UniIO Performance Scripts

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install

```
$ git clone https://github.com/fred-chen/uio_scripts.git
$ tree uio_scripts/
uio_scripts/
├── client
│   └── plotfio.sh
└── server
    ├── collect_cpu.sh
    ├── counterana.py
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```
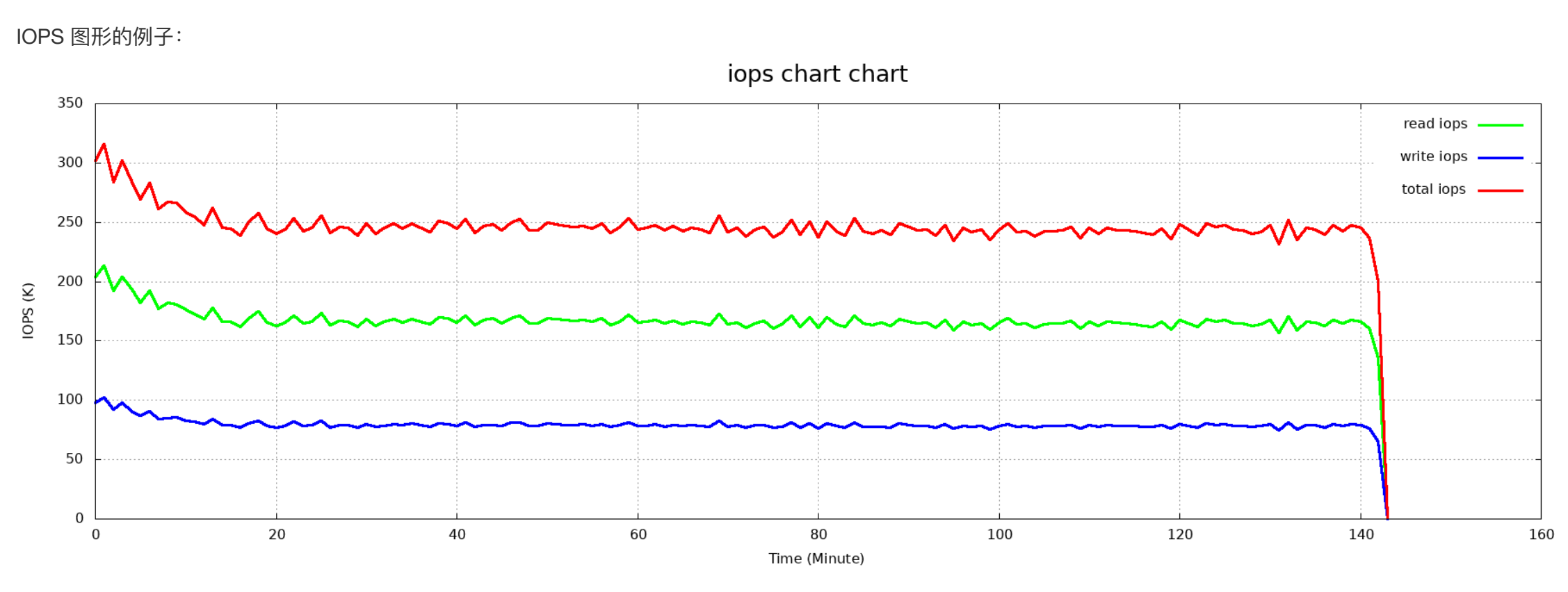

client scripts

client/plotfio.sh

```
功能：对多个 fio 日志文件中的数据进行分类汇总（fio给每个job产生一个日志文件），按时间生成数据走势图。 支持的图形类型为：IOPS，SLAT, CLAT, LAT。

用法：
# client/plotfio.sh -h
usage: plotfio.sh <logname> [-t iops|clat|slat|lat] [--title chart_title] [-k|--keep]

options:
  -t: type of plots, can be one of: iops, clat, slat, lat.
  -k: keep temp files.

