Test 2: NET3012 – IP Architectures & Solutions

Winter 2017

MPLS Modules 1-5; SA Module 1, Module 3 sections 1-2

Time: 60 minutes   Test scored out of: 45   Total Marks available: 63

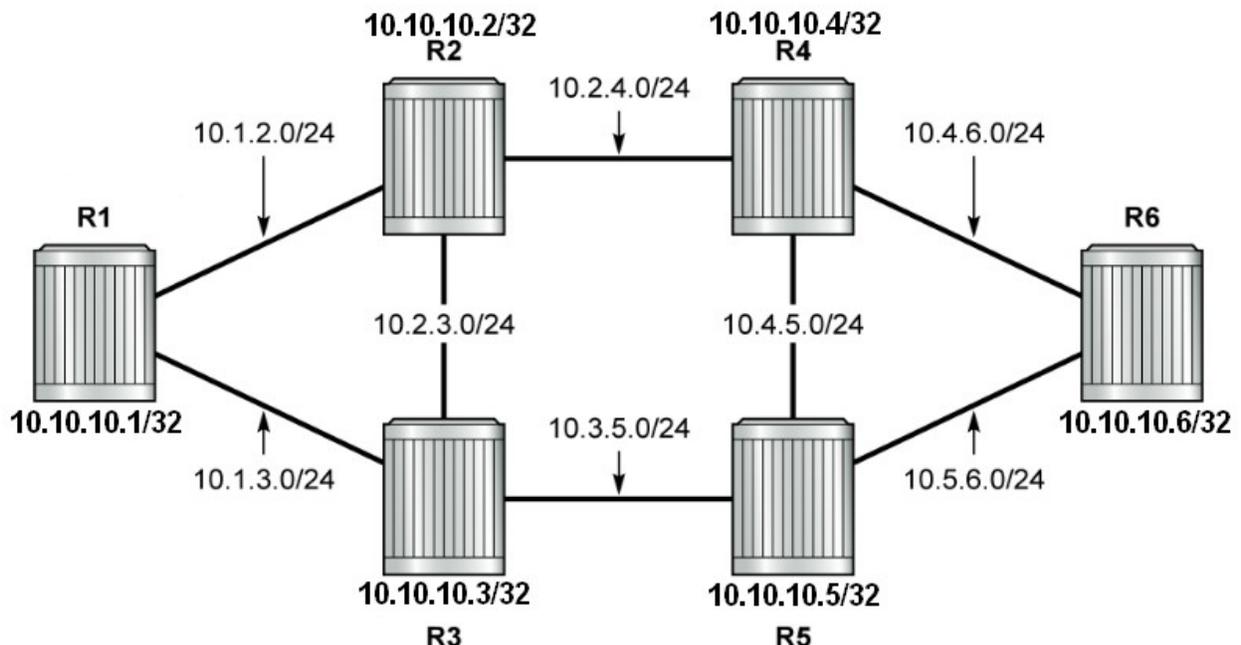   (Maximum mark will be capped)

Instructions:

1. <u>BEFORE</u> 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. When the marks for a question are not shown, the question is worth 1 mark.

