

# Test 1: NET3012 – IP Architectures & Solutions

Winter 2019

Time: 60 minutes; Test scored out of: 48 Total Marks available: 53  
(Allocation of marks is shown beside each question)

## Instructions:

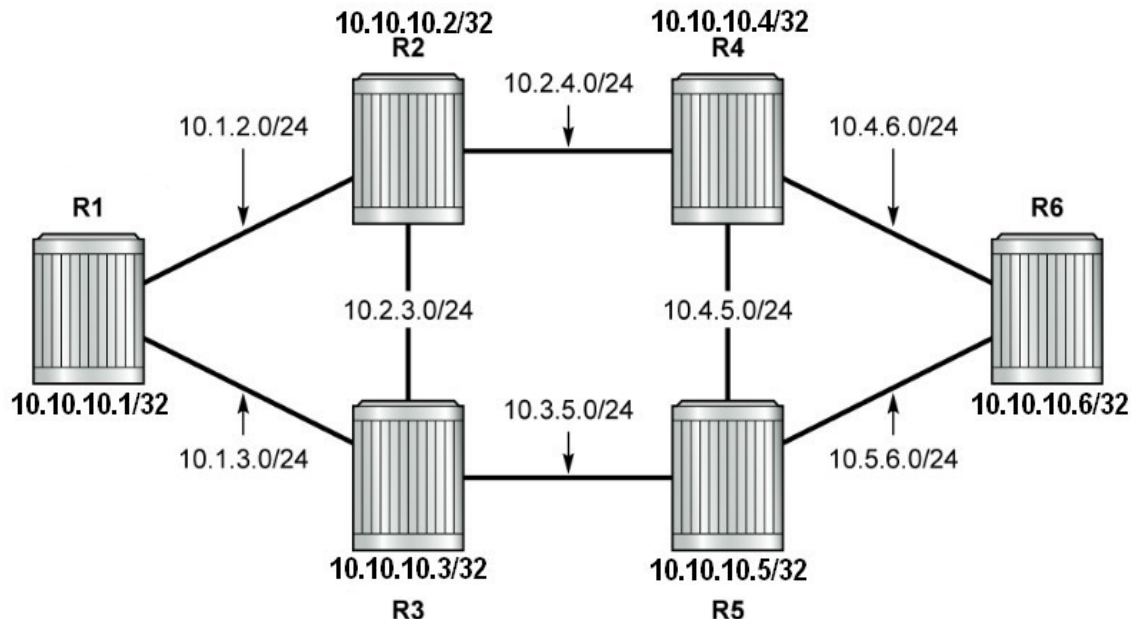
1. **BEFORE** answering any questions, please check that your copy of the test has all pages (as indicated in the footer at the bottom of each page). Please **read all questions** carefully, then answer question 0 first!
2. This is a **closed book** test. No textbooks, notes, electronic devices, or any other aids are permitted.
3. The work (and learning!) that's occurring in labs is terrific! Keep up the good work!
4. Be sure to carefully examine the reference topology provided below.
5. If you are uncertain what a question is asking, make reasonable assumptions, write those assumptions down on this test paper, and continue answering the question.

0. What is your:

NAME? \_\_\_\_\_

## Reference Topology

Use the topology below for questions which refer to R1-R6 but do **not** have a topology diagram. Note that this is similar to the topology used throughout the MPLS courseware and slide decks.



1. A. [2 marks; 1 per triplet] **Clearly** identify at least 6 of the 7 drivers for MPLS [Ref: 1.10]

B. [2 marks] Based on modules covered and lab work completed so far, identify which drivers involve LDP in one form or another? If none, please state "none".

2. [2 marks; Easy question] Draw a **clear** sketch of an MPLS header. Be sure to identify the name and size/length of each field.

3. [2 marks] Here's a repeat question from one of the weekly quizzes, just using different words! Write three synonyms for the router which:

– originates an LSP?

– originates labels for a FEC?

4. Think carefully about label distribution for LDP and RSVP in our reference topology.  
A. [1 mark] Is it likely that the LIB matches the LFIB exactly for either protocol? If yes, **clearly** identify which one, or both? If not, state "none".

