IK2215: Network Design Report

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1 General Information

ASN: 110

NETWORK: 1.110.0.0/20

2 Network overview

Figure 1 illustrates the intra-operation of AS110. AS110 consists of four routers (r1, r2, r3, and r4) and five hosts, including three servers (s1, s2, and s3) and two clients (c1 and c2). Router r1 is connected to both AS1 and AS2 via eBGP, while r1 also connects internally with r2, r3, and r4. Router r3 is linked to r2, r4, and three servers, where s1 specifically functions as the DNS server for AS120 and does not handle other internet services. Router r4 connects to the client network, where the two clients automatically receive networking information from the DHCP server in the server network. The clients are primarily used to ensure the network is functioning correctly. Detailed IP address blocks and interface configurations are provided in Section 2.2, "IP Address Allocation."

2.1 Network diagram

The network design is illustrated below:

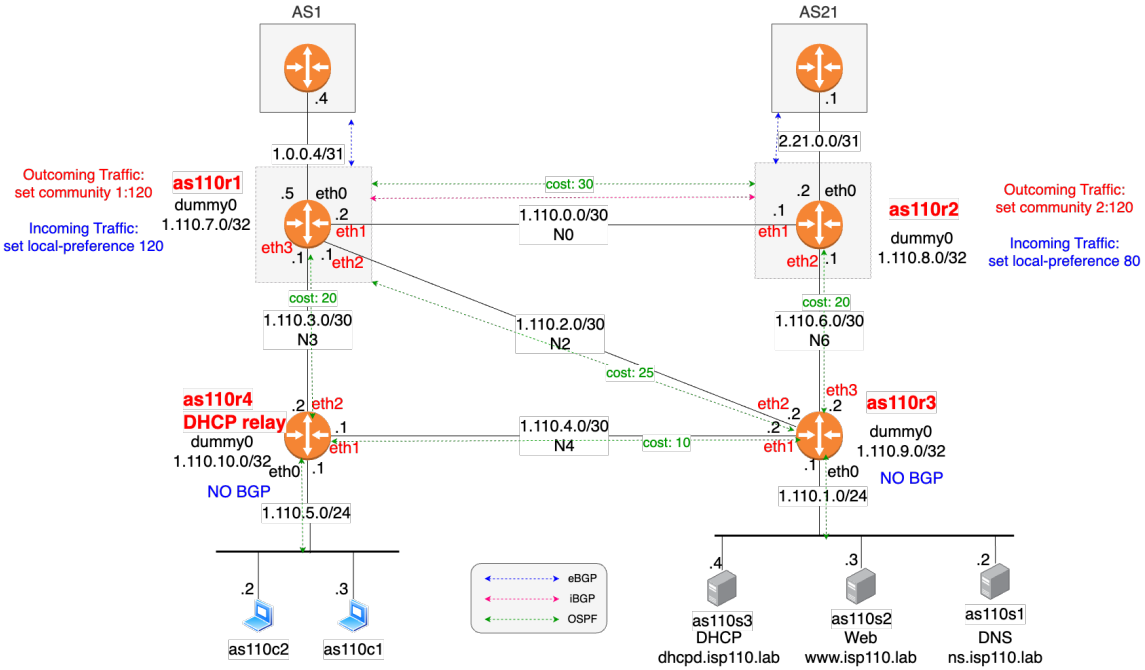

Figure 1: topology graph

2.2 IP address allocation

The IP addresses and domain names of all device interfaces are shown in the table below.

