Communication Networks 2
Exercise 1 - Basics

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Problem 1 Telephone Networks

Which of the following statements are true for telephone networks?
I: Connectionless service
II: Circuit switching is used
III: A dedicated line between caller and callee is maintained
IV: Communication not always follows same path
V: Packets are forwarded from sender to receiver via relay stations

◯(A) I, IV, V
◯(B) I, II, IV
◯(C) II and III
◯(D) II, III, IV
◯(E) III and V

Solution:
◯(A) I, IV, V
◯(B) I, II, IV
⊗(C) II and III
◯(D) II, III, IV
◯(E) III and V

Problem 2 IETF

What does "IETF" stand for?
◯(A) International Engineers Task Force
◯(B) Internet Evil Telephone Formation
◯(C) International Engineering Task Force
◯(D) Internet Engineering Task Force
◯(E) Institute of Electrical Telecommunication Formation

Solution:
◯(A) International Engineers Task Force
◯(B) Internet Evil Telephone Formation
◯(C) International Engineering Task Force
⊗(D) Internet Engineering Task Force
◯(E) Institute of Electrical Telecommunication Formation

Problem 3 TCP/IP Layer

Which Layer does not belong to the TCP/IP Layer model ?
◯(A) Transport Layer
◯(B) Network Layer
◯(C) Application Layer
◯(D) Session Layer
◯(E) Link Layer

Solution:
◯(A) Transport Layer
◯(B) Network Layer
◯(C) Application Layer
⊗(D) Session Layer
◯(E) Link Layer

Problem 4 Network Layer

What are functions of the Network Layer?
I: Reliable data transfer between adjacent stations
II: Connection between end systems
III: Connection between applications
IV: Flow control
V: Congestion control
VI: Addressing of stations
◯(A) II, IV, V
◯(B) III, IV, V
◯(C) I, II, III
◯(D) II, V, VI
◯(E) I, II, VI

Solution:
◯(A) II, IV, V
◯(B) III, IV, V
◯(C) I, II, III
⊗(D) II, V, VI
◯(E) I, II, VI

Problem 5 Basics of Communication Networks-Morse code

Encode the text Communication Networks using Morse code. How many bits are required for the code?

Solution:
Communication Networks in Morse Code is encoded as:
-.-. — – – ..- -. .. -.-. .- - .. — -. (Communication)
-. . - .– — .-. -.- ... (Networks)
Each dash is encoded with 3 bits, each dot is encoded with 1 bit
Between two signals within a character is a gap encoded with 1 bit

Between two letters a gap is encoded with 3 bits
Between two words a gap is encoded with 7 bits
In the encoding there are 29 dashes, 22 dots, 30 signal gaps within a character,
19 letter gaps and 1 word gap, hence the needed number of bits is: $29*3+22*1+30*1+19*3+7*1=203$ bits

Problem 6 Basics of Communication Networks-Baudot Code

Encode the text Communication Networks using Baudot code. How many bits are required for the code?

Solution:
Communication Networks in Baudot code is encoded as:
.oo.o ..ooo oo.o. oo.o. ..o.o oo.oo ...oo .oo.o ..o.. o.o.o ...oo ..ooo oo.oo (Comm.)
o.... (Letter blank)
oo.oo ...o. o.o.o o..oo ..ooo oo..o ooo.. o...o (Networks)
Every character in Baudot code is encoded with fixed 5 bits. There are 21 characters and one letter blank, hence the number of bits needed is: $21*5+1*5=110$ bits.

Problem 7 Morse Code vs Baudot Code

What is the fundamental difference between Morse code and Baudot code and how is it related to time multiplexing?

Solution:
Morse code is a variable length telegraphy code, while Baudot code is a fixed length telegraphy code. Fixed length code enables synchronization of sender and receiver in time multiplexing.

Problem 8 Basics of Communication Networks-Cont.1

Assume that phones are sold pairwise and hard-wired. Assume a scenario with 100 households in which an arbitrarily chosen pair of households shall be able to communicate via telephone. How many phones are required per household? How many lines are required to connect the phones? What is the complexity?

Solution:
Since phones are pairwise and hardwired, each household requires $100-1=99$ phones in order to communicate with other households. This also means that from each household 99 lines will be required, thus the number of needed lines will be: $\frac{99*100}{2}=4950$ lines.
Given n households, the complexity of number of phones is $O(n^2)$ and the complexity of number of lines is $O(n^2)$.

Problem 9 Basics of Communication Networks-Cont.2

Now assume that phones are connected to a central switchboard by which an arbitrarily chosen pair of phones can be connected. How do the numbers change?

Solution:
Each household only needs 1 phone and 1 connection to the central switchboard. For n households we need n phones and n lines.
Given n households, the complexity of number of phones is $O(n)$ and the complexity for number of lines is $O(n)$.

Problem 10 Telegraph Networks

What type of switching was used in telegraph networks? What is the difference to switching in today's Internet?

Solution:
Telegraph networks use message switching. Message switching is the predecessor of packet switching. In today's Internet, packet switching is used, where the messages (packets) are limited in size. Message switching is still in use today, a common example is e-mail.

Problem 11 Telegraph Networks-Cont.

What type of switching was used in telegraph networks? What is the difference to switching in today's Internet?

Solution:
Telegraph networks use message switching. Message switching is the predecessor of packet switching. In today's Internet, packet switching is used, where the messages (packets) are limited in size. Message switching is still in use today, a common example is e-mail.

