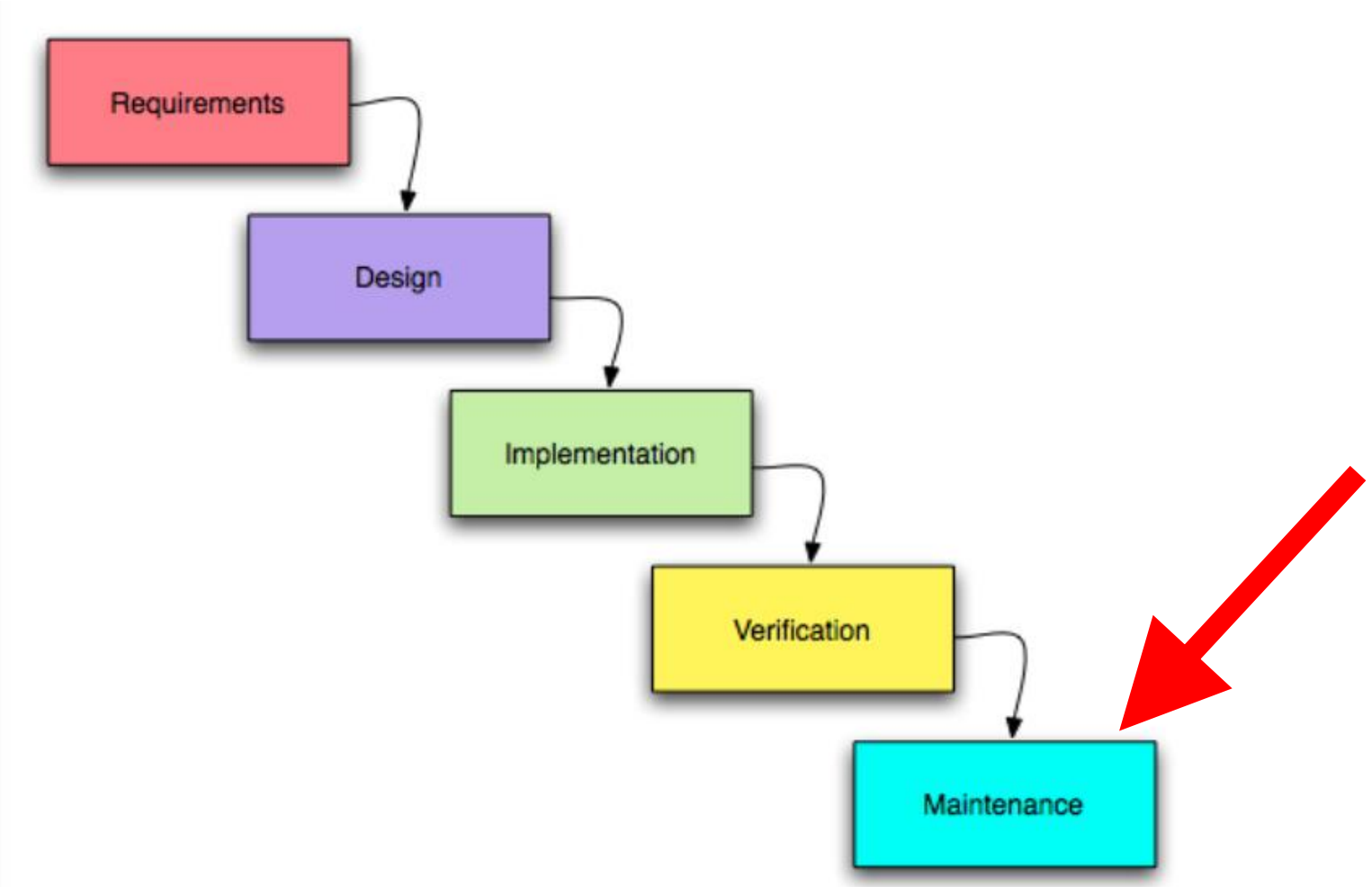
Управление производственным процессом разработки программного обеспечения

Техническая поддержка

Жизненный цикл ПО

Модель водопада [W. W. Royce, 1970]



Инструментарий

- Логгирование событий (application logs)
- Логгирование запросов (access logs)
- Трассировка запросов
- Внутренняя статистика приложения (метрики)
- Внешние мониторы
- Средства JVM для отладки приложения

Логгирование событий

```
<?xml version="1.0" encoding="UTF-8"?>
<configuration scan="true" scanPeriod="60 seconds">

    <appender name="STDOUT" class="ch.qos.logback.core.ConsoleAppender">
        <encoder>
            <pattern>%date %level [%thread] %logger{36} [%file:%line] - %msg %n</pattern>
            <charset>UTF-8</charset>
        </encoder>
    </appender>

…

    <logger name="billing" level="debug">
        <appender-ref ref="billingFileApp" />
    </logger>

    <logger name="otherChatLog" level="debug">
        <appender-ref ref="otherChatFileApp" />
    </logger>

    <logger name="net.sf.log4jdbc" additivity="false" level="info">
        <appender-ref ref="sqlFileApp" />
    </logger>

    <root>
        <level value="info" />
        <appender-ref ref="fileApp" />
        <appender-ref ref="STDOUT" />
    </root>
```

Логгирование запросов

```
[root@test]# ls -l | more
-rw-r--r--. 1 adserver adserver   1145079 Dec  5 00:00 exchange_20161204000001_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver   1019356 Dec  6 00:00 exchange_20161205000001_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver    592558 Dec  6 15:00 exchange_20161206000001_rotator-7.log.tmp.gz
-rw-r--r--. 1 adserver adserver      7083 Dec  5 00:00 geo_20161204000001_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver        77 Dec  5 00:00 geo_20161204000002_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver      5270 Dec  6 00:00 geo_20161205000001_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver        77 Dec  6 00:00 geo_20161205000002_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver        10 Dec  6 00:00 geo_20161206000001_rotator-7.log.tmp.gz
-rw-r--r--. 1 adserver adserver        10 Dec  6 00:00 geo_20161206000002_rotator-7.log.tmp.gz
-rw-r--r--. 1 adserver adserver  82221878 Dec  4 15:03 incorrect_20161204000002_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver  53043692 Dec  5 00:00 incorrect_20161204150348_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver  86537346 Dec  5 17:08 incorrect_20161205000001_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver  48959812 Dec  6 00:00 incorrect_20161205170827_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver  61770306 Dec  6 15:25 incorrect_20161206000001_rotator-7.log.tmp.gz
-rw-r--r--. 1 adserver adserver 420436531 Dec  4 00:05 stat_20161204000000_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver 479719637 Dec  4 00:10 stat_20161204000500_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver 611726753 Dec  4 00:15 stat_20161204001000_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver 648492639 Dec  4 00:20 stat_20161204001500_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver 642094862 Dec  4 00:25 stat_20161204002000_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver 652117168 Dec  4 00:30 stat_20161204002500_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver 647817685 Dec  4 00:35 stat_20161204003000_rotator-7.log.gz
-rw-r--r--. 1 adserver adserver 652128500 Dec  4 00:40 stat_20161204003500_rotator-7.log.gz
```

Трассировка

http://myserver/action?id=123&debug=true

```
#################### REQUEST (3 ms) ####################
IP                                  127.0.0.1
UUID                                ffbcc619-d57b-2740-14f6-0158d57b2740
user agent                          Mozilla/5.0 (Windows NT 10.0; WOW64) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/55.0.2883.75

#################### PRE_PROCESSING (2 ms) ####################

ROBOT DETECTION (1 ms)

FC DATA READ (2 ms)

#################### PROCESSING (1 ms) ####################

ADD BY ADSPOT (0 ms)
campaigns result                    [306357, 306358, 306359]
campaigns added                     [306357, 306358, 306359]

FILTER BY AD DIMENSIONS (0 ms)
campaigns result                    [306358, 306359]
campaigns removed                   [306357]

FILTER BY LIMITS (2 ms)
campaigns result                    [306358, 306359]
campaigns removed                       -

FILTER BY IGNORED ADS (0 ms)
campaigns result                    -
campaigns removed                   [306358, 306359]

No matched direct campaigns
```

Метрики прикладного ПО

Управлять можно только тем что можно измерить.

- Количество активных сессий
- Количество открытых соединений
- Количество подключенных клиентов
- Количество запросов в секунду

Gauge

- collection.size()

Просто и неинтересно

Counter

counter.inc() и counter.dec()

