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Fakultät IV – Elektrotechnik und Informatik
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7th Assignment: Network Protocols and Architectures, WS 11/12

Question 1: $(5 + 5 + 5 + 5 + 5 + 5 = 30$ points) *Routing / The border gateway protocol*

(a) Why are policies in the area of intra-AS routing protocols (e. g., OSPF) of little importance?

(b) Why do policies on the other hand play a more important role within Inter-AS traffic compared to global traffic optimization?

(c) Why doesn't it make sense to optimize routes for minimum (packet) delay in intra-AS routing protocols?

(d) How does BGP—as a member of the path-vector protocol family—bypass the problem of routing loops?

(e) The de-facto standard for inter-AS routing is BGP. Why is it difficult to enforce alternatives to BGP or switch completely to a different protocol that is incompatible with BGP?

(f) Why are private address spaces (10/8, 172.16/12, 192.168/16) needed which are not routed in the Internet?

Question 2: $(5 + 5 + 10 + 5 = 25$ points) *Properties of BGP*

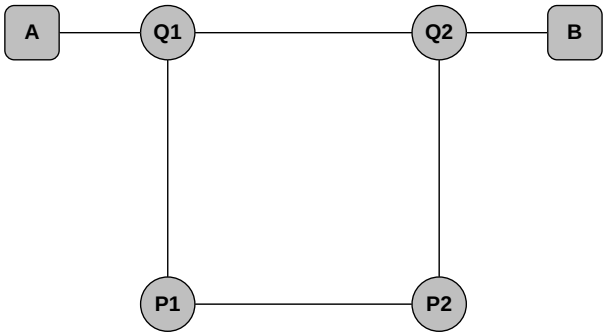

Figure 1: Intra-AS setup

Consider the topology shown in Figure 1. All edges have a weight of 5. An intra-AS routing protocol should be used.

(a) Identify the cost-optimal route from A to B.

(b) Suppose that the edge weight between Q1 and Q2 increases to 20. Given this case, state the cost optimal route from A to B. Which path will a packet actually take between A and B? Explain why.

As shown in Figure 2, the network is now split into two autonomous systems (AS). BGP is used as routing protocol between those autonomous systems.

(c) The edge weight between Q1 and Q2 is still 20. How will a packet from A to B be routed? Explain why.

(d) Supposing that the connection between Q1 and Q2 drops out, how are packets routed from A to B in this case? Explain why.

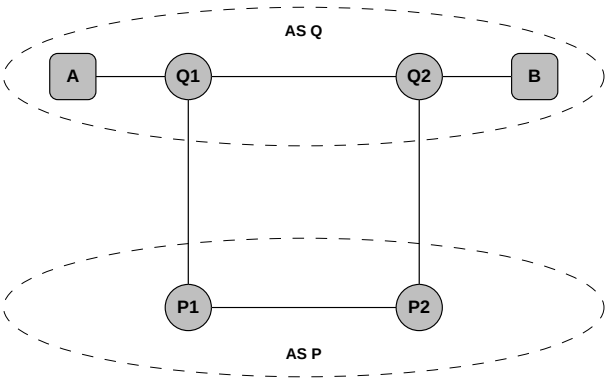

Figure 2: BGP setup

Question 3: $(5 + 20 + 10 + 10 = 45$ points) *BGP experiment*

We are going to explore BGP in a more practical manner by visualizing the route to the Université d'Antananarivo, Madagascar. First we need the IP address of the target host:

```
$ host www.univ-antananarivo.mg
www.univ-antananarivo.mg is an alias for serivera.univ-antananarivo.mg.
serivera.univ-antananarivo.mg has address 192.139.15.34
```

