

# Experiments on NCQ of SSD and Evaluations on NAISS

## 1 Single Workload Experiment

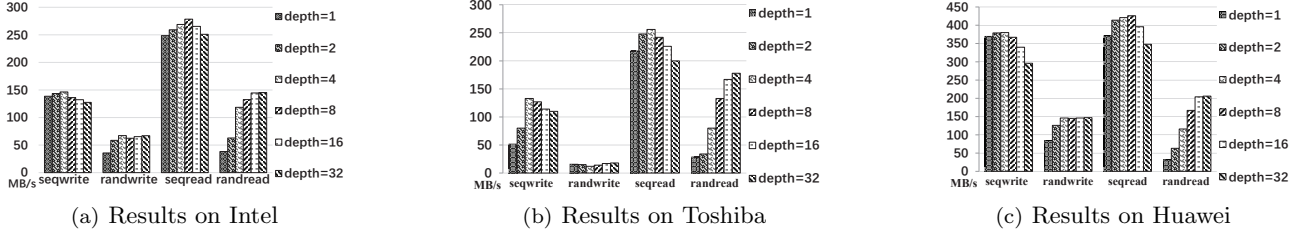


Figure 1: Bandwidth of different I/O workloads under different NCQ length when request size is 4K. *rand* and *seq* are short for random and sequential respectively.

## 2 Concurrent Workloads Experiment

The specific parameters of each workload are listed in Table 1. Notably, iodepth of FIO is set to 32 and 2 for intensive and non-intensive workloads respectively.

Table 1: Test configurations. We have eight groups of tests. In these tests, different workloads are concurrent in two VMs separately.

	VM1	VM2
TEST1	4K sequential read	4K random read
TEST2	4K sequential write	4K random write
TEST3	4K random read	128K random read
TEST4	4K random write	128K random write
TEST5	4K non-intensive read	4K intensive read
TEST6	4K non-intensive write	4K intensive write
TEST7	4K random read	4K random write
TEST8	4K sequential read	4K sequential write

## 2.1 Result of TEST1, TEST2, TEST7 and TEST8

Figure 2, 4 and 3 show results on sequentiality.

