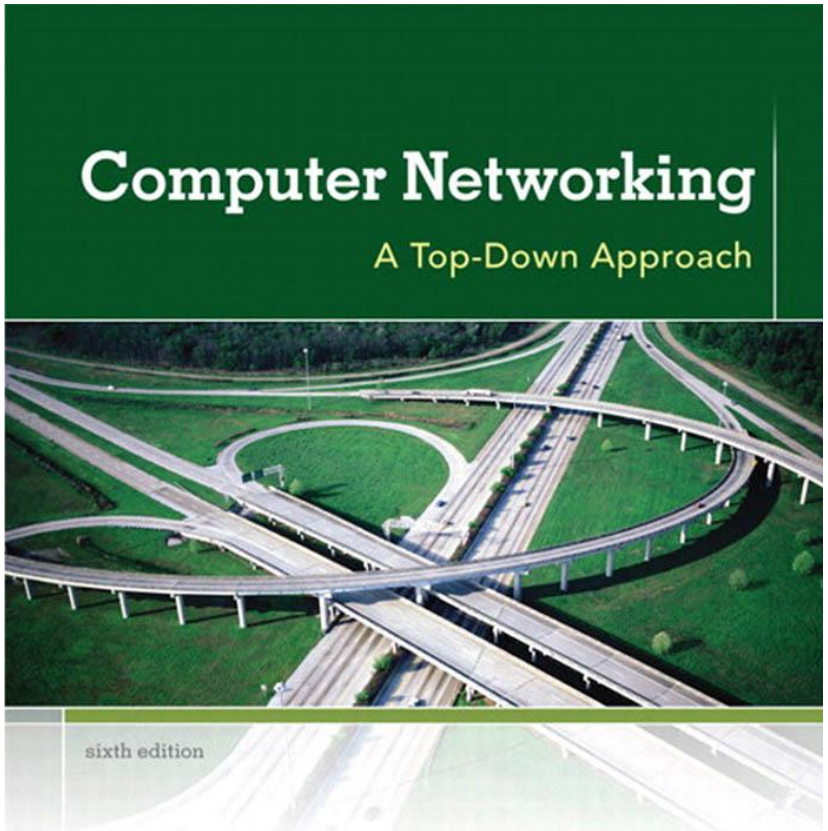
TCP Congestion Control: A Systems Approach

TCP Congestion Control: A Systems Approach

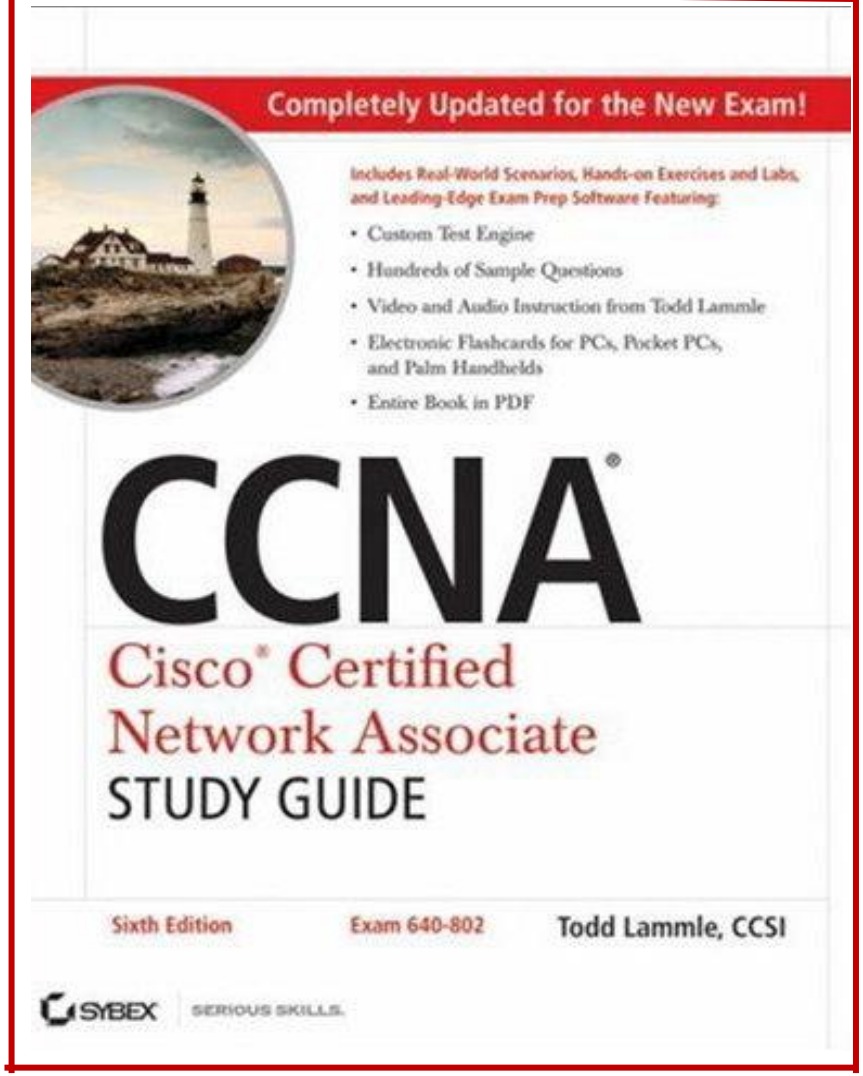
Peterson, Brakmo, and Davie

References

Ref 3



Ref 4



References

Ref 5