4. Questions taken directly from Nokia courseware are marked by a "*".

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.
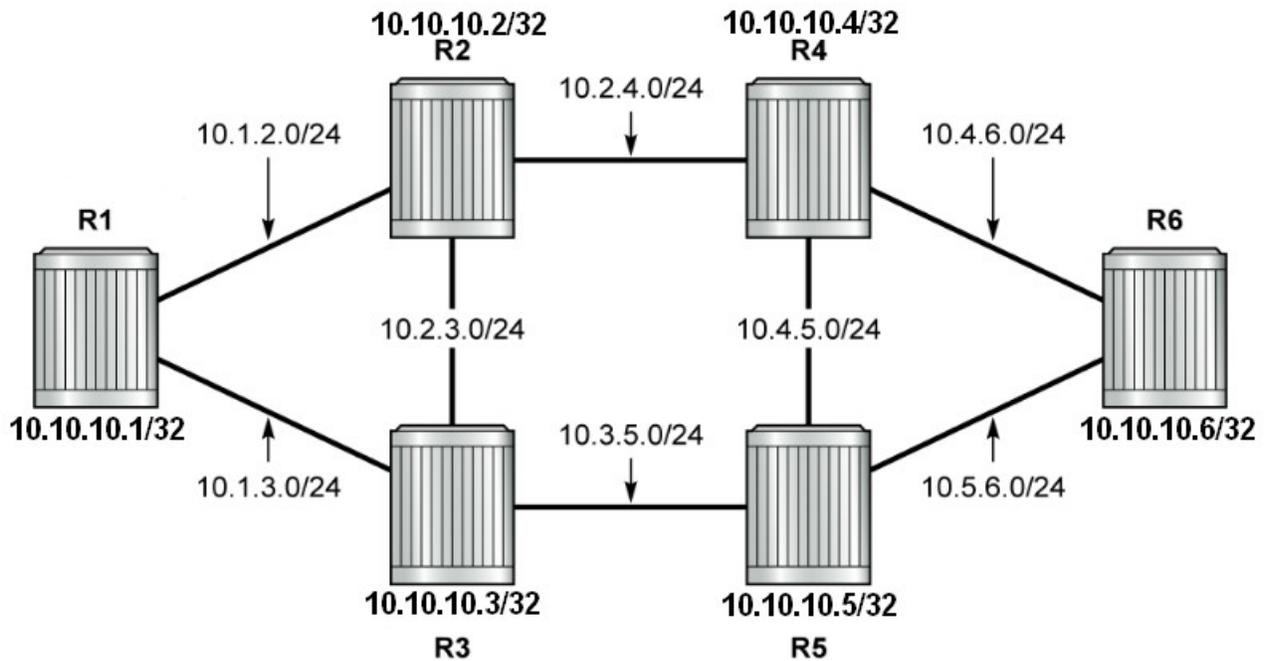
0. What is your:

NAME?   <u> Answers   </u>

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.

10.10.10.2/32 R2   10.10.10.4/32 R4
10.1.2.0/24   10.2.4.0/24   10.4.6.0/24
R1   R6
10.10.10.1/32   10.2.3.0/24   10.4.5.0/24   10.10.10.6/32
10.1.3.0/24   10.3.5.0/24   10.5.6.0/24
10.10.10.3/32   10.10.10.5/32
R3   R5

1. This question refers to the topology diagram above (which is copied on the front and back pages for practice purposes). *Please* put your **final** answers on the diagram **above**.

    Two different LSPs with two different, completely *separate* paths are needed between R1 and R6: you must guarantee that no link will be used by both LSPs (in *all* circumstances).

    A. This part is asking you to show your knowledge of admin groups.
    – [2 marks] Label the diagram above, showing suitable admin groups necessary to achieve the LSPs. For full marks, use the *minimum* possible number of labels!

       Label links along either the top path or the bottom path, but not both.

    – [2 marks] Write the configuration which would *define* the admin group(s).
    (Answer must be clear and include CLI context but spelling and syntax need not be perfect)

       R4>config>router#
                     if-attribute   [1 mark for correct context]
                            admin-group "GREEN" value 4   [1 mark for config]

    – [2 marks] For R1, write the configuration which *applies* the definition(s) to interfaces
                (your answer must clearly indicate the CLI context *where* they're applied).

       R1>config>router>mpls#
                     interface "toR6"   [1 mark for correct context]
                     admin-group "GREEN"   [1 mark for config]

– Clearly identify the data structure, message or other method that is used to communicate the definition(s) to other routers in the network. Give as specific an answer as possible.

> OSPF uses Type 10 LSAs having a 32-bit *admin-group* field to carry this information

– [Bonus] Woops! You configured the admin groups perfectly but none of the other routers have the information. Other than *no shut*, you forgot to enable something. What is it?

> [1 mark] configure router ospf *traffic-engineering*

– Everything is working properly now. For the definition you created, what exact *value* would be seen on the other routers?

> [1 mark] Admin groups are a 32-bit mask, so 2**N where N is value chosen above.

