

# Project 6 File System 设计文档

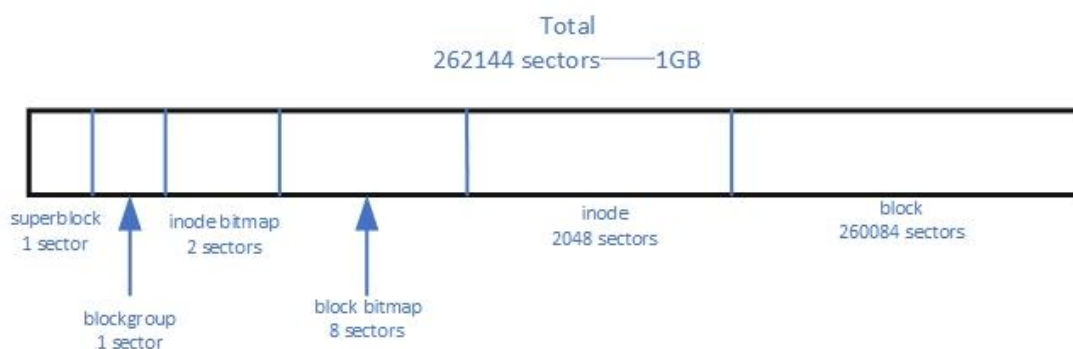
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2018.1.21

## 1. 文件系统初始化设计

### (1) 文件系统对磁盘的布局



对磁盘进行分块处理，一块为 1GB。如果最后一块空间不够 1GB，则 block 扇区数小于 260084，block bitmap 中对应项初始化时就置为 1，以此保证正确性，其余扇区按照上图进行分配。

### (2) 如何实现 superblock 的备份？如何判断 superblock 损坏？当有一个 superblock 损坏时，文件系统如何正常启动？

1、2 个系统块中的 superblock 部分存储相关元数据信息，以此来完成 superblock 的备份。

MAGIC 数与预期不一致或者校验和错误时，表示该 superblock 已损坏。

一个 superblock 损坏时，寻找第二个 superblock 并检查相关信息，如果检查合格则文件系统正常启动，同时修复第一个 superblock，否则重新构建文件系统。

### (3) superblock、inode 数据结构，并阐明各项含义。支持最大文件大小、最多文件数目，以及单个目录下能支持的最多文件数目。

```

struct superblock_t{
    uint32_t s_checknum; //校验和
    uint64_t s_size; //文件系统可用空间大小
    uint32_t s_magic; //magic number
    uint32_t s_groups_count; //组数
    uint32_t s_free_inodes_count; //可用 inode 数
    uint32_t s_free_blocks_count; //可用数据块数
    uint32_t s_total_inodes_count; //inode 总数
    uint32_t s_total_blocks_count; //数据块总数
};
  
```

```

struct inode_t{
    uint32_t i_num;//inumber
    uint16_t i_mode;//权限
    uint16_t i_links_count;//链接数
    uint32_t i_atime;// 最近的一次访问时间
    uint32_t i_ctime;// 文件状态最新改变的时间
    uint32_t i_mtime;// 最新的修改时间
    uint64_t i_size;文件大小
    uint32_t i_fnum;//目录文件数目
    uint32_t i_block[15];//数据块指针
    uint8_t i_padding[40];//保证对齐
};

```

最大文件大小：由于实现了三级指针，所以最大文件大小为 4TB 多一点。

一个 group 中最多可以存储 65536 个文件。

与最大文件类似，由于支持了三级指针，所以单个目录下能支持的最多文件数目略微大于 $2^{30}$

#### (4) 块分配策略

按需分配

#### (5) Bonus 设计

完成了 bonus1 中要求的所有操作。

## 2. 文件操作设计

### (1) Link 和 unlink 的操作流程

Link 函数：

```
int p6fs_link(const char *path, const char *newpath)
```

操作流程大致如下：

对原路径下的文件进行路径解析，得到 inode 后，将其中的 links\_count 值加一。

对新路径进行解析，在最后一级目录的 dentry 中建立对应项，同时将其 inode 号更改为原路径下文件的 inode 号。

Unlink 函数：

```
int p6fs_unlink(const char *path)
```

操作流程大致如下：

得到对应文件的 inode；

修改其 links\_count 的值，状态改变时间等相关参数；

将其父目录中 dentry 相应项删除即可

## (2) Rename 涉及的操作流程

Rename 函数:

```
int p6fs_rename(const char *path, const char *newpath)
```

操作流程如下:

```

int p6fs_rename(const char *path, const char *newpath)
{
    DEBUG("Rename: from %s to %s)", path, newpath);
    if(p6fs_link(path, newpath) == -ENOENT) {
        ERR("error occured when Rename.");
        return -ENOENT;
    }

    return p6fs_unlink(path);
}

