JAMES SILABAN
5025201169

TUGAS 5 PROGRAM JARINGAN

1. Implementasikan arsitektur load balancer dengan:
   a) Mode asynchronous
   b) Mode server pool

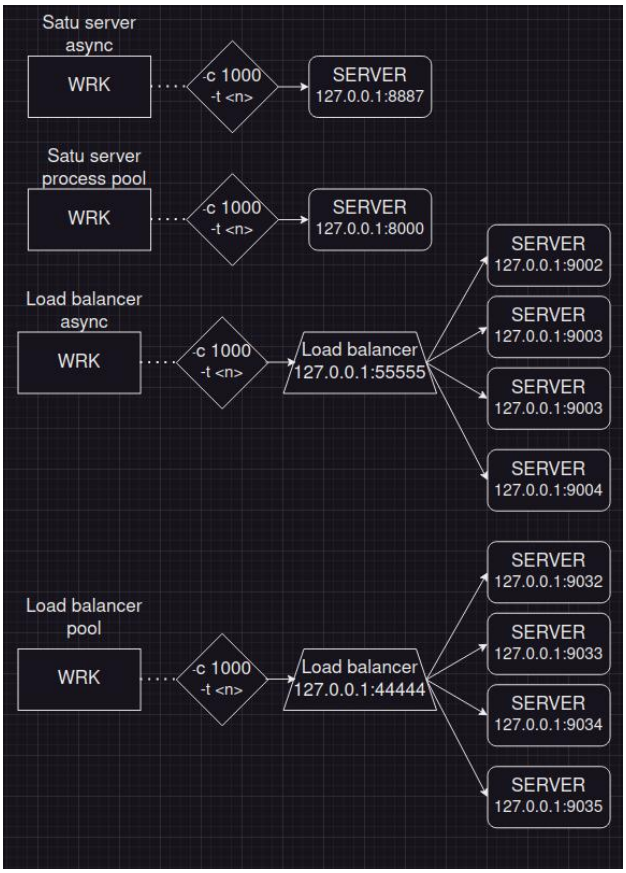
2. Buatlah perbandingan kinerja web server
3. Buatlah gambar dari arsitektur percobaan
4. Untuk pengukuran kinerja, gunakan tool *wrk* dengan jumlah request/koneksi 1000, dengan parameter concurrency 10, 50, 100, 150, 200

wrk -c 1000 -t {n} http://url

SPESIFIKASI KOMPUTER

Hardware Model	: HP 240 G8 Notebook PC
Memory	: 16,0 GiB
Processor	: Intel Core i7-1065G7 CPU @ 1.30GHz × 8
Graphics	: ICELAND(iceland, LLVM 15.0.6, DRM 3.47, 5.19.0-38-generic)
Disk Capacity	: 512,1 GB
OS Name	: Ubuntu 22.04.2 LTS
OS Type	: 64-bit
GNOME Version	: 42.5

ARSITEKTUR PERCOBAAN



JAMES SILABAN
5025201169

DOKUMENTASI

1. Satu Server Async

a) 10 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 10 http://127.0.0.1:8887
Running 10s test @ http://127.0.0.1:8887
  10 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     6.89ms   74.48ms   1.96s    99.05%
    Req/Sec     0.91k   652.45     3.42k    64.12%
  67650 requests in 10.04s, 9.48MB read
  Socket errors: connect 0, read 0, write 0, timeout 15
Requests/sec:   6738.51
Transfer/sec:      0.94MB
```

b) 50 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 50 http://127.0.0.1:8887
Running 10s test @ http://127.0.0.1:8887
  50 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     4.93ms   58.96ms   1.84s    99.25%
    Req/Sec   596.60    478.26     2.24k    47.17%
  75561 requests in 10.08s, 10.59MB read
  Socket errors: connect 0, read 0, write 0, timeout 17
Requests/sec:   7495.37
Transfer/sec:      1.05MB
```

c) 100 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 100 http://127.0.0.1:8887
Running 10s test @ http://127.0.0.1:8887
  100 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     6.92ms   72.62ms   1.95s    98.95%
    Req/Sec   425.55    423.16     2.02k    72.50%
  66574 requests in 10.09s, 9.33MB read
  Socket errors: connect 0, read 0, write 0, timeout 21
Requests/sec:   6599.30
Transfer/sec:      0.93MB
```

d) 150 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 150 http://127.0.0.1:8887
Running 10s test @ http://127.0.0.1:8887
  150 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     9.65ms   87.41ms   1.95s    98.50%
    Req/Sec   344.62    377.36     1.80k    77.10%
  63481 requests in 10.10s, 8.90MB read
  Socket errors: connect 0, read 0, write 0, timeout 32
Requests/sec:   6284.84
Transfer/sec:      0.88MB
```