examples:
  plotfio.sh log/82rw*iops* -t iops  # plot iops chart for logs that the path match 'log/82rw*iops*'
```

IOPS 图形的例子：

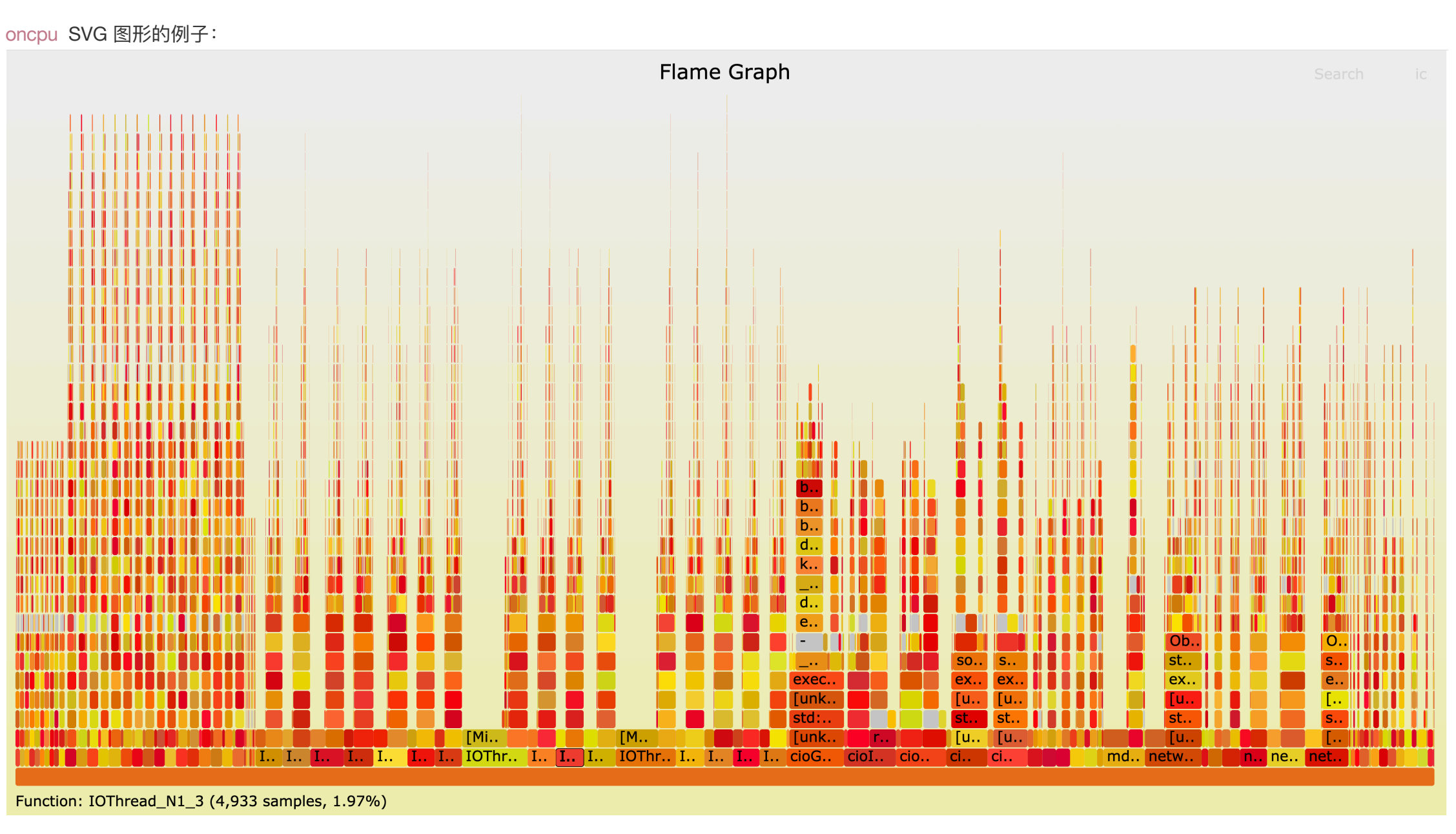


server scripts

server/collect_cpu.sh