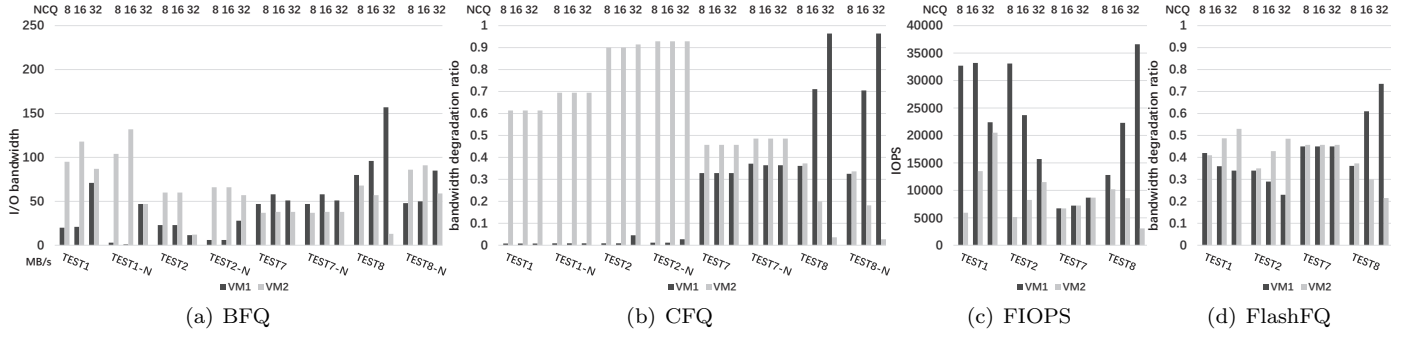


Figure 2: Results on Intel SSD

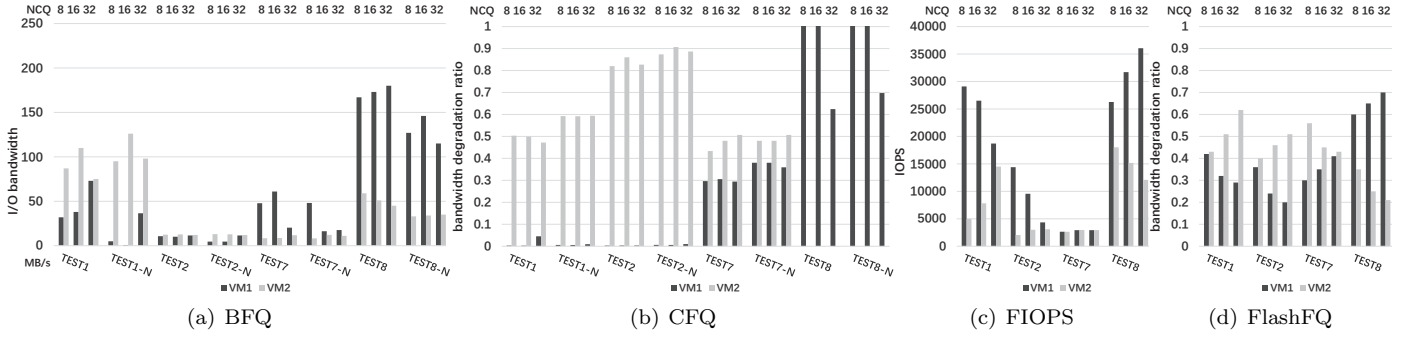


Figure 3: Results on Toshiba SSD

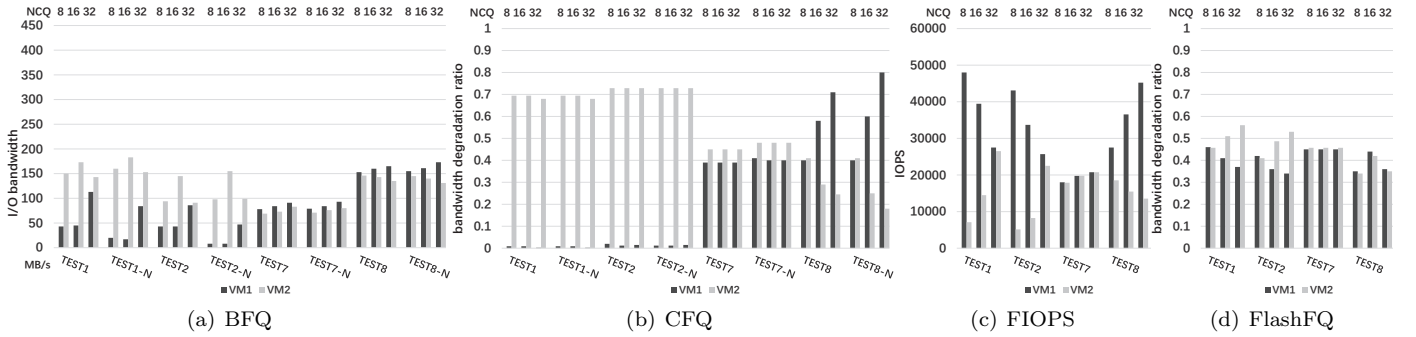


Figure 4: Results on Huawei SSD.

## 2.2 Result of TEST3 and TEST4

Figure 5, 6 and 7 show the results on request size.

