Технополис
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Сравнительный отчёт по тестированию для Stage 3

Дисциплина: Проектирование высоконагруженных систем

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2019

Содержание

1 Get empty

1.1 stage 3

Рассмотрим результаты нагрузочного тестирования на запросы данных при отсутсвии каких-либо данных на сервере:

```
Running 2m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 4.212ms, rate sampling interval: 21ms
  Thread calibration: mean lat.: 4.205ms, rate sampling interval: 21ms
  Thread calibration: mean lat.: 3.951ms, rate sampling interval: 19ms
  Thread calibration: mean lat.: 4.017ms, rate sampling interval: 20ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     6.37ms   38.18ms   1.00s    99.42%
    Req/Sec     2.60k     0.87k   13.05k    75.29%
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    2.12ms
 75.000%    5.16ms
 90.000%   10.82ms
 99.000%   24.98ms
 99.900%  759.29ms
 99.990%  986.11ms
 99.999%    1.00s
100.000%    1.00s

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.053     0.000000            1         1.00
       0.568     0.100000        80088         1.11
       0.942     0.200000       160059         1.25
       1.220     0.300000       240103         1.43
       1.621     0.400000       320173         1.67
       2.125     0.500000       400014         2.00
       2.539     0.550000       440030         2.22
       3.013     0.600000       479998         2.50
       3.569     0.650000       519962         2.86
       4.267     0.700000       560141         3.33
       5.155     0.750000       600033         4.00
       5.695     0.775000       620083         4.44
       6.339     0.800000       640006         5.00
       7.103     0.825000       659966         5.71
       8.063     0.850000       679966         6.67
       9.311     0.875000       700025         8.00
      10.031     0.887500       709982         8.89
      10.823     0.900000       719946        10.00
      11.751     0.912500       730007        11.43
      12.807     0.925000       740013        13.33
      13.991     0.937500       749995        16.00
      14.639     0.943750       754991        17.78
      15.343     0.950000       759982        20.00
      16.087     0.956250       764955        22.86
      16.895     0.962500       769997        26.67
      17.791     0.968750       774968        32.00
      18.287     0.971875       777485        35.56
      18.831     0.975000       779941        40.00
      19.471     0.978125       782499        45.71
      20.207     0.981250       784977        53.33
      21.183     0.984375       787446        64.00
      21.823     0.985938       788703        71.11
```

22.671	0.987500	789940	80.00	
23.903	0.989062	791195	91.43	
25.983	0.990625	792440	106.67	
29.839	0.992188	793692	128.00	
32.575	0.992969	794318	142.22	
38.687	0.993750	794941	160.00	
52.383	0.994531	795565	182.86	
82.495	0.995313	796190	213.33	
211.071	0.996094	796815	256.00	
260.863	0.996484	797127	284.44	
313.343	0.996875	797440	320.00	
359.935	0.997266	797752	365.71	
433.407	0.997656	798065	426.67	
530.431	0.998047	798377	512.00	
575.999	0.998242	798533	568.89	
625.663	0.998437	798690	640.00	
669.183	0.998633	798846	731.43	
718.847	0.998828	799003	853.33	
765.439	0.999023	799159	1024.00	
790.015	0.999121	799236	1137.78	
815.103	0.999219	799315	1280.00	
838.655	0.999316	799394	1462.86	
862.207	0.999414	799471	1706.67	
887.295	0.999512	799549	2048.00	
899.583	0.999561	799588	2275.56	
912.383	0.999609	799627	2560.00	
924.671	0.999658	799666	2925.71	
937.471	0.999707	799705	3413.33	
950.271	0.999756	799745	4096.00	
956.415	0.999780	799764	4551.11	
962.559	0.999805	799783	5120.00	
968.703	0.999829	799803	5851.43	
974.847	0.999854	799822	6826.67	
981.503	0.999878	799843	8192.00	
984.575	0.999890	799854	9102.22	
986.623	0.999902	799861	10240.00	
988.671	0.999915	799872	11702.86	
990.719	0.999927	799882	13653.33	
992.767	0.999939	799891	16384.00	
994.303	0.999945	799897	18204.44	
995.327	0.999951	799900	20480.00	
996.351	0.999957	799906	23405.71	
997.375	0.999963	799912	27306.67	
997.887	0.999969	799915	32768.00	
998.911	0.999973	799924	36408.89	
998.911	0.999976	799924	40960.00	
998.911	0.999979	799924	46811.43	
999.423	0.999982	799927	54613.33	
999.423	0.999985	799927	65536.00	
999.935	0.999986	799930	72817.78	
999.935	0.999988	799930	81920.00	
1000.447	0.999989	799934	93622.86	
1000.447	0.999991	799934	109226.67	
1000.447	0.999992	799934	131072.00	
1000.447	0.999993	799934	145635.56	
1000.959	0.999994	799935	163840.00	
1000.959	0.999995	799935	187245.71	
1001.471	0.999995	799937	218453.33	
1001.471	0.999996	799937	262144.00	
1001.471	0.999997	799937	291271.11	

```
    1001.471     0.999997       799937    327680.00
    1001.471     0.999997       799937    374491.43
    1001.983     0.999998       799939    436906.67
    1001.983     1.000000       799939          inf
#[Mean    =        6.370, StdDeviation   =       38.177]
#[Max     =     1001.472, Total count    =       799939]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  899972 requests in 1.50m, 59.22MB read
  Non-2xx or 3xx responses: 899972
Requests/sec:   9999.74
Transfer/sec:    673.81KB
```