```

## 3. 目录操作设计

### (1) Rmdir 的操作流程

Rmdir 函数:

```
int p6fs_rmdir(const char *path)
```

操作大致流程如下:

路径解析, 找到该目录对应的 inode

首先进行权限检查

其次如果该目录不为空, 则返回-ENOTEMPTY

若该目录为空目录, 则将其 inode 以及其映射的空间进行释放

将父目录中 dentry 对应项删除即可

## 4. 关键函数功能 (测试展示)

此部分由于较为关键函数代码量都较大, 所以不在此处进行展示。

将此部分用于展示最后的测试部分:

**测试第一部分:**

dd 第一块 superblock 后, 启动正常, 截图如下:

```

root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            989M    0  989M   0% /dev
tmpfs           202M    3.7M 198M   2% /run
/dev/mapper/ubun--vg-root 8.3G  6.7G  1.2G  86% /
tmpfs           1007M   216K 1007M   1% /dev/shm
tmpfs           5.0M    4.0K  5.0M   1% /run/lock
tmpfs           1007M    0 1007M   0% /sys/fs/cgroup
/dev/sda1       472M    58M  390M  13% /boot
tmpfs           202M    60K  202M   1% /run/user/1000
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# sudo dd if=/dev/zero of=/dev/sdb bs=4096 count=1
1+0 records in
1+0 records out
4096 bytes (4.1 kB, 4.0 KiB) copied, 0.101424 s, 40.4 kB/s
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# ./p6fs /dev/sdb ./mnt/
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            989M    0  989M   0% /dev
tmpfs           202M    3.7M 198M   2% /run
/dev/mapper/ubun--vg-root 8.3G  6.7G  1.2G  86% /
tmpfs           1007M   216K 1007M   1% /dev/shm
tmpfs           5.0M    4.0K  5.0M   1% /run/lock
tmpfs           1007M    0 1007M   0% /sys/fs/cgroup
/dev/sda1       472M    58M  390M  13% /boot
tmpfs           202M    60K  202M   1% /run/user/1000
p6fs            3.7G  4.0K  3.7G   1% /home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self#

```

## 测试第二部分:

1、Umount 后是否能启动? 可以, 截图如下:

```

common.c common.h common.o disk.c disk.h disk.o example fuse-main.c fuse-main.o hello lib logging.c logging.h io
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# cd mnt/
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ls
test.0.0 test.1.0 test.2.0 test.3.0 test.4.0 test.5.0 test.6.0 test.7.0 test.8.0 test.9.0
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# cd ..
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# umount ./mnt/
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# ./p6fs /dev/sdb ./mnt/
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            989M    0  989M   0% /dev
tmpfs           202M    3.7M 198M   2% /run
/dev/mapper/ubun--vg-root 8.3G  6.7G  1.2G  86% /
tmpfs           1007M   216K 1007M   1% /dev/shm
tmpfs           5.0M    4.0K  5.0M   1% /run/lock
tmpfs           1007M    0 1007M   0% /sys/fs/cgroup
/dev/sda1       472M    58M  390M  13% /boot
tmpfs           202M    60K  202M   1% /run/user/1000
p6fs            3.7G  4.0K  3.7G   1% /home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self#