– [3 marks] For R1, write the configuration which *uses* admin groups for each of the
  two LSPs (your answer must clearly indicate the context *where* they're invoked).
   [1 mark: correct context; 1 mark = include; 1 mark = exclude]
   lsp "to_R6-First"   cspf
   lsp "to_R6-First"   primary "loose" **include** "GREEN"
   lsp "to_R6-Second"   cspf
   lsp "to_R6-Second"   primary "loose"   **exclude** "GREEN"

B. [3 marks] Now forget about Part A and the admin groups. Using any *other* *TE method* you like, create an LSP which does **not** use either of the vertical links. Label the diagram if necessary and write the config below. (Config must be clear but need not be perfect.)

> Can use any of: TE metrics, hop-limit, strict path, bandwidth
> Marks awarded for a correct: (a) Method; (b) Definition; (c) Context

C. [3 marks] Your boss comes in and doesn't like what you've done for part B. Use a *third* TE method of your choice to create an LSP which **uses** a vertical link (either one is fine). Label the diagram if necessary and write the config below. (Clear but need not be perfect.)

> Can use any of: TE metrics, hop-limit, strict path, bandwidth
> Marks awarded for a correct: (a) Method; (b) Definition; (c) Context

D. Well done; the boss likes it! But what if she hadn't liked it? Is there yet another TE method that could be used to ensure the LSP **uses** a vertical link? Be specific: if yes, explain how/which method; if no, explain why the remaining methods can't work.

> Yes: there are 2 remaining TE methods from which to choose.

2. [2 marks] From your answers to the question above, clearly identify _how many_ of _your_ chosen methods:

(a) use LDP? __0__   (b) use RSVP? __all!__   (c) require **CSPF**? __all (3)__

3. The diagram below illustrates 4 routers in OSPF Area 55 (left side) and Area 0 (right side).
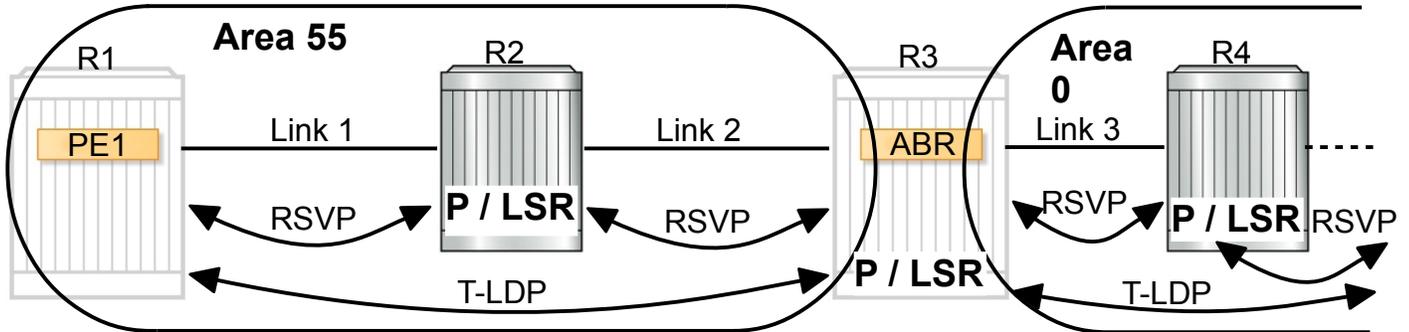
* marks the S-bit

LDP-over-RSVP is implemented and fully functional between PE1 and PE2 (which is waaay off in Area 99 to the right; not shown).

There are three items which you must show on the diagram, so plan how to use the space:
(a) the type of router; (b) the sessions between routers; (c) PDUs for link 1, 2, 3.

Here's the knowledge that needs to be **clearly** shown:
A. [1 mark] R1 is labeled as a PE router. What kind of routers are R2-R4? Label them!
B. [2 marks] Label and identify the _kind_ of MPLS session(s) between routers. For R3 and R4, don't forget to give an indication of what's happening off towards the right.
C. [4 marks] three MPLS PDUs, one for each of links 1, 2, 3. For full marks:
– general detail: indicate the payload data and any label(s) (in the correct order!)
– specific detail: the protocol used to exchange each of the label (in the correct order!)
– specific detail: label values; choose values at random but be sure to show where they must be the same and where would likely be different
– which label(s) have the S-bit set
D. [2 marks] If we added a _VPRN_ using the above LSP for transport, what would be the net contribution to the change of customer TTL between _ingress_ at R1 and _egress_ at R4:

(a) if all LSPs were operating in pipe mode? __Contribution = decrement by 1__

(b) if all LSPs were operating in uniform mode? __Contribution = decrement by 4__

4. [1 mark; Bonus] The previous question asked about TTL in a somewhat general sense. Very specifically now, if/when the TTL is _actually_ decremented _in the customer payload_, clearly identify which router(s) perform a decrement.
    Ref: Module 2, slide 18
    VPRN so (only) PE routers actually decrement the _customer_ TTL, so PE1 (PE2).

