운영체제

Assignment5

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2019202103

이은비

Assignment 5

<introduction>

I/O zone을 이용하여 세가지 linux I/O scheduler의 성능을 테스트 해봅니다.
이때 사용하는 linux I/O scheduler는 Noop/CFQ/deadline을 사용합니다. 또한 각각의 record size를 4KB/8KB/16KB/32KB를 각각 3번씩 test해보고 sequential write, sequential read,randomr/w, 임의의 옵션값을 추가하여 그 결과값을 평균값을 낸 후 그 값을 표 및 그래프를 작성합니다. 또한 hardware spec또한 확인한후 상세스펙을 기술합니다.

<conclusion>

<noop scheduler>

```
os2019202103@ubuntu:~/iozone3_471/src/current$ echo noop | sudo tee /sys/block/sda/queue/scheduler
noop
os2019202103@ubuntu:~/iozone3_471/src/current$ cat /sys/block/sda/queue/scheduler
[noop] deadline cfq
os2019202103@ubuntu:~/iozone3_471/src/current$ rm -rf ~/izone_test
os2019202103@ubuntu:~/iozone3_471/src/current$ sync
os2019202103@ubuntu:~/iozone3_471/src/current$ echo 3 | sudo tee /proc/sys/vm/drop_caches
3
```

Noop I/O scheduler로 scheduler를 변경합니다. 그리고 test이전에 캐시 및 버퍼를 비우는 과정을 거친 뒤 test를 시작합니다.

(4kb) 3번의 실습을 통해 4kb의 옵션의 결과값의 평균값을 구합니다.

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 4k -r 4k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:44:35 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 4 kB
        Record Size 4 kB
        Command line used: iozone -e -I -a -s 4m -r 4k -r 4k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       4    27358    26604    26953    24839   23126     22966    24228     24233

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096       4    26568    28360    30861    30046   19680     18234    17808     16770

ozone test complete.
```

```
                                                    random    random     bkwd    record    stride
      kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
    4096       4    25376    27404    28609    29156   25826     27524    18518     18889

test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
26434	27456	28808	28014	22877	22908	20185	19964

(8kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 8k -r 8k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:45:21 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 8 kB
        Record Size 8 kB
        Command line used: iozone -e -I -a -s 4m -r 8k -r 8k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       8    47148    59939   61260    71083   60238    62377    63068    57348

iozone test complete.
```

```
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       8    47175    48974   58410    48271   35596    36911    37106    36027

iozone test complete.
```

```
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       8    44487    57095   52695    57351   55787    59608    49954    32960

ozone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
46270	55336	57455	58902	52540	52965	50043	42112

(16kb)