1.2 stage 2

Сравним с результатами из stage 2:

```

Running 1m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 4.672ms, rate sampling interval: 21ms
  Thread calibration: mean lat.: 4.046ms, rate sampling interval: 20ms
  Thread calibration: mean lat.: 2.280ms, rate sampling interval: 10ms
  Thread calibration: mean lat.: 4.643ms, rate sampling interval: 21ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     4.04ms    5.51ms  95.74ms   89.63%
    Req/Sec     2.62k   834.36     8.33k    75.98%
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    1.99ms
 75.000%    5.03ms
 90.000%    9.75ms
 99.000%   25.14ms
 99.900%   58.01ms
 99.990%   88.89ms
 99.999%   94.46ms
100.000%   95.81ms

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.054     0.000000            1         1.00
       0.551     0.100000        50098         1.11
       0.919     0.200000       100112         1.25
       1.176     0.300000       150050         1.43
       1.553     0.400000       200127         1.67
       1.992     0.500000       250035         2.00
       2.405     0.550000       275047         2.22
       2.897     0.600000       300075         2.50
       3.469     0.650000       325026         2.86
       4.167     0.700000       350058         3.33
       5.027     0.750000       375087         4.00
       5.535     0.775000       387538         4.44
       6.115     0.800000       400032         5.00
       6.787     0.825000       412486         5.71
       7.583     0.850000       424992         6.67
       8.543     0.875000       437542         8.00
       9.103     0.887500       443774         8.89
       9.751     0.900000       450016        10.00
      10.495     0.912500       456258        11.43
      11.359     0.925000       462494        13.33
```

12.399	0.937500	468766	16.00
12.975	0.943750	471858	17.78
13.655	0.950000	475008	20.00
14.439	0.956250	478132	22.86
15.319	0.962500	481252	26.67
16.447	0.968750	484357	32.00
17.135	0.971875	485921	35.56
17.919	0.975000	487493	40.00
18.879	0.978125	489050	45.71
20.015	0.981250	490616	53.33
21.423	0.984375	492173	64.00
22.255	0.985938	492953	71.11
23.247	0.987500	493744	80.00
24.351	0.989062	494514	91.43
25.759	0.990625	495296	106.67
27.631	0.992188	496077	128.00
28.847	0.992969	496467	142.22
30.463	0.993750	496858	160.00
32.015	0.994531	497250	182.86
33.887	0.995313	497642	213.33
36.799	0.996094	498031	256.00
38.623	0.996484	498225	284.44
39.935	0.996875	498419	320.00
40.895	0.997266	498621	365.71
42.559	0.997656	498813	426.67
45.695	0.998047	499008	512.00
47.583	0.998242	499104	568.89
50.335	0.998437	499200	640.00
52.767	0.998633	499298	731.43
55.935	0.998828	499396	853.33
58.271	0.999023	499493	1024.00
59.519	0.999121	499543	1137.78
60.607	0.999219	499592	1280.00
61.887	0.999316	499640	1462.86
63.135	0.999414	499689	1706.67
65.183	0.999512	499737	2048.00
68.159	0.999561	499762	2275.56
72.575	0.999609	499787	2560.00
75.391	0.999658	499811	2925.71
77.055	0.999707	499835	3413.33
81.791	0.999756	499859	4096.00
84.735	0.999780	499872	4551.11
85.823	0.999805	499885	5120.00
86.847	0.999829	499896	5851.43
87.551	0.999854	499909	6826.67
88.255	0.999878	499920	8192.00
88.639	0.999890	499928	9102.22
88.959	0.999902	499933	10240.00
89.279	0.999915	499939	11702.86
89.599	0.999927	499945	13653.33
89.919	0.999939	499951	16384.00
90.303	0.999945	499955	18204.44
90.495	0.999951	499957	20480.00
90.751	0.999957	499960	23405.71
91.071	0.999963	499963	27306.67
91.967	0.999969	499966	32768.00
92.607	0.999973	499968	36408.89
92.927	0.999976	499969	40960.00
93.311	0.999979	499971	46811.43
93.631	0.999982	499973	54613.33

```
      93.887     0.999985       499974     65536.00
      94.207     0.999986       499975     72817.78
      94.207     0.999988       499975     81920.00
      94.463     0.999989       499976     93622.86
      94.719     0.999991       499977    109226.67
      95.039     0.999992       499978    131072.00
      95.039     0.999993       499978    145635.56
      95.039     0.999994       499978    163840.00
      95.359     0.999995       499979    187245.71
      95.359     0.999995       499979    218453.33
      95.615     0.999996       499980    262144.00
      95.615     0.999997       499980    291271.11
      95.615     0.999997       499980    327680.00
      95.615     0.999997       499980    374491.43
      95.615     0.999998       499980    436906.67
      95.807     0.999998       499981    524288.00
      95.807     1.000000       499981          inf
#[Mean    =        4.043, StdDeviation   =        5.508]
#[Max     =       95.744, Total count    =       499981]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  599971 requests in 1.00m, 40.16MB read
  Non-2xx or 3xx responses: 399984
Requests/sec:   9998.64
Transfer/sec:    685.38KB
```

2 Put

2.1 stage 3

Рассмотрим результаты нагрузочного тестирования на запись данных:

```
Running 2m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 4.240ms, rate sampling interval: 22ms
  Thread calibration: mean lat.: 4.265ms, rate sampling interval: 23ms
  Thread calibration: mean lat.: 4.011ms, rate sampling interval: 21ms
  Thread calibration: mean lat.: 4.421ms, rate sampling interval: 23ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency    15.63ms   86.28ms   1.01s    97.99%
    Req/Sec     2.62k     0.91k   12.14k    75.50%
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    2.38ms
 75.000%    5.88ms
 90.000%   13.07ms
 99.000%  565.76ms
 99.900%  961.02ms
 99.990%    1.00s
 99.999%    1.01s
100.000%    1.01s

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.058     0.000000            1         1.00
       0.594     0.100000        80172         1.11
       0.973     0.200000       160383         1.25
       1.296     0.300000       240130         1.43
       1.726     0.400000       320246         1.67
```