5. Which signaling protocol is used to create the following: *
    a. The inner label of a label stack in a VPLS application?   <u>T-LDP</u>

    b. The outer label of a label stack in a VPLS application?   <u>LDP or RSVP</u>

6. [1 mark] We did labs on a variety of MPLS shortcuts. Once the shortcuts were operating properly, when you displayed the routing table, what indication do you see that an IGP route uses an MPLS shortcut?

    The attribute "tunneling" appears after the egress interface.

7. Which of the following attributes is **not** carried in link-state packets for Traffic Engineering? *
    A. Maximum bandwidth
    B. IGP metric   **Correct**
    C. Administrative groups
    D. Unreserved bandwidth
    E. Maximum reservable bandwidth
    F. All of the above parameters are carried in link-state packets.

8. [1 mark] What is the meaning of acronym B.U.M. in the context of VPN services?

    B = broadcast; U = _Unknown_ destination unicast; M = multicast

    [1 mark] **Clearly** identify what do the three components of B.U.M have in common?

    All 3 need to be flooded everywhere throughout the VPLS

9. [2 marks] **Clearly** identify the VPLS flooding behavior for traffic ingressing on a:

    (a) SAP: flooded everywhere, i.e. to all _other_ SAPs, spoke-SDPs, and mesh-SDPs

    (b) spoke-SDP: flooded everywhere, i.e. to all _other_ SAPs, spoke-SDPs, and mesh-SDPs

    (c) mesh-SDP: flooded only (all) _other_ SAPs and spoke-SDPs, and _not_ to mesh-SDPs

10. How many SDPs in total are configured on a local ePipe service? __0__

11. **A**. [1 mark] Name all the VPWS services currently supported by Nokia SR 7750 routers. *

    epipe, fpipe, apipe, cpipe, ipipe   [Need at least 4 for the mark]

    B. [2 marks] Clearly identify the type of traffic carried by each type of VPWS service(s).

    epipe: ethernet frames   [1 mark per pair]
    fpipe: Frame Relay frames
    apipe: ATM cells
    cpipe: TDM circuits/frames
    ipipe: IP data arriving encapsulated in ATM, Frame Relay, or TDM

12. [2 marks] It is important to understand the difference between point-to-point and multi-point services. **Clearly** identify as many services as possible that are examples of:

    point-to-point services: VPWS; also accepted: mirror service

    multi-point services: VPLS, VPRN

13. [1 mark] **Clearly** explain whether the concept of _local vs distributed_ is related to the concept of _point-to-point vs multi-point_, and if so, _how are they related?_

    They aren't related at all. P-to-P/multi-point defines _max_ number of SAPs while Local/distributed defines _where_ SAPs are.

14. [2 marks; 1 per pair] The "Module Summary" for SA Module 1 states: "Before you can provision services, you must do the following:" and then lists four items. **Clearly** identify those four items. *

    Depending on how you categorize the config, either of two answers is acceptable.
    <u>Given in lab</u>   <u>Given in courseware</u>
    Configure interfaces, especially system   Configure IGP routing protocols
    Configure IGP routing protocols   Build the IP/MPLS core network
    Enable the service label protocol   Configure MPLS LSPs
    Configure MPLS LSPs   Construct the core SDP service-tunnel
    (Here SDP is considered part of Svc def'n)

15. [1 mark] **Clearly** identify the two options for SDP transport through the provider core. (**N.B.** This is not asking for the two options for _LSP_ transport!)

    MPLS and GRE

16. [2 marks] In a 6PE network, which version of IP is run by each of the 3 different types of routers. *   Be **clear** and complete.