Device	Interface	IP address	Domain name
r1	eth0	1.0.0.5/31	as110r1eth0.isp110.lab
r1	eth1	1.110.0.2/30	as110r1eth1.isp110.lab
r1	eth2	1.110.2.1/30	as110r1eth2.isp110.lab
r1	eth3	1.110.3.1/30	as110r1eth3.isp110.lab
r1	dummy0	1.110.7.0/32	as110r1dummy0.isp110.lab
r2	eth0	2.21.0.1/31	as110r2eth0.isp110.lab
r2	eth1	1.110.0.1/30	as110r2eth1.isp110.lab
r2	eth2	1.110.6.1/30	as110r2eth2.isp110.lab
r2	dummy0	1.110.8.0/32	as110r2dummy0.isp110.lab
r3	eth0	1.110.1.1/24	as110r3eth0.isp110.lab
r3	eth1	1.110.4.2/30	as110r3eth1.isp110.lab
r3	eth2	1.110.2.2/30	as110r3eth2.isp110.lab
r3	eth3	1.110.6.2/30	as110r3eth3.isp110.lab
r3	dummy0	1.110.9.0/32	as110r3dummy0.isp110.lab
r4	eth0	1.110.5.1/24	as110r4eth0.isp110.lab
r4	eth1	1.110.4.1/30	as110r4eth1.isp110.lab
r4	eth2	1.110.3.2/30	as110r4eth2.isp110.lab
r4	dummy0	1.110.10.0/32	as110r4dummy0.isp110.lab
s1	eth0	1.110.1.2/24	ns.isp110.lab
s2	eth0	1.110.1.3/24	www.isp110.lab
s3	eth0	1.110.1.4/24	dhcpd.isp110.lab
c1	eth0	1.110.5.3/24	as110c1.isp110.lab
c2	eth0	1.110.5.2/24	as110c2.isp110.lab

3 Routing and service implementation

This section describes ISP implementation to realize routing and service requirements.

3.1 Routing

This section describe ISP implementation to fulfill routing requirements.

3.1.1 Intra-domain routing

In the internal network, we will use the OSPF protocol with the help of Dijkstra's algorithm for the selection of the best transmission path. This means that we don't need to use a lot of memory and the convergence is fast. Updates are only sent via IP multicast when the routing state changes, which saves bandwidth.
To control traffic, we manually adjust the path cost of each router to ensure that there are no equal-cost paths, with the primary route going through gateway router r1 and the backup router being r2. Because of the direct connection to the top-tier provider, AS1, all traffic in normal operation goes through r1. This configuration optimizes the performance and reliability of the network.
Our network is designed to be highly redundant, with at least two independent paths between routers, guaranteeing continuous operation in the event of an internal link failure.

Table 1 and Table 2 below show the primary and secondary routing paths respectively.

Path	r1	r2	servers	clients
r1	X	-	r3	r4
r2	-	X	r3	r3 r4
servers	r3	r3	X	r3 r4
clients	r4	r4 r3	r4 r3	X

Table 1: Intermediate nodes in the primary routing path from row to column. X represents a path to itself, - represents a direct link without any intermediate node.

Path	r1	r2	servers	clients
r1	X	r3	r4 r3	r3 r4
r2	r3	X	r1 r3	r1 r4
servers	r3 r4	r3 r1	X	r3 r1 r4
clients	r4 r3	r4 r1	r4 r1 r3	X

Table 2: Intermediate nodes in the secondary routing path from row to column (when the primary routing path fails). X represents a path to itself, - represents a direct link without any intermediate node.

3.1.2 Inter-domain routing

•BGP policy setting and routing
According to the guideline, AS1 is used as the primary link and AS21 is used as the backup link. For traffic within the AS, all traffic to the external network should be prioritized through the primary link connected to AS1. To accomplish this, we use BGP's local-preference attribute. local-preference is used to determine the priority of routes within the AS, with higher values giving higher priority. Therefore, set the local-preference of the path from inside the AS to AS1 higher than the other paths, set it to 120.

The backup link takes over all incoming and outgoing traffic when the primary link fails, and the local-reference of the standby link should be lower than that of the primary link (set to 80). This way the standby link will only be used when the link fails. Under normal circumstances, the standby link also serves as an alternate Internet connection in case the primary link fails. When the primary link is restored, the primary link becomes the default path again and traffic is automatically restored to the primary link.