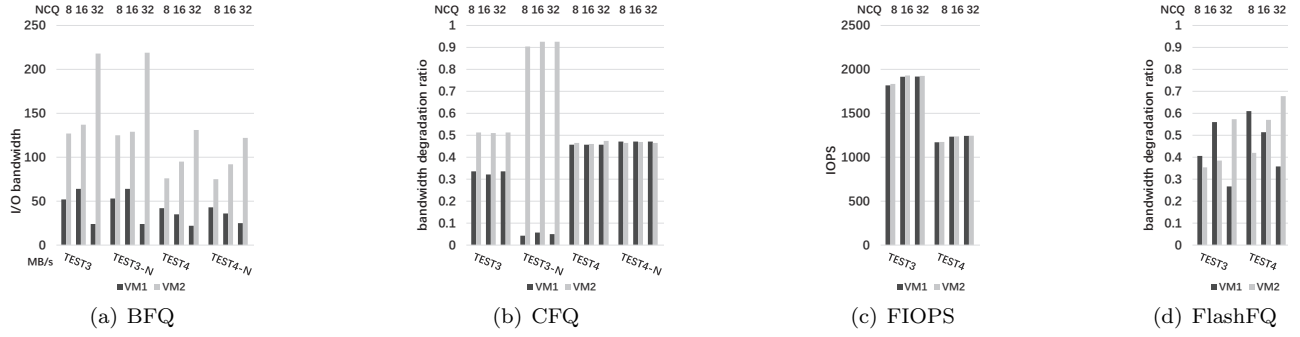


Figure 5: Results on Intel SSD

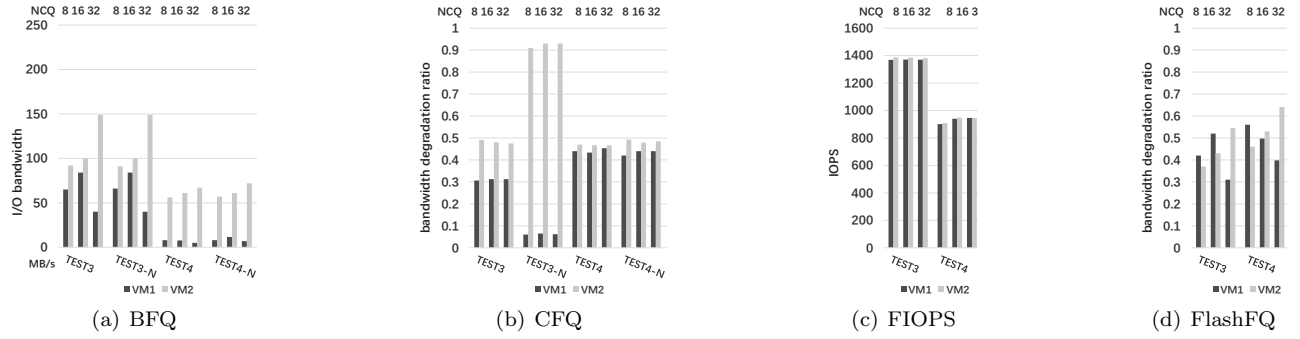


Figure 6: Results on Toshiba

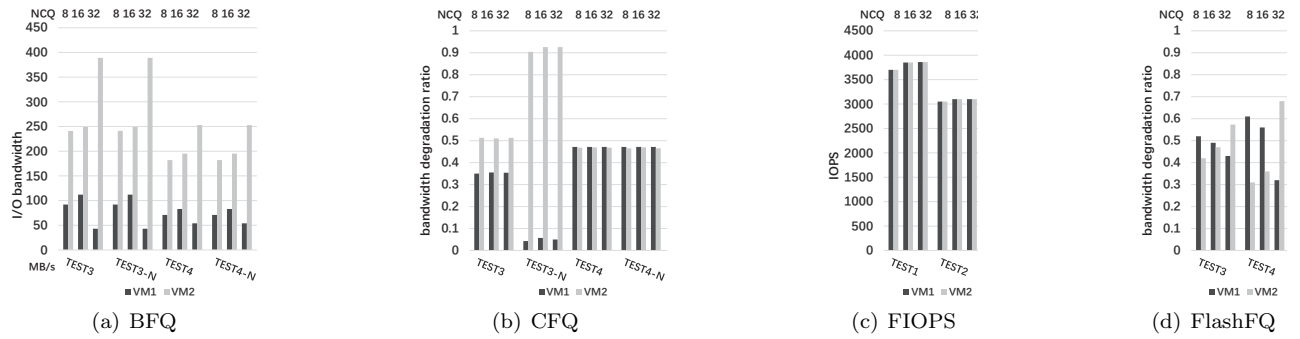


Figure 7: Results on Huawei

## 2.3 Results of TEST5 and TEST6

Figure 8, 9 and 10 show the results on intensity.

