

Aerie: Flexible File-System Interfaces to Storage-Class Memory (SCM)

H. Volos  HP Labs

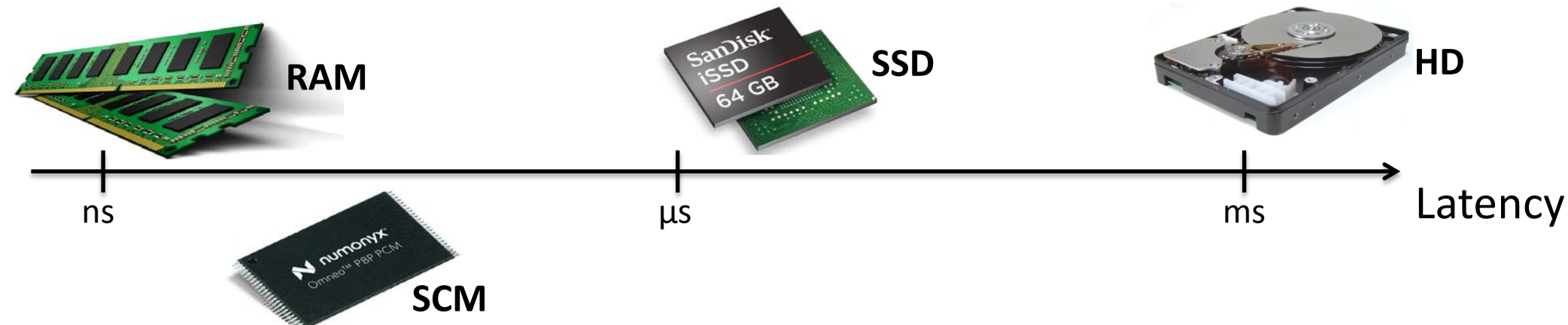
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STORAGE- CLASS MEMORY (SCM)

