

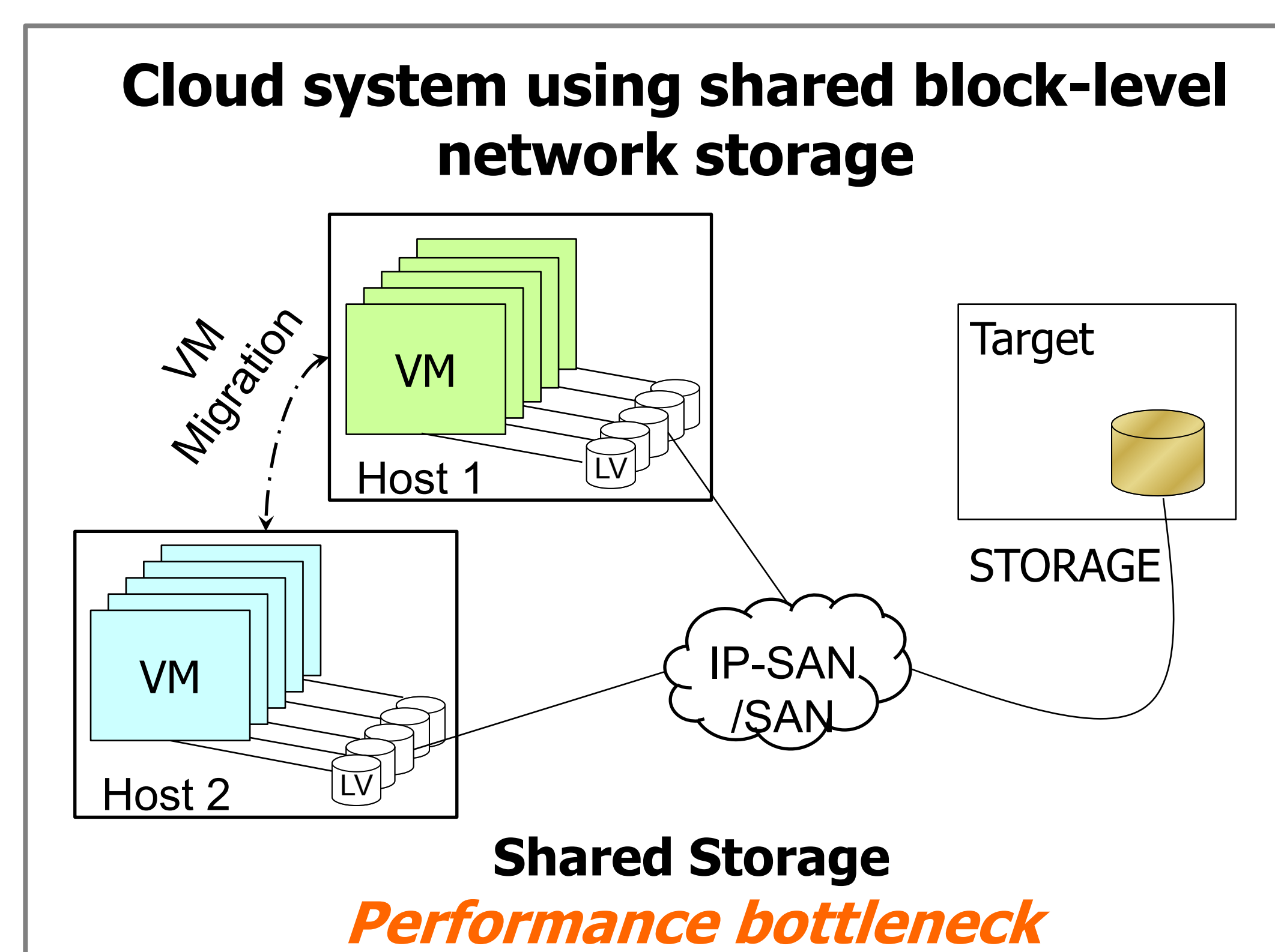
Dynamic Block-level Cache Management for Cloud Computing Systems

Dulcardo Arteaga, Douglas Otstott, Dr. Ming Zhao

School of Computing and Information Sciences, Florida International University

Background

- **Goal:** Improve I/O performance of virtual machines (VMs) in cloud systems using caching
- **Background**
 - Block-level network storage (iSCSI, NBD, SAN) is commonly used in cloud systems
 - Fast VM migrations
 - Improved data availability
 - Scalability becomes a serious issue as the size of cloud systems increases
 - Bottleneck in shared network storage
 - Performance interference across VMs



