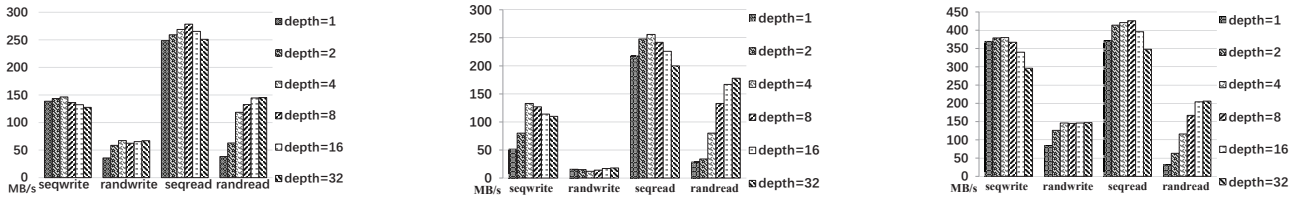
Experiments on NCQ of SSD and Evaluations on NASS

1 Single Workload Experiment



(a) Results on Intel (b) Results on Toshiba (c) Results on Huawei

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

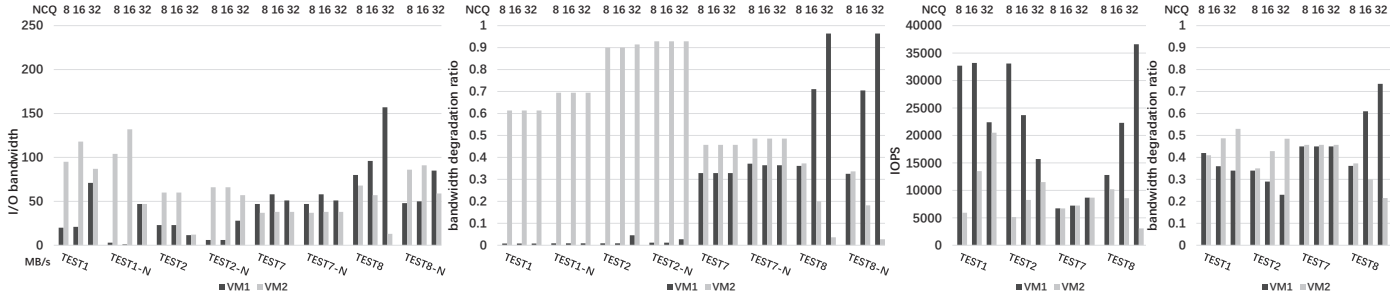
The specific parameters of each workload are listed in Table 1. Notably, iodepth of FIO is set to 32 and 2 for intensive and non-intensive workloads respectively.

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

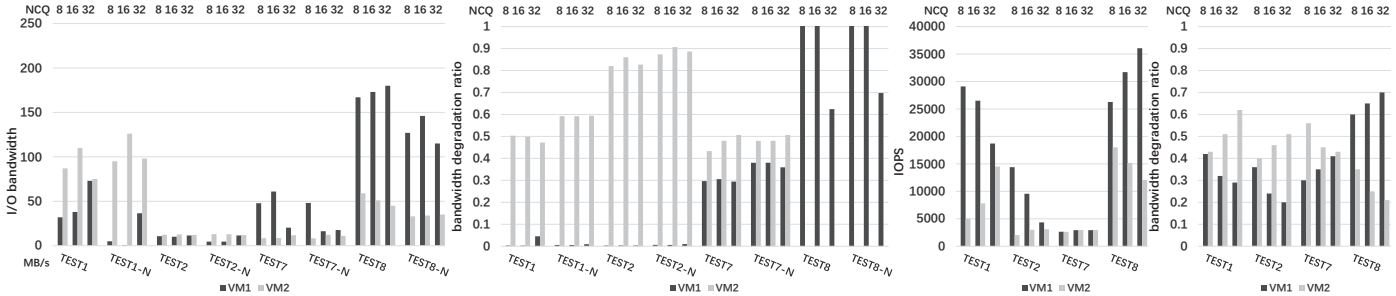
2.1 Resutl of TEST1, TEST2, TEST7 and TEST8

Figure 2, 4 and 3 show results on sequentiality.