e) 200 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 200 http://127.0.0.1:8887
Running 10s test @ http://127.0.0.1:8887
  200 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     9.80ms   89.43ms   1.95s    98.50%
    Req/Sec   331.09    372.36     1.94k    77.60%
  65869 requests in 10.10s, 9.23MB read
  Socket errors: connect 0, read 0, write 0, timeout 31
Requests/sec:   6521.46
Transfer/sec:      0.91MB
```

2. Satu Server Process Pool

a) 10 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 10 http://127.0.0.1:8000
Running 10s test @ http://127.0.0.1:8000
  10 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency    68.76ms   87.29ms   1.78s    97.19%
    Req/Sec   179.01     96.99   690.00     65.07%
  17552 requests in 10.05s, 2.46MB read
  Socket errors: connect 0, read 0, write 0, timeout 38
Requests/sec:   1747.23
Transfer/sec:    250.82KB
```

b) 50 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 50 http://127.0.0.1:8000
Running 10s test @ http://127.0.0.1:8000
  50 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   122.53ms   88.56ms   1.98s    96.94%
    Req/Sec    43.73     30.30   400.00     70.07%
  19469 requests in 10.10s, 2.73MB read
  Socket errors: connect 0, read 0, write 0, timeout 73
Requests/sec:   1927.67
Transfer/sec:    276.73KB
```

c) 100 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 100 http://127.0.0.1:8000
Running 10s test @ http://127.0.0.1:8000
  100 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   136.00ms  119.36ms   1.90s    95.84%
    Req/Sec    30.19     24.16   272.00     76.79%
  18277 requests in 10.10s, 2.56MB read
  Socket errors: connect 0, read 0, write 0, timeout 58
Requests/sec:   1809.55
Transfer/sec:    259.77KB
```

d) 150 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 150 http://127.0.0.1:8000
Running 10s test @ http://127.0.0.1:8000
  150 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   126.53ms  126.62ms   1.99s    97.49%
    Req/Sec    20.41     16.03   150.00     82.00%
  18221 requests in 10.10s, 2.55MB read
  Socket errors: connect 0, read 0, write 0, timeout 37
Requests/sec:   1803.85
Transfer/sec:    258.95KB
```

e) 200 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 200 http://127.0.0.1:8000
Running 10s test @ http://127.0.0.1:8000
  200 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   107.07ms   98.20ms   1.88s    97.48%
    Req/Sec    20.18     14.35   212.00     74.13%
  17305 requests in 10.10s, 2.43MB read
  Socket errors: connect 0, read 0, write 0, timeout 67
Requests/sec:   1713.26
Transfer/sec:    245.95KB
```

3. Load Balancer Async

a) 10 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 10 http://127.0.0.1:55555
Running 10s test @ http://127.0.0.1:55555
  10 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     6.92ms   64.94ms   1.79s    98.98%
    Req/Sec   612.53    441.34     3.45k    64.55%
  49117 requests in 10.08s, 6.89MB read
  Socket errors: connect 0, read 0, write 0, timeout 20
Requests/sec:   4870.97
Transfer/sec:    699.25KB
```

b) 50 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 50 http://127.0.0.1:55555
Running 10s test @ http://127.0.0.1:55555
  50 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     7.27ms   68.41ms   1.96s    98.87%
    Req/Sec   372.09    338.58     3.25k    72.42%
  53022 requests in 10.10s, 7.43MB read
  Socket errors: connect 0, read 0, write 0, timeout 23
Requests/sec:   5250.00
Transfer/sec:    753.66KB
```

c) 100 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 100 http://127.0.0.1:55555
Running 10s test @ http://127.0.0.1:55555
  100 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     6.11ms   62.19ms   1.79s    99.25%
    Req/Sec   330.53    284.86     1.42k    63.14%
  47467 requests in 10.09s, 6.65MB read
  Socket errors: connect 0, read 0, write 0, timeout 22
Requests/sec:   4703.63
Transfer/sec:    675.23KB
```

d) 150 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 150 http://127.0.0.1:55555
Running 10s test @ http://127.0.0.1:55555
  150 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     9.30ms   84.36ms   1.95s    98.71%
    Req/Sec   299.95    305.62     2.45k    84.19%
  53119 requests in 10.09s, 7.45MB read
  Socket errors: connect 0, read 0, write 0, timeout 17
Requests/sec:   5264.97
Transfer/sec:    755.81KB
```

e) 200 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 200 http://127.0.0.1:55555
Running 10s test @ http://127.0.0.1:55555
  200 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     8.81ms   81.35ms   1.95s    98.80%
    Req/Sec   296.71    272.00     1.40k    54.74%
  52302 requests in 10.10s, 7.33MB read
  Socket errors: connect 0, read 0, write 0, timeout 19
Requests/sec:   5178.98
Transfer/sec:    743.47KB
```

4. Load Balancer Process Pool

a) 10 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 10 http://127.0.0.1:44444
Running 10s test @ http://127.0.0.1:44444
  10 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   347.70ms  249.81ms   1.88s    74.03%
    Req/Sec    27.56     20.86   130.00     72.45%
  2216 requests in 10.09s, 318.12KB read
  Socket errors: connect 0, read 1, write 0, timeout 25
Requests/sec:    219.68
Transfer/sec:     31.54KB
```

