Network Design Report

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1 General Information

ASN: 103 **NETWORK:** 1.103.0.0/20

2 Network overview

This section contains an overview of network design.

2.1 Network diagram

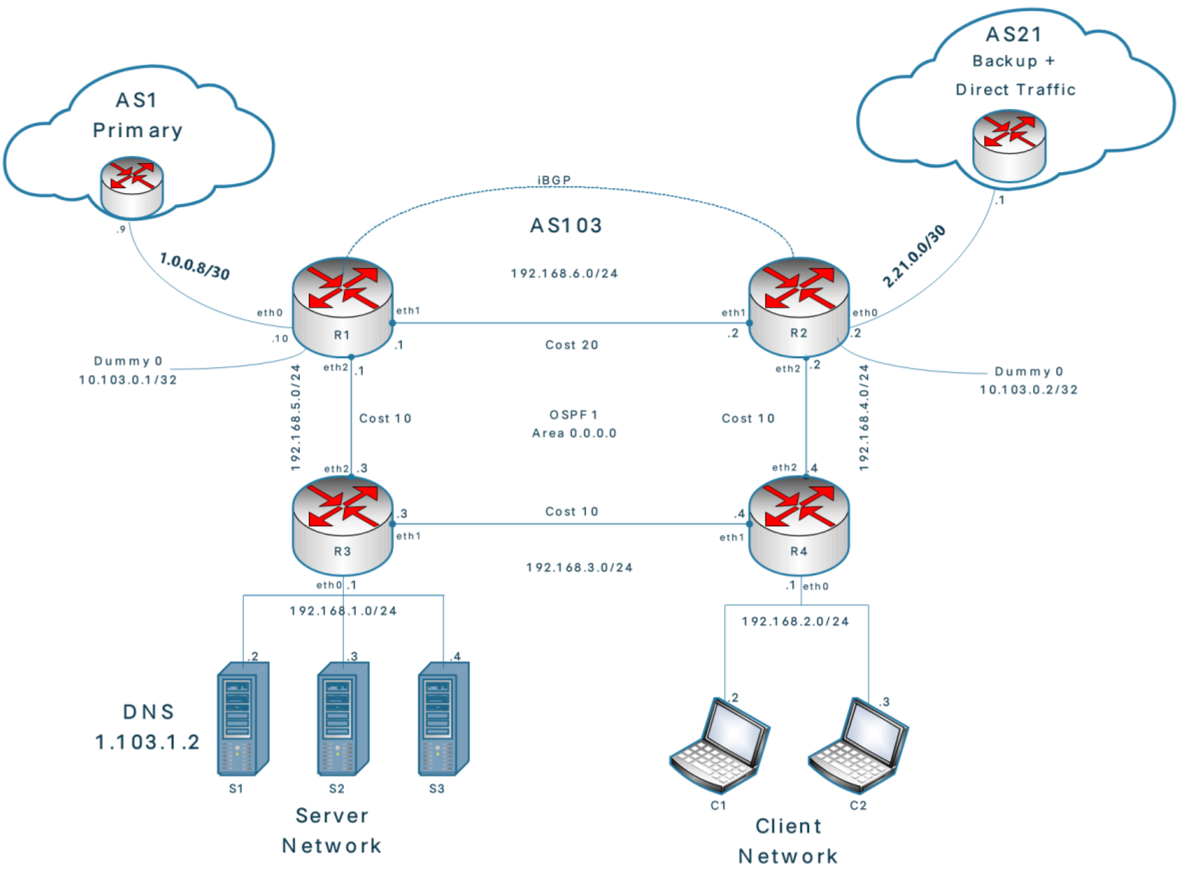

Figure 1: Network Diagram

2.2 IP address allocation

The below set of tables demonstrates an overview of IP block allocation, as well as detailed allocation per device, interface, server and host. Moreover, domains names are assigned for servers and clients as well as their gateways.