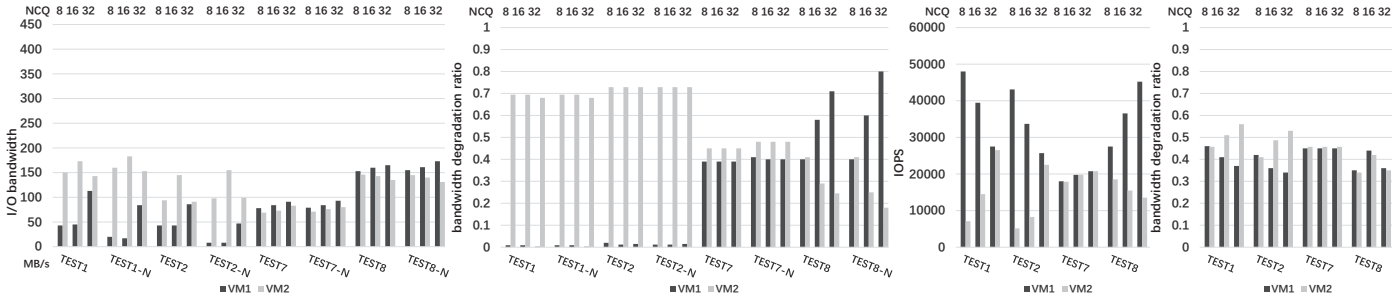
(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 2: Results on Intel SSD



(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 3: Results on Toshiba SSD

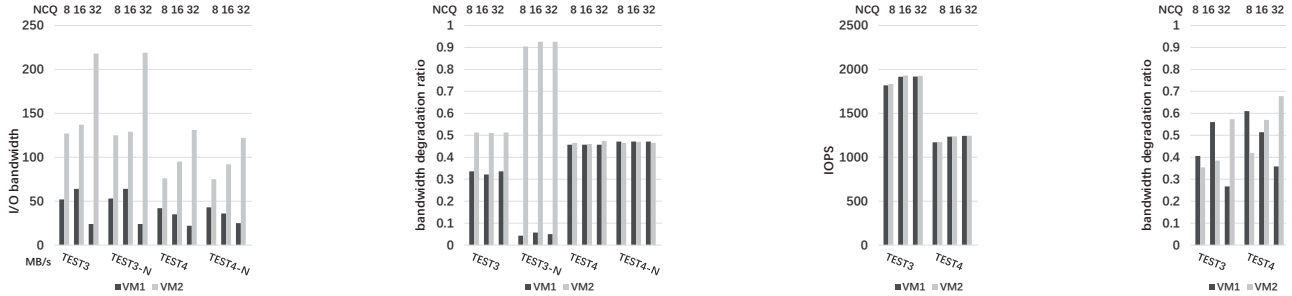


(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 4: Results on Huawei SSD.

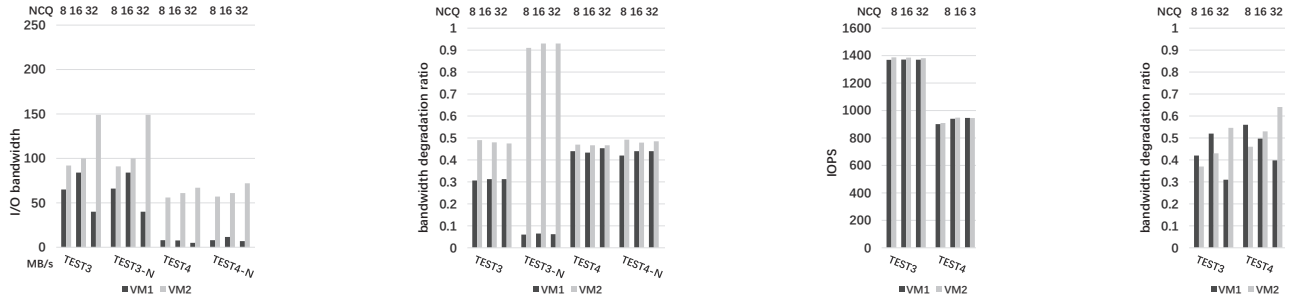
2.2 Resutl of TEST3 and TEST4

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



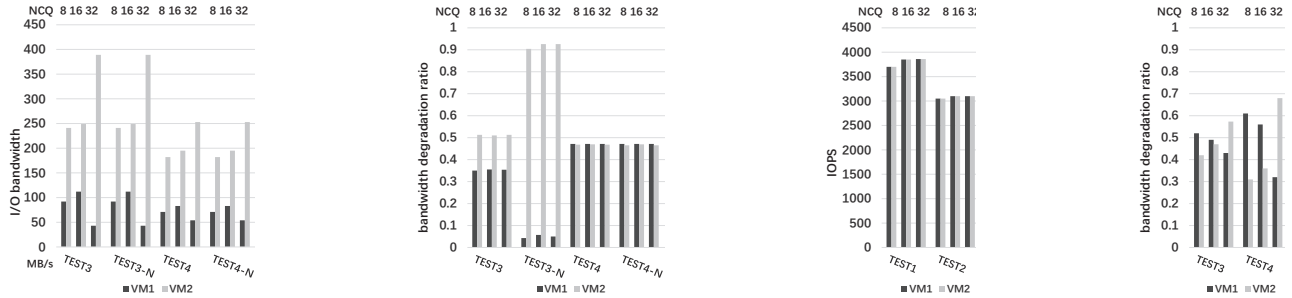
(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 5: Results on Intel SSD



