Solution of the dimensioning exercise

Hugo Miranda

June 12, 2020

1 Initial data

- 4000 pageviews/h average + 1000 stdev
  - 3σ law recommends to size the system for $4000 + 3 \times 1000 = 7000$ pageviews/h$\approx \frac{35}{18}$ pageviews/s
- 5MBytes/pageview $\approx$ 40Mbit/pageview
- HTTP requests: 50/pageview $50 \times \frac{35}{18} = 97.2$ req/s
- Traffic to and from the Internet : $\frac{35}{18} \times 40 \approx 78 Mbit/s$

2 Utilization and dimension

2.1 Firewall

Utilization is determined from the ratio between the throughput and the capacity.

Capacity 250Mbit/s

Throughput 78Mbit/s

Utilization $\frac{78}{250} = 31.2\%$

A single firewall will be enough for serving the DMZ and the intranet as the utilization will be $< 62.4\%$ (62.4% if the cache does not prevent traffic from entering the intranet).

2.2 Cache

Capacity 20000 req/m $= \frac{1000}{3}$ req/s

Throughput 97.2req/s

Utilization $\frac{97.2}{\frac{1000}{3}} = 29.16\%$

2.3 Load balancer

Capacity 10000req/m $= \frac{10000}{60} \approx 166.6$ req/s

Throughput 50% of the requests served by cache, i.e. $\frac{97.2}{2} = 48.6$ req/s

Utilization $\frac{48.6}{166.6} \approx 29.16\%$

2.4 Web servers

Capacity 20req/s

Throughput 48.6req/s

For an utilization of 50%, each webserver should handle 10req/s. $\lceil \frac{48.6}{10} \rceil = 5$ webservers.

Utilization Minimum 5. it is recommended to use 6 or 7

5 webservers $\frac{\frac{48.6}{5}}{20} = 48.6\%$

7 webservers $\frac{\frac{48.6}{7}}{20} \approx 34.71\%$

2.5 Database

Capacity 20tx/s

Throughput

Read $48.6 \times 0.9 \times 0.8 \approx 35$ tx/s

Write $48.6 \times 0.9 \times 0.2 \approx 8.75$ tx/s

Utilization

Write $\frac{8.75}{20} = 43.75\%$ advised to use hardware with bigger capacity, considering the additional load (unspecified) with synchronization

Read with 5 replicas: $\frac{\frac{35}{5}}{20} = 35\%$

2.6 Switch

Forced flow law comes into play. If a single switch is used to connect all the system components, the traffic is given by:

Step (From->To)	Traffic (Mb/s)	Obs
Internet -> Firewall	78	
Firewall -> Cache	78	
Cache -> Firewall	36	50% to load balancer
FW -> Load balancer	36	
Load balancer -> WS	36	
WS -> DB	9	Educated guess
Total	273	

Does not consider synchronization effort of the databases, ping packets of the load balancer, etc. Still, this overhead can be easily accommodated by a single switch.

3 Response time

Response time is given from inverting the performance indicators for each component.

Component	Time(s)	Obs
Firewall (1)	0.16	$\frac{1}{250Mbits/s} \times 5Mbytes$
Cache	0.15	$\frac{1}{333req/s} \times 50req$
Firewall (2)	0.08	50% of the requests
Load Balancer	0.15	$\frac{1}{166req/s} \times 25req$
WS	1.25	$\frac{1}{20req/s} \times 25req$
DB	1.125	$\frac{1}{20tx/s} \times 22.5tx$
Total	2.915	Unacceptable. Buy better hardware

4 Pending Requests

Knowing that the system receives $\frac{35}{18}$ requests/s and that each request takes 2.915s to be responded, Little's Law states that the number of pending requests in the system is $\frac{35}{18} \times 2.915 \approx 5.67$.