B. [2 marks] **Clearly** explain why or why not?

5. A student believes they have correctly configured LDP-shortcuts. [Ref: Lab work]  
A. [1 mark] **Clearly** identify what is the best command to absolutely confirm that user data is being forwarded over the LSP? Be sure to indicate whether to use regular IP commands or OAM commands!

B. [1 mark] **Clearly** explain why your given command is the best.

6. [2 marks] I've just paid my ISP a boatload of money to create express-lane LSPs from my house for using Netflix and Google. **Clearly** identify how many LSPs are required and why that many. [Be sure to state any required assumptions.]

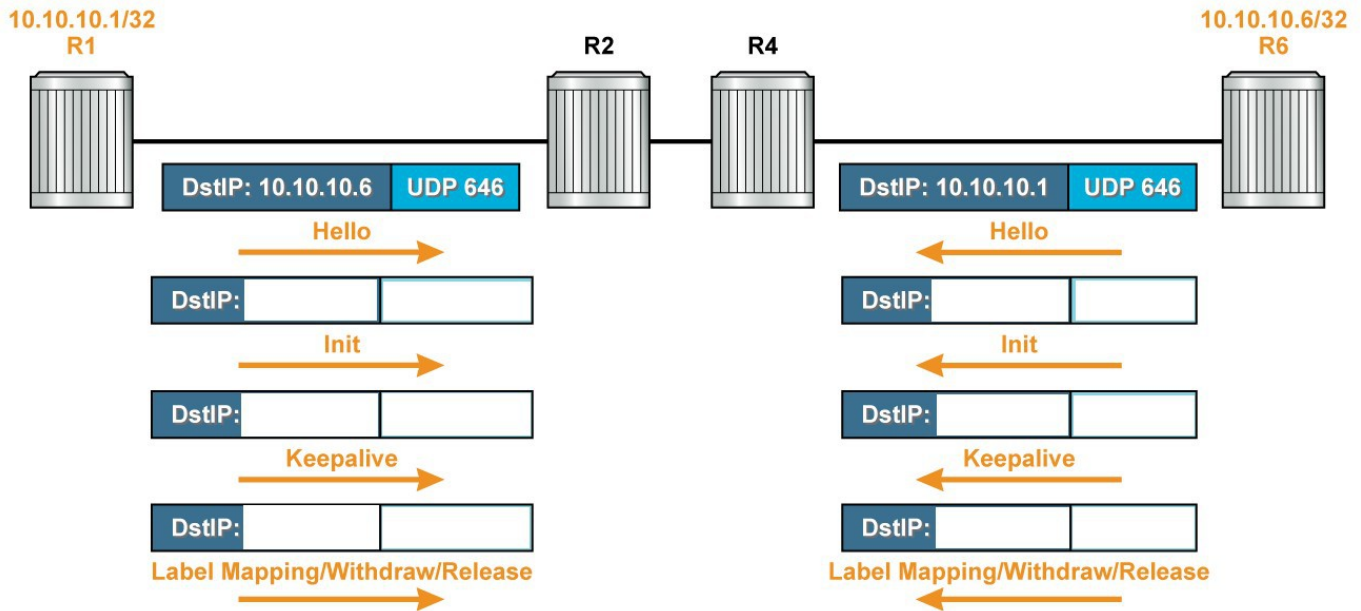
7. A. [1 mark] **Clearly** define asymmetric routing.

B. [1 mark] **Clearly** explain why OAM LSP commands have significant potential for asymmetric routing between requests and response(s).

C. [2 marks] In a conventional ("normal") network, OAM commands for LDP LSPs are not likely to have asymmetric routing, whereas the same commands for RSVP-TE LSPs are likely. **Clearly** explain why this is the case.

8. [1 mark] **Clearly** and *fully* identify the protocol shown below. [Ref: slide 87]

The protocol is: \_\_\_\_\_



[2 marks] Complete the blank spaces with (possible) values for the L3 and L4 addressing (including protocol!)

[1 mark] What is the protocol's specific *name* for the L3 address that you just filled in?