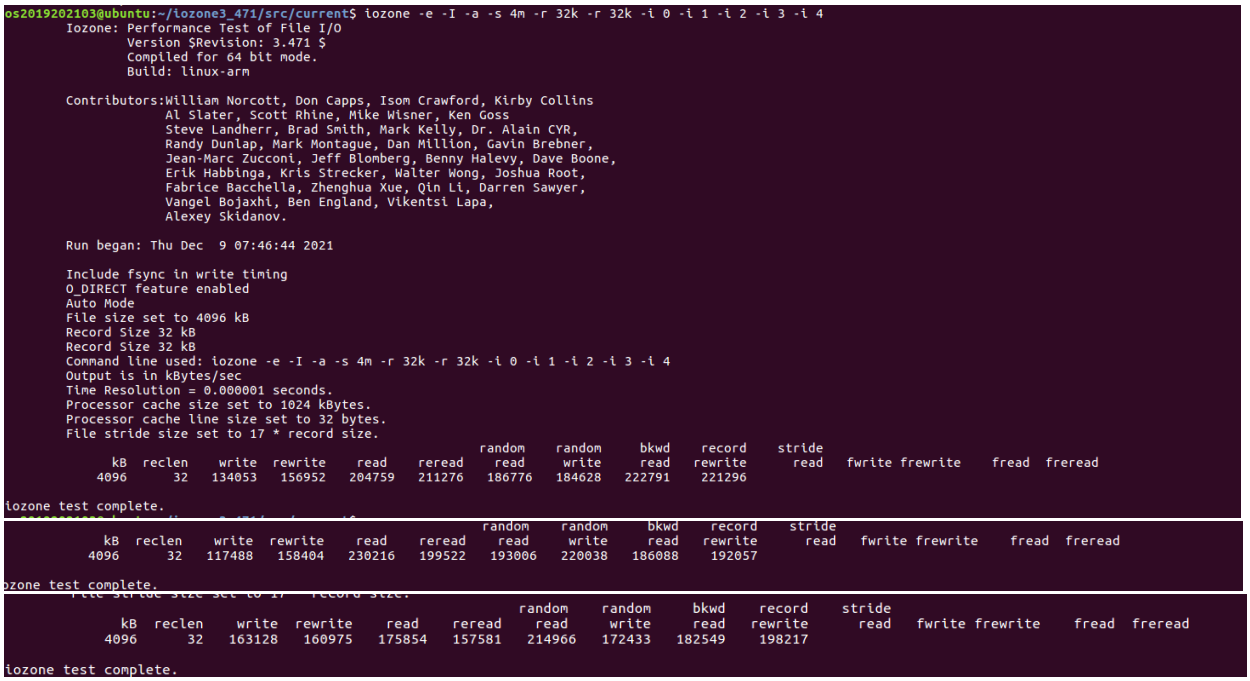
```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 16k -r 16k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:46:04 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 16 kB
        Record Size 16 kB
        Command line used: iozone -e -I -a -s 4m -r 16k -r 16k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096      16    57671    71025   79058    86528   75926    75893    78479    78233

iozone test complete.
```

```
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096      16    87562   112725  102295   119965  122639   110598   104495   119229

ozone test complete.
```

```
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096      16    84208   105861   88004   108362   97163    94889    94465    99100

zone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
76480	96537	89929	99062	97685	97807	92480	98854

(32kb)



Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
138223	158777	203610	189460	198244	192366	197143	203857

Noop scheduler의 옵션 결과값(평균값)table

Byte	Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
4kb	26434	27456	28808	28014	22877	22908	20185	19964
8kb	46270	55336	57455	58902	52540	52965	50043	42112
16kb	76480	96537	89929	99062	97685	97807	92480	98854
32kb	138223	158777	203610	189460	198244	192366	197143	203857

<옵션값 항목>//보고서 추가사항

0 = write/re-write, 1 = read/re-read, 2 = random-read/write, 3 = read-backwards,
4 = re-write-record, 5 = stride-read, 6 = fwrite/re-fwrite, 7 = fread/re-fread,
8 = random mix, 9 = pwrite/re-pwrite, 10 = pread/re-pread, 11 = pwritev/re-pwritev,
12 = preadv/re-preadv
에서 sequential 값인 0,1과 random r/w인 2, read-backwards인 3, re-write-record값을 선택했습니다. 3과 4를 옵션값을 선택한이유는 file의 속도를 defult값이 너무 커서 실습하는데 시간이 오래 걸려 4MB로 하였는데 6,7과 같은 값은 file의 크기를 생각보다 작게하여 오류가 생길 수있어 그에 영향을 받지않는 옵션을 선택하였습니다.

<deadline>