```
功能：利用 linux bcc/eBPF 搜集 oncpu，offcpu，wakeup，offwakup 用户态和内核态软件栈，并生成交互式 SVG 图案。
运行条件：
  kernel version >4.8
  eBPF enabled with kernel
  bcc installed
  FlameGraph installed and located in ../FlameGraph

用法：
# server/collect_cpu.sh -h
usage: collect_cpu.sh [process_name] [-w prefix] [-t time] [-g oncpu|offcpu|wakeup|offwakeup] [-x exclude_stack] [-k]

options:
  -k:    keep temp files.

examples:
  collect_cpu.sh              # gather all types of cpu data for 60 seconds and generate flame graphs. prefix 'this'

  collect_cpu.sh cio_array      # gather all types of cpu data of process 'cio_array' for 60 seconds
                                # and generate flame graphs. prefix 'this'.

  collect_cpu.sh -w 82rw -t 30 -g oncpu    # gather oncpu data for 30 seconds
                                           # and generate flame graphs. prefix '82rw'
```

oncpu SVG 图形的例子：



server/counterana.py

```
功能：分析 'arrayctl counters' 命令所记录的 UniIO 内部计数器日志。主要可用的功能有：
1. 分析 counter 值的走势：
   以线性回归的结果为基础，大致分析 counter 随时间变化的趋势。可能的结果有：
   * 'NOCHANGE' 从始至终都没有改变过的counter。这些counter往往是没用的。可能是因为被disable，或者未更新，或者有bug。
   * 'UP'      不停增加的counter。这些counter意味某种操作的时间或数量不断增加，或资源加速消耗，可能导致性能问题。
   * 'DOWN'    不停减少的counter。这些counter跟UP趋势的counter类似，可能意味着系统正走向某种瓶颈，导致性能问题。
   * 'SPIKES'   总体没有明显增减，但会有突然的剧烈波动。这种趋势可能意味着客户端压力的突变，或者cio_array内部资源分配出现抖动。
   * 'FLAT'     总体没有明显增减，也没有剧烈波动。这种趋势属较为平衡状态，关注优先级可以放低。
2. 打印直方图：可以分析一个或多个counter的值分布，直方图将counter数量分布在 log2() 个桶中。
3. 打印 counter 的基本分类汇总信息：min, max, mean, and standard deviation for counters
4. 绘制 counter 图形，展示 counter 的值随时间的变化。绘制完成后会为指定的每个 counter 生成一个 .png 文件。
5. 使用 '-r n| --ramplines n' 参数，可以跳过前后n次采样的数据。采样的开始和结束阶段系统往往还处于不太稳定的状态，跳过这些采样数据有助于提高分析的准确性。
6. 使用 '--startline s --endline e' 参数，可以只分析某个时间段的数据。'counterana.py' 会抽取第 s 行和第 e 行之间的数据。如果数据是按每分钟采样的，那么 '--startline 60 --endline 120' 代表只分析第2个小时的数据。
7. 使用 '-g -c' 参数，可以将多个counter的数据绘制到同一个图形，方便比较counter走势。注意使用了'-c'参数时，多个counter应该具有同样的单位，否则图形会失去意义
（将时间和次数相比是没有意义的）。如果只使用 '-g' 参数，则默认为每个counter生成一张图形。

用法：
$ uio_scripts/server/counterana.py -h
usage:uio_scripts/server/counterana.py [logname] [-e counter_pattern] [-i] [-g|--graph] [-c|--combine] [-m|--histogram] [-r|--ramplines] [-k] [--startline n] [--endline n]

Analyze UniIO counter log files.