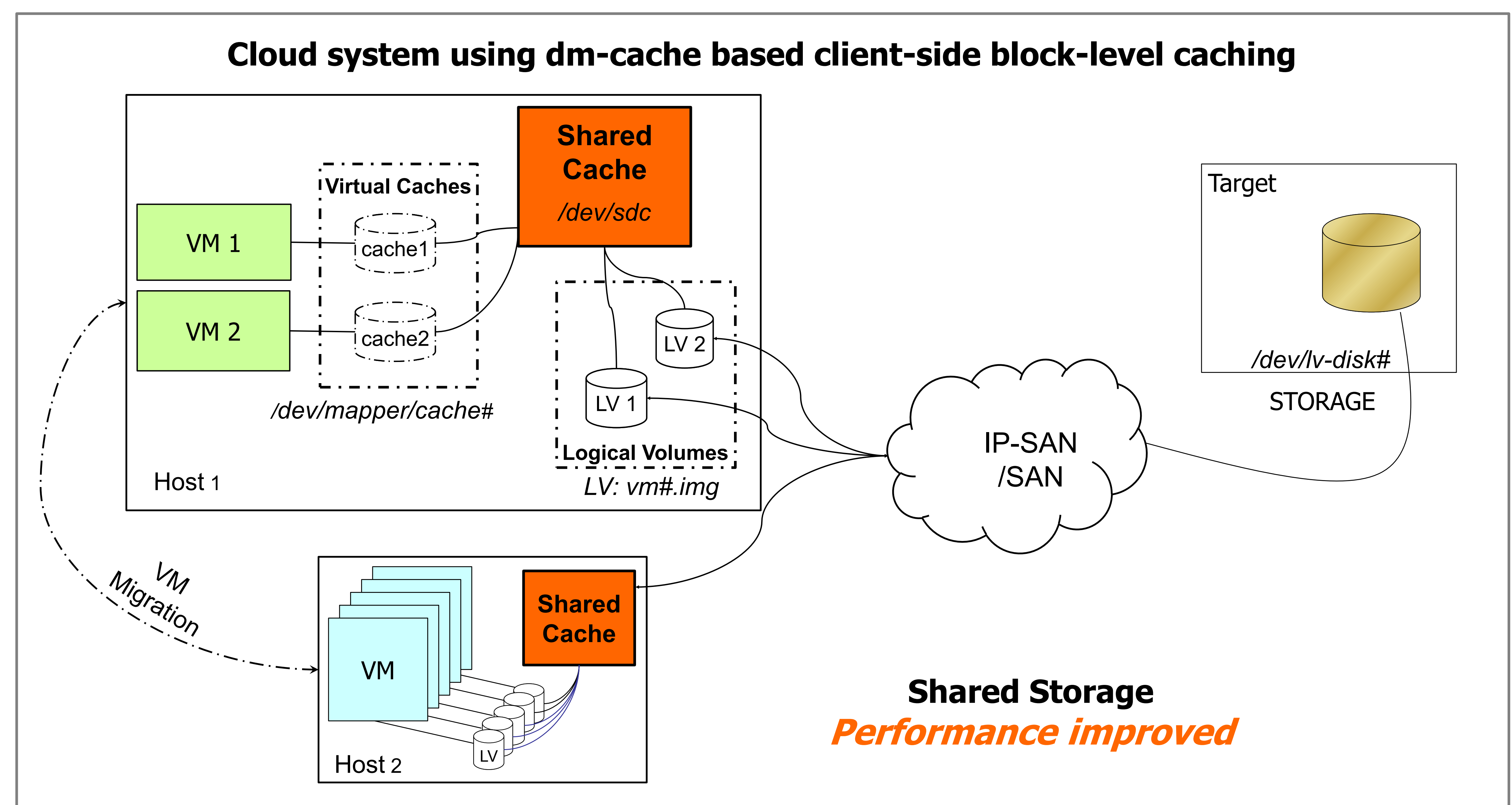
Proposed Solution

- **Dynamic block-level client-side caching for cloud computing systems**
 - Exploit data locality in VM data access to improve the performance of VMs and the load on shared storage system
 - Utilize the increasing capacity and speed of storage (particularly SSDs) available on the client-side
 - Implement via block-level virtualization to support different cloud storage systems
 - Support flexible, dynamic configuration of cache replacement and write policies