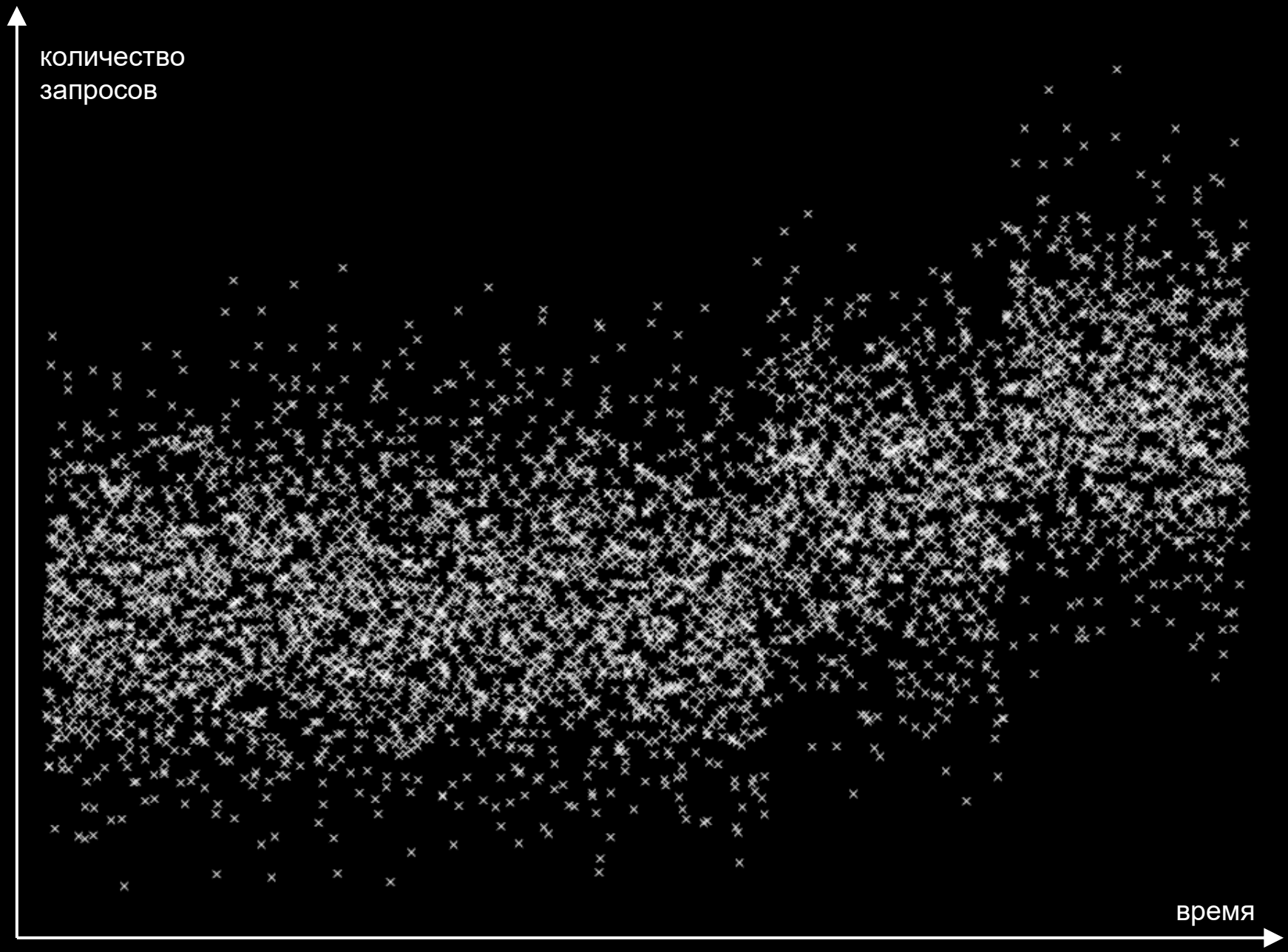
"Сейчас на сервер 215 игроков"

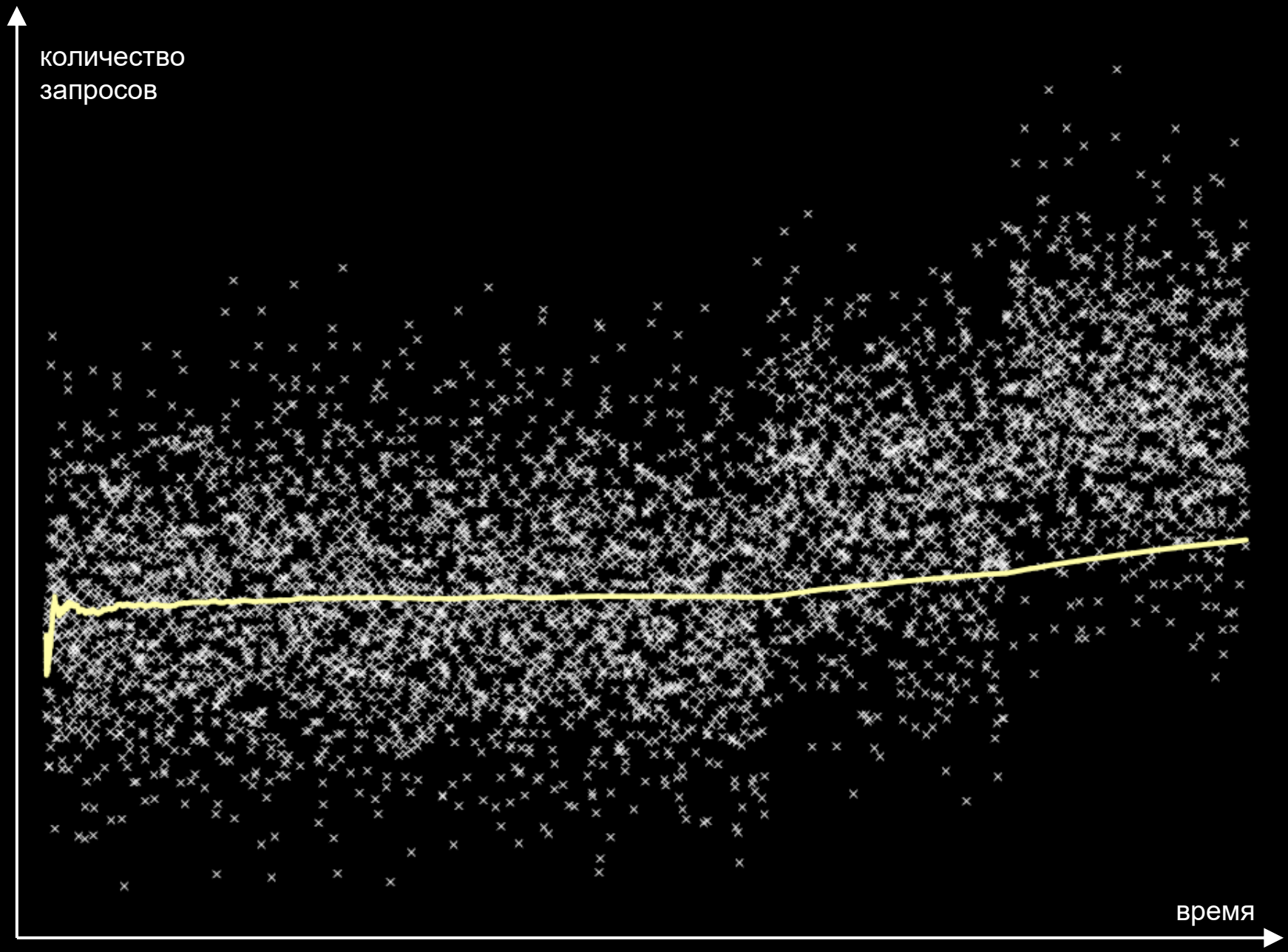
Meters

Средняя частота событий за какой-то промежуток.