(a) customer router,   (b) PE router   (c) P router?

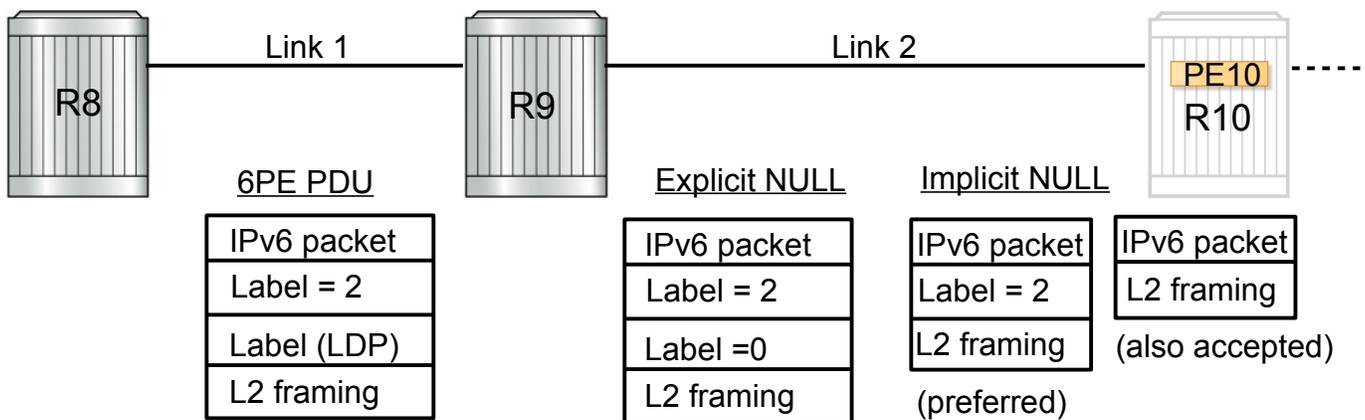 at least IPv6   both IPv4 and IPv6   IPv4 only

17. [1 mark] What label advertisement mode does RSVP-TE use? *

   Downstream on Demand

18. [1 mark] Which two messages take down RSVP RESV and PATH sessions, respectively? *

   Both are tear messages: RESV tear;   PATH tear

19. Cell phone usage is exploding and we've long ago run out of IPv4 addresses: e.g. Verizon has over 82% deployment for IPv6. Pictured below is a pair of older service routers (R8, R9) as well as a brand new, light-weight PE router (R10) installed in remote cell phone tower. 6PE is used to carry all customer IPv6 traffic.

6PE PDU
IPv6 packet
Label = 2
Label (LDP)
L2 framing

Explicit NULL

IPv6 packet
Label = 2
Label =0
L2 framing

Implicit NULL

IPv6 packet	IPv6 packet
Label = 2	L2 framing
L2 framing	(also accepted)
(preferred)	

A. [2 marks] Draw a 6PE PDU for Link 1. Include customer payload and label(s), in correct order. Identify exact values of any label that are known in advance.

B. [4 marks] Draw two 6PE PDUs for Link 2: one when R10 signals explicit NULL and the other for R10 signals implicit NULL. Identify exact values of any label known in advance.

C. Would IPv6 data still successfully flow if R10 signals a request for PHP to R9?
   [2 marks] Explain your reasoning **clearly**.
    Ref: MPLS module 2, slide 45 notes
    Yes, it would: PHP = implicit NULL, meaning the transport label is stripped, but all other labels are left intact (i.e. IPv6 explicit NULL) so R9 can still forward to R10.

D. [2 marks] Would IPv6 data still successfully flow if R9 *also* signaled R8 for PHP? Explain.

   Definitely not: R9 would receive an MPLS PDU with an IPv6 Explicit NULL and would **not** be able to forward it since there would be no match in the LFIB, nor in the FIB (R9 is IPv4 only so has _no_ IPv6 routes).

20. [1 mark; all-or-nothing] In the space below, write the numbers of at least five questions in this test that are taken directly from Nokia courseware.

Pls read the instructions! Questions marked with an "*" are taken from Nokia materials. They are: 5, 7, 11, 14, 16, 17, 18 (there are 7 questions in total).

Extra Work