IK2215: Network Design Report

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1 General Information

ASN: 125 **NETWORK:** 1.125.0.0/20

2 Network overview

This section contains an overview of network design.

2.1 Network diagram

The network design is illustrated in Figure 1 below.

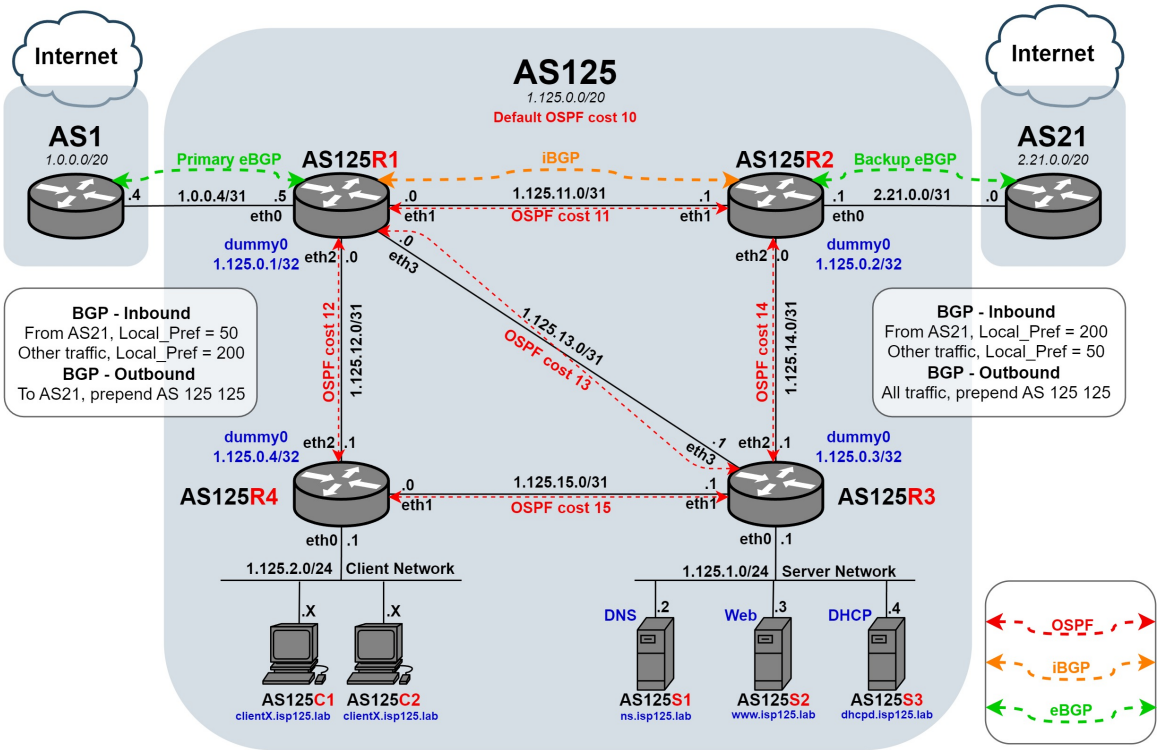

Figure 1: Network Diagram

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	r1eth0.isp125.lab
r1	eth1	1.125.11.0/31	r1eth1.isp125.lab
r1	eth2	1.125.12.0/31	r1eth2.isp125.lab
r1	eth3	1.125.13.0/31	r1eth3.isp125.lab
r1	dummy0	1.125.0.1/32	r1dummy0.isp125.lab
r2	eth0	2.21.0.1/31	r2eth0.isp125.lab
r2	eth1	1.125.11.1/31	r2eth1.isp125.lab
r2	eth2	1.125.14.0/31	r2eth2.isp125.lab
r2	dummy0	1.125.0.2/32	r2dummy0.isp125.lab
r3	eth0	1.125.1.1/24	r3eth0.isp125.lab
r3	eth1	1.125.15.1/31	r3eth1.isp125.lab
r3	eth2	1.125.14.1/31	r3eth2.isp125.lab
r3	eth3	1.125.13.1/31	r3eth3.isp125.lab
r3	dummy0	1.125.0.3/32	r3dummy0.isp125.lab
r4	eth0	1.125.2.1/24	r4eth0.isp125.lab
r4	eth1	1.125.15.0/31	r4eth1.isp125.lab
r4	eth2	1.125.12.1/31	r4eth2.isp125.lab
r4	dummy0	1.125.0.4/32	r4dummy0.isp125.lab
s1	eth0	1.125.1.2/24	ns.isp125.lab
s2	eth0	1.125.1.3/24	www.isp125.lab
s3	eth0	1.125.1.4/24	dhcpd.isp125.lab
c1	eth0	1.125.2.X/24	clientX.isp125.lab
c2	eth0	1.125.2.X/24	clientX.isp125.lab

3 Routing and service implementation

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

3.1 Routing

This section describes ISP implementation to fulfil routing requirements.

3.1.1 Intra-domain routing

We decided on using OSPF for our intra-domain routing mainly because OSPF converges faster than RIP, and by using different cost paths we can avoid having equal-cost paths between two end-points, which would not be possible with RIP since it uses the hop counts as the metric.
By connecting all routers with at least 2 interfaces to the network we can be sure that network can stay operational even when an internal link fails. Furthermore, we also used the additional interfaces on both r1 and r2 to create a shorter path between themselves as well as providing a shorter path for other routes.
The cost of each path is well-designed as 11, 12, 13, 14, and 15 to differentiate all the possible cost sums between certain end pairs. In this way, no equal-cost paths exist even in the event that one link goes down and the secondary route is activated.

