Server Load Balancer

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Introduction

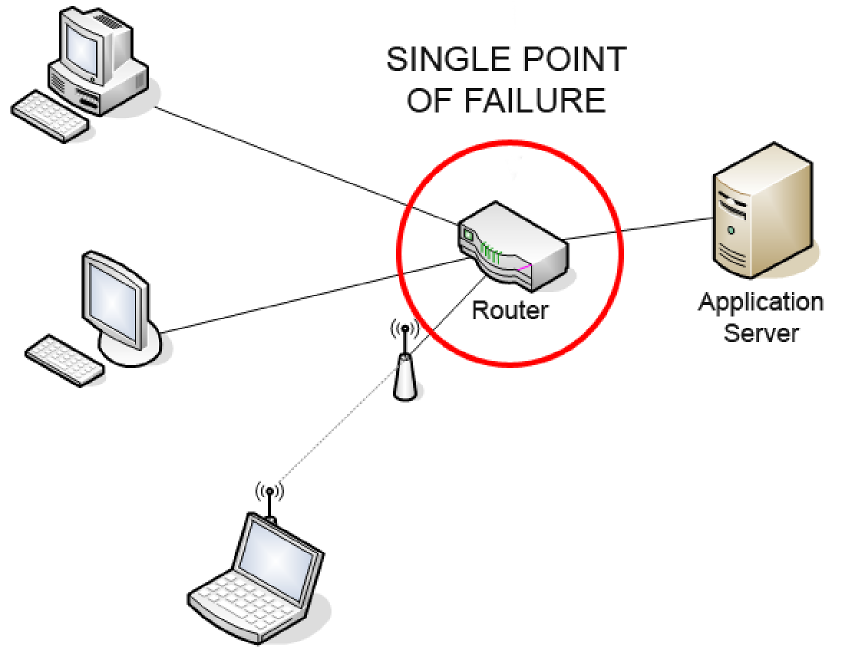
- More users, more resources needed
    - CPU, RAM, HDD …
- Scale Up & Scale Out
    - One powerful server to service more users; or
    - Multiple servers to service more users
- Pros & Cons ?
- C10K / C100K Problem

Introduction

- High Availability
  - A characteristic of a system, which aims to ensure an agreed level of operational performance, usually uptime, for a higher than normal period.
- Availability (per year)
  - 99%: 3.65days
  - 99.9%: 8.77 hours (3 nines)
  - 99.99%: 52.60 minutes (4 nines)
  - 99.999%: 5.26 minutes (5 nines)

High Availability

- Principles
  - Elimination of single points of failure.
  - Reliable crossover.
    - Reliable configuration / topology change
  - Detection of failures as they occur.
- Graceful Degradation
  - the ability of a computer, machine, electronic system or network to maintain limited functionality even when a large portion of it has been destroyed or rendered inoperative.



Single point of failure - Wikipedia

Load Balancing

- Client Side
  - e.g: DNS round-robin
  - Pros & Cons
- Server Side
  - Server Load Balancer

Server Load Balancer (1)

- Provide “Scale-Out” and HA features
- Share loading among all backend nodes with some algorithms
    - Static Algorithms: does not take into account the state of the system for the distribution of tasks.
    - Dynamic Algorithms

Server Load Balancer (2)