Next, we examine the route of a host (in this example is the source a machine in the network of TU Berlin) to the target by using `traceroute`[1]. As you can see, we get the DNS names and IP addresses of the intermediate routers, but actually we would be interested in the AS numbers. More coming next.

```
$ traceroute www.univ-antananarivo.mg
traceroute to www.univ-antananarivo.mg (192.139.15.34), 30 hops max, 60 byte packets
 1  firebird.net.t-labs.tu-berlin.de (130.149.220.126)  0.250 ms  0.243 ms  0.239 ms
 2  130.149.235.1 (130.149.235.1)  1.720 ms  2.066 ms  2.502 ms
 3  xr-tub2-ge8-7.x-win.dfn.de (188.1.33.81)  0.871 ms  1.094 ms  1.091 ms
 4  xr-pep1-te1-1.x-win.dfn.de (188.1.146.29)  2.035 ms  2.124 ms  2.259 ms
 5  zr-pot1-te0-0-0-7.x-win.dfn.de (188.1.144.54)  3.109 ms  3.107 ms  3.103 ms
 6  frf1-decix-fa10-car.belbone.be (80.81.192.12)  17.325 ms  16.613 ms  16.605 ms
 7  prs-bgc-r3-t2-2.car.belbone.be (80.84.18.109)  25.098 ms  25.082 ms  25.391 ms
 8  prs-cou-r2-t8-1.car.belbone.be (80.84.18.151)  25.735 ms  25.145 ms  25.537 ms
 9  80.84.20.129 (80.84.20.129)  239.779 ms  239.786 ms  240.655 ms
10  * * 196.192.32.131 (196.192.32.131)  244.233 ms
11  adsl.41.188.9.81.dts.mg (41.188.9.81)  245.227 ms  247.061 ms  245.953 ms
12  bas-telma.dts.mg (196.192.38.1)  245.205 ms  245.204 ms  245.196 ms
13  adsl-menres1 (196.192.38.120)  364.645 ms  364.651 ms  365.553 ms
```

Connect now by using *telnet* to *route-server.ip.tiscali.net* The above stated server provides you with an emulation of a Cisco IOS shell with the possibility to explore BGP routes from there to any IP address in the world. Enter the following command at the prompt:

```
route-server.as3257.net>show ip bgp 192.139.15.34
```

(a) Which ASes are hit on the BGP route to www.univ-antananarivo.mg? State the AS number and the corresponding name of the AS. Copy the result of `show ip bgp` to your solution.

- Hint: The line that starts with 3257 represents the BGP route. AS 3257 represents the Tiscali backbone network. To receive more detailed information about AS numbers, please visit `http://www.arin.net/` (US), or `http://www.ripe.net/whois` (Europe). The syntax to query the RIPE database to get information about the AS number needs a capital "AS" as prefix.

[1] `http://en.wikipedia.org/wiki/Traceroute`

(b) Visualize the result of traceroute in a drawing with each AS as a dashed ellipses, routers as small circles and links as lines. Include the IP addresses and AS numbers and the location information that you may guess from the routers name.

Hints:

- `route-server.as3257.net > traceroute 192.139.15.34`
- The AS numbers are given in the traceroute output. In general, the IP to AS number mapping can be obtained by invoking `show ip bgp` for each IP address or by using a web service[2]. For a quick verification, any of the IP addresses out of the network of TU Berlin (e. g., 130.149.7.201) should be mapped to ASN 680, which is DFN.
- "fra", "nyc", ... are abbreviations representing city names. "fra" is equivalent to Frankfurt/Main. Hint: Abbreviations for city names in DNS names of routers are often chosen according to airport codes[3].
- Instead of using the complete IP address scheme, you can also use a prefix, e. g., 188.1.0.0/16 and label the router with the remainig part of the IP address, e. g., 33.81, 144.221, and 145.137.
- You can use geolocation databases like `http://www.maxmind.com/app/locate_ip` in addition. (Those information might not be always accurate!)

(c) Compare the route established from route-server.ip.tiscali.net to www.univ-antananarivo.mg with the above route specified by the TU Berlin towards www.univ-antananarivo.mg computer. Which part of the paths are identical? Where do they differ?

(d) To which AS does the www.univ-antananarivo.mg host belong to? What can you speculate about the used technology in its access network?

Due Date: Thursday, December, 15th 2011 only until 13:55 h s. t.

- **As PDF files (no MS Office or OpenOffice files):** Uploaded via ISIS (`https://www.isis.tu-berlin.de/course/view.php?id=5258`)
- **On paper:** Postbox in the Telefunkenhochhaus (basement, behind the doorman right)
- Put your name, StudentID number (Matrikelnummer) **and** the name of your tutor on your solution.

[2] `http://asn.cymru.com/cgi-bin/whois.cgi`
[3] `http://en.wikipedia.org/wiki/List_of_airports_by_IATA_code`