

Application I/O Characteristics

Application I/O characteristics influence the overall performance of storage system and storage solution design. This document describes key application I/O characteristics.

Random and Sequential

I/O is characterized as either *random or sequential*. Random I/O refers to successive read-write operations from noncontiguous addresses – accesses that are spread across the addressable capacity of the LUN. Examples of applications that largely generate random I/O include messaging, online transaction processing (OLTP) applications.

Sequential I/O refers to successive read-write operations from contiguous addresses – one logical block address after another. In sequential I/O access, disk seek time is reduced because the read-write head moves little to access the next block. Examples of sequential I/O include data backup.

Reads and Writes

Another aspect of the I/O workload is the ratio of read I/Os to write I/Os generated by an application. The sum of the read rate and the write rate is the I/O rate (the number of I/O operations per second). The application's I/O rate is one of the important factors that determine the minimum number of disks required for the application. In the storage system, cache plays an important role to improve the system performance. Table 1 summarizes how read I/O and write I/O interact with the cache.

Table 1: Read-Write Interactions with Cache

I/O Type	Read	Write
Random	Hard to effectively cache (difficult to predict prefetch); requires multiple fast disks for good performance.	Caching is effective, resulting in response time better than disk response time.
Sequential	Caching is extremely effective (predicting prefetch is easy); reads are done at cache speeds.	Caching is effective; cache is flushed quickly because entire disk stripe elements can be written.

Typical read versus write ratio for common business applications are as follows:

- Online transaction processing (OLTP) — 67 percent reads and 33 percent writes.
- Decision support system (DSS) — also referred to as data warehouse or business intelligence. I/O load is 80 percent to 90 percent reads to data tables including frequent table scans (sequential reads).
- Backup — As long as the file system is not fragmented, file-based backups are sequential.

I/O Request Size

The size of I/O generated by an application can vary depending on the type of the application. Some of the overhead to execute an I/O is fixed. If data exists in large chunks, it is more efficient to transmit larger blocks because a host can move data faster by using larger I/Os than smaller I/Os. The response time of each large transfer is longer than the response time for a single small transaction, but the combined service time of many smaller transactions is greater than a single transaction that contains the same amount of data. Table 2 shows typical applications and their characteristics.

Table 2: Application Characteristics

Application	Seek Type	I/O Request Sizes	Percentage of I/O as Writes
Microsoft Exchange	Random	32 KB	Moderate to high
SAP/Oracle applications	Random	~8 KB	Depends on application
RDBMS: Data entry/OLTP	Random	Database or file system page size	Moderate to high
RDBMS: Online (transaction) logs	Sequential	512 byte+	High, except for archiving process
RDBMS: Temp space	Random	Database or file system page size	Very high