```
os2019202103@ubuntu:~/iozone3_471/src/current$ echo deadline | sudo tee /sys/block/sda/queue/scheduler
deadline
os2019202103@ubuntu:~/iozone3_471/src/current$ cat /sys/block/sda/queue/scheduler
noop [deadline] cfq
os2019202103@ubuntu:~/iozone3_471/src/current$ rm -rf ~/izone_test
os2019202103@ubuntu:~/iozone3_471/src/current$ sync
os2019202103@ubuntu:~/iozone3_471/src/current$ echo 3 | sudo tee /proc/sys/vm/drop_caches
3
```

deadline I/O scheduler로 scheduler를 변경합니다. 그리고 test이전에 캐시 및 버퍼를 비우는 과정을 거친 뒤 test를 시작합니다.

(4kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 4k -r 4k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:50:12 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 4 kB
        Record Size 4 kB
        Command line used: iozone -e -I -a -s 4m -r 4k -r 4k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       4    24048    28536   28641    28554   26812    25819    27784     28391

iozone test complete.
```

```
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       4    28816    29989   29762    31407   29156    28206    28697     28772

zone test complete.
```

```
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       4    29246    29887   31594    33423   28079    29811    30009     29580

iozone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
27370	29471	29999	31128	28016	27945	28830	28914

(8kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 8k -r 8k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:51:40 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 8 kB
        Record Size 8 kB
        Command line used: iozone -e -I -a -s 4m -r 8k -r 8k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       8    53612    60116   58949    55301   53318    47801    53950     53254

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       8    49741    54014    53534    59333   53908    54711    49752     53775

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096       8    47683    58309    58270    55668   52166    62083    63640     55316

ozone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
50345	57480	56918	56767	53131	54865	55781	54115

(16kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 16k -r 16k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:52:13 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 16 kB
        Record Size 16 kB
        Command line used: iozone -e -I -a -s 4m -r 16k -r 16k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
             kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
           4096      16    98779   107317   112406   124695   113986   121820   127947     85063

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096      16   102344   108445   131712   144143   106928    94113   105287     98395

ozone test complete.
```

```
                                                    random    random     bkwd    record    stride
              kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
            4096      16    89208   137306   114177   109735   104300   107436   123611    124445

iozone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
96777	117689	119432	126191	108405	108010	118948	102634

(32kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 32k -r 32k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:Willlam Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:52:48 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 32 kB
        Record Size 32 kB
        Command line used: iozone -e -I -a -s 4m -r 32k -r 32k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
             kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
           4096      32   132027   166829   233695   195530   149636   232821   216341    208488

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096      32   163244   172070   211854   209482   196346   198142   203640    174796

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096      32    94293    93809    92324   210755   211307   129929   187561    158037

one test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
131590	172884	217462	200962	178663	211876	208897	199757

Deadline scheduler 옵션값(평균값) table

Byte	Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
4kb	27370	29471	29999	31128	28016	27945	28830	28914
8kb	50345	57480	56918	56767	53131	54865	55781	54115
16kb	96777	117689	119432	126191	108405	108010	118948	102634
32kb	131590	172884	217462	200962	178663	211876	208897	199757

<CFQ scheduler>

```
os2019202103@ubuntu:~/iozone3_471/src/current$ cat /sys/block/sda/queue/scheduler
noop [deadline] cfq
os2019202103@ubuntu:~/iozone3_471/src/current$ echo cfq | sudo tee /sys/block/sda/queue/scheduler
cfq
os2019202103@ubuntu:~/iozone3_471/src/current$ cat /sys/block/sda/queue/scheduler
noop deadline [cfq]
os2019202103@ubuntu:~/iozone3_471/src/current$ rm -rf ~/izone_test
os2019202103@ubuntu:~/iozone3_471/src/current$ sync
os2019202103@ubuntu:~/iozone3_471/src/current$ echo 3 | sudo tee /proc/sys/vm/drop_caches
3
os2019202103@ubuntu:~/iozone3_471/src/current$
```

CFQ I/O scheduler로 scheduler를 변경합니다. 그리고 test이전에 캐시 및 버퍼를 비우는 과정을 거친 뒤 test를 시작합니다.

(4kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 4k -r 4k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
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                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:55:37 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 4 kB
        Record Size 4 kB
        Command line used: iozone -e -I -a -s 4m -r 4k -r 4k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                            random    random     bkwd    record    stride
             kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
           4096       4    25634    23255    23232    25815    26644    26336    26023     24480

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096       4    20337    20760   23311   25524   25026   23766   23084   21975

                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096       4    23161    22075   24269   25970   25756   24333   24895   24539

iozone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
23044	22030	23604	25770	25809	24817	24667	23665

(8kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 8k -r 8k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:56:13 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 8 kB
        Record Size 8 kB
        Command line used: iozone -e -I -a -s 4m -r 8k -r 8k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                    random    random     bkwd    record    stride
             kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
           4096       8    40566    41460   47766   49507   57395   53354   57772   50615

iozone test complete.
        File stride size set to 17 * record size.
                                                    random    random     bkwd    record    stride
             kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
           4096       8    40680    40833   52368   57758   57818   49860   60421   50495

iozone test complete.
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096       8    36756    37735   46728   51681   50502   50315   52244   45432

ozone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
39334	40009	48954	52982	55283	51176	56812	48847

(16kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 16k -r 16k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:56:44 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 16 kB
        Record Size 16 kB
        Command line used: iozone -e -I -a -s 4m -r 16k -r 16k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                    random    random     bkwd    record    stride
             kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
           4096      16    52558    57159   78804   88426   95694   95573  103316   72153

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096      16    70711    58598    70770    82432   89037    98143   101220    80225

ozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096      16    61294    71923    73748   107001   114454   104500   112099    85141

iozone test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
61521	62560	74441	92620	99728	99405	105545	79173

(32kb)