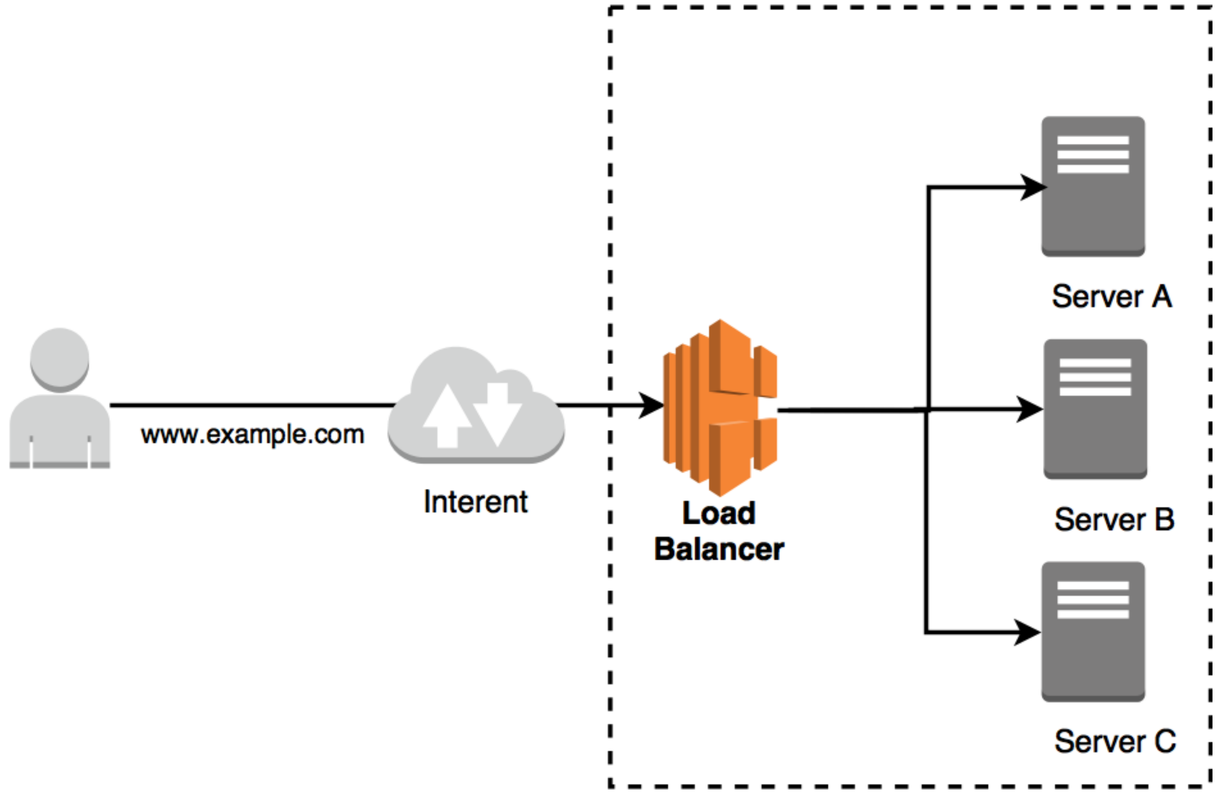
- Layer 4 or Layer 7
  - Layer 4 Switch
- Distribution Algorithms
  - Round-robin
  - Random
  - Ratio
  - Hash Table
  - Least-connections
  - Persistence
    - Session-ID (e.g. HTTP Cookie)

Server Load Balancer (3)

- Persistence (Stickiness)
  - "The Server" in OLG
  - How to handle information that must be kept across the multiple requests in a user's session.
- Session ID?
  - Cookie
  - IP Address
  - TCP Connection
- Pros & Cons ?

Server Load Balancer (4)

- SSL offloading (SSL/TLS termination)
  - Pros?
- Problems of Server Load Balancer
  - SPoF
  - Capacity Limit
  - Latency

