

Test 2: NET3012 – IP Architectures & Solutions

Winter 2015

Time: 50 minutes; Test scored out of: 43 Total Marks available: 46
(Allocation of marks is shown beside each question)

Instructions:

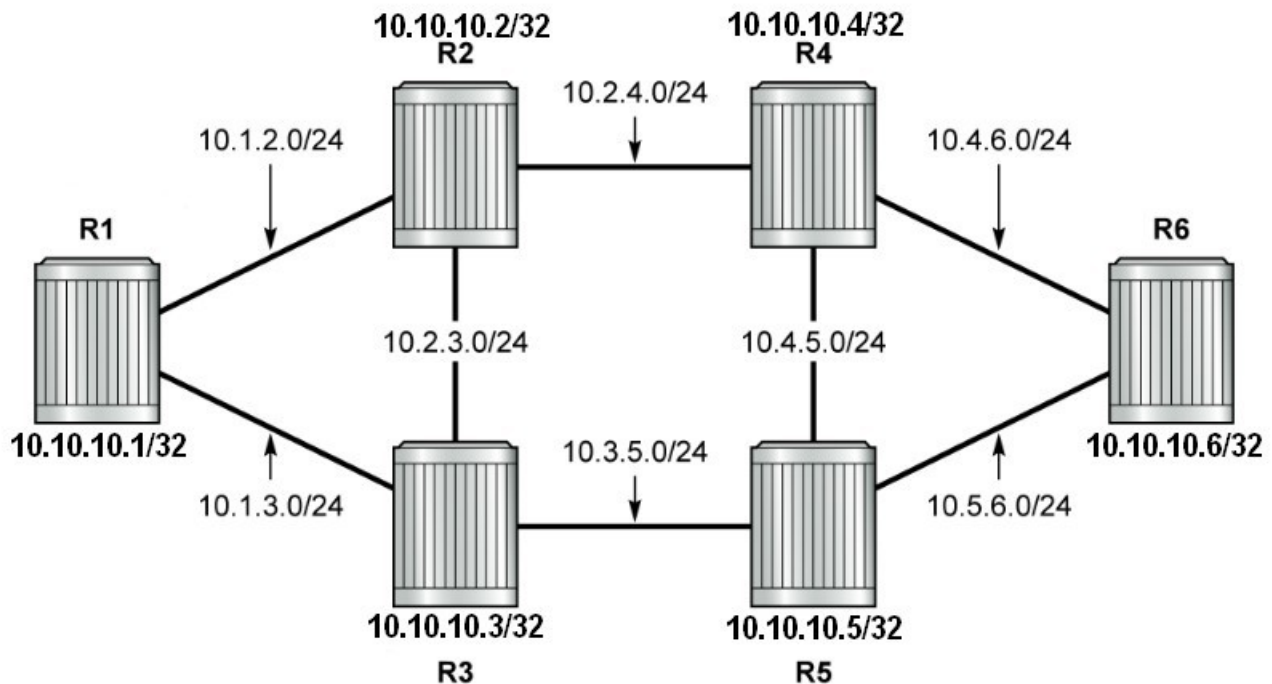
1. **BEFORE** answering any questions, please check that your copy of the test has all pages (as indicated in the footer at the bottom of each page). Please **read all questions** carefully, then answer question 0 first!
2. This is a **closed book** test. No textbooks, notes, electronic devices, or any other aids are permitted.
3. 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? Answers

Reference Topology

Use the topology below for questions which refer to R1-R6 but do **not** have a topology diagram. Note that this is the standard topology we have been using throughout the course.



1. [1 mark] Which of the following protocol(s) **cannot** be transported in MPLS? **Ch 11, Q1**
(i) IP (ii) Ethernet (iii) ATM (iv) Frame Relay

All of the above protocols can be transported in MPLS

2. [1 mark] According to the Alcatel-Lucent course material, **clearly** identify what is the primary purpose of using MPLS for IGP shortcuts? **Ch 11, Q2**

To reduce the number of IBGP sessions required

3. [1 mark] Which statement(s) is/are **correct** regarding the definition of a P router? **Ch11, Q3**
(A) P routers are service-aware.
(B) P routers are typically LERs.
(C) P routers perform label PUSH and POP operations.
(D) P routers have all their interfaces inside the service provider domain. **Yes**
(E) None of the above.

4. [2 marks] For the first two answers in the previous question that are **not** correct (whichever ones those are), **clearly** explain why they are not correct.

P routers are **NOT** service aware because they swap only the **outer** label which is a transport label and never a service label.

P routers are **never** LERs because they are internal to the provider network. A "service" are configured exclusively on routers at the edge of the provider network (ie. LER).

