VE489 Computer Networks

UM-SJTU Joint Institute, Summer 2020

Prof. Xudong Wang

Highlights of Chapter 1

1 Requirements and Advice

In this chapter, we will introduce the basic but the most important concepts of computer networks. Students are expected to fully understand these concepts. **Never ever memorize these concepts without really understanding them. Use examples and practice to study these concepts.**

2 Topics

Important topics that will be covered in this chapter include (but are not limited to):

- What is a computer network? How about a communication network?
- The architecture of telephone and telegraph, which leads to the concepts of message switching and circuit switching
- The architecture of computer networks and examples
- The example of visiting a website via the Internet
- The protocol stack of a computer network: services, layers, and protocols
- Different protocol stack models
- Specifications and standards

3 Technical Terms

Do you really understand the following technical terms? If not, study the class notes and textbooks to find out the details.

- *Message switching, circuit switching, packet switching*
- *Protocol stack, layers, and services*
- *Key layer functions: physical, data link, routing, transport, application*
- *Connection versus connectionless communications*
- *Hop-by-hop versus end-to-end communications*
- *Error control, congestion control, and flow control*
- *Unicast, multicast, and broadcast*
- *Network topology: point-to-point, point-to-multipoint, ad hoc, mesh*

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Highlights of Chapter 2

1 General Requirements

In this chapter, we will explain the physical layer for computer networks and its related key functions in this layer. Students are expected to fully understand the meaning of the physical layer, the roles of this layer, and key functions provided by this layer. Most importantly, the students need to know the general system architecture of the physical layer. Some fundamental theories for the physical layer will be covered in this chapter too; students should be able to apply such theories in a practical system.

2 Topics

Important topics that will be covered in this chapter include (but are not limited to):

- Roles of the Physical Layer and the system architecture
- Signal representation
- Digital communications and digitization of analog signals
- Signal transmission and channel capacity
- Modulation technologies
- Coding and error control mechanisms
- Multiplexing in the physical layer
- Transmission media

3 Technical Terms

Do you really understand the following technical terms? If not, study the class notes and textbooks to find out the details.

- *Physical layer, baseband, transmitter, receiver*
- *Digitization, Shannon-Nyquist sampling theorem, quantization, PCM, compression*
- *Channel bandwidth, channel capacity: Shannon Theory*
- *Modulation, constellation*
- *Channel coding, Hamming code, CRC, checksum*
- *Multiplexing: TDM, CDM, etc.*
- *Transmission media, frequency, and bandwidth*

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Highlights of Chapter 3

1 General Requirements

In this chapter, we will study the data link layer (or layer 2) of a computer network. Particularly, we will focus on the upper sub-layer, i.e., the logical link control (LLC) layer, in this chapter, while the lower sub-layer, i.e., the medium access control, will be covered in the next chapter. Students are expected to understand the layering and functions of these sub-layers. Mostly importantly, students need to know the key functions provided by LLC, their working mechanisms, and design/analysis of these functions.

2 Topics

Important topics that will be covered in this chapter include (but are not limited to):

- Sub-layers and functions of the data link layer
- Framing in logical link control
- Error control in the data link layer versus the transport layer
- ARQ protocols
- Flow control
- Multiplexing in the data link layer
- Link maintenance

3 Technical Terms

Do you really understand the following technical terms? If not, study the class notes and textbooks to find out the details.

- *Data link layer, logical link control, and medium access control*
- *Framing, character-oriented framing, byte stuffing, bit stuffing, generic framing*
- *ARQ and its relationship with FEC*
- *Mechanism, design and analysis of Stop-and-Wait ARQ, Go-back-N ARQ, and Selective Repeat ARQ*
- *Flow control in the data link layer*
- *Multiplexing and queueing in the data link layer*
- *Examples of logical link control*

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Highlights of Chapter 4

1 General Requirements

In this chapter, we continue to study the data link layer (or layer 2) of a computer network. Particularly, we will focus on the lower sub-layer, i.e., the medium access control (MAC) layer. Students are expected to understand the key functions and the typical protocols of the MAC layer. They also need to know the relationship between MAC and LLC.

2 Topics

Important topics that will be covered in this chapter include (but are not limited to):

- Differences between multiplexing, multiple access, and medium access control
- Key functions of medium access control
- Different categories of MAC
- Static channelization for MAC
- Dynamic channelization for MAC
- Scheduling and resource reservation
- Random access protocol
- Data link switching and bridging

3 Technical Terms

Do you really understand the following technical terms? If not, study the class notes and textbooks to find out the details.

- *Multiple access and medium access control*
- *Channelization, static channelization, and dynamic channelization*
- *Polling, token ring, scheduling, and resource allocation*
- *Random access, ALOHA, slotted ALOHA, CSMA, and CSMA/CD*
- *CSMA/CA and IEEE 802.11 MAC*
- *Ethernet and IEEE 802.3*
- *Link layer switching and bridging*

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Highlights of Chapter 5

1 General Requirements

In this chapter, we look into the details of layer 3, i.e., the network layer of a computer network. The key functionalities of layer 3 include packet forwarding, routing, packet-level traffic management, and flow-level traffic management. Students are expected to understand such key mechanisms and the associated algorithms and protocols.

2 Topics

Important topics that will be covered in this chapter include (but are not limited to):

- Key functions of layer 3
- Relationship between layer 3 and upper/lower layers
- General architecture of layer 3
- Addressing and forwarding
- Optimality principle of routing
- Routing algorithms and protocols
- Layer 3 traffic management

3 Technical Terms

Do you really understand the following technical terms? If not, study the class notes and textbooks to find out the details.

- *Addressing, forwarding, and routing*
- *Optimality principle*
- *Static routing, dynamic routing, centralized routing, distributed routing, hierarchical routing, flooding, etc.*
- *Distance vector routing and Bellman-Ford algorithm*
- *Link-state routing and Dijkstra algorithm*
- *Fair queueing*
- *Leaky bucket algorithm*
- *Token bucket algorithm*

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Highlights of Chapter 6

1 General Requirements

In this chapter, we will learn the details of layer 4, i.e., the transport layer of a computer network. In the Internet, layer 4 mainly consists of UDP and TCP, and both provide best-effort services. UDP provides a simple datagram service, which is well suited for real-time applications. TCP ensures reliable transport of byte streams. It is sophisticated, as many functions are built into one protocol. Such functions include connection setup/teardwon, flow control, congestion control, and error control. Students are expected to understand key mechanisms of both TCP and UDP.

2 Topics

Important topics that will be covered in this chapter include (but are not limited to):

- Transport layer in the protocol stack
- UDP protocol
- TCP protocol, including all key mechanisms
- Fast retransmit and fast recovery in TCP

3 Technical Terms

Do you really understand the following technical terms? If not, study the class notes and textbooks to find out the details.

- *UDP and datagram service*
- *TCP and byte-stream service*
- *Best effort transport*
- *Connection-oriented versus connectionless in transport layer*
- *Pseudo-header and checksum, well-known port number, full duplex connection*
- *Connection setup in TCP*
- *Connection close in TCP*
- *State machine of TCP*
- *Nagle's algorithm, Silly window syndrome*
- *Control mechanisms in TCP (Error control, flow control, and congestion control)*