b) 50 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 50 http://127.0.0.1:44444
Running 10s test @ http://127.0.0.1:44444
  50 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   537.00ms  286.82ms   1.87s    63.20%
    Req/Sec    12.79     11.32    80.00     80.40%
  2253 requests in 10.10s, 323.43KB read
  Socket errors: connect 0, read 1, write 0, timeout 52
Requests/sec:    223.12
Transfer/sec:     32.03KB
```

c) 100 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 100 http://127.0.0.1:44444
Running 10s test @ http://127.0.0.1:44444
  100 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   436.90ms  208.45ms   1.98s    66.10%
    Req/Sec    11.20      8.65    70.00     62.85%
  2413 requests in 10.10s, 346.40KB read
  Socket errors: connect 0, read 1, write 0, timeout 53
Requests/sec:    238.90
Transfer/sec:     34.30KB
```

d) 150 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 150 http://127.0.0.1:44444
Running 10s test @ http://127.0.0.1:44444
  150 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   489.60ms  260.23ms   1.80s    58.44%
    Req/Sec     8.30      6.98    50.00     73.81%
  2179 requests in 10.10s, 312.81KB read
  Socket errors: connect 0, read 1, write 0, timeout 35
Requests/sec:    215.74
Transfer/sec:     30.97KB
```

e) 200 threads

```
(base) jovyan@1bf49b991355:~/work/progjar/latihan-tugas/tugas-5$ wrk -c 1000 -t 200 http://127.0.0.1:44444
Running 10s test @ http://127.0.0.1:44444
  200 threads and 1000 connections
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency   484.54ms  292.40ms   1.91s    61.78%
    Req/Sec     7.07      7.23    70.00     87.84%
  2147 requests in 10.10s, 308.21KB read
  Socket errors: connect 0, read 2, write 0, timeout 72
Requests/sec:    212.57
Transfer/sec:     30.52KB
```

TABEL PERBANDINGAN

Satu Server				
	Concurrency	Timeout	Request per second	Transfer per second
Asynchronous	10	15	6738.51	940
	50	17	7492.37	1050
	100	21	6599.3	930
	150	32	6284.84	880
	200	31	6521.46	910
Process Pool	10	38	1747.23	250.82
	50	73	1927.67	276.73
	100	58	1809.55	259.77
	150	37	1803.85	258.95
	200	67	1713.26	245.95
Load Balancer				
Asynchronous	10	20	4870.97	699.25
	50	23	5250	753.66
	100	22	4703.63	675.23
	150	17	5264.97	755.81
	200	19	5178.98	743.47
Process Pool	10	25	219.65	31.54
	50	52	223.12	32.03
	100	53	238.9	34.3
	150	35	215.74	30.97
	200	72	212.57	30.52

PENJELASAN PERCOBAAN

Percobaan dilakukan dengan pada satu server dan load balancer. Setiap percobaan, akan digunakan 1000 requests dengan variasi threads (10, 50, 100, 150, dan 200). Parameter yang digunakan adalah concurrency menandakan berapa banyak thread yang digunakan saat mengirim request, timeout yang berarti jumlah request gagal yang diakibatkan habis waktu, request per second yang menyatakan jumlah request yang mampu dikirim ke server setiap detik, serta transfer per

second yang menjelaskan mengenai jumlah transfer setiap satuan detik dengan satuan kilobyte (KB).

Pada percobaan satu server asynchronous, didapatkan rentang timeout sekitar 15--31 dengan request per second di rentang 6500an--7400an dan rentang transfer per second di kisaran 880--1050. Pada percobaan satu server process pool, didapatkan rentang timeout sekitar 38--73 dengan request per second di rentang 1700an--1900an dan rentang transfer per second di kisaran 245--276.

Kemudian, pada percobaan load balancer asynchronous, didapatkan rentang timeout sekitar 19--23 dengan request per second di rentang 4700an--5200an dan transfer per second di kisaran 699--755. Percobaan load balancer process pool mendapatkan rentang timeout sekitar 25-72 dengan request per second di rentang 212--238 dan transfer per second di kisaran 30--34.

KESIMPULAN

Baik pada percobaan satu server maupun dengan load balancer, didapatkan bahwa server asynchronous memiliki performa jauh lebih baik dibanding dengan server process pool. Bahkan, server process pool memiliki jumlah timeout yang lebih banyak daripada server asynchronous. Sehingga server asynchronous terbukti lebih ampuh dalam menangani process yang memiliki input dan output yang besar (I/O bound).

Perbedaan hasil dari penggunaan satu server saja dengan load balancer begitu berbeda. Terjadi penurunan signifikan pada penggunaan load balancer, baik itu pada server asynchronous dan server process pool. Walaupun dengan menggunakan load balancer akan membagikan beban ke setiap server dengan sama banyaknya, sehingga beban yang dimiliki oleh server sama beratnya, akan tetapi, itu tidak menjadi penentu pada semua kasus bahwa menggunakan load balancer akan meningkatkan performa.

Link github: https://github.com/silabanjames/tugas-program-jaringan/tree/main/tugas5