Computer Networks Technologies and Services	September 8th, 2017
First and last name	Student ID

NOTES

i. Nothing else than what is needed to write (pen, eraser), a piece of ID, and possibly water and food can be taken to the seat where you take your exam. Please leave any other item you might have (coat, bag, phone, calculator, and any other object) at the front or back of the classroom.

ii. The answers to each question must be written exclusively on the same page of the question, which is the only material that will be graded.

iii. Do not forget to write your name and student ID in each one of the marked spaces on the exam paper.

iv. In case you will use part of pages containing the questions as a scratch pad, please indicate it clearly and possibly cross out such parts before handing in the exam.

v. The score assigned to answers varies from zero to the maximum score reported at the end of the question. Please notice that the maximum scores of all questions do not necessarily sum up to 30.

vi. When answering questions, please feel free to use drawings whenever they can help expressing and clarifying the answer.

vii. Answers that are not understandable (for example because written badly or with bad handwriting) might be considered wrong.

viii. During the test, any communication with other classmates is prohibited and will cause the student to be sent away from the classroom

ix. The instructors and the assistants that are present during the test are there for the sole purpose of verifying proper progress of the exam. Their role is not giving any support to the interpretation of the text, neither helping the students to correctly formulate the answers. Please avoid any such request.

Question 1) Considering an optical network, (7 points)

A) Briefly explain what characterizes it with respect to other networking technologies.

optical network it's characterized by switching of optical signals. Typically optical signals are transported via optical fibers that can be interconnected by optical switches. So here what is switched is this signal, not bits. In reality when we have optical switches with electrical core you are dealing also with bits (in this case it is and modes, BITRATE DEPENDENT)

B) List two functions performed by the control plane.

1) Resource Discovery (topology, access point identification, Resource usage)
2) Connection management /signaling (i.e. lightpath setup, modification take down)

C) Mention one protocol possibly used for routing.