- Количество запросов в секунду

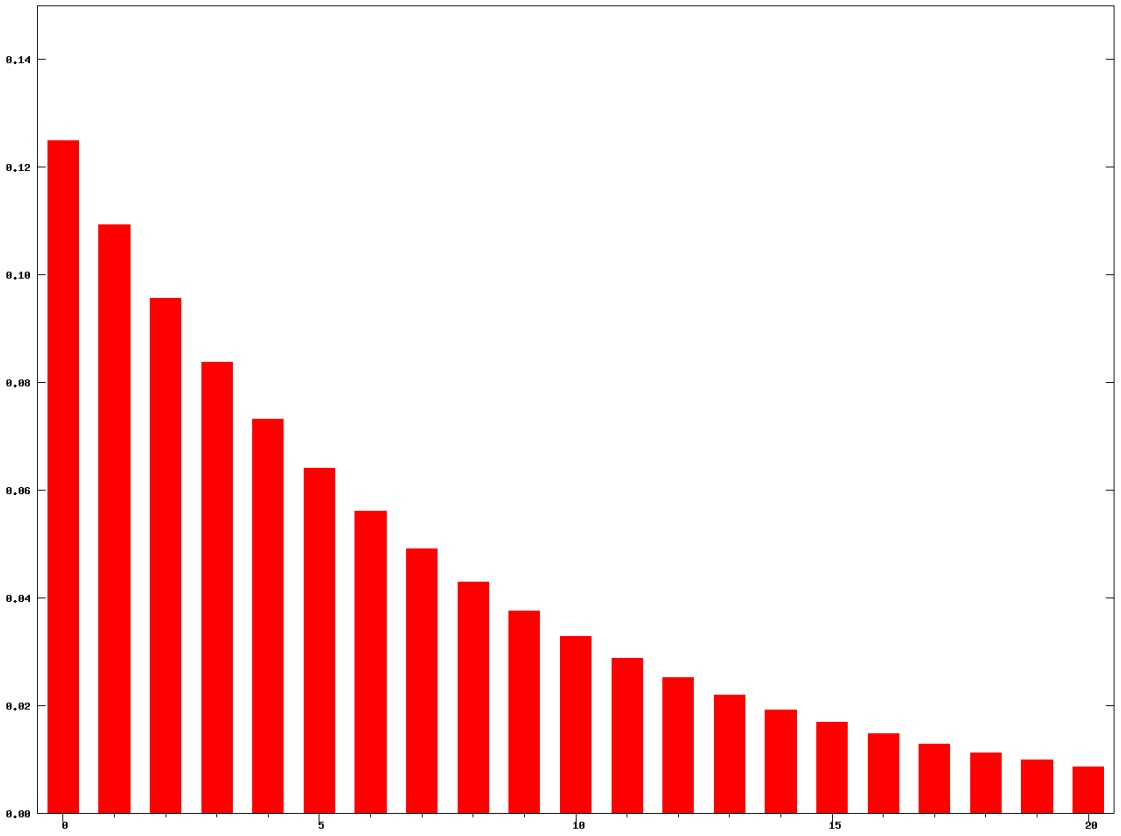
avg = requests / elapsed time

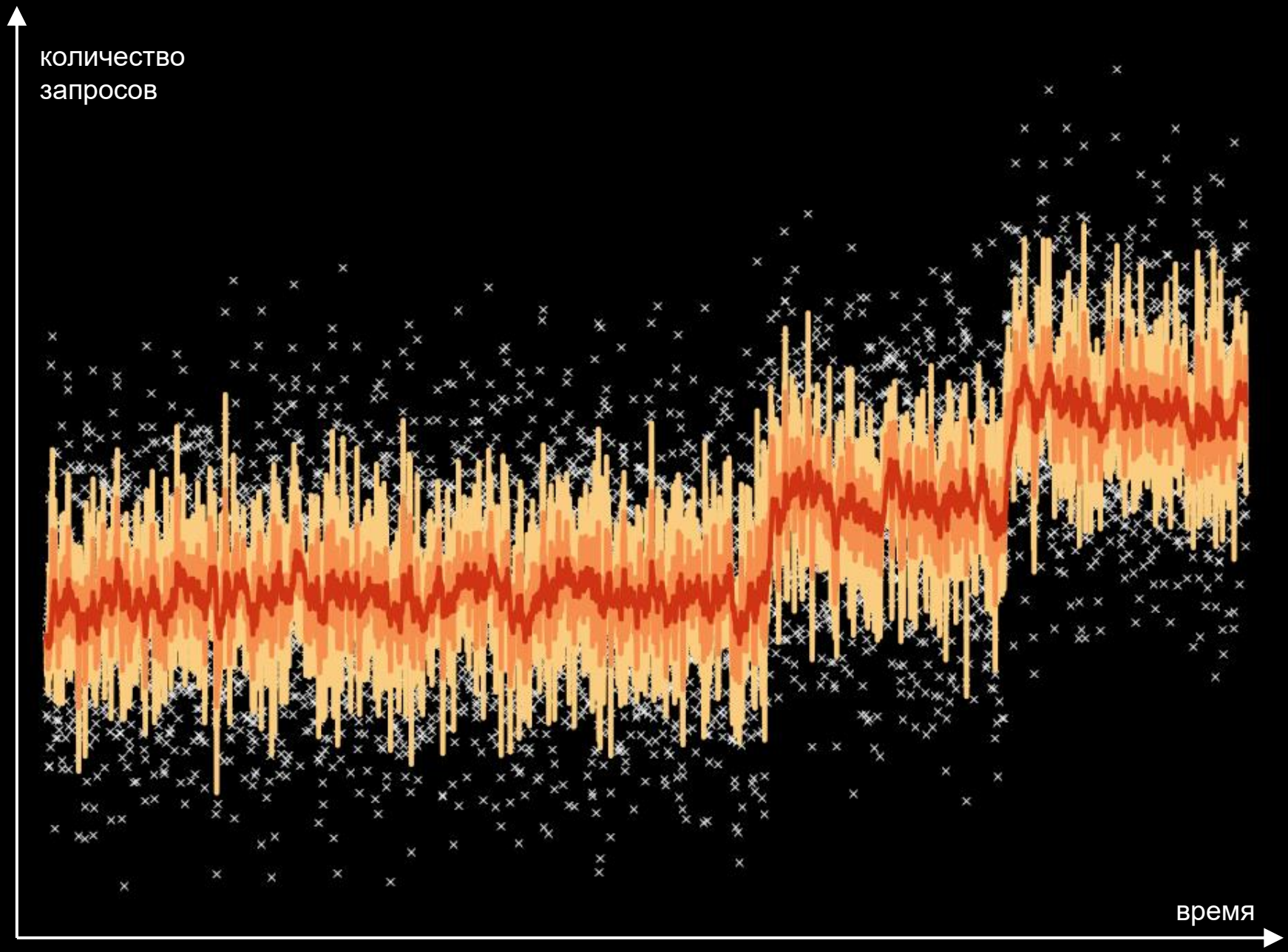

количество
запросов
время


количество
запросов
время

Экспоненциальное скользящее среднее

$$EMA_t = \alpha \cdot p_t + (1 - \alpha) \cdot EMA_{t-1},$$




количество
запросов
время

EWMA

Традиционно используются интервалы

- 1 минута
- 5 минут
- 15 минут

```
$ uptime
15:48:21 up 5 days,  1:50,  1 user,  load average: 0.13, 0.31, 0.36
```

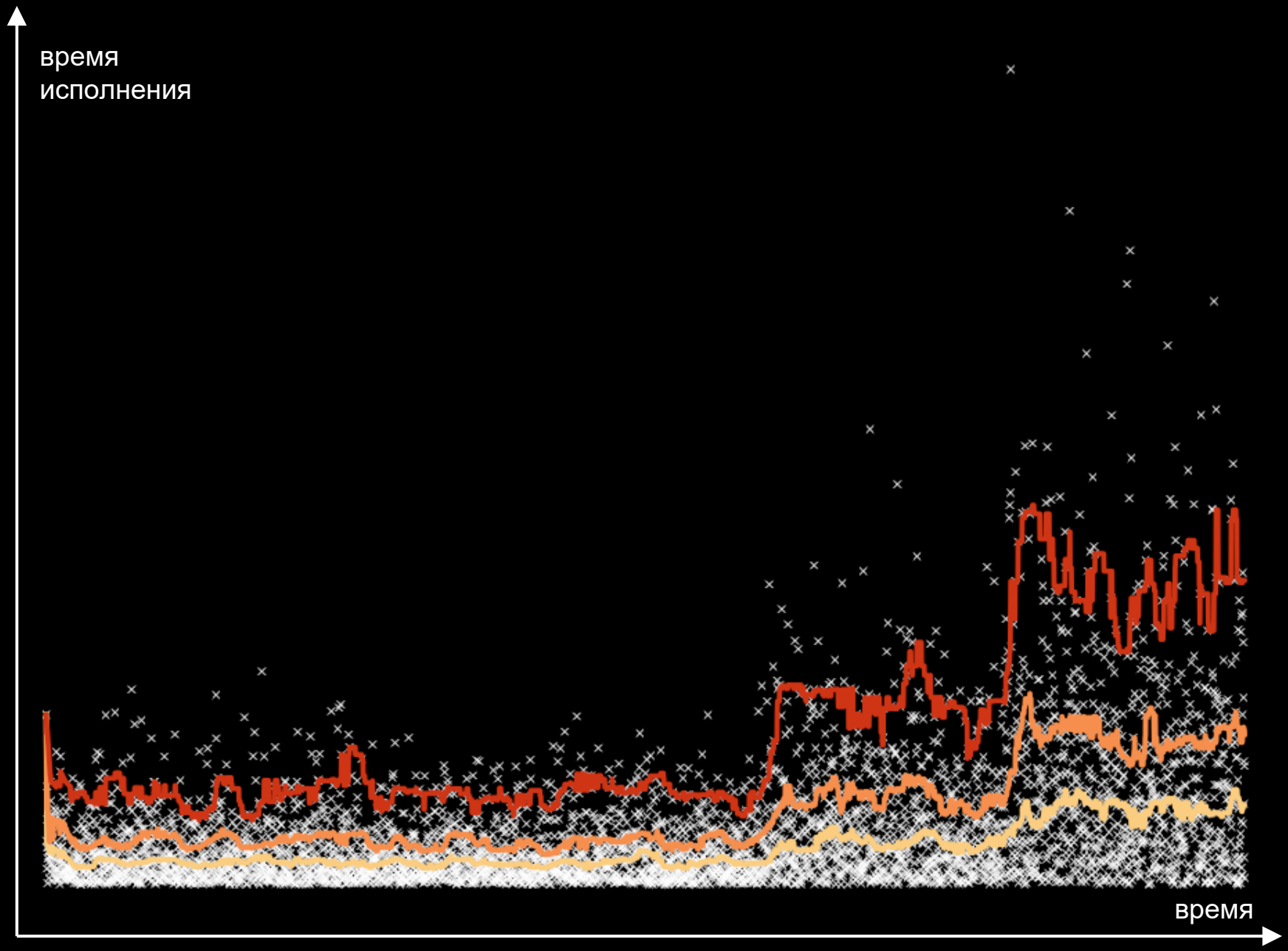
Histograms

Статистическое распределение величины в потоке данных.

- Время выполнения запросов
- Количество найденных записей
- Время проведенное в игре

Histograms

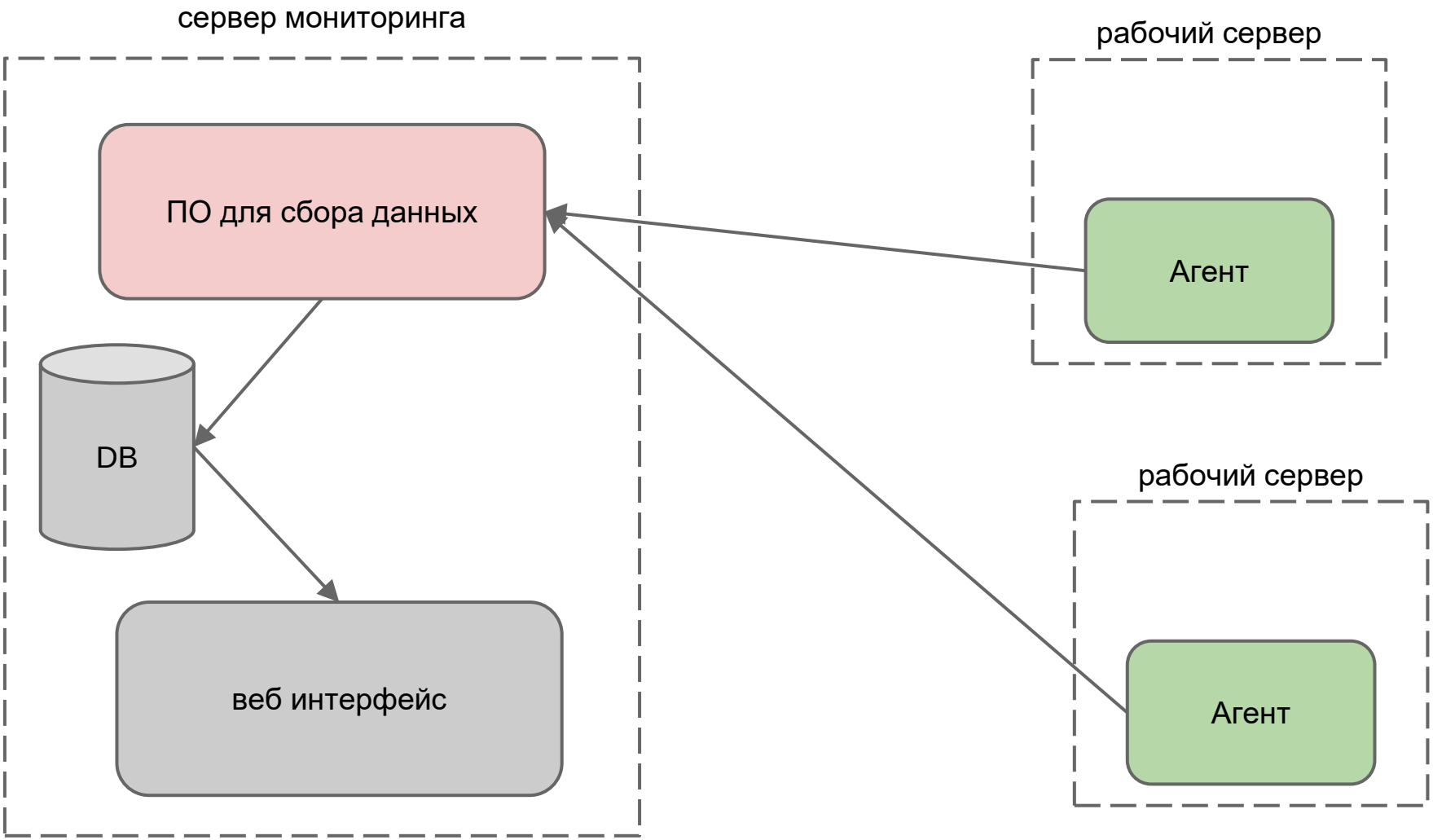
- Минимум
- Максимум
- Среднее
- Медиана
- Стандартное отклонение
- 75% перцентиль
- 80% перцентиль
- 98% перцентиль
- 99% перцентиль
- 99.9% перцентиль


время
исполнения
время

Мониторинг

Отвечает на вопрос насколько нагружена система и насколько еще ее можно нагрузить. Помогает в расследовании инцидентов.