```

2、测试 df 命令输出结果

```

root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            989M    0  989M   0% /dev
tmpfs           202M    3.7M 198M   2% /run
/dev/mapper/ubun--vg-root 8.3G  6.7G  1.2G  86% /
tmpfs           1007M   216K 1007M   1% /dev/shm
tmpfs           5.0M    4.0K  5.0M   1% /run/lock
tmpfs           1007M    0 1007M   0% /sys/fs/cgroup
/dev/sda1       472M    58M  390M  13% /boot
tmpfs           202M    60K  202M   1% /run/user/1000
p6fs            3.7G  4.0K  3.7G   1% /home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# df -i
Filesystem      Inodes  IUsed  IFree  IUse% Mounted on
udev            209960    470 209490    1% /dev
tmpfs           219638    645 218993    1% /run
/dev/mapper/ubun--vg-root 557056 243233 313823  44% /
tmpfs           219638     9 219629    1% /dev/shm
tmpfs           219638     6 219632    1% /run/lock
tmpfs           219638    16 219622    1% /sys/fs/cgroup
/dev/sda1       124928    304 124624    1% /boot
tmpfs           219638    31 219607    1% /run/user/1000
p6fs            262144     1 262143    1% /home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self#

```

3、测试目录相关

```

root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# rmdir hello/
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ls
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# mkdir hello
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ls
hello
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# mkdir hello
mkdir: cannot create directory 'hello': File exists
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# rmdir hello
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# rmdir hello
rmdir: failed to remove 'hello': No such file or directory
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt#

```

#### 4、touch 命令

```
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# touch hello.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ls
hello.c
```

## 5、链接相关

```
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# cat hello.c
hello, world!
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ln hello.c hellohard.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ls
hello.c  hellohard.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# cat hellohard.c
hello, world!
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ln -s hello.c hellosymb.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# cat hellosymb.c
hello, world!
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# mkdir helldir
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# mv hello.c helldir/hellooo.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# cd helldir/
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt/helldir# ls
hellooo.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt/helldir# cat hellooo.c
hello, world!
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt/helldir# cd ..
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ls
helldir  hellohard.c  hellosymb.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# rm hellohard.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# ls
helldir  hellosymb.c
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt#
```

## 6、vim 打开并写入、cat 读取

[illegible]

## 7、mv 与 rm 命令

见 5 中的 mv 与 rm 命令

## 8、getattr 测试

```
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt# stat helloworld.c
File: 'helloworld.c' -> 'hello.c'
Size: 4096          Blocks: 0          IO Block: 4096   symbolic link
Device: 26h/38d Inode: 11         Links: 1
Access: (0777/lrwxrwxrwx)  Uid: (  0/   root)   Gid: (  0/   root)
Access: 2018-01-21 20:30:13.000000000 +0800
Modify: 2018-01-21 20:28:10.000000000 +0800
Change: 2018-01-21 20:28:10.000000000 +0800
 Birth: -
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt#
```