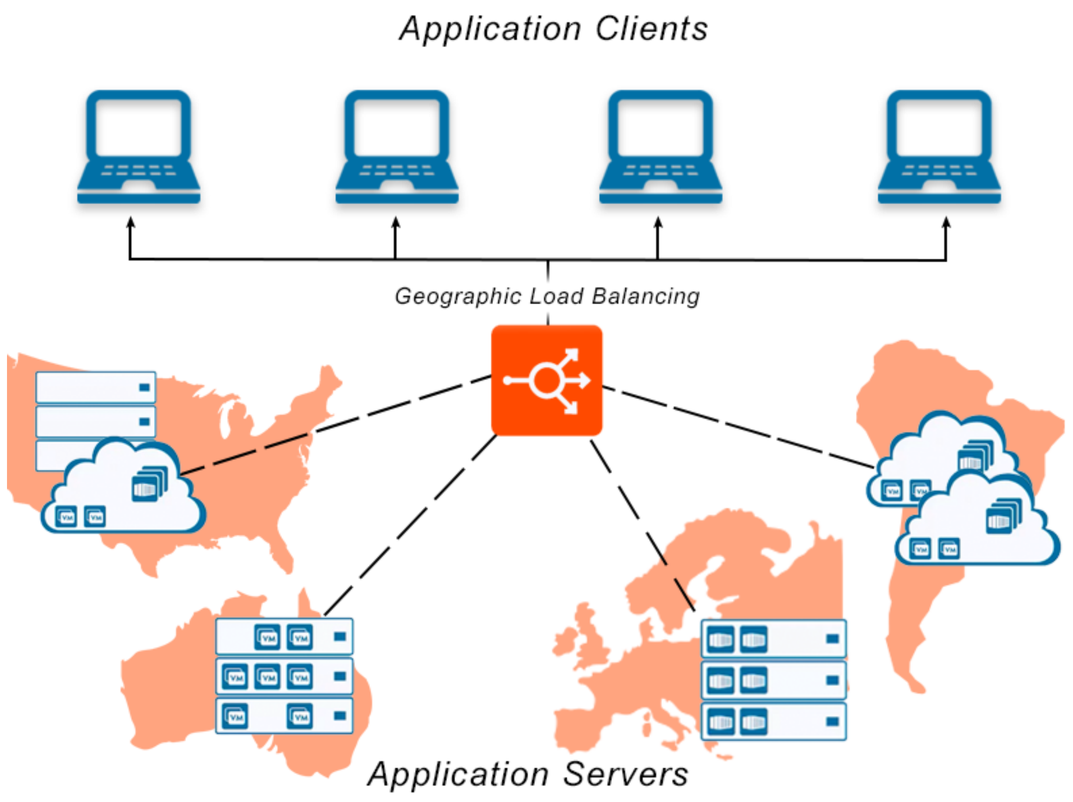


HW & SW of Server Load Balancer

- Nginx
- Ingress in K8S
- PF in FreeBSD
- haproxy
- Envoy Proxy
- F5 BIG-IP
- A10
- on Cloud
    - AWS ELB (Elastic Load Balancer)
    - Google CLB (Cloud Load Balancer)

Global Server Load Balancer (GSLB)

- Globally balancing traffic to the nearest node.
- Pros
  - (Speed of light)
- Cons ?
- Technology
  - GeoDNS
    - resolve IP address based by the location of clients
  - Anycast
    - use BGP
    - Google DNS 8.8.8.8



Haproxy

- http://www.haproxy.org
- Reliable & High Performance TCP/HTTP Load Balancer
  - Layer 4 (TCP) and Layer 7 (HTTP) load balancing
  - SSL/TLS termination
  - Gzip compression
  - Health checking
  - HTTP/2

Haproxy - Installation

- In FreeBSD:
  - pkg install haproxy
  - You can also build it from ports
  - Config file: /usr/local/etc/haproxy.conf

Haproxy - Configuration

```
global
    daemon
    log 127.0.0.1 local0
    log 127.0.0.1 local1 notice
    maxconn 4096
    tune.ssl.default-dh-param 2048

defaults
    log                 global
    retries             3
    maxconn             2000
    timeout connect     5s
    timeout client      50s
    timeout server      50s

listen stats
    bind 127.0.0.1:9090
    balance
    mode http
    stat enable
    stat auth admin:admin
```

Haproxy - Configuration

```
frontend www_csie_nctu
    bind 140.113.208.102:80
    mode http
    use_backend www_csie_nctu_server

frontend cscc_csie_nctu
    bind 140.113.208.103:80
    mode http
    use_backend www_csie_nctu_server

frontend game_server
    bind 140.113.208.104:9876
    mode tcp

backend www_csie_nctu_server
    balance roundrobin
    mode http
    http-request set-header X-forwarded-Port %[dst_port]
    http-request set-header X-forwarded-Proto https if { ssl_fc }
    server www1 192.168.99.1:80
    server www1 192.168.99.2:80
```

Haproxy - Configuration

```
backend cscc_csie_nctu_server
    balance roundrobin
    mode http
    option httpchk HEAD /health_check.php HTTP/1.1\r\nHost:\ cscc.cs.nctu.edu.tw
    option forwardfor
    http-request set-header X-forwarded-Port %[dst_port]
    http-request set-header X-forwarded-Proto https if { ssl_fc }
    server www1 192.168.99.101:80 check fall 3 rise 2
    server www1 192.168.99.102:80 check fall 3 rise 2
```