2.379	0.500000	400263	2.00
2.835	0.550000	440330	2.22
3.351	0.600000	480289	2.50
3.991	0.650000	520280	2.86
4.815	0.700000	560349	3.33
5.875	0.750000	600319	4.00
6.555	0.775000	620373	4.44
7.367	0.800000	640332	5.00
8.399	0.825000	660313	5.71
9.695	0.850000	680329	6.67
11.247	0.875000	700328	8.00
12.127	0.887500	710373	8.89
13.071	0.900000	720362	10.00
14.095	0.912500	730342	11.43
15.247	0.925000	740375	13.33
16.591	0.937500	750368	16.00
17.359	0.943750	755419	17.78
18.239	0.950000	760410	20.00
19.327	0.956250	765362	22.86
20.783	0.962500	770381	26.67
23.679	0.968750	775357	32.00
26.735	0.971875	777856	35.56
32.111	0.975000	780351	40.00
45.663	0.978125	782854	45.71
166.015	0.981250	785360	53.33
307.455	0.984375	787860	64.00
380.927	0.985938	789105	71.11
450.303	0.987500	790359	80.00
523.519	0.989062	791608	91.43
594.943	0.990625	792858	106.67
657.919	0.992188	794115	128.00
692.735	0.992969	794734	142.22
728.063	0.993750	795358	160.00
759.807	0.994531	796000	182.86
796.159	0.995313	796610	213.33
833.535	0.996094	797238	256.00
850.943	0.996484	797550	284.44
868.351	0.996875	797861	320.00
888.319	0.997266	798176	365.71
903.679	0.997656	798493	426.67
922.111	0.998047	798797	512.00
930.815	0.998242	798959	568.89
938.495	0.998437	799123	640.00
945.151	0.998633	799274	731.43
952.831	0.998828	799431	853.33
962.047	0.999023	799579	1024.00
967.167	0.999121	799659	1137.78
972.287	0.999219	799740	1280.00
976.895	0.999316	799815	1462.86
981.503	0.999414	799900	1706.67
985.087	0.999512	799972	2048.00
987.647	0.999561	800016	2275.56
989.695	0.999609	800053	2560.00
991.743	0.999658	800094	2925.71
994.303	0.999707	800129	3413.33
996.863	0.999756	800177	4096.00
997.375	0.999780	800193	4551.11
997.887	0.999805	800206	5120.00
998.911	0.999829	800232	5851.43
999.423	0.999854	800243	6826.67

```
    1000.959     0.999878       800275      8192.00
    1000.959     0.999890       800275      9102.22
    1001.471     0.999902       800284     10240.00
    1002.495     0.999915       800299     11702.86
    1003.007     0.999927       800306     13653.33
    1003.519     0.999939       800313     16384.00
    1004.031     0.999945       800318     18204.44
    1004.543     0.999951       800322     20480.00
    1005.055     0.999957       800327     23405.71
    1006.079     0.999963       800333     27306.67
    1006.591     0.999969       800337     32768.00
    1007.103     0.999973       800340     36408.89
    1007.615     0.999976       800343     40960.00
    1007.615     0.999979       800343     46811.43
    1008.127     0.999982       800348     54613.33
    1008.127     0.999985       800348     65536.00
    1008.639     0.999986       800352     72817.78
    1008.639     0.999988       800352     81920.00
    1008.639     0.999989       800352     93622.86
    1009.151     0.999991       800355    109226.67
    1009.151     0.999992       800355    131072.00
    1009.151     0.999993       800355    145635.56
    1009.663     0.999994       800358    163840.00
    1009.663     0.999995       800358    187245.71
    1009.663     0.999995       800358    218453.33
    1009.663     0.999996       800358    262144.00
    1009.663     0.999997       800358    291271.11
    1009.663     0.999997       800358    327680.00
    1009.663     0.999997       800358    374491.43
    1010.175     0.999998       800359    436906.67
    1010.175     0.999998       800359    524288.00
    1010.175     0.999998       800359    582542.22
    1010.175     0.999998       800359    655360.00
    1010.175     0.999999       800359    748982.86
    1010.687     0.999999       800360    873813.33
    1010.687     1.000000       800360          inf
#[Mean    =       15.630, StdDeviation   =       86.281]
#[Max     =     1010.176, Total count    =       800360]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  899946 requests in 1.50m, 57.50MB read
Requests/sec:   9999.45
Transfer/sec:    654.26KB
```