## 测试第三部分

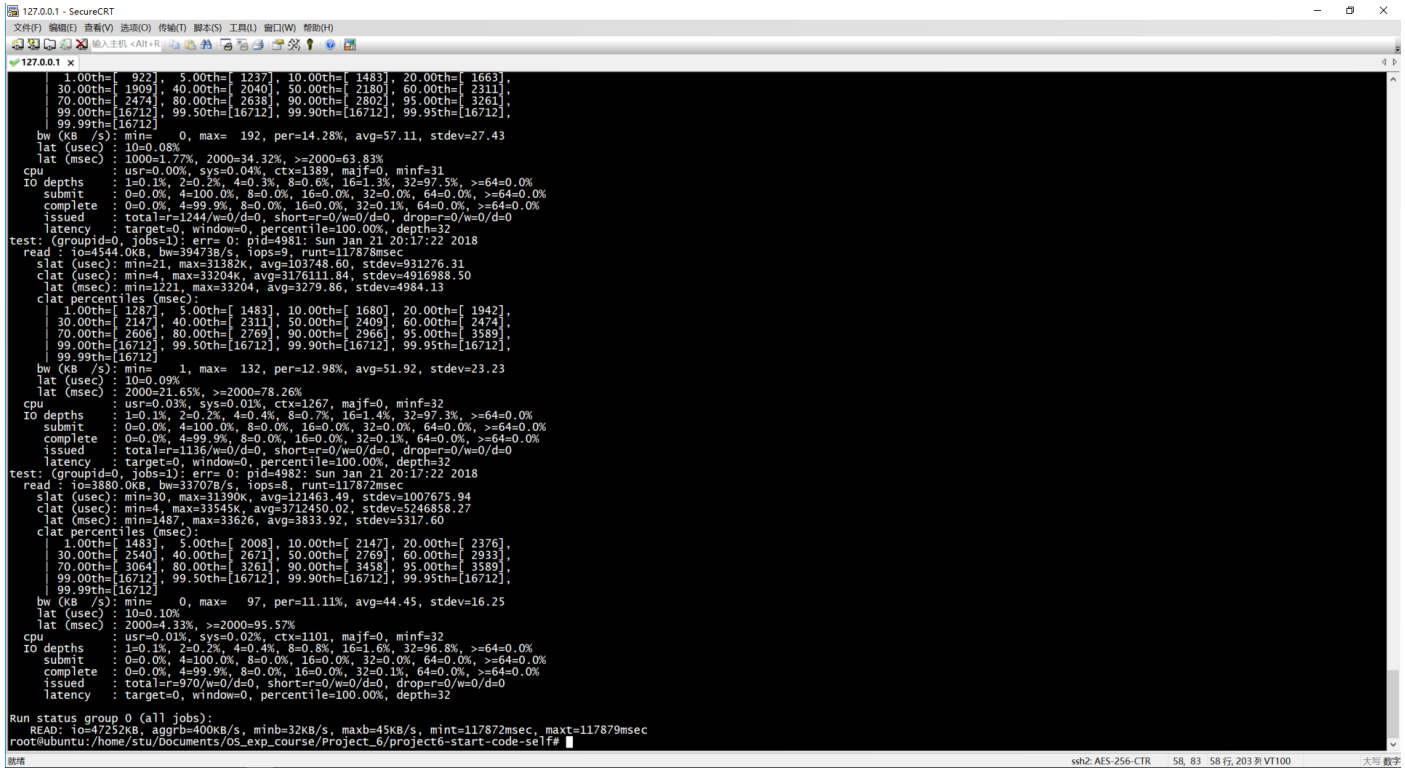
### 1、写测试

```
127.0.0.1 - SecureCRT
文件(F) 编辑(E) 查看(V) 选项(O) 传输(T) 脚本(S) 工具(I) 窗口(W) 帮助(H)
127.0.0.1 x
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# sudo fio -ioengine=libaio -bs=128k -numjobs=10 -runtime=100 -name=test -directory=/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt/ -size=100M
test: (g=0): rw=write, bs=128K-128K/128K-128K/128K-128K, ioengine=libaio, iodepth=32
...
fio-2.2.10
Starting 10 threads
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
test: Laying out io file(s) (1 file(s) / 100MB)
fio: pid=4891, err=2/file:filesetup.c:615, func=open(/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt/test.4.0), error=No s
fio: pid=4894, err=2/file:filesetup.c:615, func=open(/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt/test.1.0), error=No s
jobs: 8 (f=8): [w(6),x(1),w(2),x(1)] [95.2% done] [0KB/102KB/0KB/s] [0/7/0 iops] [eta 00m:05s]
test: (groupid=0, jobs=1): err=0: pid=4885: Sun Jan 21 20:12:00 2018
write: io=21378KB, bw=218344B/s, iops=1, runt=100250msec
slat (msec): min=5, max=5526, avg=600.27, stdev=641.52
clat (usec): min=5, max=26217K, avg=15766826.32, stdev=5667148.96
lat (msec): min=567, max=27103, avg=16367.10, stdev=5771.71
clat percentiles (msec):
  | 1.00th=[ 570], 5.00th=[ 5342], 10.00th=[ 7308], 20.00th=[10421],
  | 30.00th=[13566], 40.00th=[15008], 50.00th=[16712], 60.00th=[16712],
  | 70.00th=[16712], 80.00th=[16712], 90.00th=[16712], 95.00th=[16712],
  | 99.00th=[16712], 99.50th=[16712], 99.90th=[16712], 99.95th=[16712],
  | 99.99th=[16712]
bw (KB/s): min= 5, max= 750, per=15.01%, avg=273.47, stdev=178.54
lat (usec): 10=0.60%, 20=0.60%, 50=0.60%, >=2000=98.20%
lat (msec): 750=0.60%, 2000=0.60%, >=2000=98.20%
cpu:
  | usr=0.00%, sys=0.07%, ctx=5398, majf=0, minf=1
IO depths:
  | i=0.6%, 2=1.2%, 4=2.4%, 8=4.8%, 16=9.6%, 32=81.4%, >=64=0.0%
submit:
  | 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
complete:
  | 0=0.0%, 4=99.3%, 8=0.0%, 16=0.0%, 32=0.7%, 64=0.0%, >=64=0.0%
issued:
  | total=r=0/w=167/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
latency:
  | target=0, window=0, percentile=100.00%, depth=32
test: (groupid=0, jobs=1): err=0: pid=4886: Sun Jan 21 20:12:00 2018
write: io=23552KB, bw=240844B/s, iops=1, runt=100136msec
slat (msec): min=851, max=5416.3K, avg=543645.46, stdev=610055.62