System Design

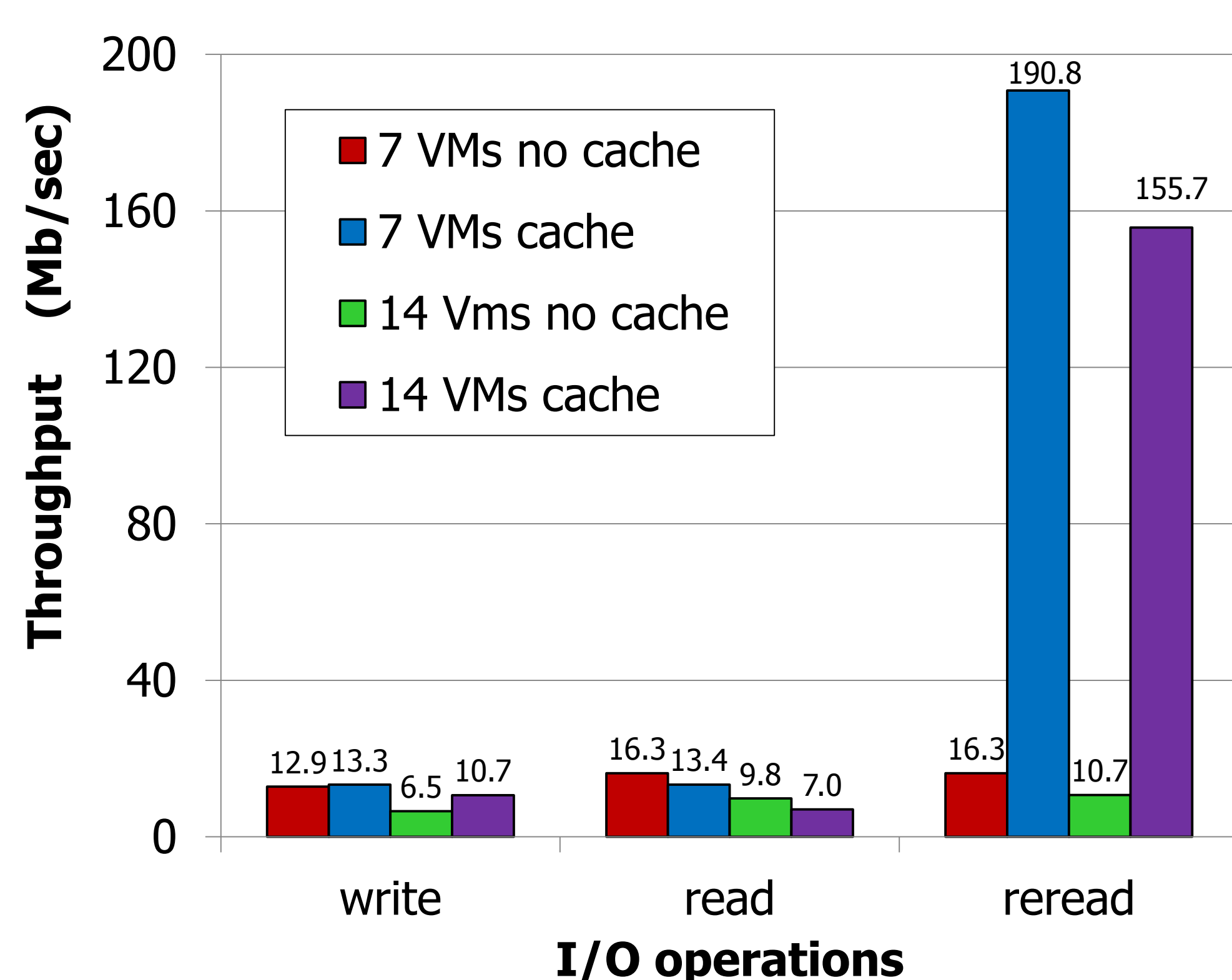
- **Block device virtualization based caching**
 - **DM-cache:** a generic block-level disk cache utility for storage systems
 - Built upon device-mapper, a framework for creating virtual block devices on Linux
 - Can be transparently plugged into an existing IP-SAN/SAN storage system
- **Shared cache for co-hosted VMs**
 - Create per-VM virtual caches to differentiate block-level I/Os from different VMs
 - Map the different virtual caches to the same physical cache device to maximize cache utilization
 - Can support different cache space allocation policies