(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 6: Results on Toshiba

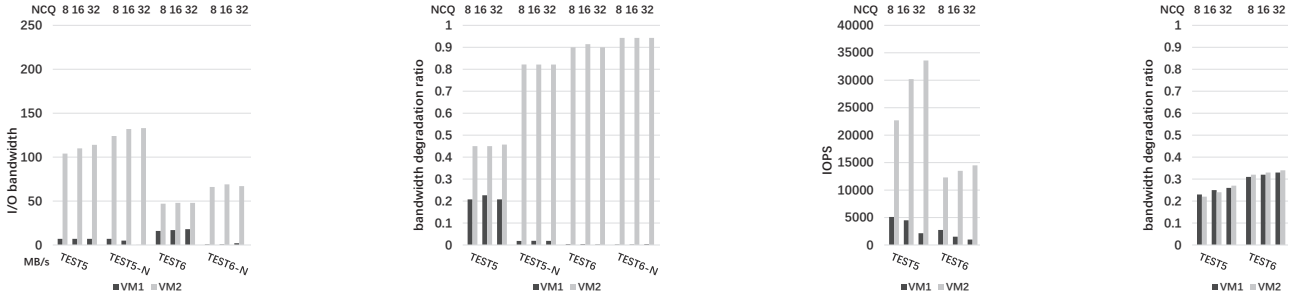


(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 7: Results on Huawei

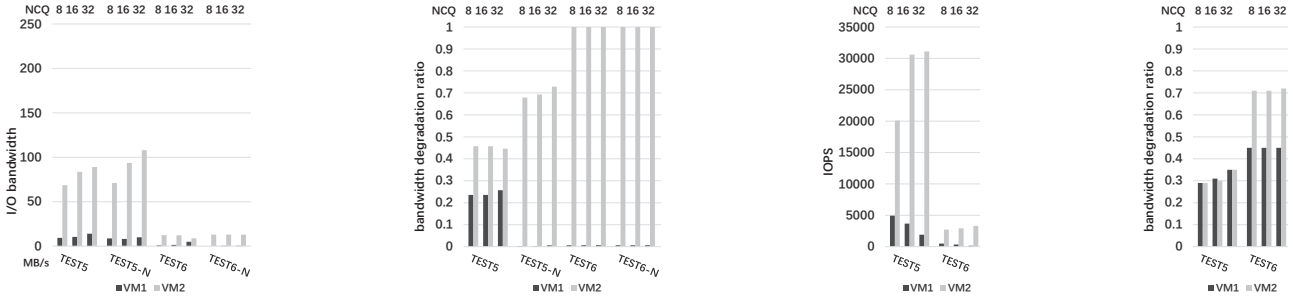
2.3 Results of TEST5 and TEST6

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



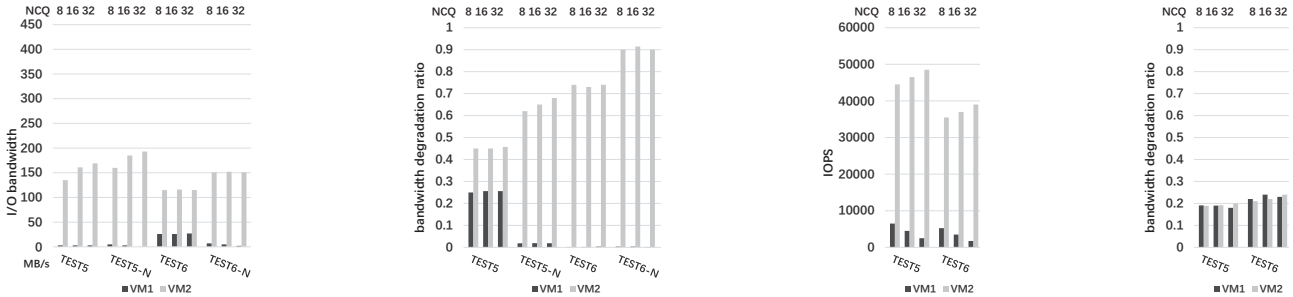
(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 8: Results on Intel SSD



