Threading Opportunities in High-Performance Flash-Memory Storage



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Revolutionary Storage Technologies

- Storage-Intensive Supercomputing (SISC) at LLNL
 - System architectures for applications with *massive datasets*
 - New technologies: processing elements, networks, and storage
- NAND-Flash storage in high-performance computing
 - Flash chips have great potential: 100x access times, 10x bandwidth
 - However, few commercial products have delivered performance
- Exception: Fusion-io's ioDrive
 - PCIe x4 card with 80-320 GB of flash
 - Theoretical read speed of 700 MB/s
 - Hardware allows many IOPs to be in-flight concurrently







Threaded I/O Microbenchmarks

- Observation: Increasing number of IOPs improves performance
 - Opposite of what we expect from hard drives
 - Due to flash memory packaging: chip is actually a die stack
- Implemented a set of I/O microbenchmarks to investigate
 - Threaded with mixed I/O characteristics (mostly read-only)
 - Currently: Block transfer, kNN, external sort, binary search
- Example: k-Nearest Neighbors (kNN)
 - Stream through all training vectors and find
 k vectors that are most similar to each input vector
 - Each thread works on portion of training data







kNN Results

- Single ioDrive vs. Three SATA hard drives in RAID0
 - ioDrive provided a 3x improvement to end application
 - Small number of threads can have large impact with flash memory