2.2 stage 2

Сравним с результатами из stage 2:

```
Running 1m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 2.661ms, rate sampling interval: 12ms
  Thread calibration: mean lat.: 2.453ms, rate sampling interval: 11ms
  Thread calibration: mean lat.: 11.778ms, rate sampling interval: 71ms
  Thread calibration: mean lat.: 8.227ms, rate sampling interval: 44ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     8.28ms   57.84ms   1.00s    99.06%
    Req/Sec     2.65k     0.88k   13.33k    79.72%
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    1.78ms
 75.000%    4.13ms
```

```
 90.000%    8.06ms
 99.000%   39.87ms
 99.900%  903.68ms
 99.990%  992.26ms
 99.999%    1.00s
100.000%    1.00s

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.044     0.000000            1         1.00
       0.500     0.100000        50056         1.11
       0.859     0.200000       100041         1.25
       1.092     0.300000       149996         1.43
       1.412     0.400000       200049         1.67
       1.781     0.500000       250082         2.00
       2.038     0.550000       274967         2.22
       2.435     0.600000       299969         2.50
       2.897     0.650000       324933         2.86
       3.439     0.700000       349961         3.33
       4.127     0.750000       374952         4.00
       4.547     0.775000       387436         4.44
       5.027     0.800000       399960         5.00
       5.575     0.825000       412407         5.71
       6.227     0.850000       424917         6.67
       7.031     0.875000       437395         8.00
       7.515     0.887500       443665         8.89
       8.059     0.900000       449903        10.00
       8.711     0.912500       456141        11.43
       9.543     0.925000       462398        13.33
      10.623     0.937500       468660        16.00
      11.287     0.943750       471780        17.78
      12.055     0.950000       474899        20.00
      12.967     0.956250       478027        22.86
      14.047     0.962500       481140        26.67
      15.431     0.968750       484255        32.00
      16.303     0.971875       485829        35.56
      17.391     0.975000       487399        40.00
      18.799     0.978125       488958        45.71
      20.735     0.981250       490513        53.33
      23.343     0.984375       492071        64.00
      25.247     0.985938       492849        71.11
      28.047     0.987500       493631        80.00
      33.855     0.989062       494412        91.43
      67.519     0.990625       495190       106.67
     223.487     0.992188       495971       128.00
     299.263     0.992969       496363       142.22
     382.719     0.993750       496754       160.00
     461.823     0.994531       497143       182.86
     544.767     0.995313       497537       213.33
     612.863     0.996094       497925       256.00
     653.311     0.996484       498121       284.44
     699.903     0.996875       498315       320.00
     729.599     0.997266       498511       365.71
     768.511     0.997656       498705       426.67
     807.935     0.998047       498902       512.00
     830.463     0.998242       498999       568.89
     847.871     0.998437       499096       640.00
     876.031     0.998633       499194       731.43
     891.391     0.998828       499293       853.33
```

```
     907.775     0.999023       499389      1024.00
     916.991     0.999121       499438      1137.78
     926.207     0.999219       499489      1280.00
     934.399     0.999316       499537      1462.86
     945.663     0.999414       499584      1706.67
     953.343     0.999512       499633      2048.00
     958.975     0.999561       499657      2275.56
     963.583     0.999609       499681      2560.00
     970.751     0.999658       499708      2925.71
     974.335     0.999707       499730      3413.33
     977.919     0.999756       499754      4096.00
     980.479     0.999780       499768      4551.11
     983.039     0.999805       499780      5120.00
     985.087     0.999829       499791      5851.43
     987.647     0.999854       499803      6826.67
     990.207     0.999878       499816      8192.00
     991.743     0.999890       499824      9102.22
     992.767     0.999902       499829     10240.00
     993.791     0.999915       499835     11702.86
     995.839     0.999927       499841     13653.33
     997.375     0.999939       499847     16384.00
     997.887     0.999945       499851     18204.44
     998.399     0.999951       499854     20480.00
     998.911     0.999957       499857     23405.71
     999.423     0.999963       499859     27306.67
     999.935     0.999969       499862     32768.00
    1000.447     0.999973       499865     36408.89
    1000.447     0.999976       499865     40960.00
    1000.959     0.999979       499868     46811.43
    1000.959     0.999982       499868     54613.33
    1001.471     0.999985       499873     65536.00
    1001.471     0.999986       499873     72817.78
    1001.471     0.999988       499873     81920.00
    1001.471     0.999989       499873     93622.86
    1001.471     0.999991       499873    109226.67
    1001.471     0.999992       499873    131072.00
    1001.471     0.999993       499873    145635.56
    1001.471     0.999994       499873    163840.00
    1001.983     0.999995       499875    187245.71
    1001.983     0.999995       499875    218453.33
    1001.983     0.999996       499875    262144.00
    1001.983     0.999997       499875    291271.11
    1001.983     0.999997       499875    327680.00
    1001.983     0.999997       499875    374491.43
    1001.983     0.999998       499875    436906.67
    1002.495     0.999998       499876    524288.00
    1002.495     1.000000       499876          inf
#[Mean    =        8.280, StdDeviation   =       57.841]
#[Max     =     1001.984, Total count    =       499876]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  599917 requests in 1.00m, 38.33MB read
Requests/sec:   9999.02
Transfer/sec:    654.23KB
```