Архитектура систем мониторинга



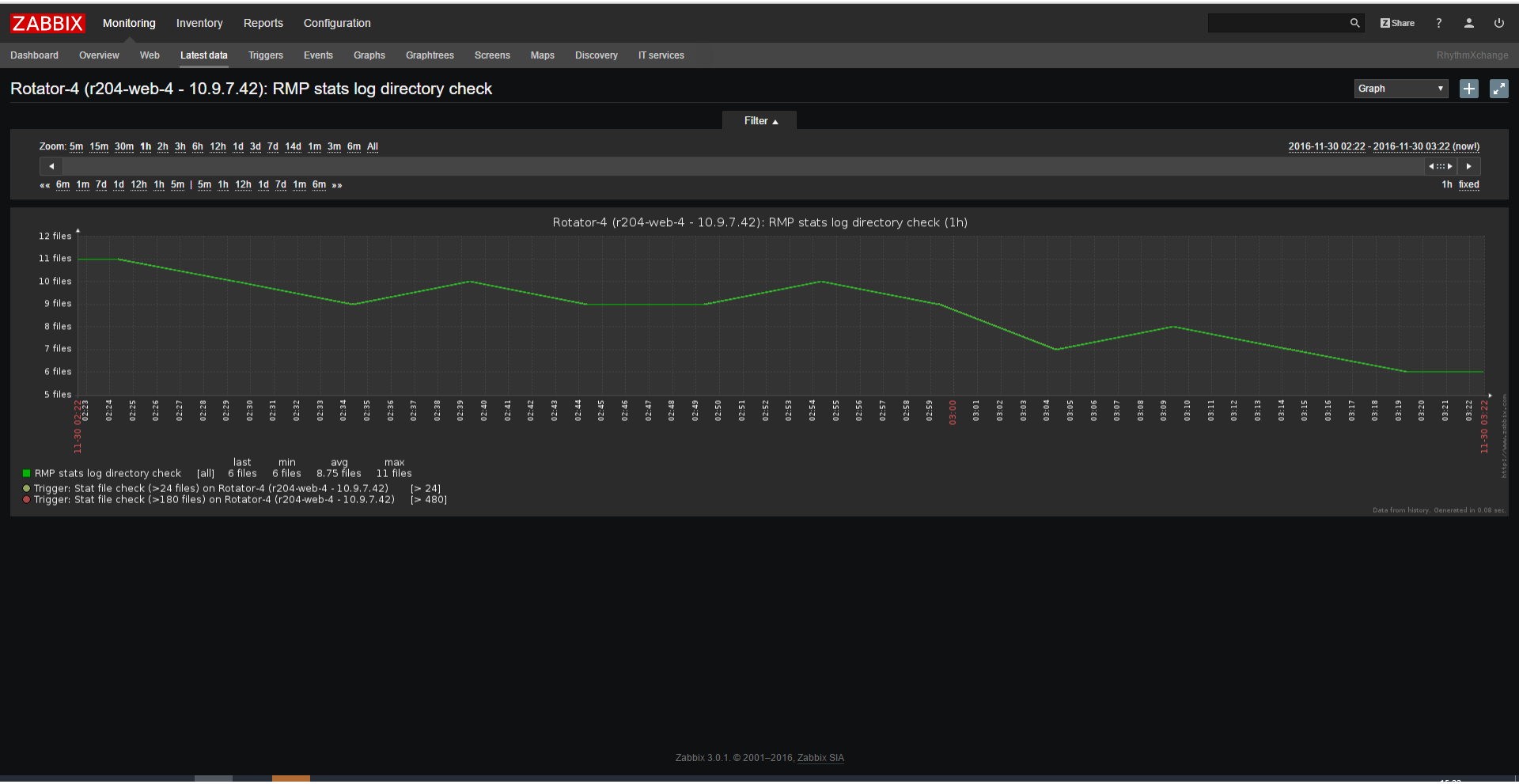
Типичные мониторы

- Используемая память
- Загрузка CPU
- Загрузка сети
- Загрузка IO
- Свободное место на дисках
- Метрики прикладного ПО (СУБД, кэши, веб серверы и т.п.)

Существующие решения

- Zabbix
- Nagios
- Cacti

Пример графика



Алерты

- Исчерпание места на диске
- Превышение максимальной нагрузки
- Остановка сервисов
- Потеря связи

Настройка алертов дело ответственное.

JVM tools

- Log JVM events
- Crash log file
- Stack trace
- Memory dump
- Profiling

Log JVM events

Log class loader events:
-verbose:class

[Loaded java.util.zip.ZipFile$ZipFileInflaterInputStream from C:\Java\jdk1.8_x64\jre\lib\rt.jar]

[Loaded org.apache.commons.io.FileUtils from file:/C:/Users/den/.gradle/caches/modules-2/files-2.1/commons-io/commons-io/1.2/ad6ae511ca4608a18317fcb19850fd113bb2ae8/commons-io-1.2.jar]

[Loaded java.io.FileFilter from C:\Java\jdk1.8_x64\jre\lib\rt.jar]

Log JVM events

Log garbage collector events:

-verbose:gc –XX:+PrintGCDetails –XX:+PrintGCTimeStamps

```
0.785: [GC [PSYoungGen: 305840K->43640K(305856K)]
      400108K->291080K(1004928K), 0.2197630 secs]
      [Times: user=0.56 sys=0.03, real=0.22 secs]

1.100: [GC [PSYoungGen: 164752K->43632K(305856K)]
      412192K->340488K(1004928K), 0.0878209 secs]
      [Times: user=0.37 sys=0.00, real=0.09 secs]

1.188: [Full GC (System) [PSYoungGen: 43632K->0K(305856K)]
      [PSOldGen: 296856K->340433K(699072K)]
      340488K->340433K(1004928K)
      [PSPermGen: 1554K->1554K(16384K)], 0.4053311 secs]
      [Times: user=0.41 sys=0.00, real=0.40 secs]
```

Crash log file

[root@test]# more hs_err_pid116018.log
#
There is insufficient memory for the Java Runtime Environment to continue.
Native memory allocation (mmap) failed to map 12288 bytes for committing reserved memory.
...
JRE version: Java(TM) SE Runtime Environment (8.0_51-b16) (build 1.8.0_51-b16)
Java VM: Java HotSpot(TM) 64-Bit Server VM (25.51-b03 mixed mode linux-amd64)
Failed to write core dump. Core dumps have been disabled. To enable core dumping, try "ulimit -c unlimited" before startin
g Java again
#
--------------- T H R E A D ---------------

Current thread (0x00007f0dde330000): JavaThread "pool-7-thread-24602" [_thread_new, id=68854, stack(0x00007f092a347000,0x00
007f092a380000)]

Stack: [0x00007f092a347000,0x00007f092a380000], sp=0x00007f092a37e9c0, free space=222k
Native frames: (J=compiled Java code, j=interpreted, Vv=VM code, C=native code)
V [libjvm.so+0xaaccfa] VMError::report_and_die()+0x2ba
…
--------------- P R O C E S S ---------------

Java Threads: (=> current thread)
=>0x00007f0dde330000 JavaThread "pool-7-thread-24602" [_thread_new, id=68854, stack(0x00007f092a347000,0x00007f092a380000)]
  0x00007f0dde32e000 JavaThread "pool-7-thread-24601" [_thread_blocked, id=68853, stack(0x00007f092a380000,0x00007f092a3b900
0)]
….

Stack trace

kill -3 <pid>

jstack <pid>

jstack –F <pid>

Stack trace

Full thread dump Java HotSpot(TM) 64-Bit Server VM (24.75-b04 mixed mode):

"WidgetUpdate-5770" daemon prio=10 tid=0x00007fab1c0c1800 nid=0x3a16 waiting on condition [0x00007fab3a517000]
   java.lang.Thread.State: WAITING (parking)
        at sun.misc.Unsafe.park(Native Method)
        - parking to wait for <0x00000006d0873d10> (a java.util.concurrent.locks.AbstractQueuedSynchronizer$ConditionObject)
        at java.util.concurrent.locks.LockSupport.park(LockSupport.java:186)
…
"http-bio-127.0.0.1-8080-exec-96" daemon prio=10 tid=0x00007faa7c09d000 nid=0x51e4 waiting on condition [0x00007fab3b1a3000]
   java.lang.Thread.State: WAITING (parking)
        at sun.misc.Unsafe.park(Native Method)
        - parking to wait for <0x00000006c9d86698> (a java.util.concurrent.locks.AbstractQueuedSynchronizer$ConditionObject)
        at java.util.concurrent.locks.LockSupport.park(LockSupport.java:186)
        at java.util.concurrent.locks.AbstractQueuedSynchronizer$ConditionObject.await(AbstractQueuedSynchronizer.java:2043)
        at java.util.concurrent.LinkedBlockingQueue.take(LinkedBlockingQueue.java:442)
        at org.apache.tomcat.util.threads.TaskQueue.take(TaskQueue.java:104)
        at org.apache.tomcat.util.threads.TaskQueue.take(TaskQueue.java:32)
        at java.util.concurrent.ThreadPoolExecutor.getTask(ThreadPoolExecutor.java:1068)
        at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1130)
        at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:615)
        at java.lang.Thread.run(Thread.java:745)