Key Features

- Persistent
- Memory-like interface (load/store)
- Short access time



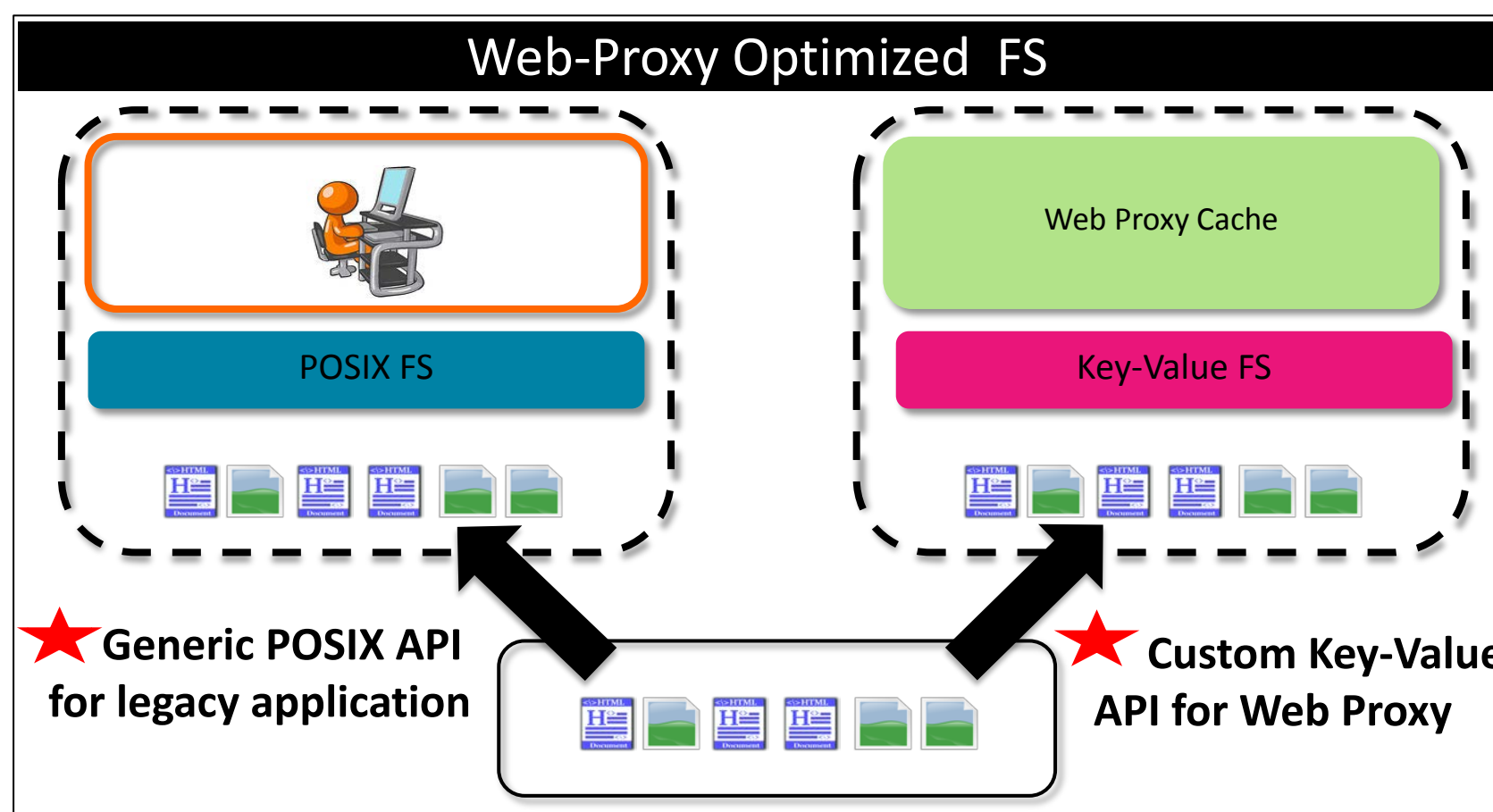
SCM Technologies

- Flash-backed DRAM
- STT-RAM
- Phase-Change Memory
- Memristor

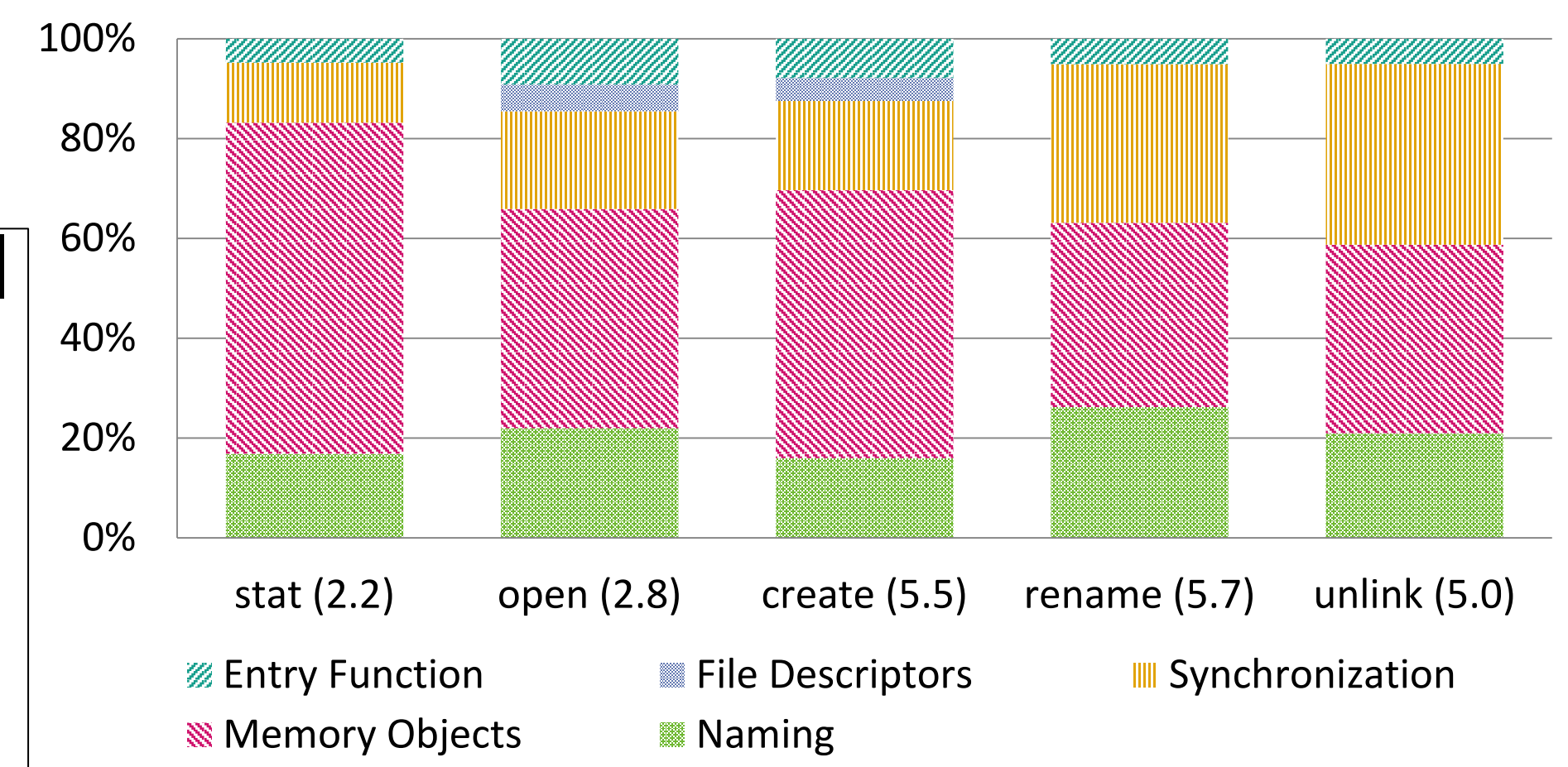
THE ABSTRACTION COST OF FILE

Generic Interface and Policies

- + Offers programming convenience
- Has fixed components and costs
- Hinders app-specific customization