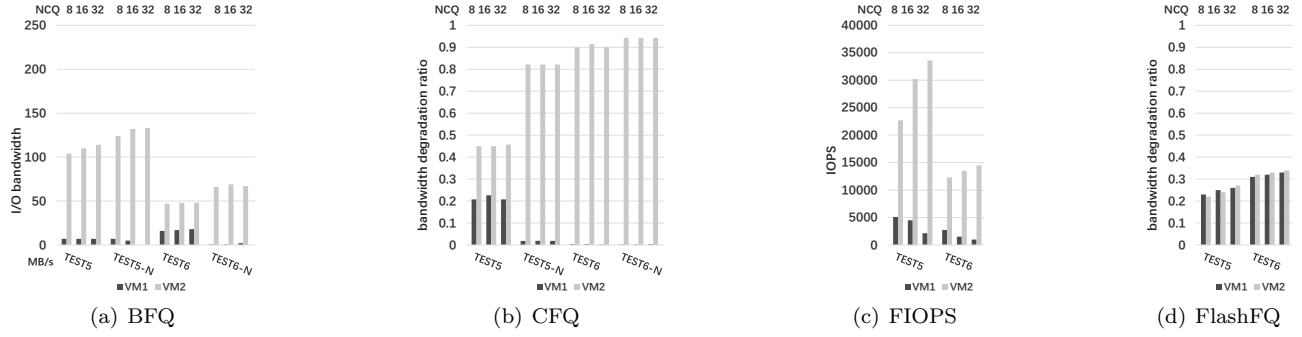


Figure 8: Results on Intel SSD

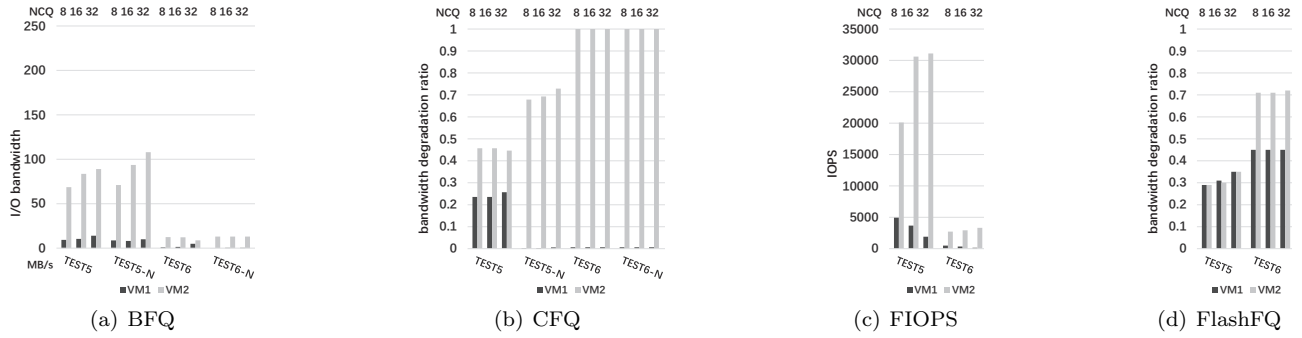


Figure 9: Results on Toshiba

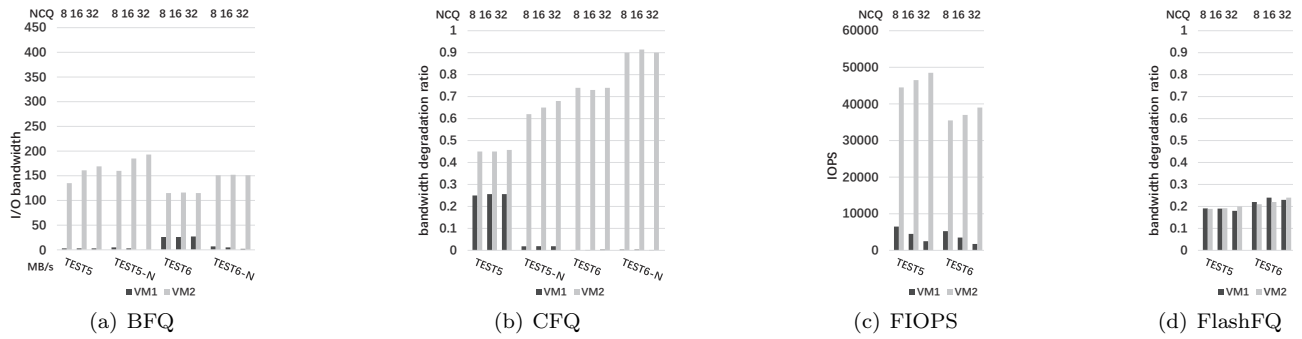


Figure 10: Results on Huawei

### 3 Effectiveness of NAISS

#### 3.1 AggreBDL Evaluation

Figure 11 shows the effect of AggreBDL.