9. [1 mark; Weekly pop-quiz question; **Bonus**] What are the two controls that need to be flipped "On" to activate traffic engineering for RSVP?

10. This question focuses on label operations and label stacks (compare with next question!)

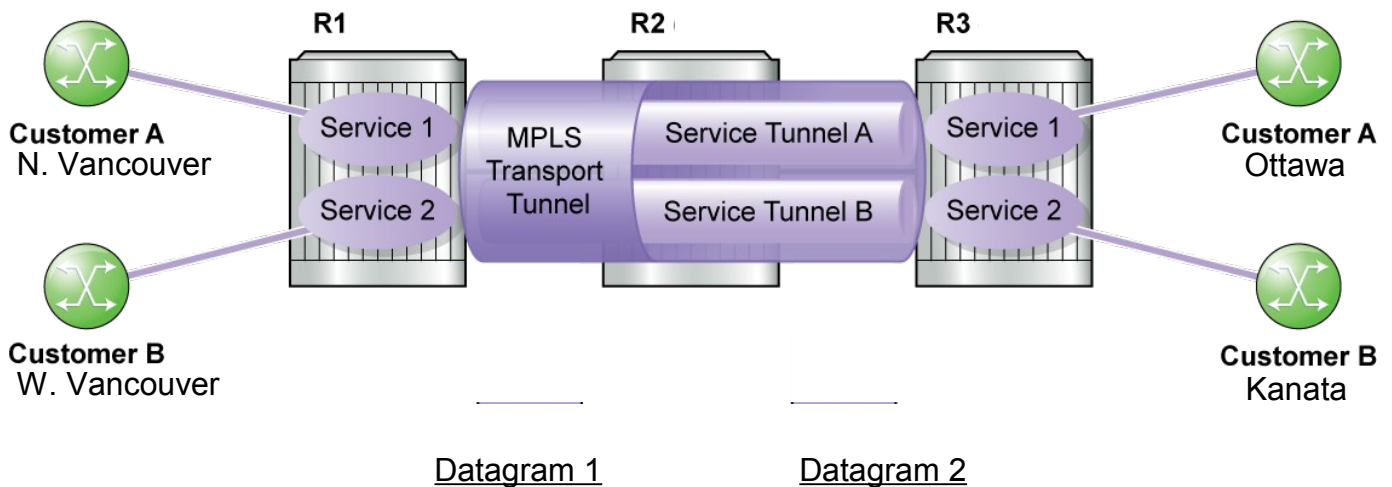
Study the topology below carefully. I would like to call my grandmother in North Vancouver and ask her what she made for dinner last Sunday, and I'll want to take my turn talking to tell her about the SuperBowl. Fortunately, **Algonquin (Customer A)** has a VoIP connection direct to Vancouver via a VPN service. But note that the connection also provides a VPN service to another customer (How does that affect label operations?!) [Ref: slide 2-7]

Mark up the diagram below to **clearly** indicate:

A. [2 mark] R1, R2, R3 are what **type(s)** / role(s) of MPLS router?  
Make sure your answer is complete!

B. [2 marks] For each router, the full set of **operation(s)** it performs on labels.

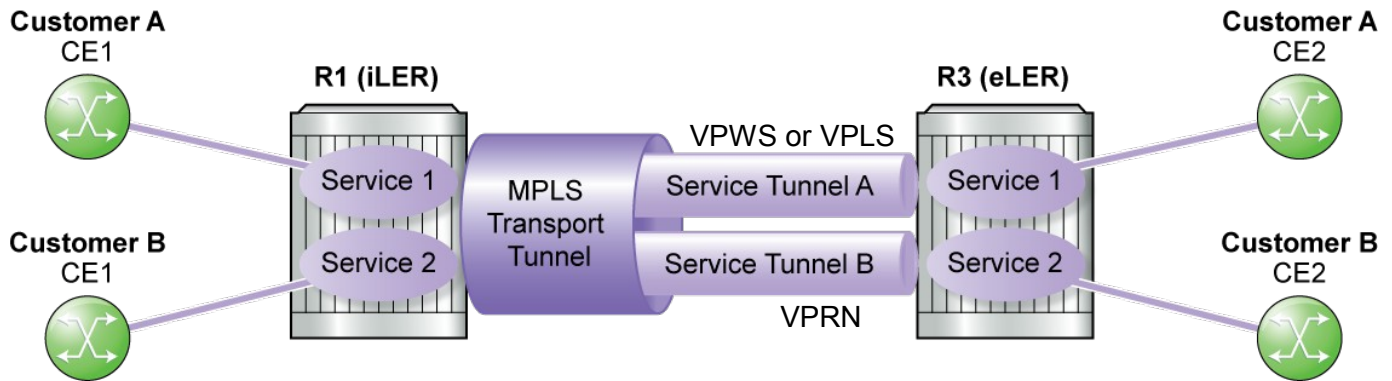
C. [2 marks] Draw two diagrams, one between each pair of routers, showing a simplified **datagram**. At a minimum, the datagram must include the payload and a fully identified label stack.