```
os2019202103@ubuntu:~/iozone3_471/src/current$ iozone -e -I -a -s 4m -r 32k -r 32k -i 0 -i 1 -i 2 -i 3 -i 4
        Iozone: Performance Test of File I/O
                Version $Revision: 3.471 $
                Compiled for 64 bit mode.
                Build: linux-arm

        Contributors:William Norcott, Don Capps, Isom Crawford, Kirby Collins
                     Al Slater, Scott Rhine, Mike Wisner, Ken Goss
                     Steve Landherr, Brad Smith, Mark Kelly, Dr. Alain CYR,
                     Randy Dunlap, Mark Montague, Dan Million, Gavin Brebner,
                     Jean-Marc Zucconi, Jeff Blomberg, Benny Halevy, Dave Boone,
                     Erik Habbinga, Kris Strecker, Walter Wong, Joshua Root,
                     Fabrice Bacchella, Zhenghua Xue, Qin Li, Darren Sawyer,
                     Vangel Bojaxhi, Ben England, Vikentsi Lapa,
                     Alexey Skidanov.

        Run began: Thu Dec  9 07:57:23 2021

        Include fsync in write timing
        O_DIRECT feature enabled
        Auto Mode
        File size set to 4096 kB
        Record Size 32 kB
        Record Size 32 kB
        Command line used: iozone -e -I -a -s 4m -r 32k -r 32k -i 0 -i 1 -i 2 -i 3 -i 4
        Output is in kBytes/sec
        Time Resolution = 0.000001 seconds.
        Processor cache size set to 1024 kBytes.
        Processor cache line size set to 32 bytes.
        File stride size set to 17 * record size.
                                                    random    random     bkwd    record    stride
             kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
           4096      32    92098    93162   113440   148665  214799   130098   173853   160785

iozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096      32    77625    95213    98947   134874   191268   126725   147411   146978

ozone test complete.
```

```
                                                    random    random     bkwd    record    stride
          kB  reclen    write  rewrite    read    reread    read     write     read   rewrite      read   fwrite frewrite    fread  freread
        4096      32    94293    93809    92324   210755   211307   129929   187561   158037