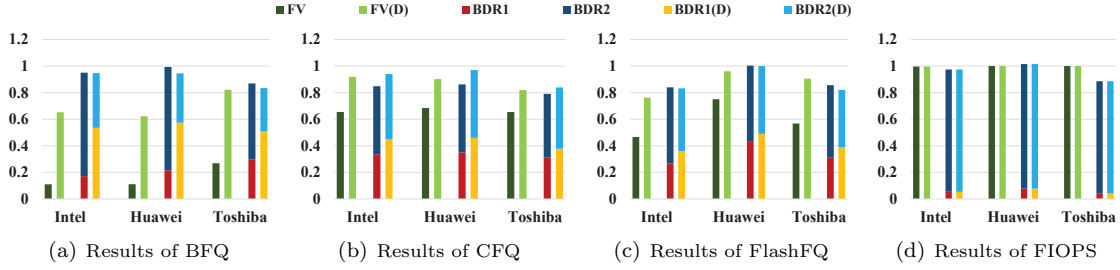


Figure 11: Effectiveness of AggreBDL. We compare the fairness of original I/O schedulers with our modified I/O schedulers on three SSDs.  $BDR_i$  is bandwidth degradation ratio of  $W_i$ .  $EV$  is the sum of BDR of all workloads. (D) stands for result of modified I/O schedulers.

#### 3.2 AntiBDL Evaluation

Figure 12 shows the effect of AntiBDL.

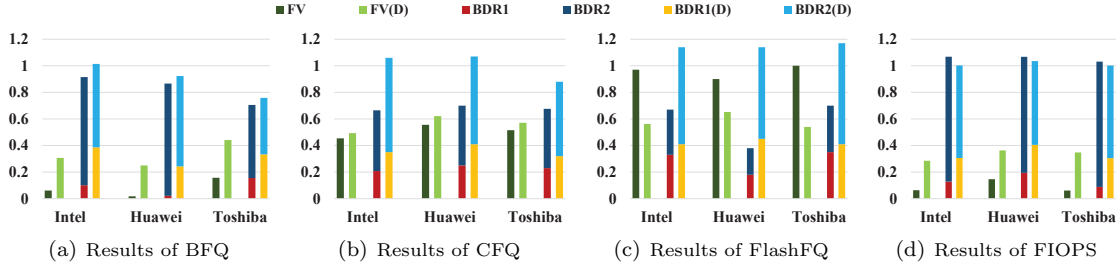


Figure 12: Effectiveness of AntiBDL

#### 3.3 SeqBDL Evaluation

Figure 13 shows results in single workload and Figure 14 shows the effect of SeqBDL in concurrent environment.

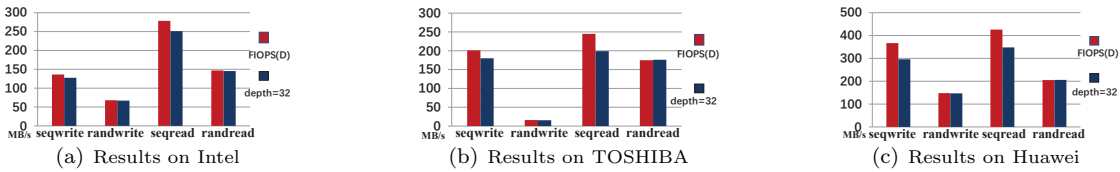


Figure 13: Bandwidth comparison of different I/O workloads in modified FIOPS(D) and FIOPS(32) when request size is 4K. *Rand* is short for random and *seq* is short for sequential.

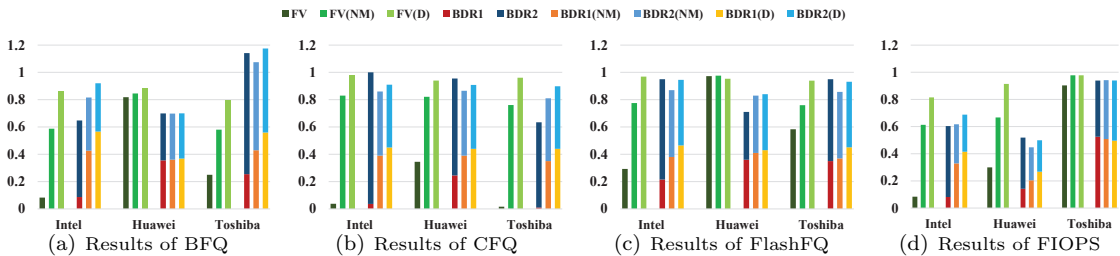


Figure 14: Effectiveness of SeqBDL. NM stand for NAISS without SeqBDL, D means full function NAISS.