Haproxy Configuration

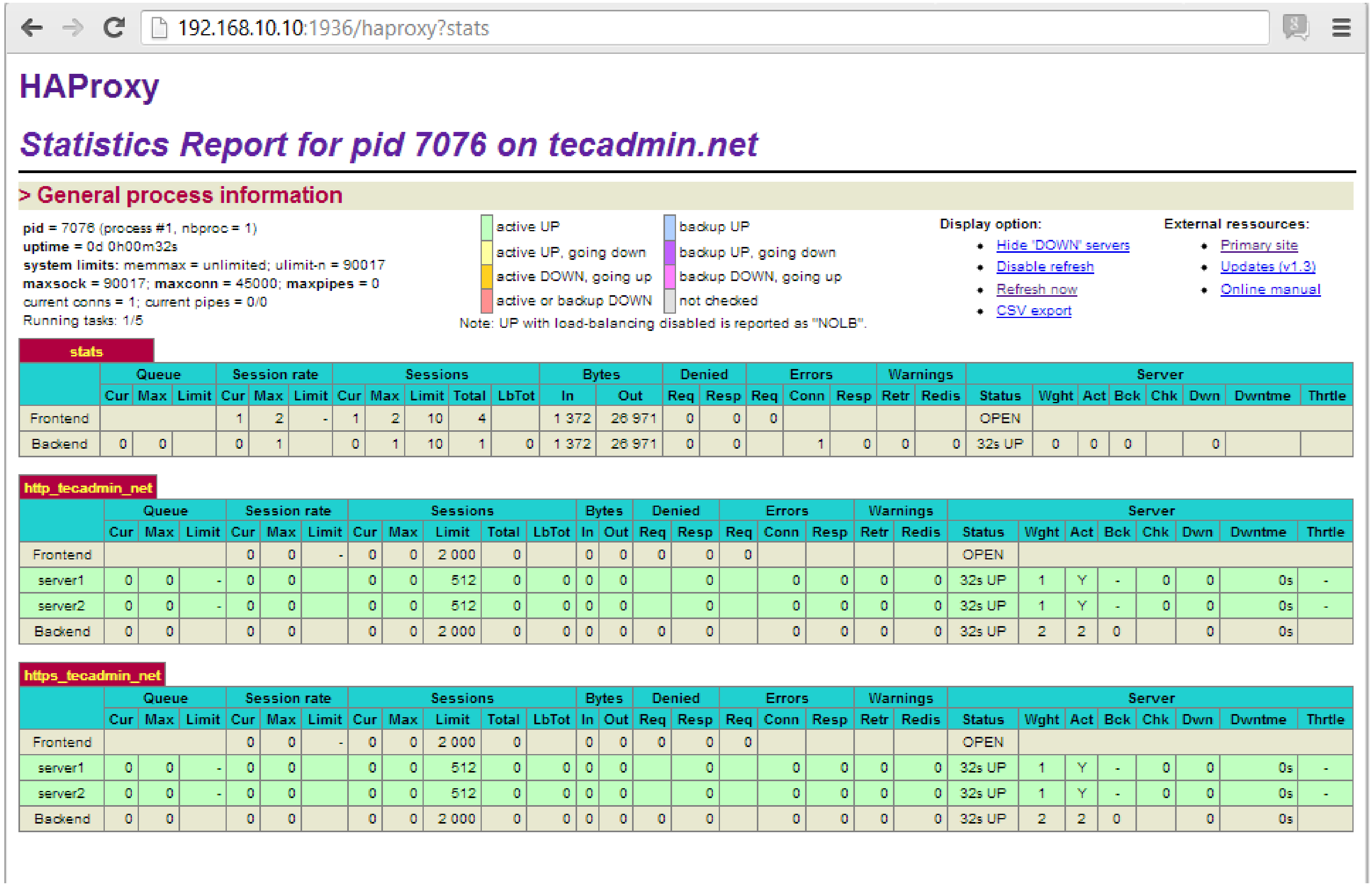
- global
  - log
  - chroot
  - uid / gid
  - pidfile

Haproxy Configuration

- defaults
  - log
  - option
  - retries
  - timeout

Haproxy Configuration

- listen
  - stats



192.168.10.10:1936/haproxy?stats

HAProxy

Statistics Report for pid 7076 on tecadmin.net

> General process information

pid = 7076 (process #1, nbproc = 1)
uptime = 0d 0h00m32s
system limits: memmax = unlimited; ulimit-n = 90017
maxsock = 90017; **maxconn** = 45000; **maxpipes** = 0
current conns = 1; current pipes = 0/0
Running tasks: 1/5

🟩 active UP	🟦 backup UP
🟨 active UP, going down	🟪 backup UP, going down
🟧 active DOWN, going up	🟪 backup DOWN, going up
🟥 active or backup DOWN	⬜ not checked

Note: UP with load-balancing disabled is reported as "NOLB".