one test complete.
```

Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
88005	94061	101570	164765	205791	128917	169608	155267

CFQ scheduler 옵션값(평균값) table

Byte	Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
4kb	23044	22030	23604	25770	25809	24817	24667	23665
8kb	39334	40009	48954	52982	55283	51176	56812	48847
16kb	61521	62560	74441	92620	99728	99405	105545	79173
32kb	88005	94061	101570	164765	205791	128917	169608	155267

Noop scheduler의 옵션 결과값(평균값)table

Byte	Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
4kb	26434	27456	28808	28014	22877	22908	20185	19964
8kb	46270	55336	57455	58902	52540	52965	50043	42112
16kb	76480	96537	89929	99062	97685	97807	92480	98854
32kb	138223	158777	203610	189460	198244	192366	197143	203857

Deadline scheduler 옵션값(평균값) table

Byte	Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
4kb	27370	29471	29999	31128	28016	27945	28830	28914
8kb	50345	57480	56918	56767	53131	54865	55781	54115
16kb	96777	117689	119432	126191	108405	108010	118948	102634
32kb	131590	172884	217462	200962	178663	211876	208897	199757

CFQ scheduler 옵션값(평균값) table

Byte	Wirte	Rewrite	Read	Reread	Randomread	Randomwrite	Bkwdread	Record rewrite
4kb	23044	22030	23604	25770	25809	24817	24667	23665
8kb	39334	40009	48954	52982	55283	51176	56812	48847
16kb	61521	62560	74441	92620	99728	99405	105545	79173
32kb	88005	94061	101570	164765	205791	128917	169608	155267

위의 정리된 table을 참고하여서 아래 옵션값들을 각각의 schedule별로 값을 비교하면

Sequential write값을 비교

Byte	NOOP	DEADLINE	CFQ
4kb	26434	27370	23044
8kb	46270	50345	39334
16kb	76480	96777	61521
32kb	138223	131590	88005

ouput값은 kbytes/sec이며, 전체적으로 생각했을 때 Sequential write는 DEADLINE>NOOP>CFQ값이므로 앞의 순서대로 성능이 좋다고 예측할 수 있습니다.

Sequential read값을 비교

Byte	NOOP	DEADLINE	CFQ
4kb	28808	29999	23604
8kb	57455	56918	48954
16kb	89929	119432	74441
32kb	203610	217462	101570

Sequential write와 같이 sequential read값도 전체적으로 생각하면 DEADLINE>NOOP>CFQ값이므

로 앞의 순서대로 성능이 좋다고 예측할 수 있습니다.

Random r/w값을 비교

->random read

Byte	NOOP	DEADLINE	CFQ
4kb	22877	28016	25809
8kb	52540	53131	55283
16kb	97685	108405	99728
32kb	198244	178663	205791

4kb~16kb까지는 DEADLINE>CFQ>NOOP이므로 이 순서대로 성능이 좋다고 예측할 수 있고, 32kb는 CFQ>NOOP>DEADLINE이므로 이 순서로 성능이 좋다고 예측할 수 있습니다.

->random write

Byte	NOOP	DEADLINE	CFQ
4kb	22908	27945	24817
8kb	52965	54865	51176
16kb	97807	108010	99405
32kb	192366	211876	128917

8kb에서는 DEADLINE>NOOP>CFQ순이지만 오차를 고려하면 Random read와 비슷하게 4kb~16kb까지는 DEADLINE>CFQ>NOOP이므로 이 순서대로 성능이 좋다고 예측할 수 있고, 32kb는 CFQ>NOOP>DEADLINE이므로 이 순서로 성능이 좋다고 예측할 수 있습니다.

Bkwd read 값을 비교

Byte	NOOP	DEADLINE	CFQ
4kb	20185	28830	24667
8kb	50043	55781	56812
16kb	92480	118948	105545
32kb	197143	208897	169608

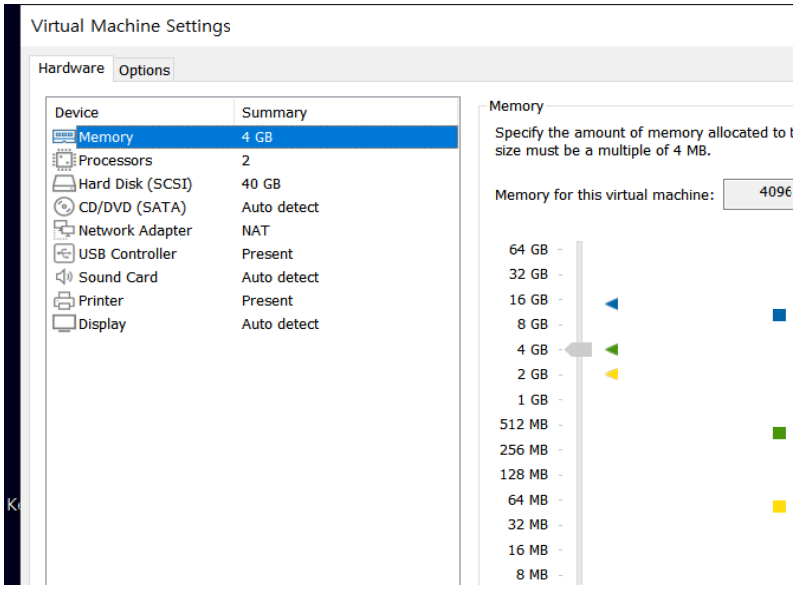
Bkwd read값은 4kb~16kb까지는 DEADLINE>CFQ>NOOP이므로 이 순서대로 성능이 좋다고 예측할 수 있고, 32kb는 CFQ>NOOP>DEADLINE이므로 이 순서로 성능이 좋다고 예측할 수 있습니다

Record rewrite값을 비교

Byte	NOOP	DEADLINE	CFQ
4kb	19964	28914	23665
8kb	42112	54115	48847
16kb	98854	102634	79173
32kb	203857	199757	155267

Record rewrite값은 4kb~8kb까지는 DEADLINE>CFQ>NOOP이므로 이 순서대로 성능이 좋다고 예측할 수 있고, 16kb~32kb는 CFQ>NOOP>DEADLINE이므로 이 순서로 성능이 좋다고 예측할 수 있습니다.

<hardware spec>



CPU즉 processors는 2이며, HDD harddisk는 40GB, memory는 4GB입니다.

<reference>

광운대학교/운영체제실습 15주차 강의자료

옵션값

//https://m.blog.naver.com/PostView.naver?isHttpsRedirect=true&blogId=nanong7&logNo=20207265849

i/o zone

https://duksoo.tistory.com/entry/IOzone-%EC%9D%84-%EC%9D%B4%EC%9A%A9%ED%95%9C-Disk-%EC%84%B1%EB%8A%A5-%EC%B8%A1%EC%A0%95%EB%B2%95