Cost of Common VFS Ops



★ Hierarchical FS overhead matters for fast hardware

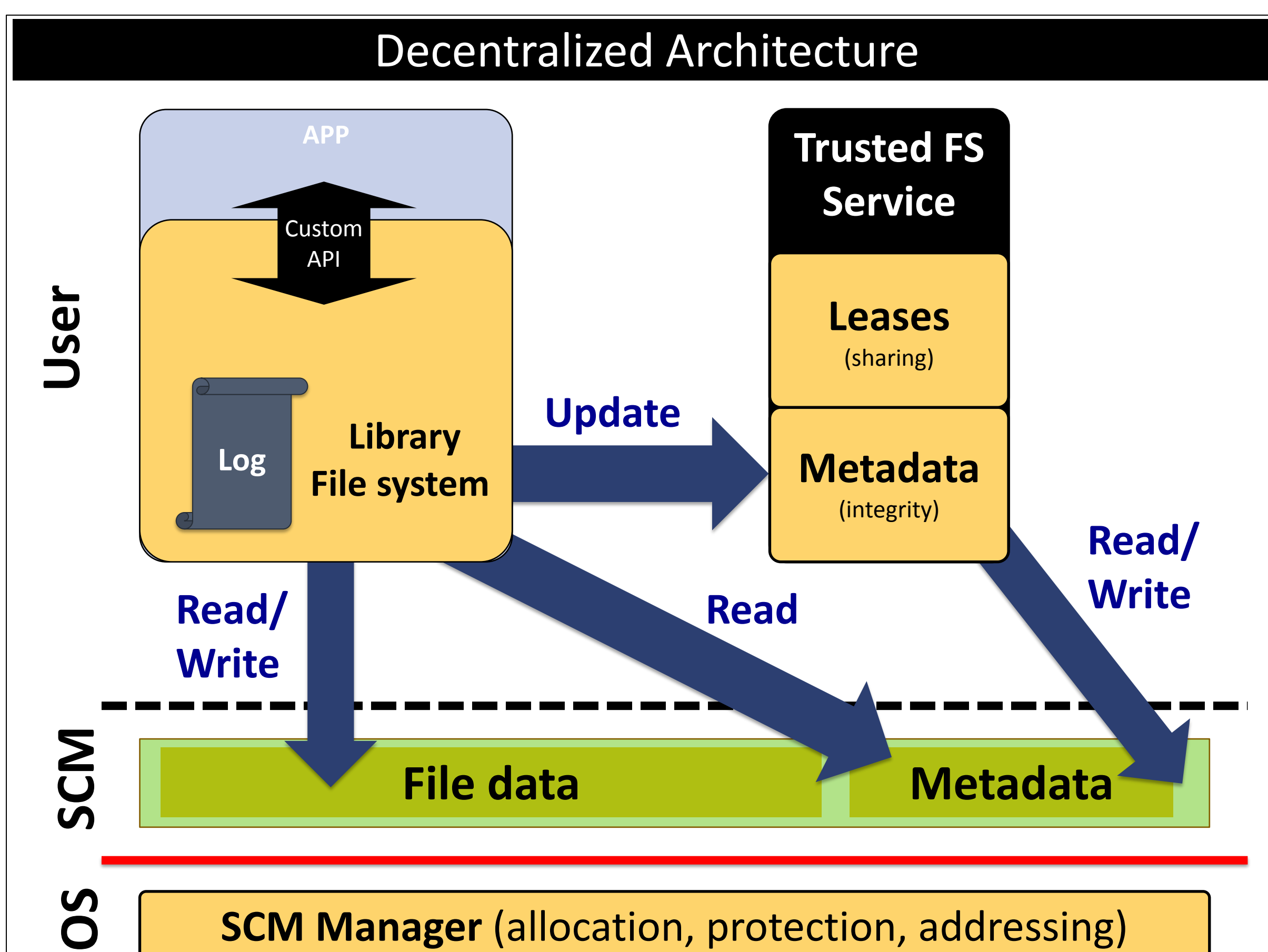
★ Kernel overheads matter for fast hardware