11. This question focuses on the datagrams and potential changes to them as a VPN payload.

Demonstrate your knowledge of at least two VPN services (L1 or L2, and L3) by sketching three datagrams, one at: (1) ingress, (2) in transit, and (3) egress of the service.

- For all **three** diagrams in each set, you should include a "layer" for: (i) customer L2 framing; (ii) customer L3 header; (iii) customer data
- For the transit diagram, you must include a properly identified label stack, in the correct layer relative to the customer layers.
- Markings to indicate when layers are identical [a common symbol, whether a letter, digit, shape, etc] and when they are different [different symbols] as they transit across.



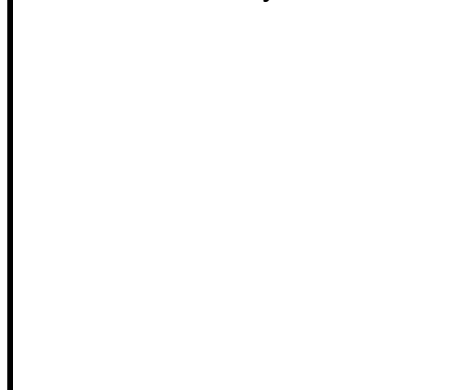
**A.** [3 marks] Sketch the three datagrams for **Service A**, a VPWS or VPLS. Remember:

- customer layers
- label stack
- mark layers to indicate when identical, when different



**B.** [3 marks] Sketch the three datagrams for **Service B**, a VPRN. Remember:

- customer layers
- label stack
- mark layers to indicate when identical, when different



12. [2 marks] Consider the lab work you've done with LDP-shortcuts. Carefully study the additional results presented below from testing LDP-shortcuts on the lab topology.

```
*A:R2# configure router ldp no shortcut-local-ttl-propagate
*A:R2# traceroute 10.10.10.10
traceroute to 10.10.10.10, 30 hops max, 40 byte packets
 1 10.10.10.10 (10.10.10.10)      2.24 ms  2.22 ms  2.14 ms
```

```
*A:R2# show router arp
```

```
=====
ARP Table (Router: Base)
=====
```

IP Address	MAC Address	Expiry	Type	Interface
10.10.10.2	02:05:ff:00:00:00	00h00m00s	Oth	system
10.2.6.2	52:54:00:a9:28:fe	00h00m00s	Oth[I]	first
10.2.6.6	52:54:00:a4:83:c9	03h55m33s	Dyn[I]	first

```
-----
No. of ARP Entries: 3
=====
```

```
*A:R10# show router arp
```

```
=====
ARP Table (Router: Base)
=====
```