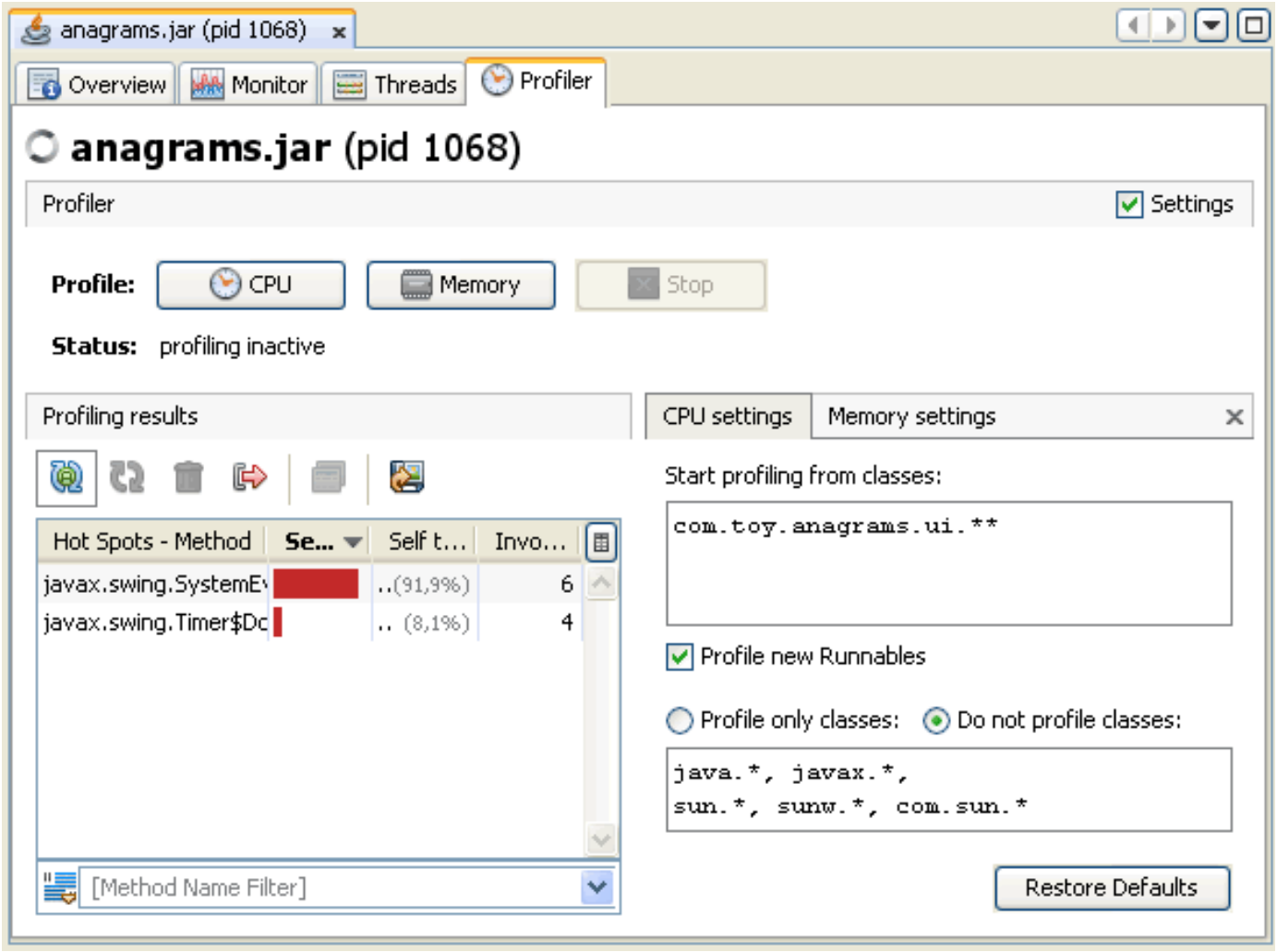
Memory dump

jmap –histo:live <pid>

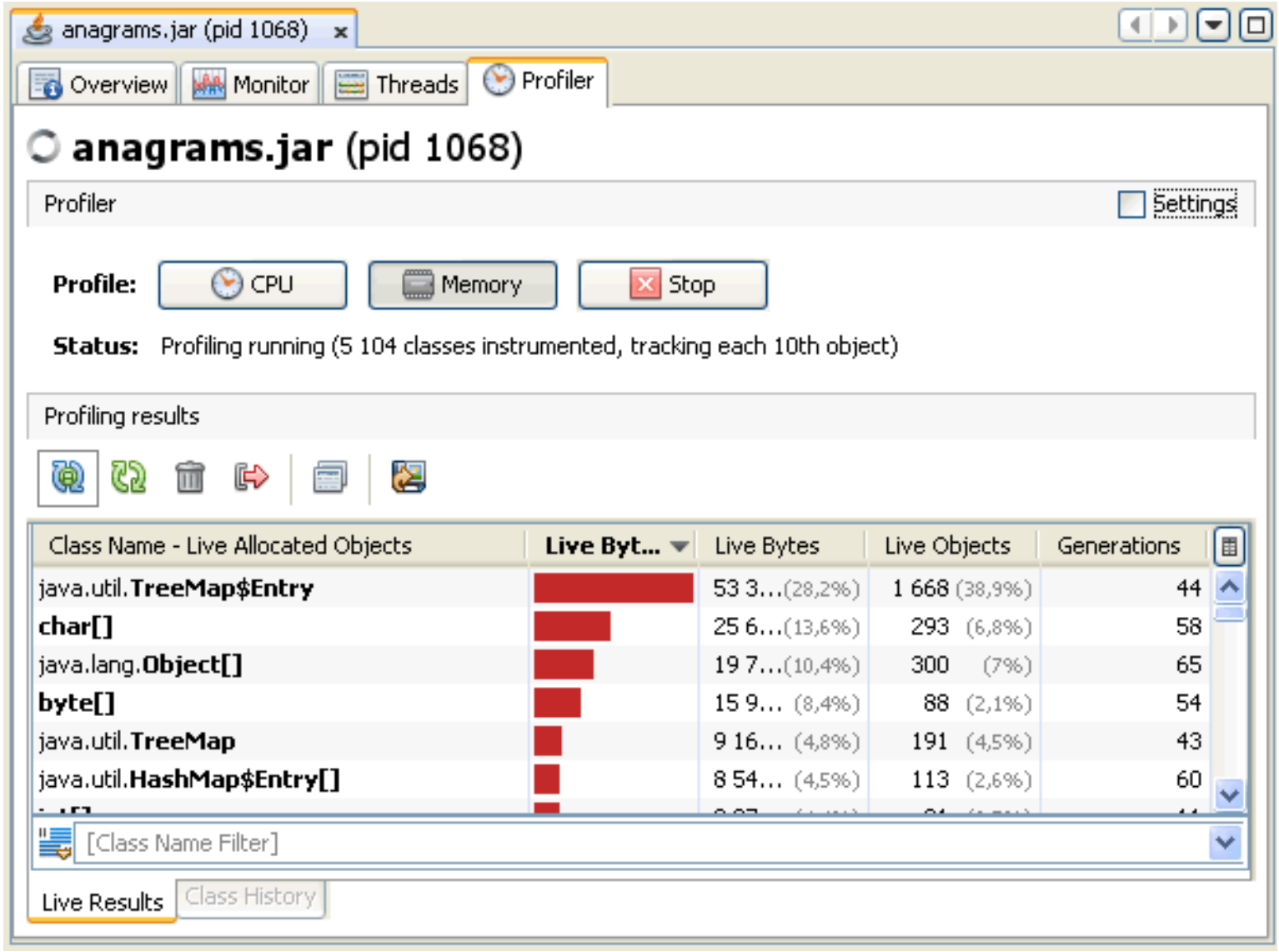
```
 num     #instances         #bytes  class name
----------------------------------------------
   1:       7227553      486659904  [C
   2:         73776      318542064  [B
   3:       4271465      307545480  net.sf.ehcache.Element
   4:       4088350      224451200  [Ljava.io.Serializable;
   5:       7219958      173278992  java.lang.String
   6:       4271464      170858560  net.sf.ehcache.store.chm.SelectableConcurrentHashMap$HashEntry
   7:       4691198      150118336  org.hibernate.cache.spi.CacheKey
   8:       4271465      136686880  net.sf.ehcache.DefaultElementEvictionData
   9:       3833903      122684896
org.hibernate.cache.ehcache.internal.strategy.AbstractReadWriteEhcacheAccessStr
ategy$Item
  10:       3692365      118155680  java.sql.Timestamp
  11:       5478141       87650256  java.lang.Integer
  12:       2324741       74391712  org.hibernate.cache.spi.entry.StandardCacheEntryImpl
…
10341:             1             16  java.security.ProtectionDomain$1
10342:             1             16  sun.reflect.GeneratedMethodAccessor1407
10343:             1             16  org.apache.wicket.resource.loader.ClassStringResourceLoader
10344:             1             16  sun.reflect.GeneratedSerializationConstructorAccessor464
Total      67947402     3065619552
```