★ Flexible APIs a must for fast hardware

TOWARDS FLEXIBLE INTERFACES

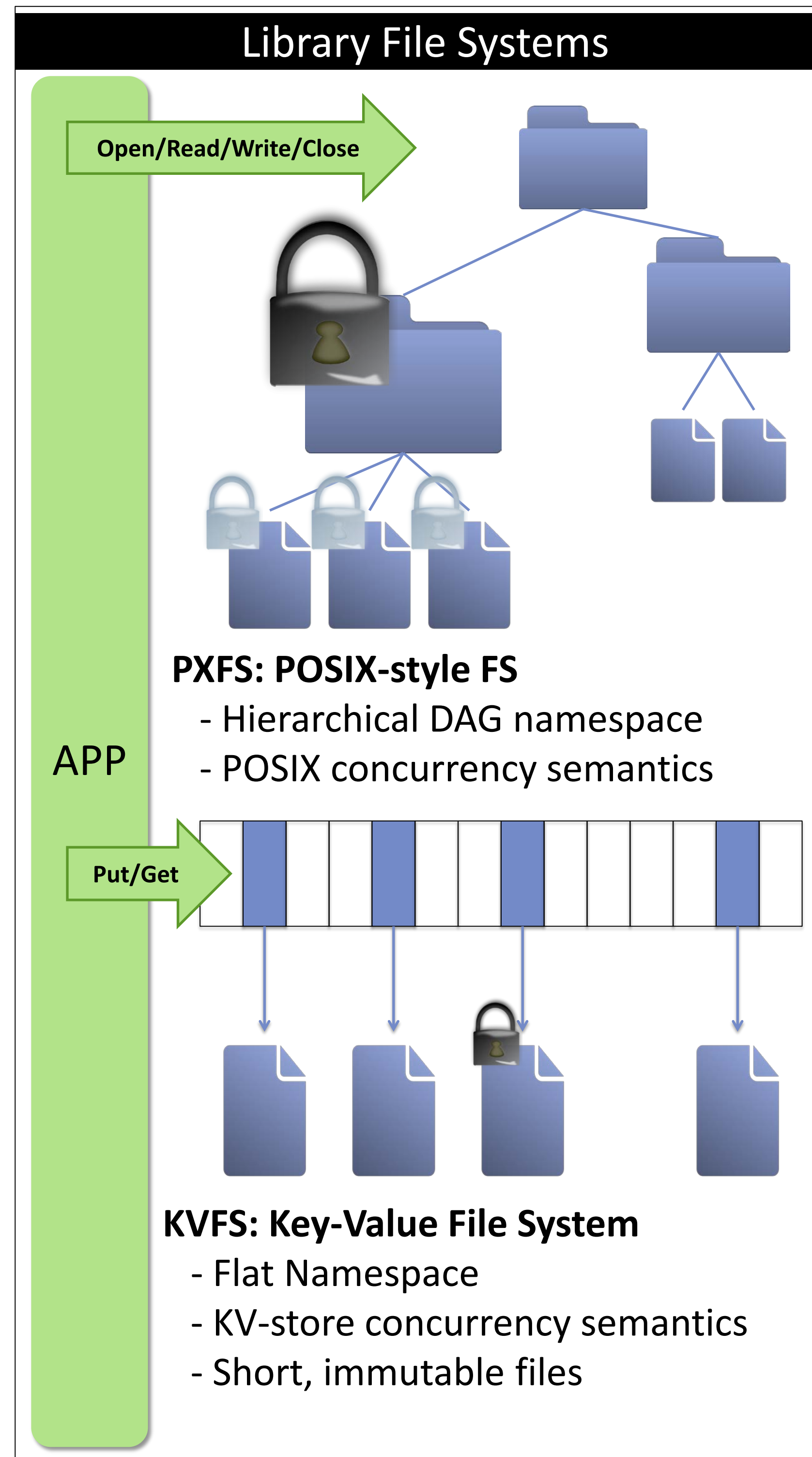
Library File-systems

Enables common operations (open/read/write/close file data, read meta-data) without frequent involvement of a trusted centralized entity