3 Get

3.1 stage 3

Рассмотрим результаты нагрузочного тестирования на запрос ранее записанных данных:

```
Running 2m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 7.918ms, rate sampling interval: 34ms
  Thread calibration: mean lat.: 6.620ms, rate sampling interval: 30ms
  Thread calibration: mean lat.: 6.457ms, rate sampling interval: 28ms
  Thread calibration: mean lat.: 6.742ms, rate sampling interval: 31ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     6.62ms   41.86ms   1.01s    99.49%
    Req/Sec     2.57k   604.97     8.63k    75.24%
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    2.41ms
 75.000%    5.10ms
 90.000%   10.28ms
 99.000%   20.72ms
 99.900%  801.79ms
 99.990%  993.28ms
 99.999%    1.01s
100.000%    1.01s

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.070     0.000000            1         1.00
       0.629     0.100000        80065         1.11
       1.014     0.200000       160220         1.25
       1.364     0.300000       240102         1.43
       1.790     0.400000       320058         1.67
       2.413     0.500000       399999         2.00
       2.803     0.550000       440088         2.22
       3.229     0.600000       480035         2.50
       3.729     0.650000       519998         2.86
       4.343     0.700000       560156         3.33
       5.103     0.750000       599997         4.00
       5.563     0.775000       620024         4.44
       6.111     0.800000       639950         5.00
       6.775     0.825000       659926         5.71
       7.615     0.850000       679892         6.67
       8.783     0.875000       699965         8.00
       9.487     0.887500       709947         8.89
      10.279     0.900000       719888        10.00
      11.151     0.912500       729940        11.43
      12.095     0.925000       739905        13.33
      13.119     0.937500       749906        16.00
      13.671     0.943750       754880        17.78
      14.255     0.950000       759891        20.00
      14.887     0.956250       764884        22.86
      15.575     0.962500       769903        26.67
      16.327     0.968750       774865        32.00
      16.751     0.971875       777396        35.56
      17.215     0.975000       779912        40.00
      17.727     0.978125       782355        45.71
      18.319     0.981250       784905        53.33
      18.991     0.984375       787388        64.00
      19.359     0.985938       788609        71.11
```

19.823	0.987500	789867	80.00	
20.351	0.989062	791132	91.43	
21.023	0.990625	792379	106.67	
21.983	0.992188	793603	128.00	
22.863	0.992969	794235	142.22	
25.151	0.993750	794854	160.00	
31.359	0.994531	795477	182.86	
143.487	0.995313	796102	213.33	
275.455	0.996094	796727	256.00	
346.367	0.996484	797041	284.44	
413.951	0.996875	797352	320.00	
477.183	0.997266	797664	365.71	
556.031	0.997656	797978	426.67	
626.175	0.998047	798290	512.00	
662.527	0.998242	798449	568.89	
695.807	0.998437	798605	640.00	
721.919	0.998633	798758	731.43	
764.415	0.998828	798914	853.33	
806.911	0.999023	799071	1024.00	
826.879	0.999121	799149	1137.78	
849.407	0.999219	799228	1280.00	
869.375	0.999316	799305	1462.86	
888.831	0.999414	799384	1706.67	
909.823	0.999512	799461	2048.00	
919.551	0.999561	799500	2275.56	
929.791	0.999609	799540	2560.00	
937.471	0.999658	799578	2925.71	
949.247	0.999707	799618	3413.33	
960.511	0.999756	799656	4096.00	
966.655	0.999780	799676	4551.11	
972.287	0.999805	799695	5120.00	
978.431	0.999829	799716	5851.43	
983.551	0.999854	799734	6826.67	
988.671	0.999878	799755	8192.00	
991.743	0.999890	799765	9102.22	
993.791	0.999902	799776	10240.00	
995.327	0.999915	799784	11702.86	
997.887	0.999927	799793	13653.33	
1000.959	0.999939	799804	16384.00	
1001.983	0.999945	799810	18204.44	
1002.495	0.999951	799814	20480.00	
1003.519	0.999957	799818	23405.71	
1005.055	0.999963	799823	27306.67	
1006.591	0.999969	799828	32768.00	
1007.103	0.999973	799830	36408.89	
1008.127	0.999976	799833	40960.00	
1008.639	0.999979	799835	46811.43	
1009.151	0.999982	799837	54613.33	
1010.175	0.999985	799840	65536.00	
1010.687	0.999986	799842	72817.78	
1010.687	0.999988	799842	81920.00	
1011.199	0.999989	799844	93622.86	
1011.199	0.999991	799844	109226.67	
1011.711	0.999992	799845	131072.00	
1012.223	0.999993	799847	145635.56	
1012.223	0.999994	799847	163840.00	
1012.223	0.999995	799847	187245.71	
1012.735	0.999995	799850	218453.33	
1012.735	0.999996	799850	262144.00	
1012.735	0.999997	799850	291271.11	

```
    1012.735     0.999997       799850    327680.00
    1012.735     0.999997       799850    374491.43
    1012.735     0.999998       799850    436906.67
    1012.735     0.999998       799850    524288.00
    1012.735     0.999998       799850    582542.22
    1012.735     0.999998       799850    655360.00
    1012.735     0.999999       799850    748982.86
    1013.247     0.999999       799851    873813.33
    1013.247     1.000000       799851          inf
#[Mean    =        6.617, StdDeviation   =       41.858]
#[Max     =     1012.736, Total count    =       799851]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  899861 requests in 1.50m, 63.04MB read
Requests/sec:   9998.42
Transfer/sec:    717.29KB
```

3.2 stage 2

Сравним с результатами из stage 2:

```
Running 1m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 3.438ms, rate sampling interval: 16ms
  Thread calibration: mean lat.: 5.724ms, rate sampling interval: 27ms
  Thread calibration: mean lat.: 3.747ms, rate sampling interval: 17ms
  Thread calibration: mean lat.: 6.750ms, rate sampling interval: 32ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     3.97ms    5.20ms  59.33ms   89.67%
    Req/Sec     2.58k   628.37     7.18k    76.17%
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    1.97ms
 75.000%    4.93ms
 90.000%    9.35ms
 99.000%   26.19ms
 99.900%   47.42ms
 99.990%   56.77ms
 99.999%   58.69ms
100.000%   59.36ms

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.073     0.000000            4         1.00
       0.564     0.100000        50008         1.11
       0.932     0.200000       100055         1.25
       1.182     0.300000       150176         1.43
       1.547     0.400000       200037         1.67
       1.967     0.500000       250035         2.00
       2.363     0.550000       275042         2.22
       2.855     0.600000       300071         2.50
       3.423     0.650000       325104         2.86
       4.103     0.700000       350105         3.33
       4.931     0.750000       375133         4.00
       5.411     0.775000       387573         4.44
       5.947     0.800000       400045         5.00
       6.563     0.825000       412601         5.71
       7.295     0.850000       425056         6.67
       8.179     0.875000       437548         8.00
       8.727     0.887500       443845         8.89
```