Problem 12 Telephone Networks

Explain how switching in telephone networks changed from the beginning until today.

Solution:
In telephone networks circuit switching is used. A dedicated line between the source (caller) and the destination (callee) is maintained.
The same concept is still used today, with the difference that no dedicated line but resources are reserved.

Problem 13 Television

What kind of medium is television? What is the difference to telephony and telegraphy?

Solution:

- Television: broadcast medium
- Telephony/telegraphy: unicast medium

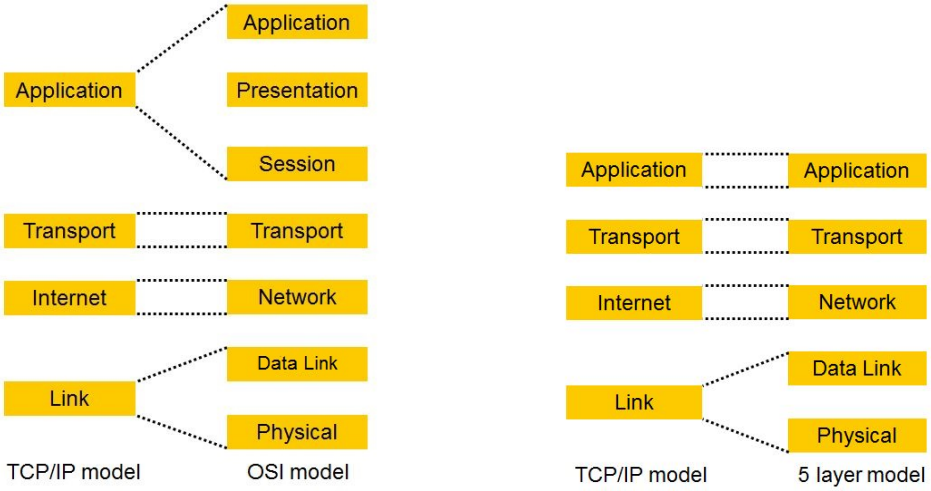
Problem 14 ISO/OSI Model vs TCP/IP Model

What are the fundamental differences between the ISO/OSI model, the TCP/IP model, and the 5-layer model for describing communication networks?

Solution:
The ISO/OSI model defines 7 layers and a strict distinction between those layers. Its standardization process took too long (1979-1983) and in the meantime the TCP/IP model was established and applied in practice.

The TCP/IP model defines 4 abstract layers combining different layers of the ISO/OSI model.

The 5-layer model is a hybrid model between ISO/OSI model and TCP/IP model. This model is more used in academic research.

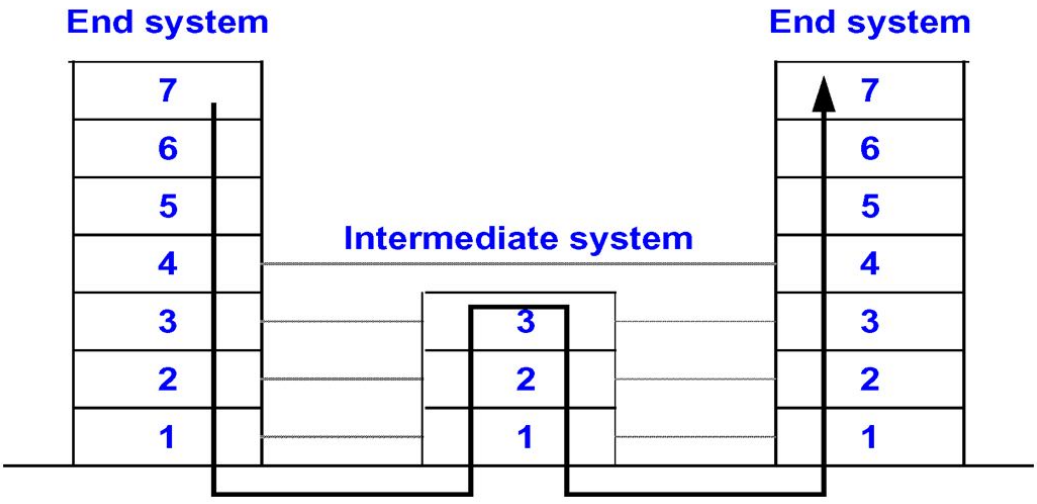


Problem 15 Layer Model Procedure Subjects

What happens with user data as it is transmitted from a sending application to a receiving application? Sketch the procedure subject to the layer models?

Solution:

From the sending application, user data travels downwards through all layers (7 layers in regard the ISO/OSI model, fewer layers when considering another layer model). From the lowest layer of the sender, the data is send through intermediate systems to the lowest layer of the receiver. At the intermediate systems the data needs to be passed up to the third layer because the address of the packet, which is needed in the intermediate system to decide where the packet has to be send to, is part of the IP-header. After reaching the receiver the user data goes upwards through all layers to the receiving application.



Problem 16 Connectionless vs Connection Oriented Services

What is the difference between a connectionless and a connection-oriented service? Which phases are typically distinguished when using a connection-oriented service?

Solution:

- connectionless: no connection establishment phase; goes straight to transfer phase; no need to maintain state
- connection-oriented: connection must be established before sending data;
  3 phases:
  - (1)connect
  - (2)transfer data
  - (3)disconnect