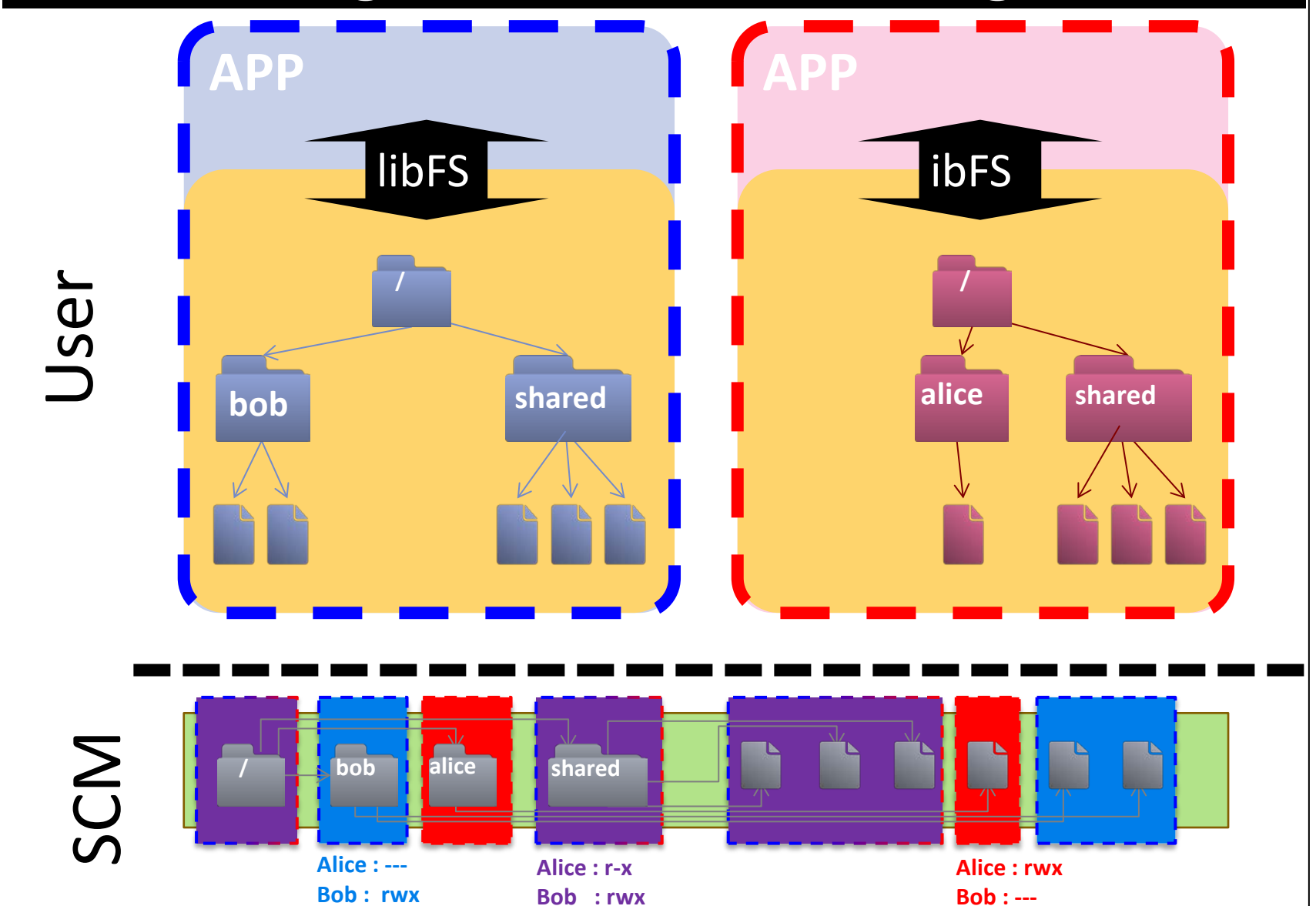


System Components

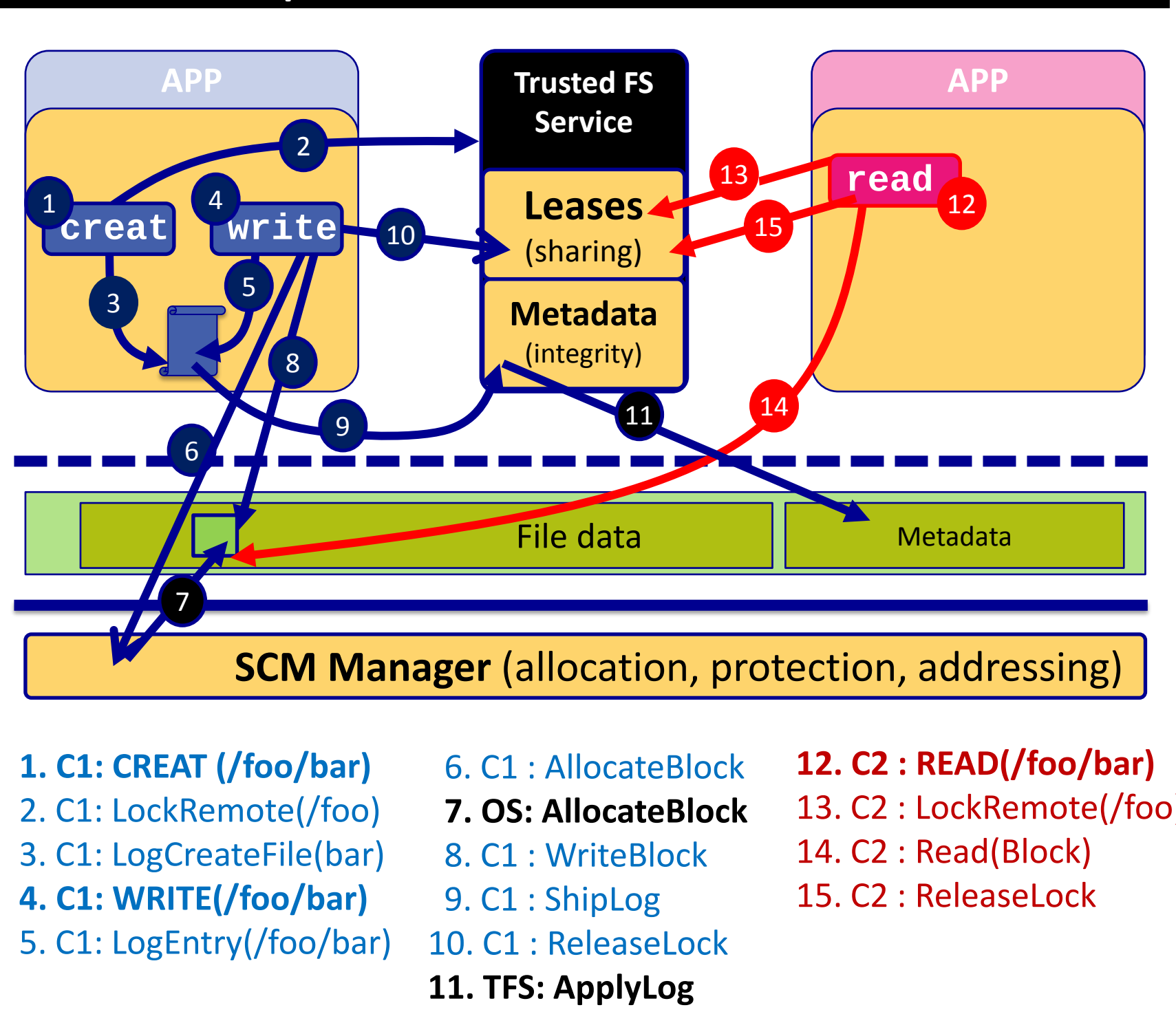
- **Library File-System (libFS)**
 - Exposes file system API
 - Implements naming and mapping
- **Trusted File-System Service (TFS)**
 - Guarantees integrity of metadata updates
 - Enforces concurrency ctrl
- **SCM Manager**
 - Securely records and enforces resource usage



Enforcing FS Permissions using MMU



Example: The Life of a Shared File



EVALUATION

Performance Model

- Writes to DRAM + s/w created delay
- Reads to DRAM (no delay)

Platform

- Intel(R) Xeon(R) E5645 2.40GHz (6 cores with 2 h/w threads per core)
- x86-64 Linux 3.2.2