For the BGP peer with AS1 (neighbor 1.0.0.4), this path is advertised via the outbound route map TRAFFIC_OUT with community 1:120 appended to ensure that the external network knows that this is the primary path.The BGP peer with AS21 (neighbor 2.21.0.0) is configured with the same outbound route map TRAFFIC_OUT as the primary link, but the community value is set to 2:120 to ensure that this link is not misused as a transit path.

For internal BGP peers, we will use the dummy0 address, The advantage of this approach is that iBGP sessions remain stable even if the physical link fails. This is accomplished by configuring neighbor 1.110.8.0 update-source 1.110.7.0 and neighbor 1.110.8.0 next-hop-self, ensuring that the iBGP session will not be interrupted even if the physical link fails.

•Prefix Announcement
To avoid leaking internal subnet information, we will only announce the aggregation prefix 1.110.0.0/20 to the outside world and suppress all more specific subnet prefixes (e.g., /24, /30). This effectively reduces the number of routing entries in the external routing table while protecting the subnet structure of the internal network.

•Strategies to Avoid Loops

To avoid routing loops due to link failures or internal routing inconsistencies, we will use BGP community attributes and local-preference policies. In the event of a primary link failure, we can configure lower local-preference values for the backup link, ensuring it is only used when the primary link is down. Additionally, the use of BGP community attributes will help control how traffic from external ASes (such as AS21) enters and exits AS110, preventing unintended transit paths that could lead to routing loops.
At the same time, we must ensure that route redistribution between BGP and internal IGPs (such as OSPF) does not lead to conflicts. Route filtering and prioritization using local-preference and community attributes can be configured to ensure that traffic continues to flow along the correct path when an internal AS110 link failure is detected.
How our network works to implement the BGP is shown as follow:

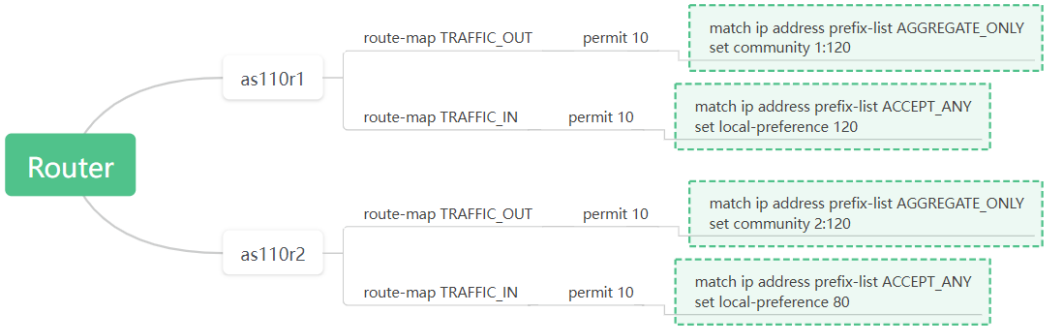

Figure 2: BGP implementation

3.2 Internet service

This section describes ISP implementation to fulfill service requirements.

3.2.1 DNS

as110s1 functions as the DNS server, with IP address 1.110.1.2 and the name ns.isp110.lab. We are using BIND 9 to set up the DNS service, which will create and manage a distributed hostname and address database for the network's computers.The DNS IP address and default gateway will be provided to the hosts when they obtain their IP addresses from the DHCP server.

3.2.2 Web

as110s2 functions as the Web server, with IP address 1.110.1.3 and the name www.isp110.lab
The web server main page should be a simple text-based page named index.html and contains the following information:
- ASN: 110
- NETWORK: 1.110.0.0/20
- NAME1: <Zixian Ke>
- EMAIL1:<zixiank@kth.se>
- NAME2:<Xiang Guo>
- EMAIL2:<xiangguo@kth.se>

3.2.3 DHCP

as110s3 functions as the DHCP server, with IP address 1.110.1.4 and the name dhcpd.isp110.lab. as110r4 functions as the DHCP relay. We configure the isc-dhcp service on as110s3 and set up the isc-dhcp-relay service on as110r4. The subnet which the dhcp server service for is 1.110.5.0/31 and the ip address assigned to clients is range from 1.110.5.2 to 1.110.5.3.