(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 9: Results on Toshiba



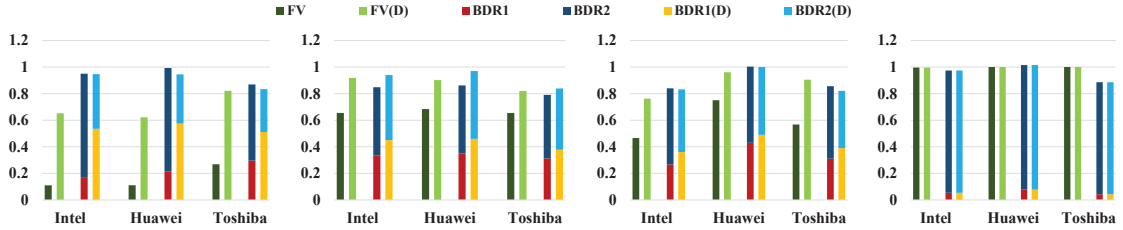
(a) BFQ (b) CFQ (c) FIOPS (d) FlashFQ

Figure 10: Results on Huawei

3 Effectiveness of NASS

3.1 AggreBDL Evaluation Figure

11 shows the effect of AggreBDL.

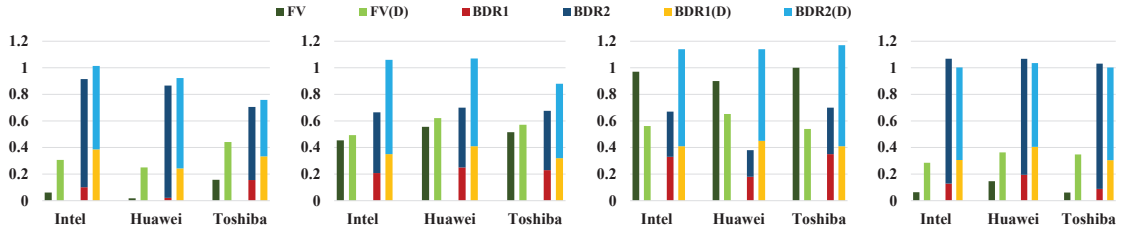


(a) Results of BFQ (b) Results of CFQ (c) Results of FlashFQ (d) Results of FIOPS

Figure 11: Effectiveness of AggreBDL. We compare the fairness of original I/O schedulers with our modified I/O schedulers on three SSDs. *BDRi* is bandwith degradation ratio of *Wi*. *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.

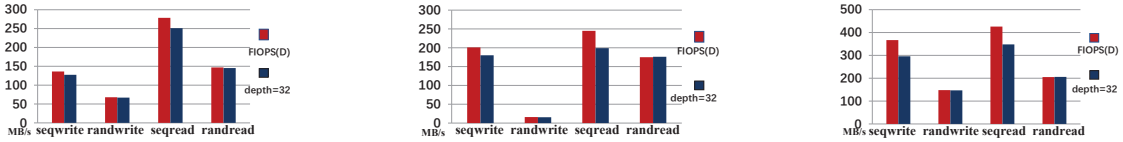


(a) Results of BFQ (b) Results of CFQ (c) Results of FlashFQ (d) Results of FIOPS

Figure 12: Effectiveness of AntiBDL

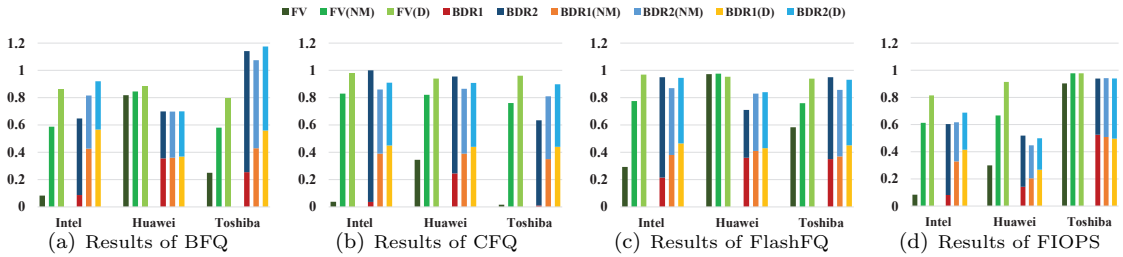
3.3 SeqBDL Evaluation

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



(a) Results on Intel (b) Results on TOSHIBA (c) Results on Huawei

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.



(a) Results of BFQ (b) Results of CFQ (c) Results of FlashFQ (d) Results of FIOPS

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