10.103.0.0/20	10.103.0.0/21	10.103.0.0/22	10.103.0.0/23	10.103.0.0/24	Loopback Interfaces
				10.103.1.0/24	Server Network
			10.103.2.0/23	10.103.2.0/24	Client Network
				10.103.3.0/24	R3,R4 Interconnection
		10.103.4.0/22	10.103.4.0/23	10.103.4.0/24	R2.R4 Interconnection
				10.103.5.0/24	R1.R3 Interconnection
			10.103.6.0/23	10.103.6.0/24	R1,R2 Interconnection
				10.103.7.0/24	Reserved
	10.103.8.0/21	10.103.8.0/22	10.103.8.0/23	10.103.8.0/24	Reserved
				10.103.9.0/24	Reserved
			10.103.10.0/23	10.103.10.0/24	Reserved
				10.103.11.0/24	Reserved
		10.103.12.0/22	10.103.12.0/23	10.103.12.0/24	Reserved
				10.103.13.0/24	Reserved
			10.103.14.0/23	10.103.14.0/24	Reserved
				10.103.15.0/24	Reserved

Network	IP Address	Device	Interface	Domain Name
10.103.1.0/24	10.103.1.1	as103r3	eth0	gws.isp103.lab
	10.103.1.2	as103h1	N/A	ns.isp103.lab
	10.103.1.3	as103h2	N/A	www.isp103.lab
	10.103.1.4	as103h3	N/A	dhcpd.isp103.lab
	10.103.1.5-254	Reserved	N/A	N/A
10.103.2.0/24	10.103.2.1	as103r4	eth0	gwc.isp103.lab
	10.103.2.2	as103rc1	N/A	client1.isp103.lab
	10.103.2.3	as103rc2	N/A	client2.isp103.lab
	10.103.2.4-254	Reserved	N/A	N/A
10.103.3.0/24	10.103.3.3	as103r3	eth1	N/A
	10.103.3.4	as103r4	eth1	N/A
	10.103.3.1-2	Reserved	N/A	N/A
	10.103.3.5-254	Reserved	N/A	N/A
10.103.4.0/24	10.103.4.2	as103r2	eth2	N/A
	10.103.4.4	as103r4	eth2	N/A
	10.103.4.1	Reserved	N/A	N/A
	10.103.4.3	Reserved	N/A	N/A
	10.103.4.5-254	Reserved	N/A	N/A
10.103.5.0/24	10.103.5.1	as103r1	eth2	N/A
	10.103.5.3	as103r3	eth2	N/A
	10.103.5.2	Reserved	N/A	N/A
	10.103.5.4-254	Reserved	N/A	N/A
10.103.6.0/24	10.103.6.1	as103r1	eth1	N/A
	10.103.6.2	as103r2	eth1	N/A
	10.103.6.3-254	Reserved	N/A	N/A
10.103.0.0/24	10.103.0.1/32	as103r1	dummy0	N/A
	10.103.0.2/32	as103r2	dummy0	N/A
	10.103.0.3-254	Reserved	N/A	N/A

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 design, OSPF routing protocol is used as intra-domain protocol because it has generally faster convergence than RIP in case of failure recovery.
As illustrated in the above topology, R1 is connected to R2 and R3, also R2 is connected to R4, and R3 and R4 are connected to each other. All routers are running OSPF v2 in the interfaces those connected to other OSPF speakers and redistribute the connected interfaces to OSPF which are the clients and server network in R4 and R3. The links cost between routers are set to 10 except the link between R1 and R2 is set to 20. By applying this connectivity and cost enforcement, all routers will have two paths to reach their destinations and, when one of the links is down, the traffic will be shifted to the other path that has higher calculated cost. There is a detailed illustration about the traffic direction within the internal network, from internal network to external network and vice versa.
Client and Server networks are connected to R3 and R4 respectively and therefore the primary path to reach each other is through R3<->R4 link with link cost 10, however, in case of this link failure Client network secondary path is R4<->R2<->R1<->R3 to reach Server network and the server network will use the same path back to Client network with link cost 40.
Client network and R1 primary path to reach each other is through R4<->R3<->R1 link with cost 20, and the secondary path in case of R1<->R3<->R1 link failure is through R4<->R2<->R1 with link cost 30, and vice versa from R1 to reach the client network.
Client network and R2 primary path to reach each other is through R4<->R2 link with cost 10, and the secondary path in case of R4<->R2 link failure is through R4<->R3<->R1<->R2 with link cost 40, and vice versa from R2 to reach the client network.
Server network and R1 primary path to reach each other is through R3<->R1 with link cost 10, and the secondary path in case as of R3<->R1 link failure is through R3<->R4<->R2 <->R1 with link cost 40, and vice Vera from R1 to reach the server network.
Server network and R2 primary path to reach each other is through R3<->R4<->R2 with link cost 20, and the secondary path in case of R3<->R4<->R2 link failure is through R3<->R1<->R2 with link cost 30, and vice versa from R2 to reach the server network.
The link cost between R1 and R2 has higher cost in compare to other links to force the internal traffic to utilize the link between R3 and R4, therefore, the link between R1 and R2 will be mainly utilized by ISP and transit traffic coming from other ASes in the normal operation.
In R1 and R2 OSPF instance, BGP protocol is redistributed to let the internal network to reach the internet, more information about BGP will be discussed in the next section.