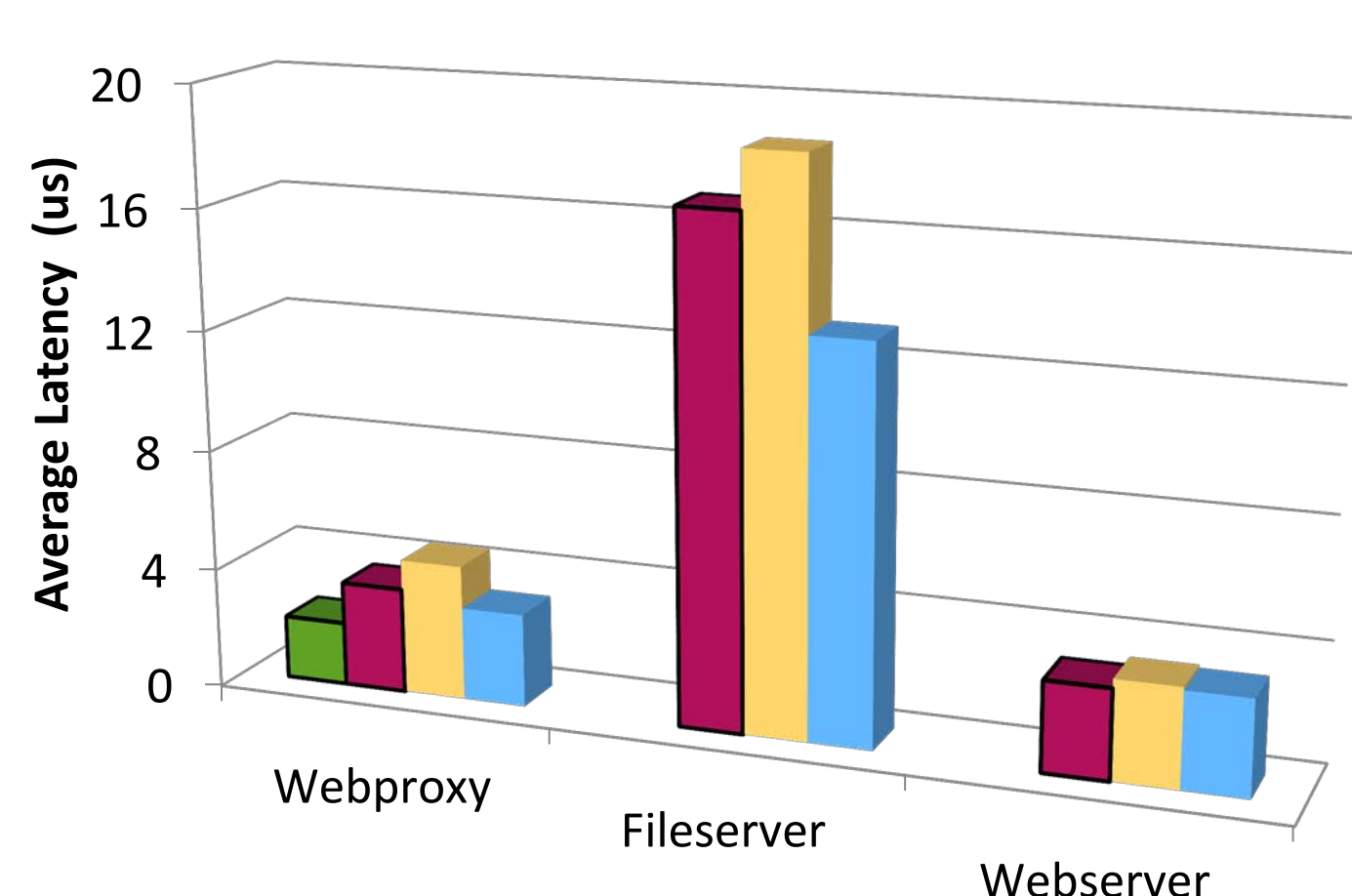
Workload

- Filebench application personalities

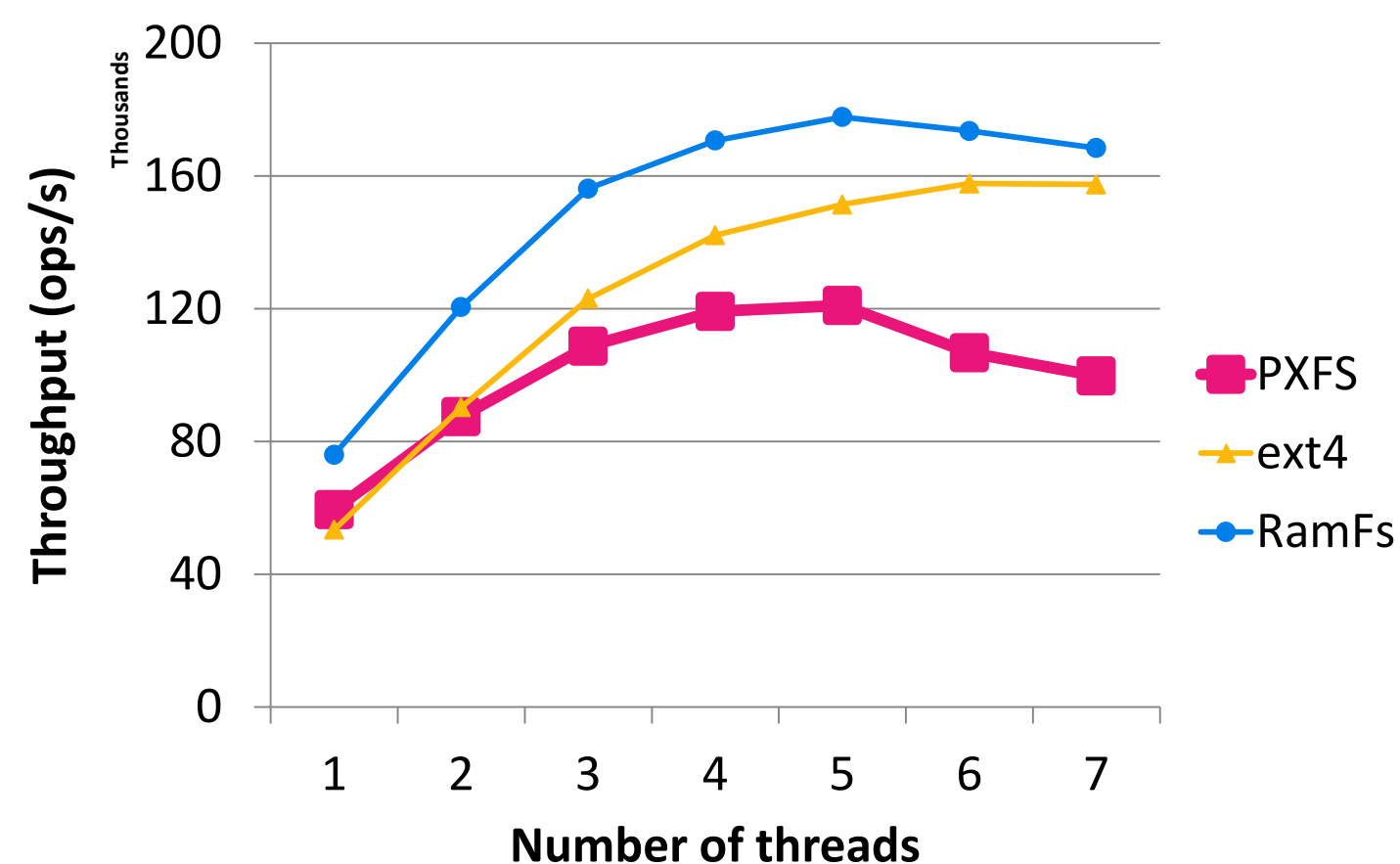
Configurations

- FlatFS: KV-style library FS
- PXFS: POSIX-style library FS
- Ext4: ext4fs + RAM-disk
- RamFS: In-memory kernel FS