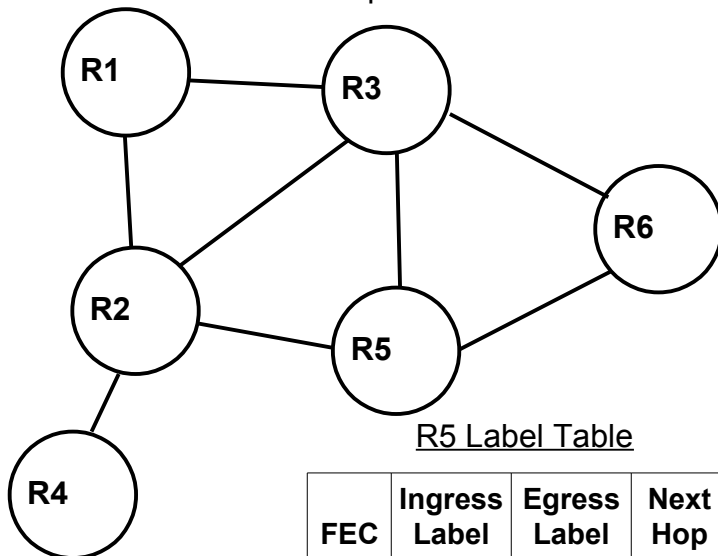
IP Address	MAC Address	Expiry	Type	Interface
10.10.10.10	02:0d:ff:00:00:00	00h00m00s	Oth	system
10.6.10.6	52:54:00:97:b7:29	03h56m34s	Dyn[I]	second
10.6.10.10	52:54:00:b9:26:12	00h00m00s	Oth[I]	second

```
-----
No. of ARP Entries: 3
=====
```

```
*A:R10#
```

The Question: **Clearly** explain exactly what part(s) of the traffic get transported over an LDP-shortcut. You may choose freely between using words, a simple diagram(s), or a combination of the two. Be sure to reference all layers of the traffic, including L2, L3, and above. If you feel there's any ambiguity, make reasonable assumptions, **write those assumptions down**, and then continue answering the question.

13. [5 marks; 1 each part] Carefully study the topology and label information presented here.



R5 Label Table

FEC	Ingress Label	Egress Label	Next Hop
X	-	220	R6
Y	-	130	R3
Z	-	160	R6
Q	-	330	R2

Ingress label	Egress label	Next Hop
<b>R1</b>		
240	350	R2
110	140	R3
330	POP	IP
140	130	R2 (
<b>R2</b>		
170	330	R1
140	POP	IP
130	150	R4
330	110	R1
<b>R3</b>		
160	130	R2
110	POP	IP
220	POP	IP
130	170	R2
200	240	R1
140	200	R6
<b>R4</b>		
150	POP	IP
210	POP	IP
160	200	R3
<b>R6</b>		
170	160	R5
220	220	R3
350	350	R5
200	POP	IP
160	160	R3

A. Pop is shown several times in the tables. **Clearly** indicate several examples of where each of (i) **push**, and (ii) **swap** would be in the tables.

B. How many labels did R1 distribute to neighbours?

C. Ignoring R3 (which is clearly very busy), which router is advertising (i.e. origin for) the most FECs? (Not to be confused with originating the most LSPs!)

D. The diagram does *not* show a complete LIB for R5. For how many LSPs is it an LSR or eLER? **Clearly** explain your answer.

E. **[Bonus]** The numbers used were simply for teaching purposes BUT if they were real, what is the proper name for the label range they are taken from? [Ref. Slide 2-11]



14. [3 marks; 1 per attribute] **Clearly** identify and (briefly) explain the options for all possible attributes for label distribution, control, and retention modes.

15. Professor Anderson is testing MPLS networks, using experimental Linux software to imitate Nokia's MPLS functionality. Carefully examine the data on the previous page. It is a snapshot in time of the LIBs from 6 routers. Then answer the following questions:

A. [2 marks] The very last line for R6 shows an identical value in both label columns. Is this value identical *randomly* or is it *necessarily* identical? **Clearly** explain and justify your answer.

B. [2 marks; Tough Question] We have no information about *when* these labels were *distributed* but we can still consider the other two attributes of control and retention. **Clearly** identify any *evidence* that indicates what attributes are revealed by the label tables.

C. [2 marks; Tough **Bonus** ; skip it if time is running out?] At least one label is invalid because it's completely impossible. Which one(s)? **Clearly** explain why?

16. A. [0 marks] Yes/No: Is Professor Anderson pleased, even delighted, with the work that's being done in labs?  
B. [1 mark] Justify your answer by quoting written proof!
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Extra Work