options:
  -e pattern:      filter of counter names
  -i:              ignore case
  -g, --graph:     plot a scatter graph for counters
  -c, --combine:   use with '-g', draw all data onto a single chart  -m, --histogram:  print histogram (log2 buckets)
  -r, --ramplines: ramping lines. to skip first and last few lines of data
  --startline:     specify a start line, to only analyze lines after that line
  --endline:       specify an end line, to only analyze lines before that line  -k:            keep temp files

if no 'logname' given in command line, counterana.py reads counter data from stdin

examples:
  counterana.py counter.log            # report all counters in 'counter.log' (massive lines will slow down the analysis)
  cat counter.log | counterana.py      # same as above

  counterana.py counter.log -e ss.obs     # only report counters that contain 'ss.obs'
  grep ss.obs counter.log | counterana.py # same as above

  counterana.py counter.log -e ss.obs -g   # report counters that contains 'ss.obs' and plot a graph for each of the counters
  counterana.py counter.log -e ss.obs -gc  # report counters that contains 'ss.obs' and plot all counter data onto a single graph
  counterana.py counter.log -e ss.obs -m   # report counters that contains 'ss.obs' and print the histogram for each of the counters

  counterana.py counter.log --startline=60 --endline=120   # report all conter data betwen 60min ~ 120min (if sample interval is 60s)

output format:
  counter_name[sample_count][unit][trends]: min, max, mean, mean_squared_deviation, standard_deviation, pct_stddev:mean, slop
  * each line summarizes a unique counter *

how to intepret:
  sample_count:   how many samples(lines) have been aggregated for a counter
  unit:           the unit of a counter (counts, uSec, KiB)
  trends:         trends of the sample value from the first sample to the last in [UP|DOWN|FLAT|NOCHANGE|SPIKES]
  slop:           result of linear regression(the 'a' in y=ax+b). how fast the sample value increase|decreases
  self explained: min, max, mean, mean_squared_deviation, standard_deviation, pct_stddev:mean
```

使用 'counterana.py' 的建议流程：

1. 第一步先分析整个日志文件，或某个子系统中的所有 counter，筛选出'UP','DOWN'趋势的counter，以便重点关注。