Profiling

jvisualvm.exe

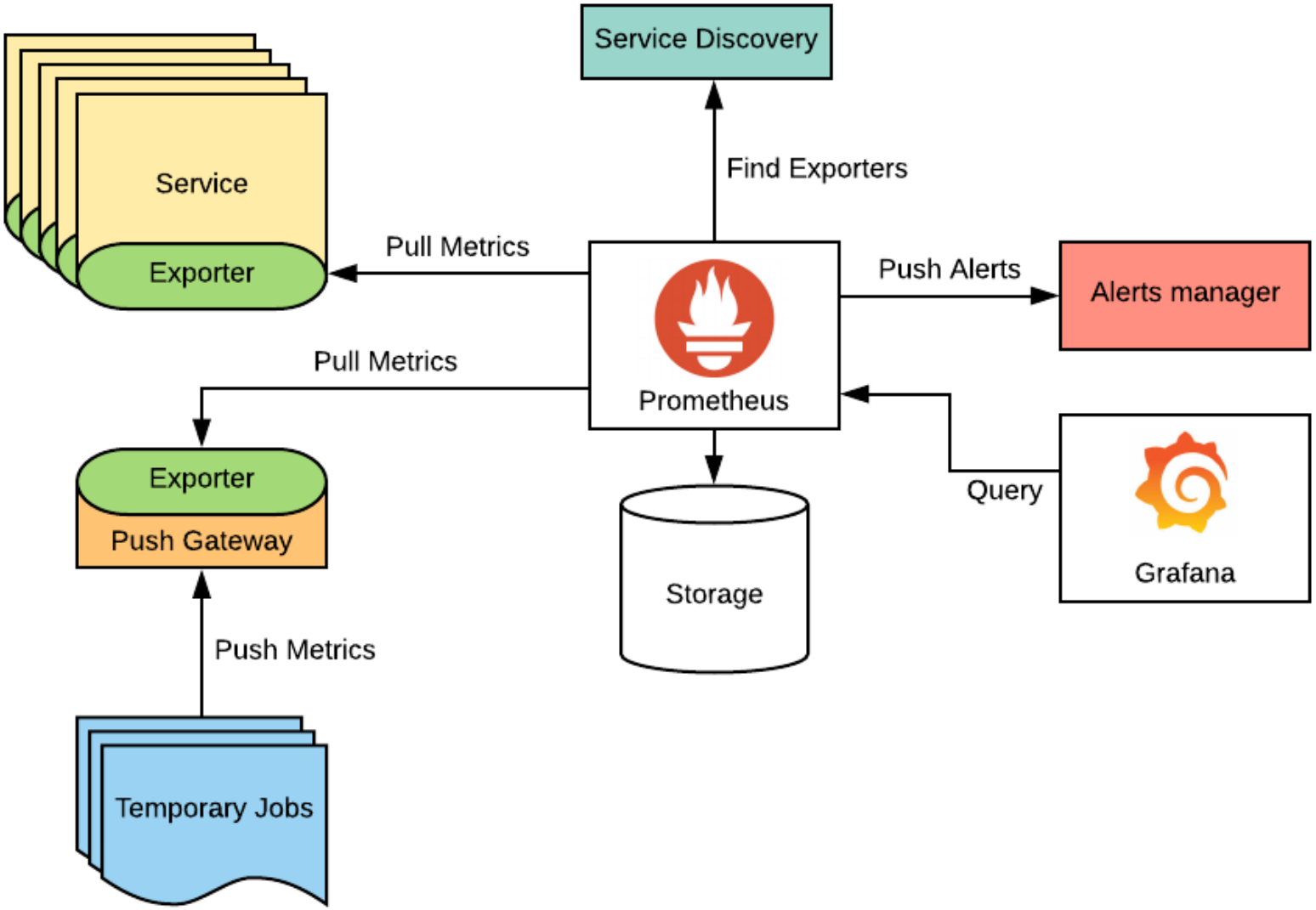


Profiling

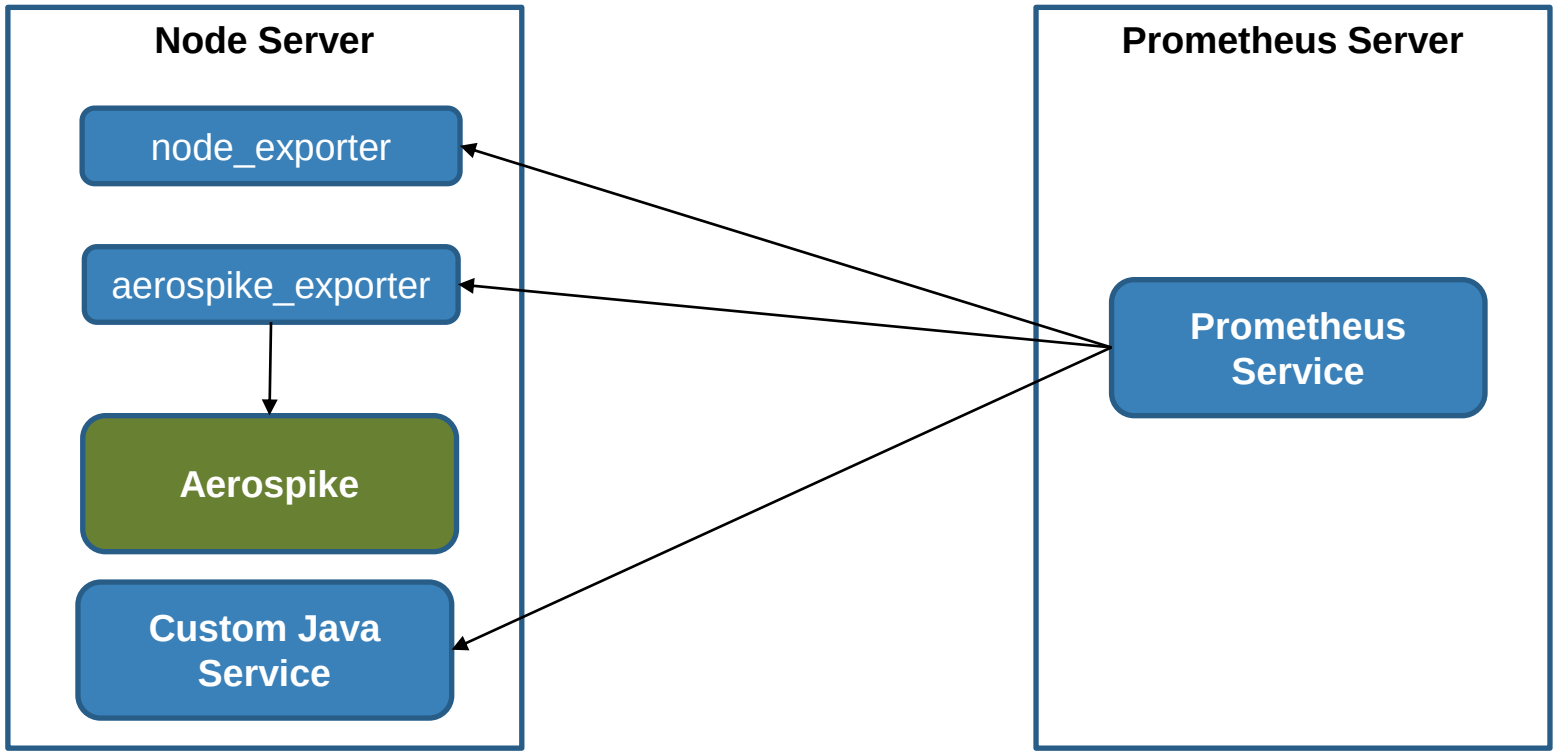

anagrams.jar (pid 1068)
Overview
Monitor
Threads
Profiler
anagrams.jar (pid 1068)
Profiler
Settings
Profile:
CPU
Memory
Stop
Status: Profiling running (5 104 classes instrumented, tracking each 10th object)
Profiling results
Class Name - Live Allocated Objects
Live Byt...
Live Bytes
Live Objects
Generations
java.util.TreeMap$Entry 53 3...(28,2%) 1 668 (38,9%) 44
char[] 25 6...(13,6%) 293 (6,8%) 58
java.lang.Object[] 19 7...(10,4%) 300 (7%) 65
byte[] 15 9... (8,4%) 88 (2,1%) 54
java.util.TreeMap 9 16... (4,8%) 191 (4,5%) 43
java.util.HashMap$Entry[] 8 54... (4,5%) 113 (2,6%) 60
[Class Name Filter]
Live Results
Class History

Prometheus + Grafana monitoring

Prometheus overview



Prometheus exporters



[root@prod-aerospike ec2-user]# **rpm -q -a | grep exporter**
node_exporter-0.18.1-1.el7.centos.x86_64

[root@prod-aerospike ec2-user]# **netstat -nap | grep LIST | grep expo**
tcp6 0 0 :::9100 :::* LISTEN 3097/node_exporter
tcp6 0 0 :::9145 :::* LISTEN 3096/aerospike_exporter

Access to the Prometheus node_exporter

[root@prometheus ec2-user]# **curl -s http://172.31.31.11:9100/metrics | grep node_cpu_seconds | more**
HELP node_cpu_seconds_total Seconds the cpus spent in each mode.
TYPE node_cpu_seconds_total counter
node_cpu_seconds_total{cpu="0",mode="idle"} 373185.27
node_cpu_seconds_total{cpu="0",mode="iowait"} 11.44
node_cpu_seconds_total{cpu="0",mode="irq"} 0
node_cpu_seconds_total{cpu="0",mode="nice"} 1.53
node_cpu_seconds_total{cpu="0",mode="softirq"} 201512.87
node_cpu_seconds_total{cpu="0",mode="steal"} 1.84
node_cpu_seconds_total{cpu="0",mode="system"} 205255.32
node_cpu_seconds_total{cpu="0",mode="user"} 465693.13
node_cpu_seconds_total{cpu="1",mode="idle"} 351126.77
node_cpu_seconds_total{cpu="1",mode="iowait"} 4.35
node_cpu_seconds_total{cpu="1",mode="irq"} 0
node_cpu_seconds_total{cpu="1",mode="nice"} 0.76
node_cpu_seconds_total{cpu="1",mode="softirq"} 201182.12
node_cpu_seconds_total{cpu="1",mode="steal"} 16.17
node_cpu_seconds_total{cpu="1",mode="system"} 195823.34
node_cpu_seconds_total{cpu="1",mode="user"} 497526.93
node_cpu_seconds_total{cpu="2",mode="idle"} 347874.86
node_cpu_seconds_total{cpu="2",mode="iowait"} 11.52
node_cpu_seconds_total{cpu="2",mode="irq"} 0
node_cpu_seconds_total{cpu="2",mode="nice"} 0.98
node_cpu_seconds_total{cpu="2",mode="softirq"} 200966.77
node_cpu_seconds_total{cpu="2",mode="steal"} 6.5
node_cpu_seconds_total{cpu="2",mode="system"} 191849.47
node_cpu_seconds_total{cpu="2",mode="user"} 505228.47