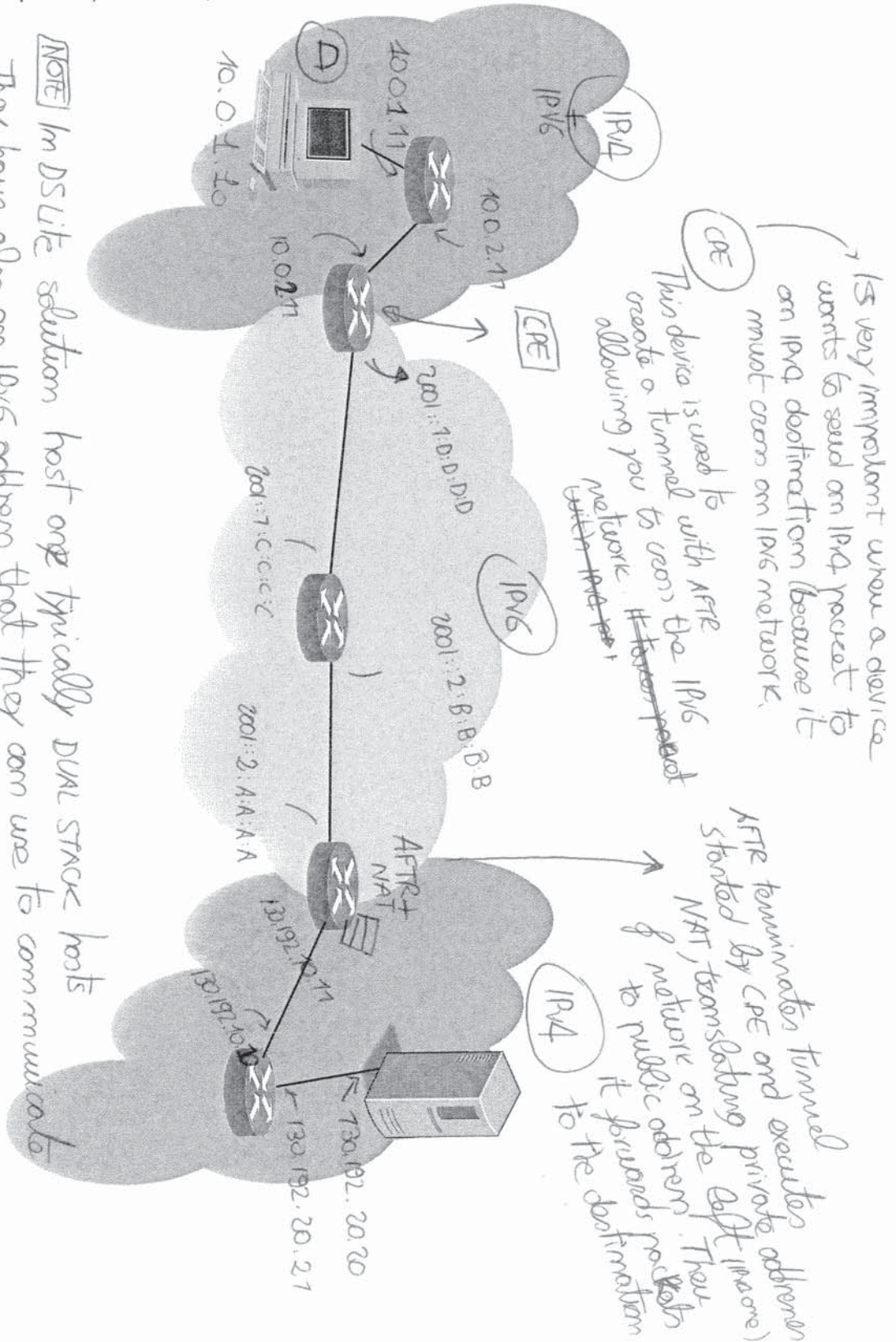Routing protocol can be OSPF, BGP, IS-IS

D) Mention a protocol possibly used for lightpath setup.

LDP, RSVP → these are the same protocol can be used by MPLS

Question 2) Considering that the figure below represents a typical DS-Lite deployment scenario, (14 points)

1. Assign an IP address to each interface of each host and network device (writing it directly on the figure, close to the interface itself).
2. Annotate (directly on the figure) the role played by devices offering specific functions (beyond forwarding IP packets) that are key for the solution to actually work.
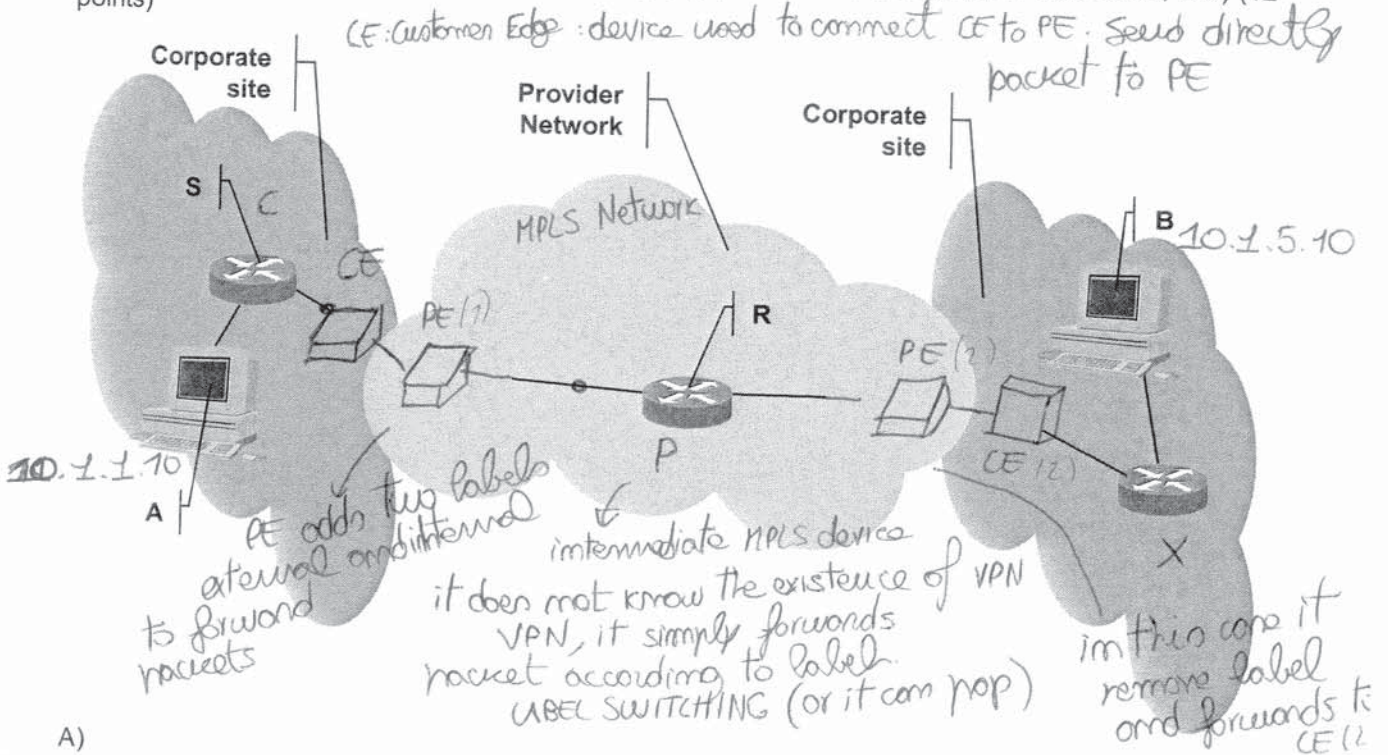