clat (usec): min=6, max=24689K, avg=1556484.12, stdev=5285683.35
lat (msec): min=471, max=25413, avg=15100.13, stdev=5352.18
clat percentiles (msec):
  | 1.00th=[ 471], 5.00th=[ 5669], 10.00th=[ 7177], 20.00th=[ 9110],
  | 30.00th=[10484], 40.00th=[11605], 50.00th=[16057], 60.00th=[16712],
  | 70.00th=[16712], 80.00th=[16712], 90.00th=[16712], 95.00th=[16712],
  | 99.00th=[16712], 99.50th=[16712], 99.90th=[16712], 99.95th=[16712],
  | 99.99th=[16712]
bw (KB/s): min= 5, max= 941, per=16.87%, avg=307.35, stdev=225.47
lat (usec): 10=0.54%, 20=0.54%, 50=0.54%, >=2000=98.91%
lat (msec): 500=0.54%, >=2000=98.91%
cpu:
  | usr=0.00%, sys=0.08%, ctx=5946, majf=0, minf=1
IO depths:
  | i=0.3%, 2=1.1%, 4=2.2%, 8=4.3%, 16=8.7%, 32=83.2%, >=64=0.0%
submit:
  | 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
complete:
  | 0=0.0%, 4=99.4%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
issued:
  | total=r=0/w=184/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
latency:
  | target=0, window=0, percentile=100.00%, depth=32
```

```
127.0.0.1 - SecureCRT
文件(F) 编辑(E) 查看(V) 选项(O) 传输(T) 脚本(S) 工具(I) 窗口(W) 帮助(H)
127.0.0.1 x
30.00th=[10814], 40.00th=[13304], 50.00th=[15401], 60.00th=[16712],
70.00th=[16712], 80.00th=[16712], 90.00th=[16712], 95.00th=[16712],
99.00th=[16712], 99.50th=[16712], 99.90th=[16712], 99.95th=[16712],
99.99th=[16712]
bw (KB/s): min= 5, max= 1109, per=17.09%, avg=311.44, stdev=216.06
lat (usec): 10=0.53%, 20=0.53%, 50=0.53%, >=2000=97.87%
lat (msec): 750=0.53%, 2000=1.06%, >=2000=97.87%
cpu:
  | usr=0.01%, sys=0.07%, ctx=6074, majf=0, minf=1
IO depths:
  | i=0.5%, 2=1.1%, 4=2.1%, 8=4.3%, 16=8.5%, 32=83.5%, >=64=0.0%
submit:
  | 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
complete:
  | 0=0.0%, 4=99.4%, 8=0.0%, 16=0.0%, 32=0.6%, 64=0.0%, >=64=0.0%
issued:
  | total=r=0/w=188/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
latency:
  | target=0, window=0, percentile=100.00%, depth=32
test: (groupid=0, jobs=1): err=0: pid=4893: Sun Jan 21 20:12:00 2018
write: io=22528KB, bw=230120B/s, iops=1, runt=100246msec
slat (msec): min=1, max=5526, avg=569.56, stdev=604.31
clat (usec): min=20, max=24684K, avg=15171989.02, stdev=6060149.73
lat (msec): min=572, max=26277, avg=15741.55, stdev=6168.44
clat percentiles (msec):