5. [1 mark] Which factor is a primary cause of IP hyper-aggregation? **Circle** your answer. *
(A) IP routing protocols do not always select the best route to a destination
(B) IP routing protocols always select multiple routes to a destination
(C) IP routing protocols do not make use of all available network attributes to select a path **Y**
(D) Improper network design results in limited network path redundancy
(E) My lab partner does not configure the network correctly during lab period.
6. [1 mark] Which of the following statements are true regarding the roles of devices in an MPLS domain? **Circle 2** answers. *
(A) An LSR is located internal to the provider domain and switches labeled packets **Yes**
(A) An LER is located internal to the provider domain and switches labeled packets
(C) An LSR is located at the boundary of the provider domain and may forward labeled or unlabeled packets
(D) An LER is located at the boundary of the provider domain and may forward labeled or unlabeled packets **Yes**
(E) An LER is located external to the provider domain and switches unlabeled packets

7. [1 mark] Which of the following statements are true? **Circle all that apply.** *
- (A) Selected labels from the FIB are populated to the LIB
 - (B) Selected labels from the LIB are populated to the LFIB
 - (C) Selected routes from the RIB are populated to the FIB
 - (D) Selected routes from the FIB are populated to the RIB
 - (E) All labels from the LIB are populated to the LFIB

Yes
Yes

8. A. [1 mark] **Clearly** identify the specific options for the three characteristics for label handling in MPLS. (ie. control mode, distribution mode, retention mode)

Label Distribution mode: downstream-on-demand, downstream-unsolicited

Control mode: independent, ordered

Retention mode: conservative, liberal

- B. [1 mark] **Clearly** identify which of the above options are used by RSVP.

RSVP uses: downstream-on-demand, ordered, conservative

9. [2 marks] **Correctly** name and **clearly** identify at least 4 types of VPWS services.
[1 mark per *pair* of pipes]
- apipe = ATM pipe
 - cpipe = TDM pipe (eg. for conventional/classical phone circuits)
 - epipe = Ethernet pipe
 - fpipe = Frame Relay pipe
 - ipipe = Interworking pipe between different L2 technologies and a L3 IP interface

10. [2 marks] **Clearly** identify which protocols are used to signal service labels for VPN services. Be very specific about what VPN service each protocol serves.

T-LDP: used for VPWS and VPLS

MP-BGP: used for VPRN service

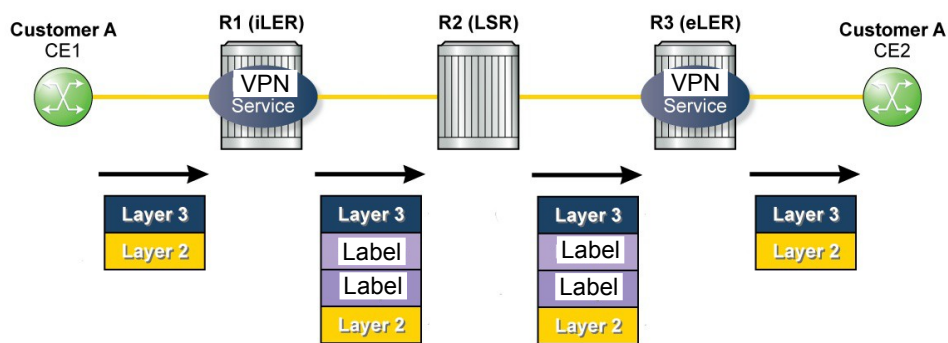
11. A. [1 mark] Within the full MPLS label space, there are several ranges of labels. **Clearly** identify the first range, (including its name). Give an indication of the approximate size of this range.

[0-15] Reserved for Special Use Labels

- B. [1 mark] **Clearly** identify a specific label value, and give its value/number, that was seen in conjunction with MP-BGP in the 6PE post-lab.

Label value **2** for IPv6 explicit Null

12. A. [2 marks] Study the diagram carefully. What kind(s) of VPN service is/are illustrated? Justify your answer!!

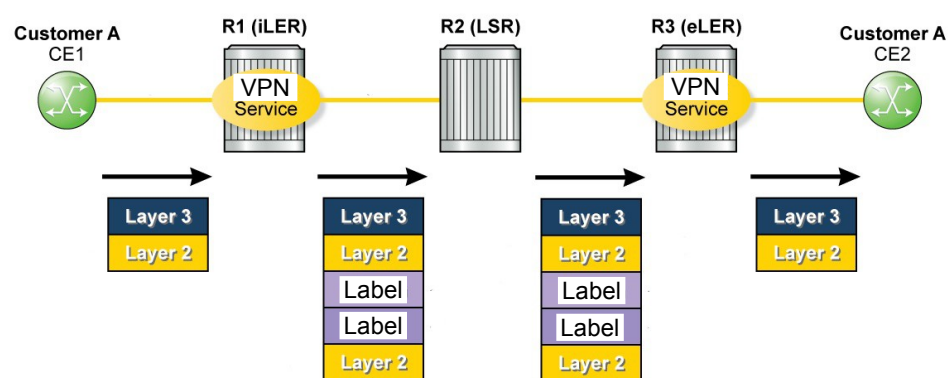


VPRN (only)
Customer framing is discarded.

- B. [1 mark] **Clearly** mark on the diagram which Ethernet headers are identical, or write "none" below if they are all unique.

NONE of the ethernet frames are all identical: always a different dst/src MAC address

13. A. [2 marks] Study the diagram carefully. What kind(s) of VPN service is/are illustrated? Justify your answer!!



Both VLL and VPLS
Customer framing is preserved intact.