Handwritten annotations on the figure:

IPv6 / IPv4 (cloud labels)

D

4001::11

10.0.1.10

100.2.11

10.0.2.11

2001:1:D:D:D:D

2001:7:C:C:C:C

IPv6 — 2001:2:B:B:B:B

2001:2:A:A:A:A

AFTR + NAT

130.192.10.20.20

130.192.20.21

130.192.10.11

IPv4

D

CPE

> Is very important whom a device wants to send an IPv4 packet to an IPv4 destination (because it must cross an IPv6 network.

CPE — This device is used with AFTR create a tunnel with AFTR (to cross) the IPv6 network. allowing you to cross the network.

AFTR terminates tunnel started by CPE and executes NAT, translating private addresses of network on the left (more) to public addresses. Then it forwards packets to the destination.

NOTE In DS Lite solution host are typically DUAL STACK hosts
They have also an IPv6 address that they can use to communicate directly to IPv6 destinations.
Recalls doing that must not be tunneled.
If you want to implement this features host A must have an IPv6 address too (e.g. 2001:A:1:2:3:a). one.
Here I not considered because not explicitly indicated destinations IPv6 to combat

LIMIT of DS Lite: AFTR terminates tunnel and implement NAT functionality here I not considered because not explicitly indicated destinations IPv6 to combat
in a network (private) & islands covered by CPE can not be overlapped by CPE can not be overlapped

Question 3) Given the scenario depicted in the figure below, in which <u>two corporate sites</u> must be connected through a <u>Layer 3 MPLS VPN</u>, (*i*) draw directly on the picture the key devices required to implement the solution (specifying their role) and (*ii*) concisely describe (best with a drawing) a packet sent from host A to host B captured

A) On the right hand side link of router S;

B) On one of the links of router R.

Please explicitly show all of the protocol headers deployed and for each of them the content of the fields that play a key role in ensuring proper functioning (e.g., source and destination IP addresses, etc.) (12 points)

CE: Customer Edge: device used to connect CE to PE. Send directly packet to PE

Corporate site

Provider Network

Corporate site

S   C

MPLS Network

CE

PE (1)

R

B 10.1.5.10

PE (2)

P

CE (2)

10.1.1.10

A

X

PE adds two labels external and internal to forward packets

intermediate MPLS device it does not know the existence of VPN, it simply forwards packet according to label. LABEL SWITCHING (or it can pop)

in this case it remove label and forwards to CE (2

A)

L2 header	IP header	TCP/UDP header	Payload	L2 trailer

IP src = IP(A) = 10.1.1.10
IP dst = IP(B) = 10.1.5.10

In the solution I assumed router S and X as not the CE devices. So I drew another CE device