Display option:
- Hide 'DOWN' servers
- Disable refresh
- Refresh now
- CSV export

External ressources:
- Primary site
- Updates (v1.3)
- Online manual

stats

	Queue			Session rate			Sessions					Bytes		Denied		Errors			Warnings		Server							
	Cur	Max	Limit	Cur	Max	Limit	Cur	Max	Limit	Total	LbTot	In	Out	Req	Resp	Req	Conn	Resp	Retr	Redis	Status	Wght	Act	Bck	Chk	Dwn	Dwntme	Thrtle
Frontend				1	2	-	1	2	10	4		1 372	26 971	0	0	0					OPEN							
Backend	0	0		0	1		0	1	10	1	0	1 372	26 971	0	0		1	0	0	0	32s UP	0	0	0		0		

http_tecadmin_net

	Queue			Session rate			Sessions					Bytes		Denied		Errors			Warnings		Server							
	Cur	Max	Limit	Cur	Max	Limit	Cur	Max	Limit	Total	LbTot	In	Out	Req	Resp	Req	Conn	Resp	Retr	Redis	Status	Wght	Act	Bck	Chk	Dwn	Dwntme	Thrtle
Frontend				0	0	-	0	0	2 000	0		0	0	0	0	0					OPEN							
server1	0	0	-	0	0		0	0	512	0	0	0	0		0		0	0	0	0	32s UP	1	Y	-	0	0	0s	-
server2	0	0	-	0	0		0	0	512	0	0	0	0		0		0	0	0	0	32s UP	1	Y	-	0	0	0s	-
Backend	0	0		0	0		0	0	2 000	0	0	0	0	0	0		0	0	0	0	32s UP	2	2	0		0	0s	

https_tecadmin_net

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server1	0	0	-	0	0		0	0	512	0	0	0	0		0		0	0	0	0	32s UP	1	Y	-	0	0	0s	-
server2	0	0	-	0	0		0	0	512	0	0	0	0		0		0	0	0	0	32s UP	1	Y	-	0	0	0s	-
Backend	0	0		0	0		0	0	2 000	0	0	0	0	0	0		0	0	0	0	32s UP	2	2	0		0	0s	

Haproxy Configuration

- frontend
  - bind
  - mode
  - option
  - use_backend

Haproxy Configuration

- backend
  - balance
    - roundrobin, leastconn, hdr(param)
  - mode
  - http-request
  - server
    - check
    - fall
    - rise
    - inter
    - cookie

Haproxy - run

- /etc/rc.conf.local
  - haproxy_enable="YES"
- /usr/local/etc/rc.d/haproxy start

- Question: how to setup a backup node for haproxy?

Haproxy - Reference

http://cbonte.github.io/haproxy-dconv/2.1/configuration.html

Envoy

- https://www.envoyproxy.io
- Developed by Lyft (a ride-sharing company like Uber) and opensourced in 2017
    - Apache License 2.0
- Features
    - Dynamic APIs for configuration
    - Service Discovery
    - gRPC / MongoDB / HTTP support
- MicroService

Envoy - Installation

- Broken in FreeBSD now (require BoringSSL)
  - You can install it on Linux instead
- https://www.getenvoy.io
  - Debian: https://www.getenvoy.io/install/envoy/debian/
  - Ubuntu: https://www.getenvoy.io/install/envoy/ubuntu/
  - Centos: https://www.getenvoy.io/install/envoy/centos/

Envoy - Configuration

```
static_resources:
  listeners:
  - name: listener_0
    address:
      socket_address: { address: 127.0.0.1, port_value: 10000 }
    filter_chains:
    - filters:
      - name: envoy.filters.network.http_connection_manager
        typed_config:
          "@type":
type.googleapis.com/envoy.extensions.filters.network.http_connection_manager.v3.HttpConnectionManag
er
          stat_prefix: ingress_http
          codec_type: AUTO
          route_config:
            name: local_route
            virtual_hosts:
            - name: local_service
              domains: ["*"]
              routes:
              - match: { prefix: "/" }
                route: { cluster: some_service }
          http_filters:
          - name: envoy.filters.http.router
```

[Examples — envoy 1.18.0-dev-fce386 documentation (envoyproxy.io)]

Envoy - Configuration

```
clusters:
- name: some_service
  connect_timeout: 0.25s
  type: STATIC
  lb_policy: ROUND_ROBIN
  load_assignment:
    cluster_name: some_service
    endpoints:
    - lb_endpoints:
      - endpoint:
          address:
            socket_address:
              address: 127.0.0.1
              port_value: 1234
```

[Examples — envoy 1.18.0-dev-fce386 documentation (envoyproxy.io)]

Envoy - Configuration

- YAML file format
- Basic concept is same as haproxy
  - Listen (frontend) address
  - Backend addresses
  - Healthy Checks
    - https://www.envoyproxy.io/learn/health-check
  - Routes

Envoy - Run

- envoy -c config.yaml

Envoy - Reference

- https://www.envoyproxy.io/docs/envoy/latest/
- https://blog.getambassador.io/envoy-vs-nginx-vs-haproxy-why-the-open-source-ambassador-api-gateway-chose-envoy-23826aed79ef