- B. [1 mark] **Clearly** mark on the diagram which Label(s) are identical, or write "none" (in the space below) if they are all unique.

The two Labels ("Bottom") directly below L2 headers are identical (ie. service labels)

- C. [1 mark] **Clearly** mark on the diagram which Label(s) have the "S" bit set, or write "none" (in the space below) if none have it set.

The two Labels ("Bottom") directly below L2 headers are at the bottom of their Stack

14. [1 mark] What is the relationship between ports and SAPs: ie how many ports can be configured per SAP, or alternatively, how many SAPs can be configured per port?

Many SAPs can be configured per port (think QinQ: $4095 * 4095 = \sim 16$ million), but a given SAP is bound to only a single port.

15. [3 marks] For a moment, forget about VPN services. MPLS can improve conventional network operation in multiple different ways. Name and **clearly** identify at least three uses for MPLS that do not require (or use) service labels. Hint: think lab work (in-lab, post-lab).

RSVP-shortcuts (and LDP-shortcuts too): for IGP tunnels

"IGP-shortcuts": for creating virtual full-mesh iBGP connectivity

6PE: for creating IPv4 tunnels to transport IPv6 traffic across a non-IPv6 aware core and requires MP-BGP for the label exchange

Also accepted: LDP-over-RSVP: for creating T.E. IGP shortcuts across multiple areas

16. [1 mark] Based on the reference topology on the front page, identify **all** possible RSVP-TE paths from R1 to R6 for a **hop-limit** count of **3**. Hint: What's important to remember about **hop-limit** count?

None! Hop-count limit includes the head-end, so no paths exist!

17. A. [1 mark+1 bonus] Write a fully-strict MPLS path from R1 to R6 in the reference topology.

```
path "fully-strict"
  hop 10 10.10.10.3 strict          OR 10.10.10.2 strict
  hop 20 10.10.10.5 strict          OR 10.10.10.4 strict
  hop 30 10.10.10.6 strict          OR 10.10.10.6 strict
  no shutdown
exit
```

- B. [1 mark] Write a fully-loose MPLS path from R1 to R6 in the reference topology.

```
path "fully-loose"
  hop 10 10.10.10.6 loose [optional; could even omit this one statement!]
  no shutdown
exit
```

- C. [1 mark] Write a MPLS path definition from R1 to R6 with a mix of strict and loose hops.

```
path "mixed-loose-strict"
  hop 10 10.10.10.4 loose          OR 10.10.10.2 strict
  hop 20 10.10.10.6 strict          OR 10.10.10.4 loose
  no shutdown
exit
```

- D. [1 mark] Each of the three definitions above need one identical statement to become fully operational. What is that statement?

no shutdown

18. [1 mark] We know that the IGP metric represents interface speed. For TE metric, give an example with a brief but **clear** explanation of what it might be used to represent.

Latency, jitter, actual \$ cost, actual physical distance, any other reasonable example

19. A. [2 marks] In the context of MPLS, what is an "ERO"? Give specific details about protocol(s) and message type(s).

Explicit Route Object: contains a list of specific hops from head-end to tail-end. It is one of the "objects" in an RSVP Path message.

B. [1 mark] What are the two sources (or mechanisms) that "build" an ERO?

CSPF (if enabled on an LSP) creates entries for the ERO
If CSPF not enabled, any strict/loose hops in the path definition get put in the ERO

20. [3 marks] Identify and give a brief but **clear** explain of three optimizations to the base RSVP protocol.

Hello Protocol: exchange Hello msgs every few secs to quickly detect if neighbor down

Session Refresh randomization: avoid big bursts of refresh messages by spreading out the timing of refresh messages for individual sessions.

Summary Refresh messages: refresh a large group of sessions with a single message containing a list of relevant sessions by an assigned number.

21. [2 marks] Correctly group the terms: PATH, PATH-Error, PATH-Tear, RESV, RESV-Error, and RESV-Tear, according to whether they flow upstream or downstream.

Downstream:

PATH

PATH-Tear

RESV-Error

Upstream:

RESV

RESV-Tear

PATH-Error

22. [2 marks] Consider a scenario of a service provider installation in Vancouver:

- All the traffic for many different services, for many different customers, needs to go to Toronto via one ePipe, except for the provider's management traffic which must be sent directly to headquarters in Ottawa via a different ePipe.
- There is only a single physical connection at the Vancouver site.

Clearly identify how you can achieve these goals, give specific details relating to an example configuration.

Simplest to use dot1Q encapsulation: management traffic tagged with VLAN ID "X"
Management epipe: sap 1/1/1:X
Customer traffic epipe: sap 1/1/1:*

B. [2 marks] Identify the MTU requirements for each of the epipes above; with a brief (eg. 1-line) explanation to justify the value.

Management epipe: **service MTU = frame MTU** (eg **1514**) since q-tag is stripped
(explicitly matched tags are always stripped)

Customer epipe: **service MTU = customer frame + 4 bytes** (eg. $1514 + 4 = 1518$)
(since sap definition is default, Q-tags aren't stripped)

Extra Work