Proposed Approach

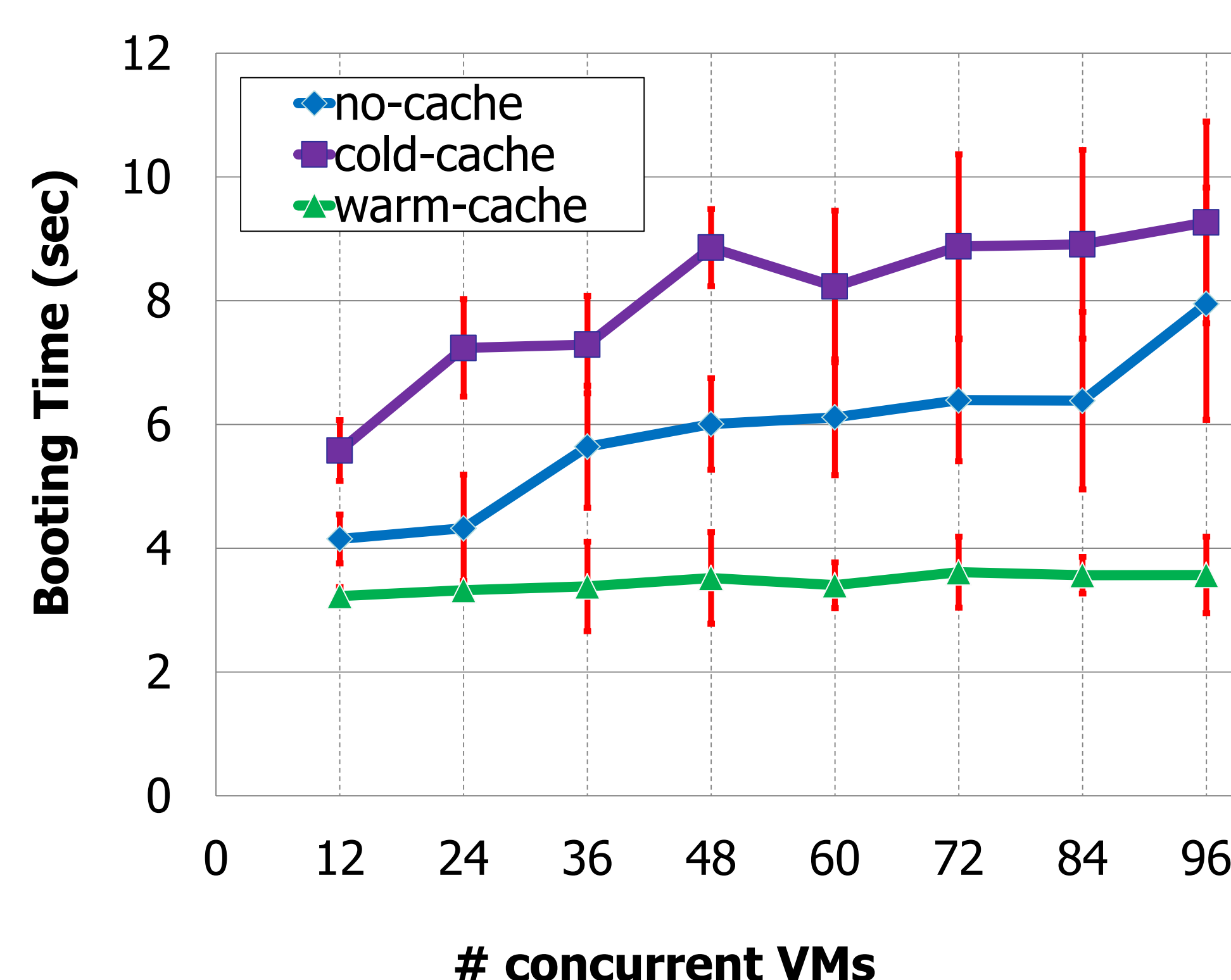


Experimental Evaluation

- **Experiment setup:**
 - Eight VM hosts, each with SSD based cache; One shared iSCSI-based network storage server



IOzone
14x higher throughput for reread



Concurrent Booting
Up to 55% faster booting

Conclusion and Future Work

- **Conclusions**
 - DM-cache effectively uses client-side storage to exploit locality for multiple VMs running on the same physical host
 - SSD-based results show substantial performance improvements for concurrent booting and IOzone runs
- **Future Work**
 - Study intelligent algorithms for shared cache space allocation while guaranteeing fairness across all VMs
 - Consider the unique characteristics of SSD devices and design optimized cache policies accordingly
 - Consider cross-client cooperative caching to further improve caching efficiency and better support VM migration