  | 1.00th=[ 570], 5.00th=[ 5145], 10.00th=[ 7046], 20.00th=[ 9372],
  | 30.00th=[10883], 40.00th=[13960], 50.00th=[16057], 60.00th=[16712],
  | 70.00th=[16712], 80.00th=[16712], 90.00th=[16712], 95.00th=[16712],
  | 99.00th=[16712], 99.50th=[16712], 99.90th=[16712], 99.95th=[16712],
  | 99.99th=[16712]
bw (KB/s): min= 5, max= 1275, per=16.17%, avg=294.71, stdev=242.23
lat (usec): 50=0.57%, 750=0.57%, 2000=0.57%, >=2000=98.30%
lat (msec): 750=0.57%, 2000=0.57%, >=2000=98.30%
cpu:
  | usr=0.00%, sys=0.08%, ctx=5695, majf=0, minf=1
IO depths:
  | i=0.6%, 2=1.1%, 4=2.3%, 8=4.5%, 16=9.1%, 32=82.4%, >=64=0.0%
submit:
  | 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
complete:
  | 0=0.0%, 4=99.3%, 8=0.0%, 16=0.0%, 32=0.7%, 64=0.0%, >=64=0.0%
issued:
  | total=r=0/w=176/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
latency:
  | target=0, window=0, percentile=100.00%, depth=32
Run status group 0 (all jobs):
WRITE: io=18265KB, aggrb=1822KB/s, minb=213KB/s, maxb=245KB/s, mint=100134msec, maxt=100250msec
root@ubuntu:/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self# sudo fio -ioengine=libaio -bs=4k -numjobs=10 -runtime=100 -name=test -directory=/home/stu/Documents/OS_exp_course/Project_6/project6-start-code-self/mnt/ -size=100M
test: (g=0): rw=randread, bs=4K-4K/4K-4K/4K-4K, ioengine=libaio, iodepth=32
...
fio-2.2.10
Starting 10 threads
Jobs: 10 (f=10): [r(10)] [3.7% done] [0KB/0KB/0KB/s] [0/0/0 iops] [eta 51m:42s]
test: (groupid=0, jobs=1): err=0: pid=4973: Sun Jan 21 20:17:22 2018
read: io=4968.0KB, bw=43156B/s, iops=10, runt=117879msec
slat (usec): min=24, max=3134K, avg=94890.31, stdev=389557.70
clat (usec): min=5, max=33250K, avg=2916221.33, stdev=4727577.75
lat (msec): min=610, max=33334, avg=3011.11, stdev=4794.79
clat percentiles (msec):
  | 1.00th=[ 1090], 5.00th=[ 1369], 10.00th=[ 1582], 20.00th=[ 1844],
  | 30.00th=[ 1991], 40.00th=[ 2114], 50.00th=[ 2180], 60.00th=[ 2278],
  | 70.00th=[ 2376], 80.00th=[ 2540], 90.00th=[ 2802], 95.00th=[ 3032],
  | 99.00th=[16712], 99.50th=[16712], 99.90th=[16712], 99.95th=[16712],
  | 99.99th=[16712]
bw (KB/s): min= 0, max= 182, per=14.19%, avg=56.75, stdev=23.31
lat (usec): 10=0.08%, 100=0.32%, 1000=0.40%, 2000=29.71%, >=2000=69.48%
lat (msec): 750=0.32%, 1000=0.40%, 2000=29.71%, >=2000=69.48%
cpu:
  | usr=0.01%, sys=0.04%, ctx=1432, majf=0, minf=32
```



