Data Networks WS 18/19
INTERNET ARCHITECTURE:

Assignment 8

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Question 1: ($6 \cdot 0.5 = 3$ points) Open Shortest Path First (OSPF)

(a) Which entities exchange routing information (DD packets)?
For routers within a particular AS: Each router stores the routing information and this routing information is exchanged between routers.

(b) How do routing entities detect that a neighbor is not reachable any more?

By default, OSPF sends hello packets every 10s (Hello interval) and a dead timer is defined as four times hello interval(4*hello interval). So if a router on a network doesn't receive at least one Hello packet from an OSFP neighbor for 40 seconds, the routers declares the neighbor to be down.

(c) Does OSPF rely on TCP or UDP?
No. OSPF runs on IP rather than TCP or UDP.

(d) What types of packets does OSPF define and when are they used?

Packet Name	Functionality
1. HELLO	Used to discover and maintain contact with neighbours
2. Database description	Includes messages that contain description of the topology of the AS i.e summarizes database contents.
3. Link State Request	It is used by one router requesting for the updated information about a portion of the Link State Database from another router.
4. Link State Update	Includes updated information about the state of certain links on the Link state database.
5. Link State Acknowledgement	Explicit acknowledgment receipt of a Link State Update message. This provides reliability to the link-state exchange process.

(e) What types of LSAs does OSPF define and when are they sent?

LSA	Functionality
Type1: Router LSA	Every router generates router link advertisements for each area to which it belongs, these advertisements describe the state of the router links to the area and are flooded only within that particular area.
Type2: Network LSA	Network link advertisements for multiaccess networks. These advertisements describe set of routers that are attached to a particular multiaccess network.
Type3: Summary LSA	Summary link advertisements an Area Border Router, takes the information that it has learnt in one area and describes and summarizes the same for another area.
Type4: ASBR Summary LSA	ASBR summary link advertisements informs the rest of the OSPF domain , as to how to get to the Autonomous System Boundary Router.
Type5: Autonomous System LSA	Autonomous system external link advertisement that are generated by the ASBR, describe routes to the destinations which lie or are external to the autonomous system.
Type6: Specialized LSA	Used in multicast OSPF application.
Type7	Used in special area type NSSA- Not-so-stubby area
Type8	External attribute LSA for BGP

(f) What is “reliable flooding”, and how is flooding made reliable?

When OSPF on a router finds a new route, it’ll result in the router sending LSAs to update all neighboring routers about the change in the link state. The neighboring routers in turn update their neighbors and so on. This results in a flooding of LSAs. This is made reliable either by explicitly acknowledging an update via Link State Acknowledgement or by an implicit acknowledgement when a router receives the same LS update that it had sent out before.

Question 2: (0.5 + 0.5 + 0.5 + 0.5 + 1 + 1 + 1 + 1 + 1 = 7 points) BGP experiment

(a) To which AS does this IP belong? State the number and name of the AS.