3.1.2 Inter-domain routing

In this design both eBGP and iBGP will be used, eBGP will be configured with external AS1 and AS21, however, iBGP will be configured internally between R1 and R2 devices to exchange BGP information and therefore facilitate the routes advertisement and traffic management between the two routers.
In R1 and R2 BGP instance, OSPF is redistributed to let the both routers to learn about the internal network, also in BGP instance static route in both routers with null0 for AS103 IP block (10.103.0.0/20) is added and then redistributed so that BGP can advertise an aggregate prefix to AS1 and AS21.
The outbound traffic from AS103 is either internet traffic or direct traffic to AS21, and for traffic that destined to internet will prefer AS1 as primary path and AS21 as a secondary path, however

direct traffic to AS21 will be routed to AS21 directly and in case of R2<->AS21 link is down the traffic will be routed through AS1, this will be achieved by applying local preference BGP attribute in R1 and R2. In R1 there will be a policy to set local preference to 200 for all prefixes received from AS1, and in R2 there will be a policy to set local preference to 300 for prefix belong to AS21 and local preference to 100 for other prefixes received from AS21 but not originated from AS21, although that after setting local preference in R1 to 200, all BGP routes expect AS21 prefix that are received from AS21 will be less preferred, but it is better to enforce it using the local preference attribute as mentioned above to be set to 100.
Furthermore, the inbound traffic from internet to AS103 is preferred through AS1 and in case of link AS103<->AS1 encountered failure, traffic will be routed through AS21, and the inbound traffic from AS21 is preferred through the direct link between AS103 and AS21 and in case of the direct link encountered a failure traffic will be shifted through AS1. From configuration point of view, both R1 and R2 are advertising the aggregated Subnet 10.103.0.0/20 of AS103 to both eBGP peers AS1 and AS21, however in R2 BGP configuration there is a policy to advertise the assigned block with as-path prepended two times to be less preferred than the IP prefix advertised through AS1 which has been advertised with no manipulation from as103r1, this manipulation in R2 will not affect the direct traffic between AS103 and AS21 since the other path for AS21 to reach AS103 through AS2 and AS1 is minimum of three AS-path away.
AS103 is acting as a secondary link for AS21 Only. Firstly, there is some manipulation in BGP advertisement to influence the inbound traffic that is destined to AS21 when it has link failure with its ISP AS2.Border R2 is advertising all routes learned from AS1 that has been received via the iBGP from R1 to AS21 without filtering but with a policy to set the AS-path prepended two times so that AS21 will never prefer this link in the normal operation. Secondly, to influence AS21 outbound traffic in case of its primary link fail, R1 is advertising AS21 IP block (2.21.0.0/20) to AS1 with a policy to set AS-path pretend to two times, therefore, AS1 customers will always prefer AS2 path to reach AS21 in the normal operation. Since AS103 is a transit AS for A21 only, the advertised routes to AS1 are filtered to include only 2 prefixes as described above and suppress other routes that learned from AS21 through iBGP, the two IP prefixes are AS103 IP block with no prepending and AS21 IP block with As-path prepended two times.

3.2 Internet service

This section describes ISP implementation to fulfill service requirements.

3.2.1 DNS

The DNS server is running at S1, it has IP address is 10.103.1.2 and its domain name is ns.isp103.lab. Bind9 installed in S1 to achieve the forward and reverse lookup for all domains inside and outside AS103 network, the inside domains are the clients, servers and their gateways as illustrated in the IP address allocation table, address(A)records are added in isp103.lab zone for all internal network, however the DNS server have both (name server) ns and A record. 103.in-addr.arpa reverse lookup is also added to all internal network including the gateways in another zone. Furthermore, In order for clients and servers to resolve domains outside isp103.lab domain, S1 configures AS1 DNS as its root DNS with IP 1.0.1.2 in other zone inside the DNS configuration file.

3.2.2 Web

The web server is running at S2, its assigned IP address is 1.103.1.3 and its domain name is www.isp103.lab.

3.2.3 DHCP

ISC DHCP is used to set up DHCP server and relay. S3 is used as the DHCP server, and it assigned IP address 1.103.1.4 and its domain name is dhcpd.isp103.lab. Since the client and server are in different subnets, DHCP relay is configured on R4 to make the clients able to send a request to DHCP server. Clients enabled their DHCP service and request IP address, Subnet Mask and Gateway IP address from the DHCP server.