## 2、随机读测试



```
127.0.0.1 - SecureCRT
文件(F) 编辑(E) 查看(V) 选项(O) 传输(T) 脚本(S) 工具(L) 窗口(W) 帮助(H)
127.0.0.1 x
1.00th= 922, 5.00th= 1237, 10.00th= 1483, 20.00th= 1663,
30.00th= 1908, 40.00th= 2040, 50.00th= 2180, 60.00th= 2311,
70.00th= 2474, 80.00th= 2618, 90.00th= 2802, 95.00th= 3261,
99.00th= 16712, 99.50th= 16712, 99.90th= 16712, 99.95th= 16712,
99.99th= 16712
bw (KB /s) : min= 0, max= 192, per=14.28%, avg=57.11, stdev=27.43
lat (usec) : 10=0.08%
lat (msec) : 1000=1.77%, 2000=34.32%, >=2000=63.83%
cpu : usr=0.00%, sys=0.04%, ctx=1389, majf=0, minf=31
io depths : 1=0.1%, 2=0.2%, 4=0.3%, 8=0.6%, 16=1.3%, 32=97.5%, >=64=0.0%
submit : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
complete : 0=0.0%, 4=99.9%, 8=0.0%, 16=0.0%, 32=0.1%, 64=0.0%, >=64=0.0%
issued : total=r=1244/w=0/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
latency : target=0, window=0, percentile=100.00%, depth=32
test: (groupid=0, jobs=1): err= 0: pid=4981: sun Jan 21 20:17:22 2018
read : io=4544.0KB, bw=394738/s, iops=9, runt=117878msec
slat (usec) : min=21, max=313824, avg=102748.60, stdev=931276.31
clat (usec) : min=4, max=33204K, avg=3176111.84, stdev=4916988.50
lat (msec) : min=1221, max=33204, avg=3279.86, stdev=4984.13
clat percentiles (msec):
  1.00th= 1287, 5.00th= 1483, 10.00th= 1680, 20.00th= 1942,
  30.00th= 2147, 40.00th= 2311, 50.00th= 2409, 60.00th= 2474,
  70.00th= 2606, 80.00th= 2769, 90.00th= 2966, 95.00th= 3589,
  99.00th= 16712, 99.50th= 16712, 99.90th= 16712, 99.95th= 16712,
  99.99th= 16712
bw (KB /s) : min= 1, max= 132, per=12.98%, avg=51.92, stdev=23.23
lat (usec) : 10=0.09%
lat (msec) : 2000=21.65%, >=2000=78.26%
cpu : usr=0.03%, sys=0.01%, ctx=1267, majf=0, minf=32
io depths : 1=0.1%, 2=0.2%, 4=0.4%, 8=0.7%, 16=1.4%, 32=97.3%, >=64=0.0%
submit : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
complete : 0=0.0%, 4=99.9%, 8=0.0%, 16=0.0%, 32=0.1%, 64=0.0%, >=64=0.0%
issued : total=r=1136/w=0/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
latency : target=0, window=0, percentile=100.00%, depth=32
test: (groupid=0, jobs=1): err= 0: pid=4982: sun Jan 21 20:17:22 2018
read : io=3880.0KB, bw=337078/s, iops=8, runt=117872msec
slat (usec) : min=30, max=31390K, avg=121463.49, stdev=1007675.94
clat (usec) : min=4, max=33545K, avg=3712450.02, stdev=5246858.27
lat (msec) : min=1487, max=33626, avg=3833.92, stdev=5317.60
clat percentiles (msec):
  1.00th= 1483, 5.00th= 2008, 10.00th= 2147, 20.00th= 2376,
  30.00th= 2540, 40.00th= 2671, 50.00th= 2769, 60.00th= 2833,
  70.00th= 3064, 80.00th= 3201, 90.00th= 3458, 95.00th= 3589,
  99.00th= 16712, 99.50th= 16712, 99.90th= 16712, 99.95th= 16712,
  99.99th= 16712
bw (KB /s) : min= 0, max= 97, per=11.11%, avg=44.45, stdev=16.25
lat (usec) : 10=0.10%
lat (msec) : 2000=4.33%, >=2000=95.57%
cpu : usr=0.01%, sys=0.02%, ctx=1101, majf=0, minf=32
io depths : 1=0.1%, 2=0.2%, 4=0.4%, 8=0.8%, 16=1.6%, 32=96.8%, >=64=0.0%
submit : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
complete : 0=0.0%, 4=99.9%, 8=0.0%, 16=0.0%, 32=0.1%, 64=0.0%, >=64=0.0%
issued : total=r=970/w=0/d=0, short=r=0/w=0/d=0, drop=r=0/w=0/d=0
latency : target=0, window=0, percentile=100.00%, depth=32
Run status group 0 (all jobs):
  READ: io=47232KB, aggrbw=400KB/s, minb=32KB/s, maxb=45KB/s, mint=117872msec, maxt=117879msec
root@ubuntu:/home/stu/documents/os_exp_course/Project_6/project6-start-code-self#
```

### 参考文献

[1] [\[单击此处键入参考文献内容\]](#)