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

Using AS125R1 and AS125R2 as border routers for the BGP implementation where AS125R1-AS1 is used as the primary link and AS125R2-AS21 is used as a backup link.
In the default state, all traffic exiting and entering AS125 will go through the primary link AS125R1-AS1R1, except for direct traffic from AS125R2 to AS21 or reverse going over the link AS125R2-AS21. If the primary link were to go down, all traffic would go and come through the backup link AS125R2-AS21. This is achieved by configuring the BGP settings in AS125R1 and AS125R2 and using BGP attributes to control route selection and traffic flow.

By configuring these BGP settings, AS125R1 and AS125R2 ensure that traffic primarily uses the AS125R1-AS1 link during normal operation. If the primary link fails, the BGP attributes and route maps are designed to redirect traffic to the backup link, AS125R2-AS21, thereby achieving the desired traffic flow and redundancy.

In AS125R1's bgpd.conf file, the following settings are used:

- The neighbor statement "neighbor 1.0.0.4 remote-as 1" establishes a BGP peering with AS1 over the primary link, AS125R1-AS1.
- BGP route-maps "T_IN" and "T_OUT" are used to manipulate route advertisements and preferences. The "route-map T_IN permit 10" statement matches the prefix-list 2.21.0.0/20 for AS21 and sets the local preference to 50 (lower than usual to prevent undesirable routes). Generally, The "route-map T_IN permit 20" and "route-map T_OUT permit 20" statements without any match condition set the local preference to 200 (higher than usual to give desirable routes). Similarly, "route-map T_OUT permit 10" matches the prefix-list for AS21 and prepends AS125 to the AS path as outbound traffic.

In AS125R2's bgpd.conf file, the following settings are implemented:

- The neighbor statement "neighbor 2.21.0.0 remote-as 21" establishes a BGP peering with AS21 over the backup link, AS125R2-AS21.
- BGP route-maps "T_IN" and "T_OUT" are used to manipulate route advertisements and preferences. The "route-map T_IN permit 10" statement matches the prefix-list 2.21.0.0/20 for AS21 and sets the local preference to 200 (higher than usual to give desirable routes). Generally, The "route-map T_IN permit 20" statement without any match condition sets the local preference to 50 (lower than usual to prevent undesirable routes). Similarly, "route-map T_OUT permit 10" without any match condition prepends AS125 to the AS path as outbound traffic.

By configuring these BGP settings in AS125R1 and AS125R2, the entire system fulfils the specified requirements:

- AS125R1 primarily handles traffic over the AS125R1-AS1 link during normal operation.
- AS125R2 primarily serves as a direct link to AS21 (AS125R2-AS21) and takes over traffic in case the primary link goes down.
- BGP attributes and route maps are used to control route selection, local preferences, and AS path attributes for efficient traffic management.
- The configuration in AS125R1 and AS125R2 ensures that AS21 does not transit through AS125 under normal operation.

In summary, this combined BGP configuration of AS125R1 and AS125R2 effectively manages traffic flow, redundancy, and ensures proper traffic paths in the event of primary link failure. Other ASes will not use AS125 in transit since the preference in this route is low and will be routed another way.

3.2 Internet service

This section describes ISP implementation to fulfil service requirements.

3.2.1 DNS

We use AS125S1 with IP address 1.125.1.2/24 as the DNS server and name it ns.isp125.lab.
We use BIND 9 to set up the DNS service with forwarders to set up the forward lookup zone for our domain isp125.lab. This zone contains records mapping host names to IP addresses for all devices in our network. For reverse lookup zone configuration, since the TLD DNS servers (for .lab and 1.in-addr.arpa domains) are already preconfigured with DNS delegation, we can easily configure the reverse lookup zone by independently managing the reverse lookup involving AS125.
We configure DNS delegation on the root DNS servers 1.0.1.2 to delegate DNS requests to the DNS server on AS125S1, allowing it to resolve device names within AS125 and vice versa configure the DNS server AS125S1 to use root DNS server and .lab DNS as external DNS servers (Primary and backup) to resolve internet domain names. Finally, we monitor the performance and availability of the DNS server to ensure its proper operation.
In this way, we ensure that all clients and servers can resolve the host names or IPs in the local AS, other ASes and the internet, and also allow other ASes to resolve device names in our ISP and ensure that both forward and reverse lookups work correctly.

3.2.2 Web

The device that runs the web server is AS125S2 with the IP address 1.125.1.3/24 and it resides within the Server Network (1.125.1.0/24). The domain name of the server is www.isp125.lab and the server will therefore be accessible through the domain name.

3.2.3 DHCP

The device that runs the DHCP server is AS125S3 with the IP address 1.125.1.4/24 and it resides within the Server Network (1.125.1.0/24), and has the dhcpd.isp125.lab domain name.
The DHCP relay is set up on AS125R4 since the server is not located on the same LAN as the clients, from there the relay will send DHCP requests along to AS125R3 and to the DHCP server. Client nodes will be randomly assigned dynamic IPs between 1.125.2.[10-20].