AS	IP	AS Name
58611	138.80.10.69	CDU-AS-AP Charles Darwin University, AU

```
fraja@wks-16-812:~$ telnet route-server.as3257.net
Trying 213.200.64.94...
Connected to route-server.ip4.tinet.net.
Escape character is '^]'.
[SSL not available]

          _   _
          | | | |     _
  __ _| |_| |_   (_)_
 / _  | __| __|   _(_)
| (_| | |_| |_   (_)
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  __/ |
 |___/
GTT Communications, Inc.

route-server -

GTT / AS3257 Public Route Server

This device provides a publicly accessable view of the GTT Communications
(AS3257) global BGP routing table, as collected from several points across
our network. This information is provided for diagnostic and informational
purposes only. Please be aware that this may not fully represent the actual
routing policy in every location.

Unauthorized access is strictly prohibited. All individuals using this
device are subject to having any and all of their activities monitored,
recorded, and examined. Any material so recorded may be disclosed to law
enforcement as appropriate. Any user who does not consent to these terms
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must disconnect immediately.

To access this service, use the following credentials:

login: public
password: public

login: public
Password:
Last login: Mon Dec 17 11:44:58 from apollo.agni.com

--- JUNOS 15.1F6-S5.6 Kernel 64-bit JNPR-10.3-20161130.340898_build

############################ route-server.ip4.gtt.net ############################
###################### GTT / AS3257 Public Route Server ##########################

213.200.87.119 Frankfurt, DE 213.200.87.89 Amsterdam, NL
213.200.87.86 Paris, FR 213.200.87.103 London, UK

213.200.87.25 New York NY, US 213.200.87.111 Ashburn VA, US
213.200.87.170 Chicago IL, US 213.200.87.63 Dallas TX, US
213.200.87.153 Los Angeles CA, US 213.200.87.21 San Jose CA, US
213.200.87.108 Palo Alto CA, US 213.200.87.138 Seattle WA, US
213.200.87.60 Toronto, CA 213.200.87.23 Montreal, CA

213.200.87.137 Tokyo, JP 213.200.87.77 HongKong, CN
213.200.87.29 Singapore, SG 213.200.87.166 Sydney, AU

For questions or comments about this service, contact: noc@gtt.net

{master}

public@route-server.as3257.net-re0> show route 138.80.10.69

inet.0: 720987 destinations, 11516738 routes (720986 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both

138.80.0.0/16 *[BGP/170] 2w3d 01:14:24, MED 0, localpref 100, from 213.200.87.170

AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 0, localpref 100, from 213.200.87.86
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 0, localpref 100, from 213.200.87.89
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 10, localpref 100, from 213.200.87.111
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 10, localpref 100, from 213.200.87.119
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:22, MED 20, localpref 100, from 213.200.87.21
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 26, localpref 100, from 213.200.87.25
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 30, localpref 100, from 213.200.87.103
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 30, localpref 100, from 213.200.87.108
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 95, localpref 100, from 213.200.87.23
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 133, localpref 100, from 213.200.87.60
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 4d 12:40:05, MED 205, localpref 100, from 213.200.87.139
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 900, localpref 100, from 213.200.87.137
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 2w3d 01:14:23, MED 1400, localpref 100, from 213.200.87.77
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified

> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 5d 16:59:39, MED 1725, localpref 100, from 213.200.87.29
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0
[BGP/170] 3d 07:08:12, MED 2475, localpref 100, from 213.200.87.166
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0

{master}

(b) From the output of the above command, please copy the Active Route to your solution.

*[BGP/170] 2w3d 01:14:24, MED 0, localpref 100, from 213.200.87.170
AS path: 3257 6461 7575 7575 58611 I, validation-state: unverified
> to 141.136.111.13 via xe-1/0/0.0

(c) What prefix has been announced by the network of www.cdu.edu.au?

213.200.87.0/8 => 8 is the prefix

(d) From which router has this route been learned? In which city is the router located?
213.200.87.119 , Frankfurt, DE

(e) State the AS path towards www.cdu.edu.au and the corresponding AS names.
AS path: 3257 6461 7575 7575 58611