```
# 下面例子分析 obs 子系统的 counters：
$ server/counterana.py -e ss.obs counter.log | grep -E 'UP|DOWN'
building aggregated array ... done.
==================================================================================
...
ss.obs.WriteSlab.outstanding[523][counts][DOWN]: min=1384126.0 max=4194304.0 mean=3042116.2 > > stddev=984976.2 stddev:mean=32.4% slop=-5432.041
ss.obs.cacheWriteEvictions[523][counts][UP]: min=742242.0 max=1237425534.0 mean=617743522.8 stddev=363576028.8 stddev:mean=58.9% slop=2407954.897
ss.obs.cacheMigrateFromWriteToRead[523][counts][UP]: min=310342.0 max=1260108523.0 mean=627497530.2 stddev=371270071.4 stddev:mean=59.2%
slop=2458905.563
...
```

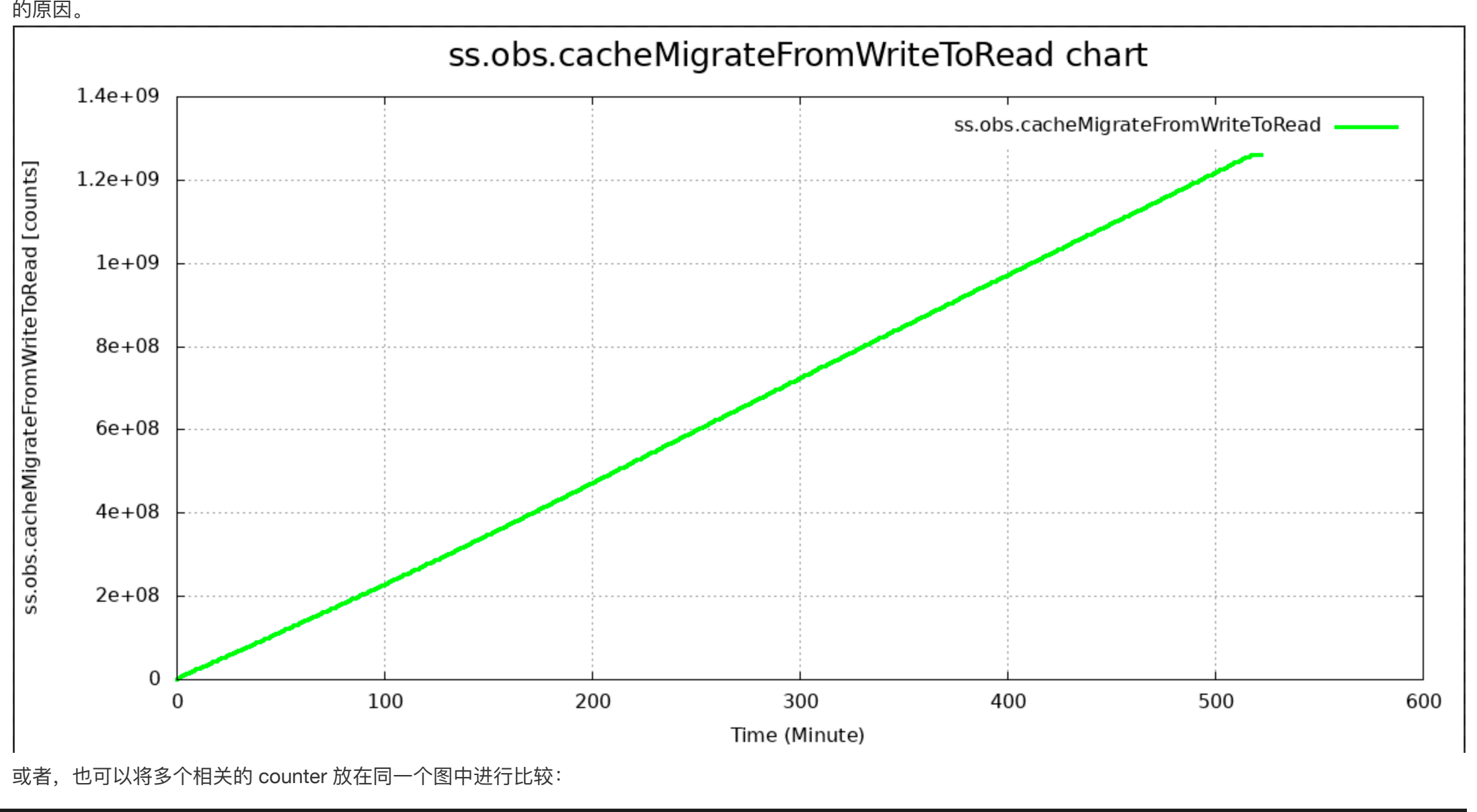
2. 观察输出，发现ss.obs.cacheMigrateFromWriteToRead 变化幅度较大(stddev:mean=58.9%)，且趋势是走高UP 。单独打印直方图(-m)查看可疑 counter 的分布情况。

```
$ server/counterana.py counter.log -e ss.obs.cacheMigrateFromWriteToRead -m
building aggregated array ... done.
==================================================================================
ss.obs.cacheMigrateFromWriteToRead[523][counts][UP]: min=310342.0 max=1260108523.0 mean=627497530.2 stddev=371270071.4 stddev:mean=59.2%
slop=2458905.563
==================================================================================