Access to the Prometheus existed exporter

[root@prod-prometheus ec2-user]# **curl -s http://172.31.31.11:9145/metrics | more**
HELP aerospike_latency_hist_read_bucket read latency histogram
TYPE aerospike_latency_hist_read_bucket gauge
aerospike_latency_hist_read_bucket{le="+Inf",namespace="dictionary"} 2191.9
aerospike_latency_hist_read_bucket{le="+Inf",namespace="session"} 0
aerospike_latency_hist_read_bucket{le="+Inf",namespace="userdata"} 14812.9
aerospike_latency_hist_read_bucket{le="1",namespace="dictionary"} 2191.9
aerospike_latency_hist_read_bucket{le="1",namespace="session"} 0
aerospike_latency_hist_read_bucket{le="1",namespace="userdata"} 14790.68065
aerospike_latency_hist_read_bucket{le="64",namespace="dictionary"} 2191.9
aerospike_latency_hist_read_bucket{le="64",namespace="session"} 0
aerospike_latency_hist_read_bucket{le="64",namespace="userdata"} 14812.9
aerospike_latency_hist_read_bucket{le="8",namespace="dictionary"} 2191.9
aerospike_latency_hist_read_bucket{le="8",namespace="session"} 0
aerospike_latency_hist_read_bucket{le="8",namespace="userdata"} 14812.9
HELP aerospike_latency_hist_read_count read ops per second for histogram
TYPE aerospike_latency_hist_read_count gauge
aerospike_latency_hist_read_count{namespace="dictionary"} 2191.9
aerospike_latency_hist_read_count{namespace="session"} 0
aerospike_latency_hist_read_count{namespace="userdata"} 14812.9

Access to the Prometheus custom exporter

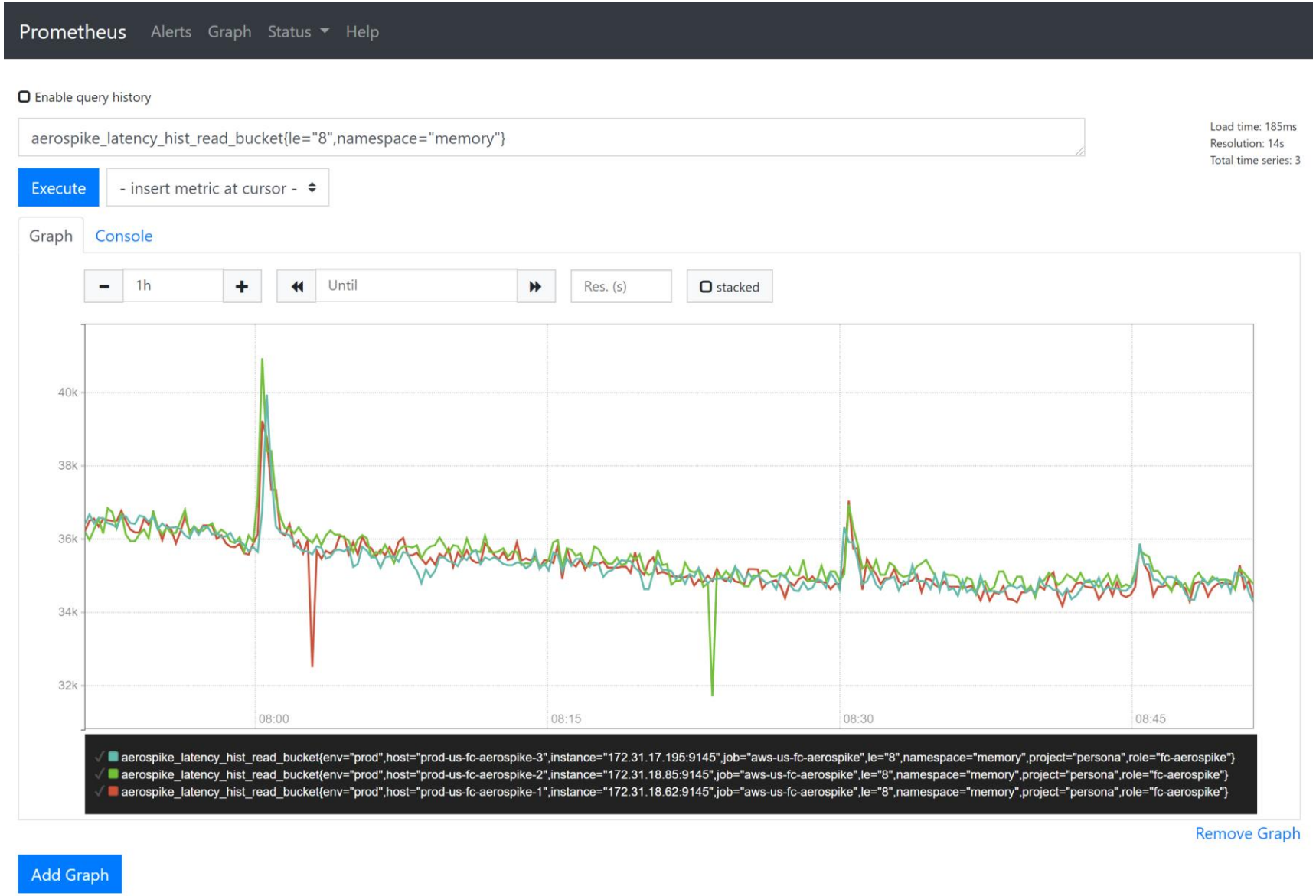
[root@prod-prometheus ec2-user]# **curl -s http://172.31.30.121/metrics/prometheus | more**
bidder_rates_Request_rate 826.62
bidder_rates_UnsupportedHttpMethod_rate 0.00
bidder_rates_UnknownError_rate 0.00
bidder_rates_BidRequest_rate 822.82
bidder_rates_PmmlRequest_rate 66.08
bidder_rates_Gdpr_rate 171.27
bidder_rates_LossRequest_rate 4.06
bidder_rates_WinRequest_rate 0.00
bidder_rates_ImpressionRequest_rate 0.00
bidder_rates_BUrl_rate 0.00
bidder_rates_ClickRequest_rate 0.00
bidder_rates_AppEventRedirectedToInstall_rate 0.00
bidder_rates_InstallRequest_rate 0.00
bidder_rates_InstallNoDetails_rate 0.00
bidder_rates_InstallError_rate 0.00
bidder_rates_RenderRequest_rate 0.00
bidder_rates_IncorrectSSP_rate 0.00
bidder_rates_EmptyTrackingData_rate 0.00
bidder_rates_CountryMismatch_rate 2.41
bidder_rates_AppEventRequest_rate 0.00
bidder_rates_NoBidResponse_rate 819.90
bidder_rates_BidResponse_rate 3.49
bidder_rates_GzipRequest_rate 124.25
bidder_rates_GzipResponse_rate 3.49

Configure Prometheus to access exporters

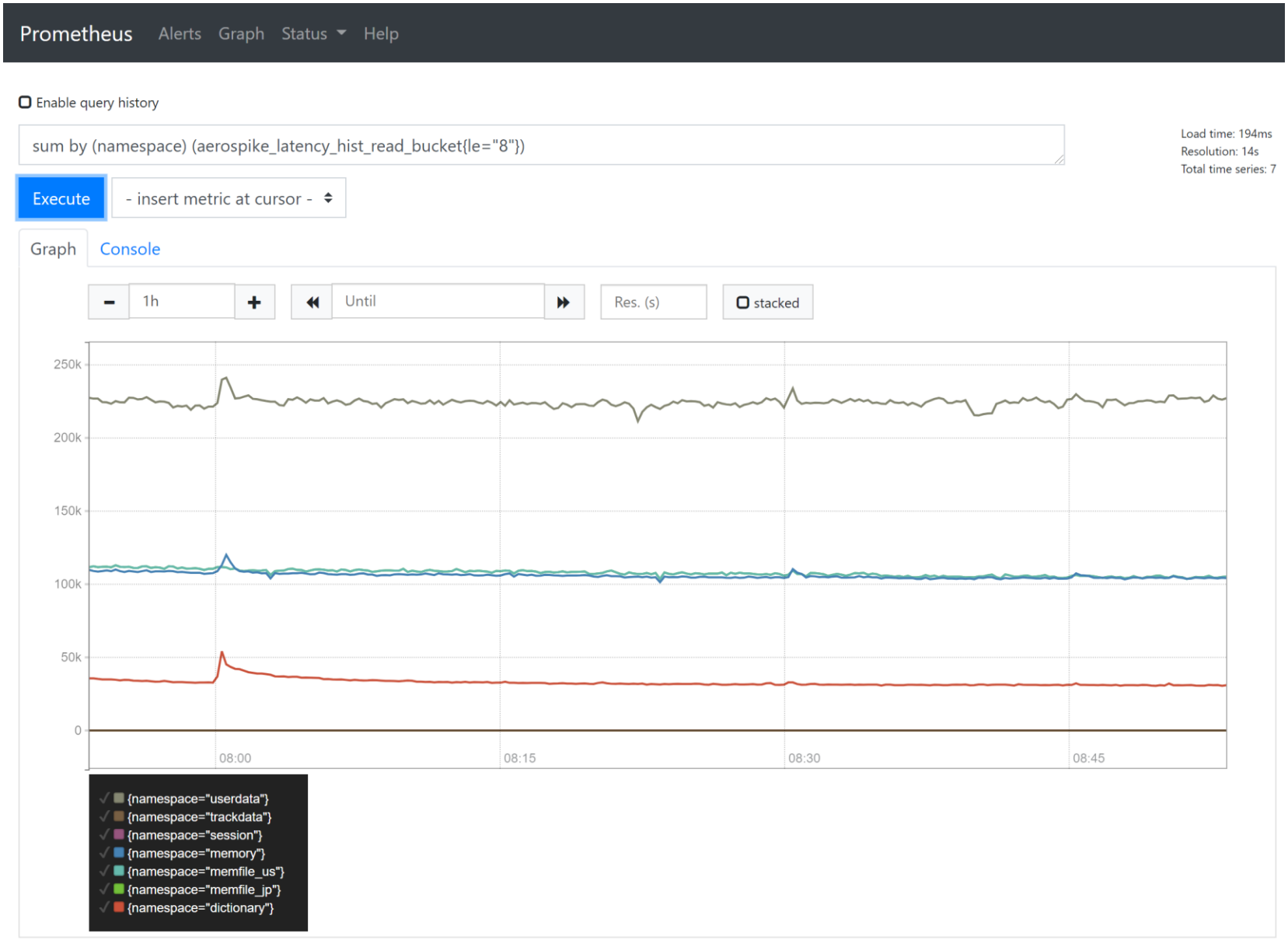
[root@prod-prometheus ec2-user]# **cat /etc/prometheus.yml | more**

```
rule_files:
  - "haproxy-us.rules"
  - "aerospike.rules"

alerting:
  alertmanagers:
  - scheme: http
    static_configs:
    - targets:
      - "alertmanager:9093"

scrape_configs:
  - job_name: 'prometheus'
    scrape_interval: 15s
    scrape_timeout: 5s

 - job_name: aws-us-cluster
    ec2_sd_configs:
      - region: us-east-1
        port: 9100
    relabel_configs:
      - action: keep
        source_labels: [__meta_ec2_instance_state]
        regex: running
      - action: replace
        source_labels: [__meta_ec2_tag_Role]
        target_label: role
        replacement: $1
```

