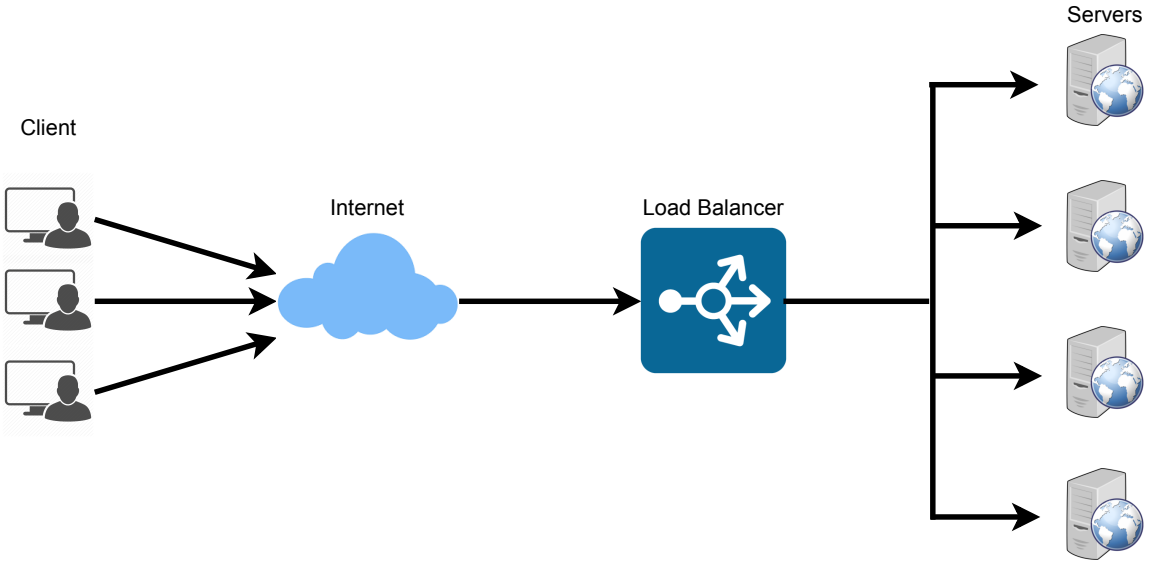
Load Balancing

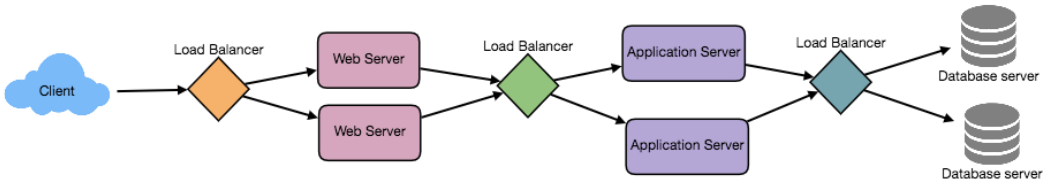
Load Balancer (LB) is another critical component of any distributed system. It helps to spread the traffic across a cluster of servers to improve responsiveness and availability of applications, websites or databases. LB also keeps track of the status of all the resources while distributing requests. If a server is not available to take new requests or is not responding or has elevated error rate, LB will stop sending traffic to such a server.

Typically a load balancer sits between the client and the server accepting incoming network and application traffic and distributing the traffic across multiple backend servers using various algorithms. By balancing application requests across multiple servers, a load balancer reduces individual server load and prevents any one application server from becoming a single point of failure, thus improving overall application availability and responsiveness.



To utilize full scalability and redundancy, we can try to balance the load at each layer of the system. We can add LBs at three places:

- Between the user and the web server
- Between web servers and an internal platform layer, like application servers or cache servers
- Between internal platform layer and database.



Benefits of Load Balancing

- Users experience faster, uninterrupted service. Users won't have to wait for a single struggling server to finish its previous tasks. Instead, their requests are immediately passed on to a more readily available resource.
- Service providers experience less downtime and higher throughput. Even a full server failure won't affect the end user experience as the load balancer will simply route around it to a healthy server.
- Load balancing makes it easier for system administrators to handle incoming requests while decreasing wait time for users.
- Smart load balancers provide benefits like predictive analytics that determine traffic bottlenecks before they happen. As a result, the smart load balancer gives an organization actionable insights. These are key to automation and can help drive business decisions.
- System administrators experience fewer failed or stressed components. Instead of a single device performing a lot of work, load balancing has several devices perform a little bit of work.

Load Balancing Algorithms

How does the load balancer choose the backend server?

Load balancers consider two factors before forwarding a request to a backend server. They will first ensure that the server they can choose is actually responding appropriately to requests and then use a pre-configured algorithm to select one from the set of healthy servers. We will discuss these algorithm shortly.