Histogram for ss.obs.cacheMigrateFromWriteToRead (counts) ... 523 samples.
               (0...1]    0
               (1...2]    0
               (2...4]    0
               (4...8]    0
              (8...16]    0
             (16...32]    0
             (32...64]    0
            (64...128]    0
           (128...256]    0
           (256...512]    0
          (512...1024]    0
         (1024...2048]    0
         (2048...4096]    0
         (4096...8192]    0
        (8192...16384]    0
       (16384...32768]    0
       (32768...65536]    0
      (65536...131072]    0
     (131072...262144]    0
     (262144...524288]    1
    (524288...1048576]    0
   (1048576...2097152]    0
   (2097152...4194304]    1
   (4194304...8388608]    2
  (8388608...16777216]    3
 (16777216...33554432]    8
 (33554432...67108864]    15
(67108864...134217728]    30
(134217728...268435456]   58
(268435456...536870912]   108
(536870912...1073741824]  216
(1073741824...2147483648] 81
```

3. 初步发现该counter的值分布在高位居多，越高越多。最后将该counter的图形走势画出(-g)，进一步查看比对：

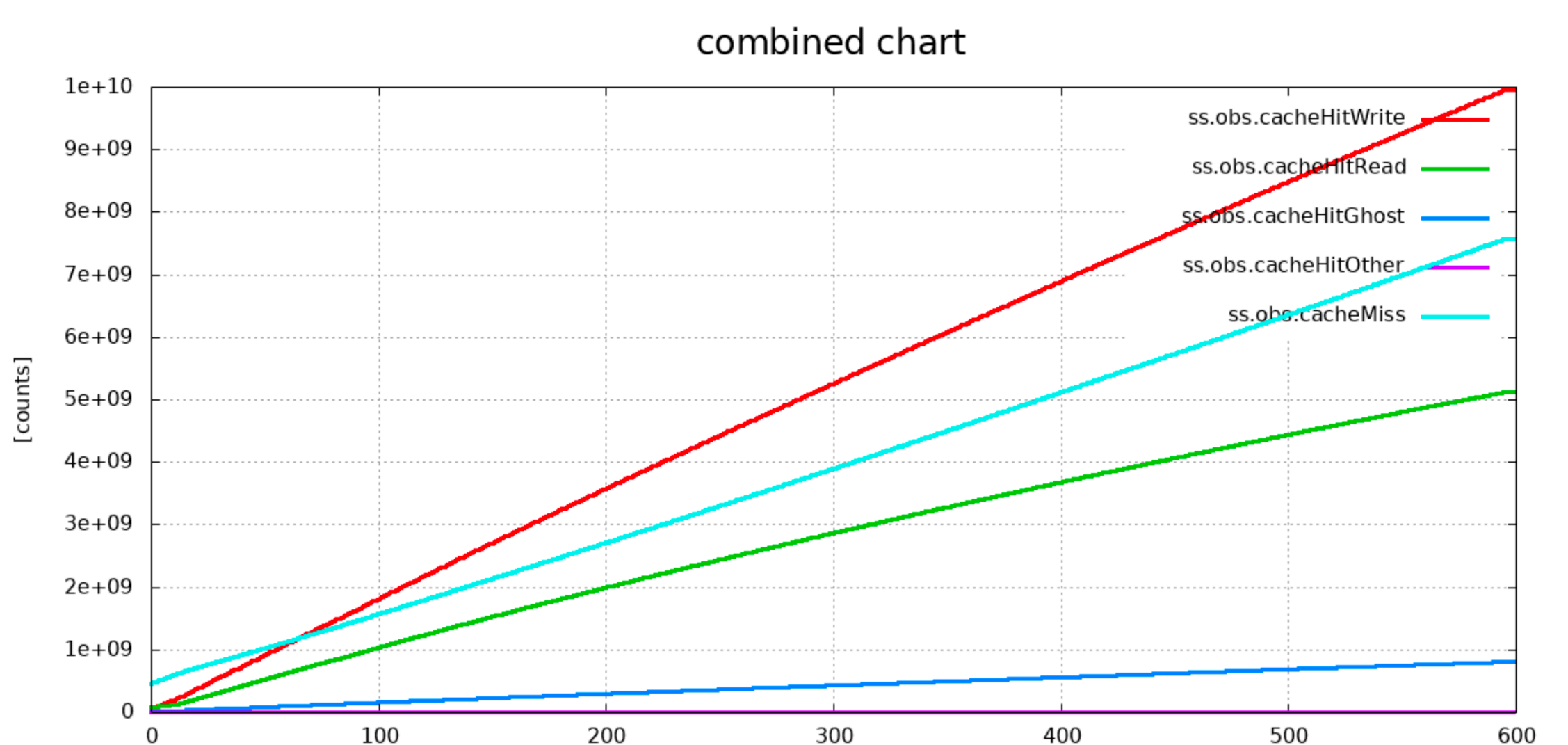
```
$ server/counterana.py counter.log -e ss.obs.cacheMigrateFromWriteToRead -g
building aggregated array ... done.
==================================================================================
ss.obs.cacheMigrateFromWriteToRead[523][counts][UP]: min=310342.0 max=1260108523.0 mean=627497530.2 stddev=371270071.4 stddev:mean=59.2%
slop=2458905.563
==================================================================================
ss.obs.cacheMigrateFromWriteToRead.png
```

4. 打开生成的图像文件 ss.obs.cacheMigrateFromWriteToRead.png ，将其趋势与其他数据(例如用plotfio.sh 生成的客户端iops或latency图形)交叉对比，分析其持续升高的原因。



5. 或者，也可以将多个相关的 counter 放在同一个图中进行比较：