B) Consider packet captured on left side of R

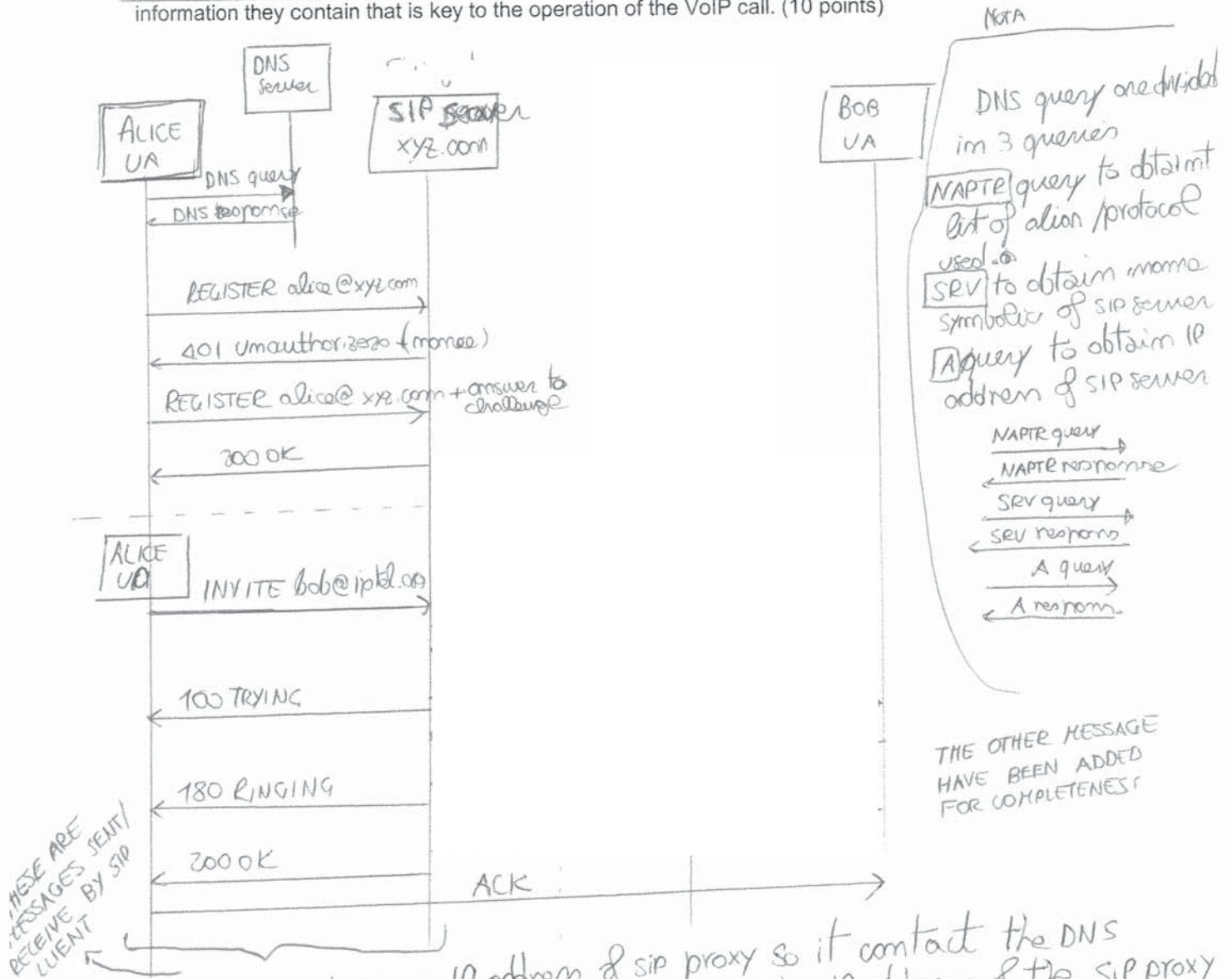| MPLS header	MPLS header	IP header	TCP/UDP header	PAYLOAD

external label used to forward packets up to PE (2)

internal label used to identify which is the destination VPN network. It is understood on by PE routers

IP src = 10.1.1.10
IP dst = 10.1.5.10

Considering R is a P and connected to PE(2) it will pop external label and forward to PE-2

Question 4) A SIP user with address alice@xyz.com is connected to the network of her Internet service provider and starts her software phone to call bob@iptel.org. Assuming that the softphone static configuration includes only the SIP address of its user, list in a schematic fashion all the messages sent and received by the SIP client, from the instant the software phone is launched to the instant in which the user starts talking to the called party. Consider messages of all possible involved protocols and show information they contain that is key to the operation of the VoIP call. (10 points)

NOTA

DNS query are divided in 3 queries
NAPTR query to obtain list of alias /protocol used.
SRV to obtain name symbolic of sip server
A query to obtain IP address of SIP server

ALICE UA
DNS query
DNS query
NAPTR query
NAPTR response
SRV query
SRV response
A query
A response

THE OTHER MESSAGE HAVE BEEN ADDED FOR COMPLETENESS

ALICE UA — DNS server — SIP server xyz.com — BOB UA

DNS query
DNS response
REGISTER alice@xyz.com
401 unauthorized (nonce)
REGISTER alice@xyz.com + answer to challenge
200 OK

ALICE UA
INVITE bob@iptel.org
100 TRYING
180 RINGING
200 OK
ACK

THESE ARE SENT/ MESSAGES BY SIP RECEIVE CLIENT

NOTE). Alice UA does not know IP address of sip proxy so it contact the DNS server in order to understand which is the IP address of the SIP proxy xyz.com. Alice proceeds to registration of its user using register message.
• When an unauthorized message arrives together with a challenge that is a nonce, she answers with REGISTER containing domain username and answer to challenge.
• As server SIP com contain also REGISTRAR server, this is the reason why I contact SIP server with register message.

NOTE The messages SENT/RECEIVED BY SIP client are only messages of first column (ie. ALICE ⟷ SIP server and ALICE ⟷ DNS) + ACK message UA xyz.com UA ser. All the others commutation are added for SIP.