9.351	0.900000	450066	10.00
10.095	0.912500	456303	11.43
10.999	0.925000	462595	13.33
12.095	0.937500	468808	16.00
12.759	0.943750	471954	17.78
13.511	0.950000	475056	20.00
14.431	0.956250	478185	22.86
15.495	0.962500	481296	26.67
16.927	0.968750	484421	32.00
17.807	0.971875	486000	35.56
18.719	0.975000	487570	40.00
19.759	0.978125	489113	45.71
21.039	0.981250	490680	53.33
22.639	0.984375	492243	64.00
23.567	0.985938	493025	71.11
24.495	0.987500	493800	80.00
25.503	0.989062	494586	91.43
26.703	0.990625	495359	106.67
28.223	0.992188	496144	128.00
29.183	0.992969	496531	142.22
30.063	0.993750	496926	160.00
31.071	0.994531	497313	182.86
32.287	0.995313	497705	213.33
33.695	0.996094	498101	256.00
34.495	0.996484	498290	284.44
35.551	0.996875	498484	320.00
37.055	0.997266	498681	365.71
38.655	0.997656	498876	426.67
41.311	0.998047	499073	512.00
42.271	0.998242	499169	568.89
43.743	0.998437	499265	640.00
45.055	0.998633	499364	731.43
46.303	0.998828	499461	853.33
47.583	0.999023	499559	1024.00
48.415	0.999121	499607	1137.78
49.119	0.999219	499658	1280.00
49.695	0.999316	499706	1462.86
50.431	0.999414	499754	1706.67
51.295	0.999512	499802	2048.00
51.839	0.999561	499829	2275.56
52.575	0.999609	499852	2560.00
53.311	0.999658	499876	2925.71
54.303	0.999707	499901	3413.33
54.943	0.999756	499924	4096.00
55.263	0.999780	499938	4551.11
55.487	0.999805	499950	5120.00
55.807	0.999829	499962	5851.43
56.223	0.999854	499973	6826.67
56.479	0.999878	499985	8192.00
56.671	0.999890	499992	9102.22
56.799	0.999902	500000	10240.00
56.863	0.999915	500006	11702.86
56.895	0.999927	500012	13653.33
57.055	0.999939	500016	16384.00
57.119	0.999945	500021	18204.44
57.151	0.999951	500022	20480.00
57.183	0.999957	500025	23405.71
57.375	0.999963	500029	27306.67
57.471	0.999969	500031	32768.00
57.791	0.999973	500033	36408.89

```
      58.047     0.999976       500034     40960.00
      58.303     0.999979       500036     46811.43
      58.367     0.999982       500037     54613.33
      58.495     0.999985       500039     65536.00
      58.559     0.999986       500040     72817.78
      58.559     0.999988       500040     81920.00
      58.687     0.999989       500042     93622.86
      58.687     0.999991       500042    109226.67
      58.783     0.999992       500043    131072.00
      58.783     0.999993       500043    145635.56
      58.783     0.999994       500043    163840.00
      59.007     0.999995       500044    187245.71
      59.007     0.999995       500044    218453.33
      59.199     0.999996       500045    262144.00
      59.199     0.999997       500045    291271.11
      59.199     0.999997       500045    327680.00
      59.199     0.999997       500045    374491.43
      59.199     0.999998       500045    436906.67
      59.359     0.999998       500046    524288.00
      59.359     1.000000       500046          inf
#[Mean    =        3.968, StdDeviation   =        5.201]
#[Max     =       59.328, Total count    =       500046]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  599952 requests in 1.00m, 41.88MB read
  Non-2xx or 3xx responses: 5
Requests/sec:   9998.66
```

4 Delete

4.1 stage 3

Рассмотрим результаты нагрузочного тестирования на удаление ранее записанных данных:

```
Running 2m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 7.918ms, rate sampling interval: 34ms
  Thread calibration: mean lat.: 6.620ms, rate sampling interval: 30ms
  Thread calibration: mean lat.: 6.457ms, rate sampling interval: 28ms
  Thread calibration: mean lat.: 6.742ms, rate sampling interval: 31ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     6.62ms   41.86ms   1.01s    99.49%
    Req/Sec     2.57k   604.97     8.63k    75.24%
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    2.41ms
 75.000%    5.10ms
 90.000%   10.28ms
 99.000%   20.72ms
 99.900%  801.79ms
 99.990%  993.28ms
 99.999%    1.01s
100.000%    1.01s

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.070     0.000000            1         1.00
       0.629     0.100000        80065         1.11
```