```
$ uio_scripts/server/counterana.py counter.log -e 'ss.obs.cache(?=Miss|Hit)' -gc
 building aggregated array ... done.
==================================================================================
ss.obs.cacheHitWrite[600][counts][UP]: min=61190410.0 max=9962262664.0 mean=5170040745.2 stddev=2889397492.9 stddev:mean=55.9% slop=16676433.790
ss.obs.cacheHitRead[600][counts][UP]: min=79458824.0 max=5126165414.0 mean=2767213820.0 stddev=1479525548.5 stddev:mean=53.5% slop=8527487.472
ss.obs.cacheHitGhost[600][counts][UP]: min=13269294.0 max=806473330.0 mean=423335945.3 stddev=230776016.9 stddev:mean=54.5% slop=1331940.169
ss.obs.cacheHitOther[600][counts][NOCHANGE]: min=0.0 max=0.0 mean=0.0 stddev=0.0 stddev:mean=0.0% slop=0.000
ss.obs.cacheMiss[600][counts][UP]: min=454818307.0 max=7578260188.0 mean=3942654687.8 stddev=2070806872.7 stddev:mean=52.5% slop=11952484.988
==================================================================================
/root/fred/ss.obs.cacheHitWrite_more.plotdata.png
```



收集 UniIO counters 的过程大致可以写成下面这样：

```
$ cat counters.sh
#!/usr/bin/env bash
#usage: ./counters.sh [interval] [runtime]

runtime=36000  # how long, default 10 hours
interval=60    # how often, default every 60 seconds

[[ ! -z "$1" ]] && runtime=$1
[[ ! -z "$2" ]] && interval=$2

total=0
while true
do
  date
  arrayctl counters
  sleep $interval
  total=$((total+$interval))
  [[ $total -ge $runtime ]] && break
done

$ nohup ./counters.sh 36000 > counter.log 2>&1 &
```

server/init_backend.sh

```
功能：
  1. 抹除 UniIO 数据盘
  2. 为 DP 后端生成 'config.ini' 配置文件
  3. 从每个后端磁盘中预留一部分空间作为 coredump 设备。
！ 注意：此脚本将重新初始化所有除了 root 设备之外的其他磁盘设备，具有相当危险性，只能用于实验环境。

用法：
$ server/init_backend.sh -h
usage: init_backend.sh [ clear|init ] [ -G dumpdev_size ]
```

server/init_cluster.sh

```
功能：uniio 单节点清空环境，后端初始化，服务启停，RPM包更换，集群拓扑初始化并创建LUN
!!! 注意，当指定了'-d|--initbackend'参数，需要当前目录下存在'init_backend.sh'，且脚本将重新初始化所有除了 root 设备之外的其他磁盘设备，具有相当危险性，只能用于实验环境。

用法：
$ server/init_cluster.sh -h
usage: init_cluster.sh [-f] [-s|--stoponly]
                  [-b|--bootonly]
                  [-r|--replace rpm_dir]
                  [-d|--initbackend] [-G dump_size]
                  [-i|--initarray]
                  [-c|--createluns --management_ip ip --iscsi_ip ip --topology ip,ip...]
  -f: force (killing cio_array)
  -s: stop only
  -b: start objmgr and objmgr-fab
  -d: initialize backend
  -G: prereserve size for coredump device
  -i: initialize array
  -c: create new luns and mappings
  --management_ip: specify the management IP address for the federation
  --iscsi_ip:      specify the management IP address for the federation
  --topology:      specify the node IP addresses for the federation
```