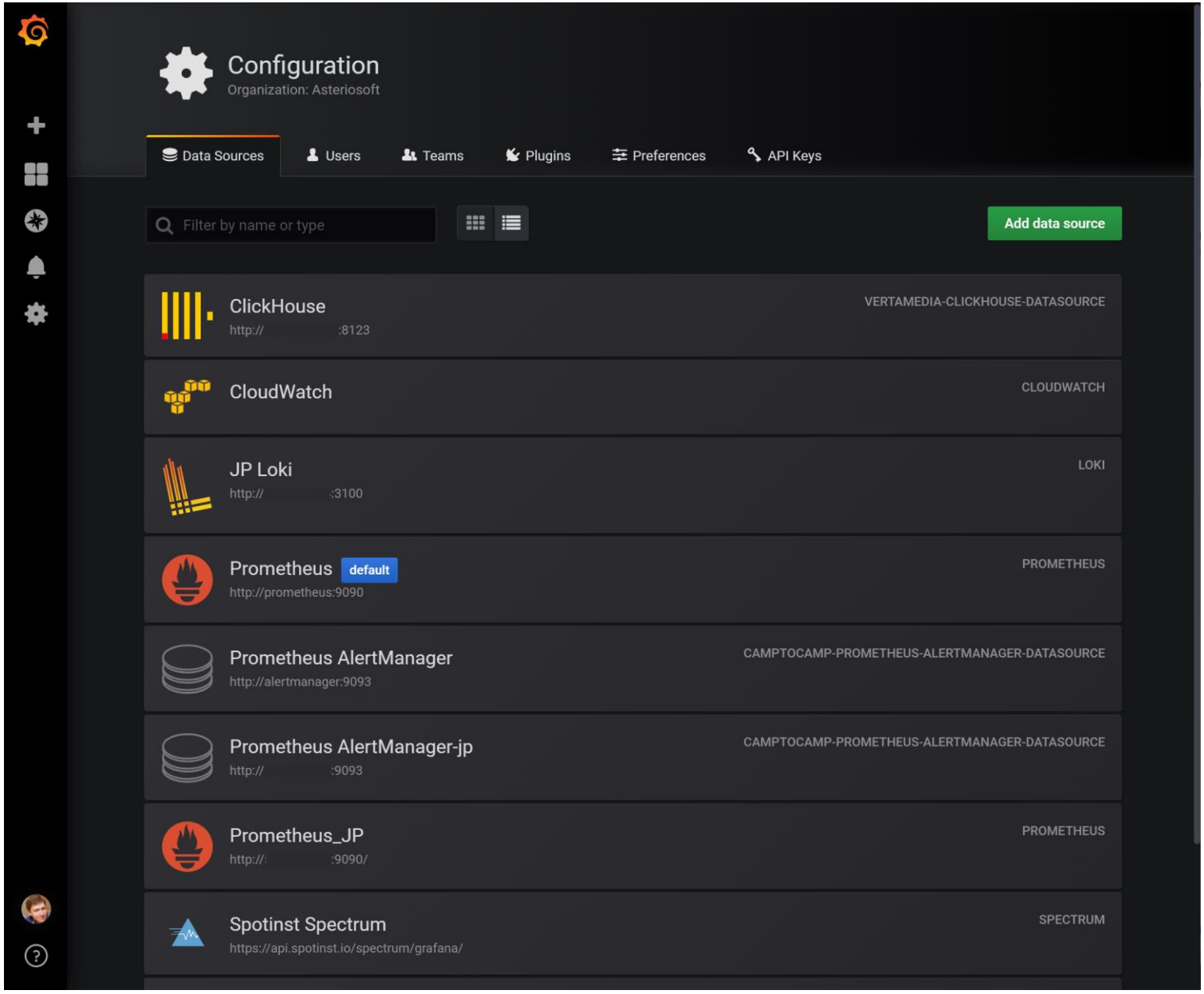
Query Prometheus



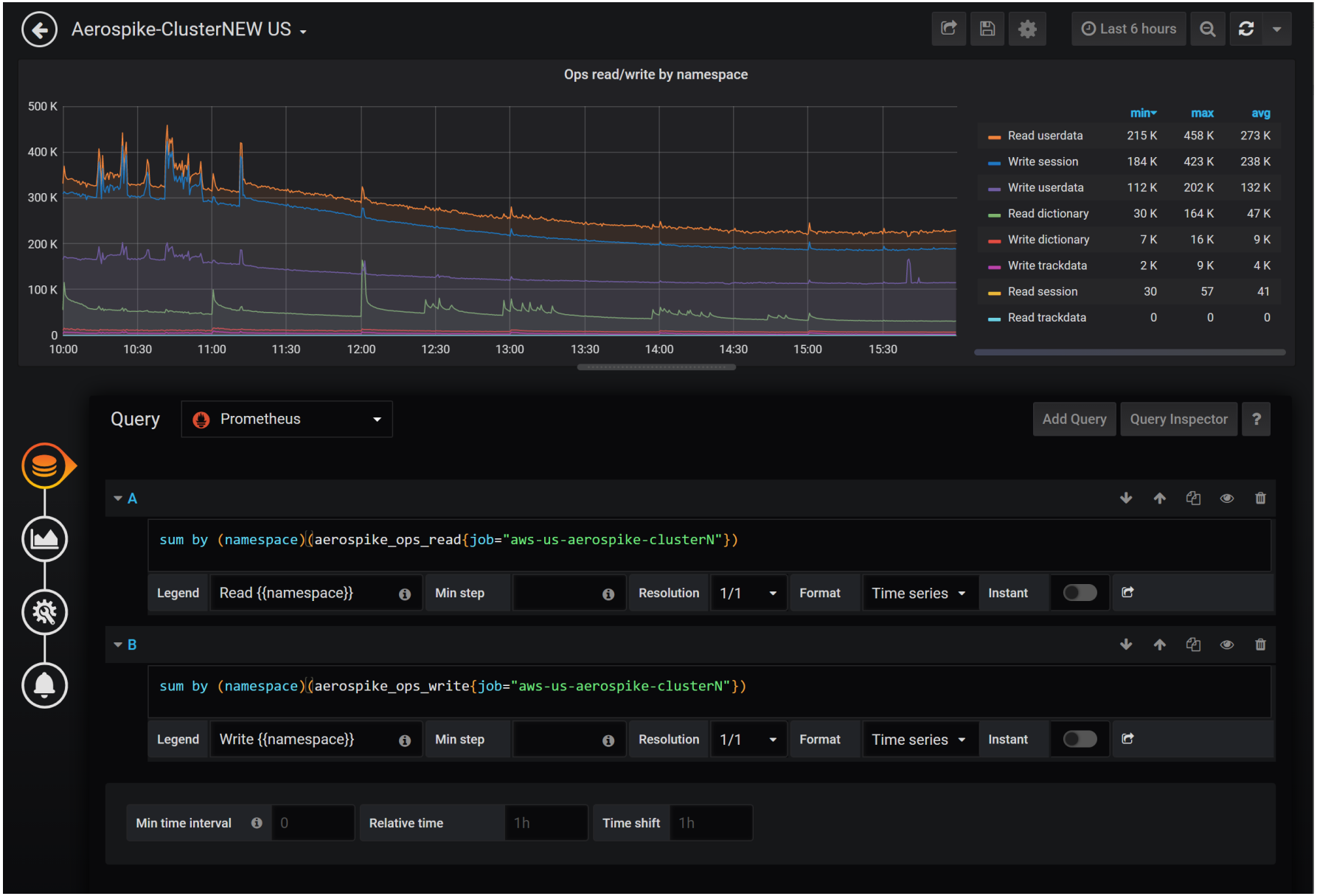
Query Prometheus



Attach Grafana



Use Grafana


Aerospike-ClusterNEW US
Last 6 hours
Ops read/write by namespace
500 K
400 K
300 K
200 K
100 K
0
10:00
10:30
11:00
11:30
12:00
12:30
13:00
13:30
14:00
14:30
15:00
15:30
min
max
avg
Read userdata 215 K 458 K 273 K
Write session 184 K 423 K 238 K
Write userdata 112 K 202 K 132 K
Read dictionary 30 K 164 K 47 K
Write dictionary 7 K 16 K 9 K
Write trackdata 2 K 9 K 4 K
Read session 30 57 41
Read trackdata 0 0 0
Query
Prometheus
Add Query
Query Inspector
A
sum by (namespace)(aerospike_ops_read{job="aws-us-aerospike-clusterN"})
Legend
Read {{namespace}}
Min step
Resolution
1/1
Format
Time series
Instant
B
sum by (namespace)(aerospike_ops_write{job="aws-us-aerospike-clusterN"})
Legend
Write {{namespace}}
Min step
Resolution
1/1
Format
Time series
Instant
Min time interval
0
Relative time
1h
Time shift
1h

Use Grafana


Aerospike-ClusterNEW US
Last 6 hours
Disk IO usage
100%
90%
80%
70%
60%
50%
40%
30%
10:30
11:00
11:30
12:00
12:30
13:00
13:30
14:00
14:30
15:00
15:30
16:00
min
max
current
172.31.31.11:9100 45% 76% 48%
172.31.31.12:9100 46% 74% 53%
172.31.31.13:9100 47% 80% 52%
172.31.31.14:9100 60% 90% 65%
172.31.31.15:9100 58% 89% 63%
172.31.31.16:9100 35% 80% 39%
172.31.31.17:9100 36% 88% 41%
172.31.31.18:9100 36% 87% 41%
172.31.31.19:9100 45% 74% 50%
Query
Prometheus
Add Query
Query Inspector
A
(max(irate(node_disk_io_time_seconds_total{job="aws-us-aerospike-clusterN_exporter",device="nvme3n1"}[10m])) by (instance, device))*100
Legend
{{instance}}
Min step
Resolution
1/1
Format
Time series
Instant
Min time interval
0
Relative time
1h
Time shift
1h