(g) Compare the traceroute from the route server with the route below, originating at MPI towards www.cdu.edu.au. Which part of the paths are identical? Where do they differ?
 # traceroute -e -I 138.80.10.69
traceroute to 138.80.10.69 (138.80.10.69), 30 hops max, 60 byte packets
1 cat65-vs-inf-01-64.mpi-klsb.mpg.de (139.19.64.254) 0.589 ms 0.671 ms 0.833 ms
2 cr-e15-16-0-228.mpi-klsb.mpg.de (139.19.0.228) <MPLS:L=734,E=0,S=1,T=1> 0.349 ms 0.421 ms 0.4633 guest-gw-1-outside.mpi-klsb.mpg.de (139.19.0.227) 0.683 ms 0.683 ms 0.728 ms
4 c65eb36-win-0-4.mpi-klsb.mpg.de (139.19.0.4) 0.669 ms 0.667 ms 0.714 ms
5 cr-dui1-te0-5-0-2-4.x-win.dfn.de (188.1.241.185) 9.322 ms 9.332 ms 9.330 ms
6 cr-fra2-be16.x-win.dfn.de (188.1.144.178) 10.034 ms 9.731 ms 9.725 ms
7 dfn.mx1.fra.de.geant.net (62.40.124.217) 9.406 ms 9.480 ms 9.635 ms

8 ae1.mx1.ams.nl.geant.net (62.40.98.129) 16.433 ms 16.437 ms 16.466 ms
9 ae2.mx1.lon.uk.geant.net (62.40.98.80) 23.717 ms 23.722 ms 23.759 ms
10 internet2-gw.mx1.lon.uk.geant.net (62.40.124.45) 98.983 ms 99.055 ms 99.044 ms
11 ae-1.4079.rtsw.ashb.net.internet2.edu (162.252.70.137) <MPLS:L=636491,E=0,S=1,T=1>
99.823 ms 99.719 ms 99.396 ms
12 et-2-1-0.4079.rtsw.clev.net.internet2.edu (162.252.70.55) <MPLS:L=385231,E=0,S=1,T=1>
107.211 ms 106.982 ms 107.131 ms
13 ae-1.4079.rtsw.eqch.net.internet2.edu (162.252.70.131) <MPLS:L=674656,E=0,S=1,T=1>
116.260 ms 116.265 ms 116.325 ms
14 et-7-0-0.4079.rtsw.minn.net.internet2.edu (162.252.70.107)
<MPLS:L=534940,E=0,S=1,T=1>
123.824 ms 123.834 ms 123.830 ms
15 et-7-0-0.4079.rtsw.miss2.net.internet2.edu (162.252.70.59)
<MPLS:L=457836,E=0,S=1,T=1>
147.000 ms 147.046 ms 146.926 ms
16 et-4-1-0.4079.rtsw.seat.net.internet2.edu (162.252.70.1) 157.074 ms 157.162 ms 157.183 ms
*17 * * **
18 et-2-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.200) <MPLS:L=301582,E=0,S=1,T=1>
209.304 ms 209.234 ms 209.538 ms
19 et-2-1-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.98) <MPLS:L=301399,E=0,S=1,T=1>
305.484 ms 302.363 ms 302.352 ms
20 et-2-3-0.pe1.mcqp.nsw.aarnet.net.au (113.197.15.144) <MPLS:L=376048,E=0,S=1,T=1>
302.837 ms 302.760 ms 302.815 ms
21 et-0-3-0.pe1.fvly.qld.aarnet.net.au (113.197.15.7) <MPLS:L=339616,E=0,S=1,T=1>
314.325 ms 314.105 ms 314.059 ms
22 xe-2-0-0.pe1.drwn.nt.aarnet.net.au (113.197.15.121) 360.420 ms 359.836 ms 360.464 ms
23 gw2.cdu.pe1.drwn.nt.aarnet.net.au (138.44.208.6) 359.901 ms 359.856 ms 359.987 ms
24 pac1core1.cdu.edu.au (138.80.0.229) 360.595 ms 360.301 ms 360.489 ms
*25 * * **
*26 * * **
27 www.cdu.edu.au (138.80.10.69) 360.611 ms 360.607 ms 360.779 ms

Our trace

public@route-server.as3257.net-re0> traceroute 138.80.10.69
traceroute to 138.80.10.69 (138.80.10.69), 30 hops max, 52 byte packets
 1 ae1-150.cr8-fra2.ip4.gtt.net (**141.136.111.13**) 0.588 ms 0.538 ms 0.551 ms
 2 et-0-0-41.cr6-sjc1.ip4.gtt.net (**89.149.141.205)** 155.678 ms 156.032 ms 155.987 ms
 3 as6461.ip4.gtt.net (**216.221.158.110**) 155.360 ms 155.362 ms 155.384 ms

4 ae16.cr1.sjc2.us.zip.zayo.com (**64.125.31.12**) 156.304 ms 156.332 ms 156.397 ms
MPLS Label=779632 CoS=0 TTL=1 S=1
5 ae12.er1.sjc2.us.zip.zayo.com (**64.125.25.22**) 157.306 ms 156.050 ms 156.724 ms
6 208.185.52.78.available.above.net (**208.185.52.78**) 160.136 ms 156.047 ms 156.079 ms
7 xe-1-0-1.pe1.msct.nsw.aarnet.net.au (**202.158.194.161**) 301.360 ms 300.900 ms 301.232 ms
MPLS Label=397344 CoS=0 TTL=1 S=1
8 et-8-1-0.pe1.brwy.nsw.aarnet.net.au (**113.197.15.152**) 299.224 ms 299.282 ms 299.470 ms
MPLS Label=300920 CoS=0 TTL=1 S=1
9 et-0-3-0.pe1.gdpt.qld.aarnet.net.au (**113.197.15.17**) 314.314 ms 314.299 ms 314.419 ms
MPLS Label=300009 CoS=0 TTL=1 S=1
10 et-1-1-0.pe1.fvly.qld.aarnet.net.au (**113.197.15.35**) 312.744 ms 314.523 ms 314.603 ms
MPLS Label=339616 CoS=0 TTL=1 S=1
11 xe-2-0-0.pe1.drwn.nt.aarnet.net.au (**113.197.15.121**) 359.710 ms 359.751 ms 359.717 ms
12 gw2.cdu.pe1.drwn.nt.aarnet.net.au (**138.44.208.6**) 358.381 ms 358.330 ms 358.318 ms
13 * * *
14 www.cdu.edu.au (138.80.10.69) 359.576 ms 359.670 ms 359.223 ms

Bold highlights show the differences.

(h) Comment on possible reasons for those differences.
By running the BGP protocol, the different ASs have updated the routing and forwarding tables of the border routers since traceroute was run last time. Due to this reason, the paths chosen in our traceroute is different and also has fewer hops than the first traceroute.

(i) Why did we invoke traceroute with the -e option and what additional information is thus contained in the traceroute? What does it reveal?

To show the ICMP (Internet Control Message Protocol) messages the option -e is evoked.The information contained in ICMP is of form:
<Multi Protocol Packet Switching (MPLS):L=label,E=exp_use,S=stack_bottom,T=TTL>