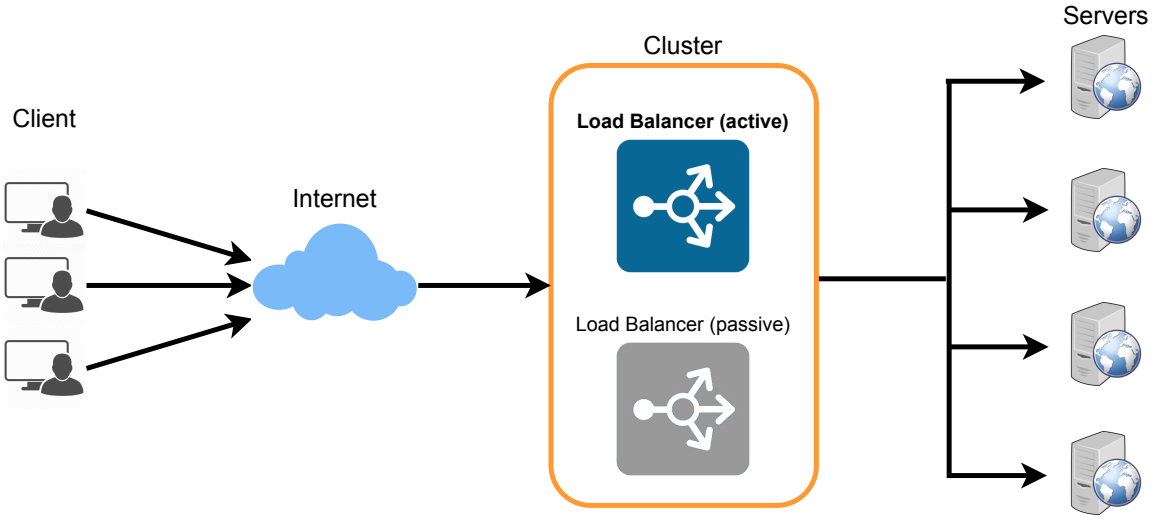
Health Checks - Load balancers should only forward traffic to “healthy” backend servers. To monitor the health of a backend server, “health checks” regularly attempt to connect to backend servers to ensure that servers are listening. If a server fails a health check, it is automatically removed from the pool, and traffic will not be forwarded to it until it responds to the health checks again.

There is a variety of load balancing methods, which use different algorithms for different needs.

- **Least Connection Method** — This method directs traffic to the server with the fewest active connections. This appraoch is most useful when there are a large number of persistent connections in the traffic unevenly distributed between the servers.
- **Least Response Time Method** — This algorithm directs traffic to the server with the fewest active connections and the lowest average response time.
- **Least Bandwidth Method** - This method selects the server that is currently serving the least amount of traffic, measured in megabits per second (Mbps).
- **Round Robin Method** — This method cycles through a list of servers and sends each new request to the next server. When it reaches the end of the list, it starts over at the beginning. It is most useful when servers are of equal specification and there are not many persistent connections.
- **Weighted Round Robin Method** — The weighted round robin scheduling is designed to better handle servers with different processing capacities. Each server is assigned a weight, an integer value that indicates the processing capacity. Servers with higher weights receive new connections first than those with less weights, and servers with higher weights get more connections than those with less weights.
- **IP Hash** — This method calculates a hash of the IP address of the client to determine which server receives the request.

Redundant Load Balancers

Load balancer can be a single point of failure, to overcome this a second load balancer can be connected to the first to form a cluster. Each LB monitors the health of the other and since both of them are equally capable of serving traffic and failure detection, in the event the main load balancer fails, the second load balancer takes over.



There are many ways to implement load balancing.

1. Smart Clients

One way to implement load-balancing is through the client applications. Developers can add the load balancing algorithm to the application or the database client. Such a client will take a pool of service hosts and balances load across them. It also detects hosts that are not responding to avoid sending requests their way. Smart clients also have to discover recovered hosts, deal with adding new hosts, etc. Smart clients look easy to implement and manage especially when the system is not large, but as the system grows, LBs need to be evolved into standalone servers.

2. Hardware Load Balancers

The most expensive–but very high performance–solution to load balancing is to buy a dedicated hardware load balancer (like a Citrix NetScaler). While they can solve a remarkable range of problems, hardware solutions are costly, and they are not trivial to configure.

As such, even large companies with large budgets will often avoid using dedicated hardware for all their load-balancing needs. Instead, they use them only as the first point of contact for user requests to their infrastructure and use other mechanisms (smart clients or the hybrid approach discussed in the next section) for load-balancing for traffic within their network.

3. Software Load Balancers

If we want to avoid the pain of creating a smart client, and since purchasing dedicated hardware is excessive, we can adopt a hybrid approach, called software load-balancers.

HAProxy is one of the popular open source software LB. The load balancer can be placed between client and server or between two server-side layers. If we can control the machine where the client is running, HAProxy could be running on the same machine. Each service we want to load balance can have a locally bound port (e.g., localhost:9000) on that machine, and the client will use this port to connect to the server. This port is, actually, managed by HAProxy; every client request on this port will be received by the proxy and then passed to the backend service in an efficient way (distributing load). If we can't manage the client's machine, HAProxy can run on an intermediate server. Similarly, we can have proxies running between different server-side components. HAProxy manages health checks and will remove or add servers to those pools. It also balances requests across all the servers in those pools.

For most systems, we should start with a software load balancer and move to smart clients or hardware load balancing as the need arises.

Well you're at the end of this section, did you complete it?

YES!

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