1.014	0.200000	160220	1.25
1.364	0.300000	240102	1.43
1.790	0.400000	320058	1.67
2.413	0.500000	399999	2.00
2.803	0.550000	440088	2.22
3.229	0.600000	480035	2.50
3.729	0.650000	519998	2.86
4.343	0.700000	560156	3.33
5.103	0.750000	599997	4.00
5.563	0.775000	620024	4.44
6.111	0.800000	639950	5.00
6.775	0.825000	659926	5.71
7.615	0.850000	679892	6.67
8.783	0.875000	699965	8.00
9.487	0.887500	709947	8.89
10.279	0.900000	719888	10.00
11.151	0.912500	729940	11.43
12.095	0.925000	739905	13.33
13.119	0.937500	749906	16.00
13.671	0.943750	754880	17.78
14.255	0.950000	759891	20.00
14.887	0.956250	764884	22.86
15.575	0.962500	769903	26.67
16.327	0.968750	774865	32.00
16.751	0.971875	777396	35.56
17.215	0.975000	779912	40.00
17.727	0.978125	782355	45.71
18.319	0.981250	784905	53.33
18.991	0.984375	787388	64.00
19.359	0.985938	788609	71.11
19.823	0.987500	789867	80.00
20.351	0.989062	791132	91.43
21.023	0.990625	792379	106.67
21.983	0.992188	793603	128.00
22.863	0.992969	794235	142.22
25.151	0.993750	794854	160.00
31.359	0.994531	795477	182.86
143.487	0.995313	796102	213.33
275.455	0.996094	796727	256.00
346.367	0.996484	797041	284.44
413.951	0.996875	797352	320.00
477.183	0.997266	797664	365.71
556.031	0.997656	797978	426.67
626.175	0.998047	798290	512.00
662.527	0.998242	798449	568.89
695.807	0.998437	798605	640.00
721.919	0.998633	798758	731.43
764.415	0.998828	798914	853.33
806.911	0.999023	799071	1024.00
826.879	0.999121	799149	1137.78
849.407	0.999219	799228	1280.00
869.375	0.999316	799305	1462.86
888.831	0.999414	799384	1706.67
909.823	0.999512	799461	2048.00
919.551	0.999561	799500	2275.56
929.791	0.999609	799540	2560.00
937.471	0.999658	799578	2925.71
949.247	0.999707	799618	3413.33
960.511	0.999756	799656	4096.00
966.655	0.999780	799676	4551.11

```
     972.287     0.999805       799695      5120.00
     978.431     0.999829       799716      5851.43
     983.551     0.999854       799734      6826.67
     988.671     0.999878       799755      8192.00
     991.743     0.999890       799765      9102.22
     993.791     0.999902       799776     10240.00
     995.327     0.999915       799784     11702.86
     997.887     0.999927       799793     13653.33
    1000.959     0.999939       799804     16384.00
    1001.983     0.999945       799810     18204.44
    1002.495     0.999951       799814     20480.00
    1003.519     0.999957       799818     23405.71
    1005.055     0.999963       799823     27306.67
    1006.591     0.999969       799828     32768.00
    1007.103     0.999973       799830     36408.89
    1008.127     0.999976       799833     40960.00
    1008.639     0.999979       799835     46811.43
    1009.151     0.999982       799837     54613.33
    1010.175     0.999985       799840     65536.00
    1010.687     0.999986       799842     72817.78
    1010.687     0.999988       799842     81920.00
    1011.199     0.999989       799844     93622.86
    1011.199     0.999991       799844    109226.67
    1011.711     0.999992       799845    131072.00
    1012.223     0.999993       799847    145635.56
    1012.223     0.999994       799847    163840.00
    1012.223     0.999995       799847    187245.71
    1012.735     0.999995       799850    218453.33
    1012.735     0.999996       799850    262144.00
    1012.735     0.999997       799850    291271.11
    1012.735     0.999997       799850    327680.00
    1012.735     0.999997       799850    374491.43
    1012.735     0.999998       799850    436906.67
    1012.735     0.999998       799850    524288.00
    1012.735     0.999998       799850    582542.22
    1012.735     0.999998       799850    655360.00
    1012.735     0.999999       799850    748982.86
    1013.247     0.999999       799851    873813.33
    1013.247     1.000000       799851          inf
#[Mean    =        6.617, StdDeviation   =       41.858]
#[Max     =     1012.736, Total count    =       799851]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  899861 requests in 1.50m, 63.04MB read
Requests/sec:   9998.42
Transfer/sec:    717.29KB
```

4.2 stage 2

Сравним с результатами из stage 2:

```
Running 1m test @ http://localhost:8080
  4 threads and 4 connections
  Thread calibration: mean lat.: 3.438ms, rate sampling interval: 16ms
  Thread calibration: mean lat.: 5.724ms, rate sampling interval: 27ms
  Thread calibration: mean lat.: 3.747ms, rate sampling interval: 17ms
  Thread calibration: mean lat.: 6.750ms, rate sampling interval: 32ms
  Thread Stats   Avg      Stdev     Max   +/- Stdev
    Latency     3.97ms    5.20ms  59.33ms   89.67%
    Req/Sec     2.58k   628.37     7.18k    76.17%
```

```
  Latency Distribution (HdrHistogram - Recorded Latency)
 50.000%    1.97ms
 75.000%    4.93ms
 90.000%    9.35ms
 99.000%   26.19ms
 99.900%   47.42ms
 99.990%   56.77ms
 99.999%   58.69ms
100.000%   59.36ms

  Detailed Percentile spectrum:
       Value   Percentile   TotalCount 1/(1-Percentile)

       0.073     0.000000            4         1.00
       0.564     0.100000        50008         1.11
       0.932     0.200000       100055         1.25
       1.182     0.300000       150176         1.43
       1.547     0.400000       200037         1.67
       1.967     0.500000       250035         2.00
       2.363     0.550000       275042         2.22
       2.855     0.600000       300071         2.50
       3.423     0.650000       325104         2.86
       4.103     0.700000       350105         3.33
       4.931     0.750000       375133         4.00
       5.411     0.775000       387573         4.44
       5.947     0.800000       400045         5.00
       6.563     0.825000       412601         5.71
       7.295     0.850000       425056         6.67
       8.179     0.875000       437548         8.00
       8.727     0.887500       443845         8.89
       9.351     0.900000       450066        10.00
      10.095     0.912500       456303        11.43
      10.999     0.925000       462595        13.33
      12.095     0.937500       468808        16.00
      12.759     0.943750       471954        17.78
      13.511     0.950000       475056        20.00
      14.431     0.956250       478185        22.86
      15.495     0.962500       481296        26.67
      16.927     0.968750       484421        32.00
      17.807     0.971875       486000        35.56
      18.719     0.975000       487570        40.00
      19.759     0.978125       489113        45.71
      21.039     0.981250       490680        53.33
      22.639     0.984375       492243        64.00
      23.567     0.985938       493025        71.11
      24.495     0.987500       493800        80.00
      25.503     0.989062       494586        91.43
      26.703     0.990625       495359       106.67
      28.223     0.992188       496144       128.00
      29.183     0.992969       496531       142.22
      30.063     0.993750       496926       160.00
      31.071     0.994531       497313       182.86
      32.287     0.995313       497705       213.33
      33.695     0.996094       498101       256.00
      34.495     0.996484       498290       284.44
      35.551     0.996875       498484       320.00
      37.055     0.997266       498681       365.71
      38.655     0.997656       498876       426.67
      41.311     0.998047       499073       512.00
      42.271     0.998242       499169       568.89
```

```
      43.743     0.998437       499265       640.00
      45.055     0.998633       499364       731.43
      46.303     0.998828       499461       853.33
      47.583     0.999023       499559      1024.00
      48.415     0.999121       499607      1137.78
      49.119     0.999219       499658      1280.00
      49.695     0.999316       499706      1462.86
      50.431     0.999414       499754      1706.67
      51.295     0.999512       499802      2048.00
      51.839     0.999561       499829      2275.56
      52.575     0.999609       499852      2560.00
      53.311     0.999658       499876      2925.71
      54.303     0.999707       499901      3413.33
      54.943     0.999756       499924      4096.00
      55.263     0.999780       499938      4551.11
      55.487     0.999805       499950      5120.00
      55.807     0.999829       499962      5851.43
      56.223     0.999854       499973      6826.67
      56.479     0.999878       499985      8192.00
      56.671     0.999890       499992      9102.22
      56.799     0.999902       500000     10240.00
      56.863     0.999915       500006     11702.86
      56.895     0.999927       500012     13653.33
      57.055     0.999939       500016     16384.00
      57.119     0.999945       500021     18204.44
      57.151     0.999951       500022     20480.00
      57.183     0.999957       500025     23405.71
      57.375     0.999963       500029     27306.67
      57.471     0.999969       500031     32768.00
      57.791     0.999973       500033     36408.89
      58.047     0.999976       500034     40960.00
      58.303     0.999979       500036     46811.43
      58.367     0.999982       500037     54613.33
      58.495     0.999985       500039     65536.00
      58.559     0.999986       500040     72817.78
      58.559     0.999988       500040     81920.00
      58.687     0.999989       500042     93622.86
      58.687     0.999991       500042    109226.67
      58.783     0.999992       500043    131072.00
      58.783     0.999993       500043    145635.56
      58.783     0.999994       500043    163840.00
      59.007     0.999995       500044    187245.71
      59.007     0.999995       500044    218453.33
      59.199     0.999996       500045    262144.00
      59.199     0.999997       500045    291271.11
      59.199     0.999997       500045    327680.00
      59.199     0.999997       500045    374491.43
      59.199     0.999998       500045    436906.67
      59.359     0.999998       500046    524288.00
      59.359     1.000000       500046          inf
#[Mean    =        3.968, StdDeviation   =        5.201]
#[Max     =       59.328, Total count    =       500046]
#[Buckets =           27, SubBuckets     =         2048]
----------------------------------------------------------
  599952 requests in 1.00m, 41.88MB read
  Non-2xx or 3xx responses: 5
Requests/sec:   9998.66
Transfer/sec:    714.67KB
```

5 Выводы

5.1 get empty

Максимальное ожидание для stage 3: 1001.983
Максимальное ожидание для stage 2: 95.80

5.2 put

Максимальное ожидание для stage 3: 1010.68
Максимальное ожидание для stage 2: 1002.495

5.3 get full

Максимальное ожидание для stage 3: 1013.247
Максимальное ожидание для stage 2: 59.359

5.4 delete

Максимальное ожидание для stage 3: 1013.247
Максимальное ожидание для stage 2: 59.359

5.5 В общем

Можно сделать вывод, что в реализации Stage 3 либо допущена какая-то серьезная ошибка, не нарушающая функциональности (так как тесты проходят), однако снижающая производительность на порядок, либо из-за увеличения кол-ва выполняемых действий при обработке запроса и добавления нового уровня абстракции (MemTablePool) скорость обработки запроса неминуемо увеличилась. Второй вариант маловероятен - вряд ли изменения внесённые в Stage 3 должны замедлять работу сервиса, поэтому нужно искать какие-то принципиальные ошибки в коде и исправлять их к следующим этапам.

Ещё одна большая проблема, возникшая в Stage 3 - отсутствие многопоточности в том виде, в котором она должна быть. Если посмотреть на результаты профилирования по CPU, по факту работают всего 1-2 потока. Это очень странно и неправильно и было замечено мной уже в результате написания данного отчёта.

Главный вывод - в ходе выполнения Stage 3 была допущена ошибка, понижающая производительность. Ну что сказать, буду фиксить.