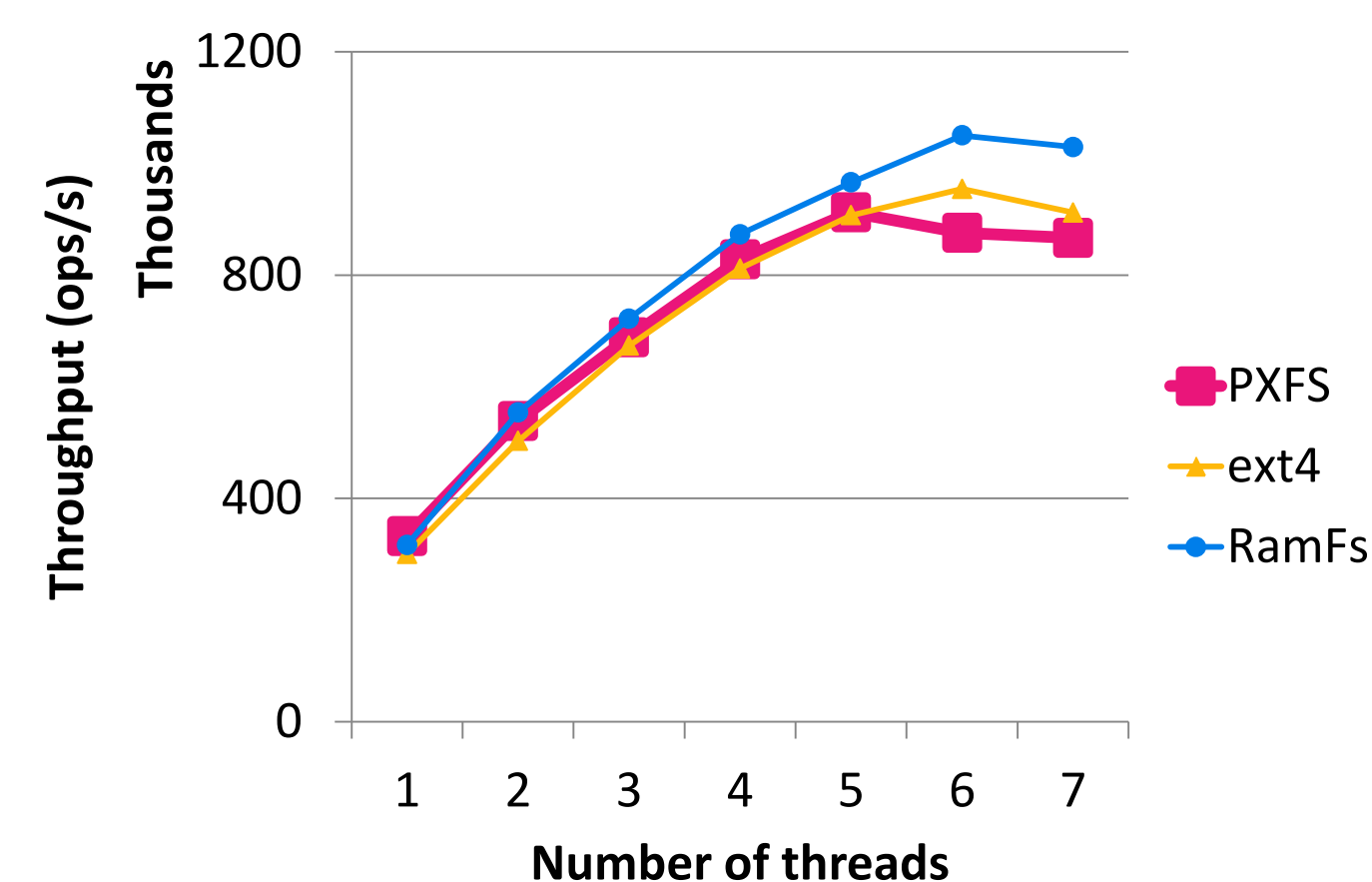
Filebench Latencies



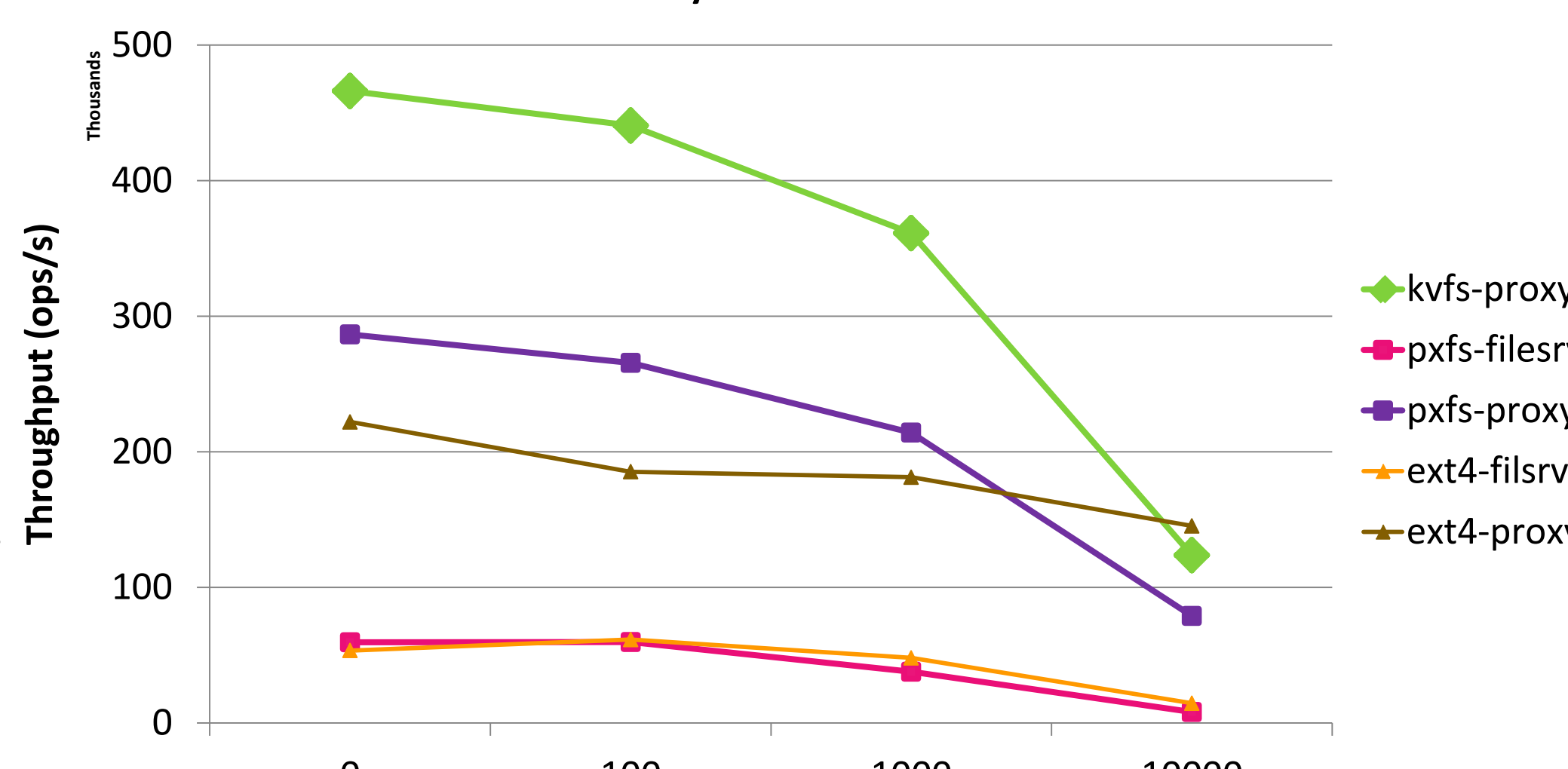
Client Scalability - Fileserver



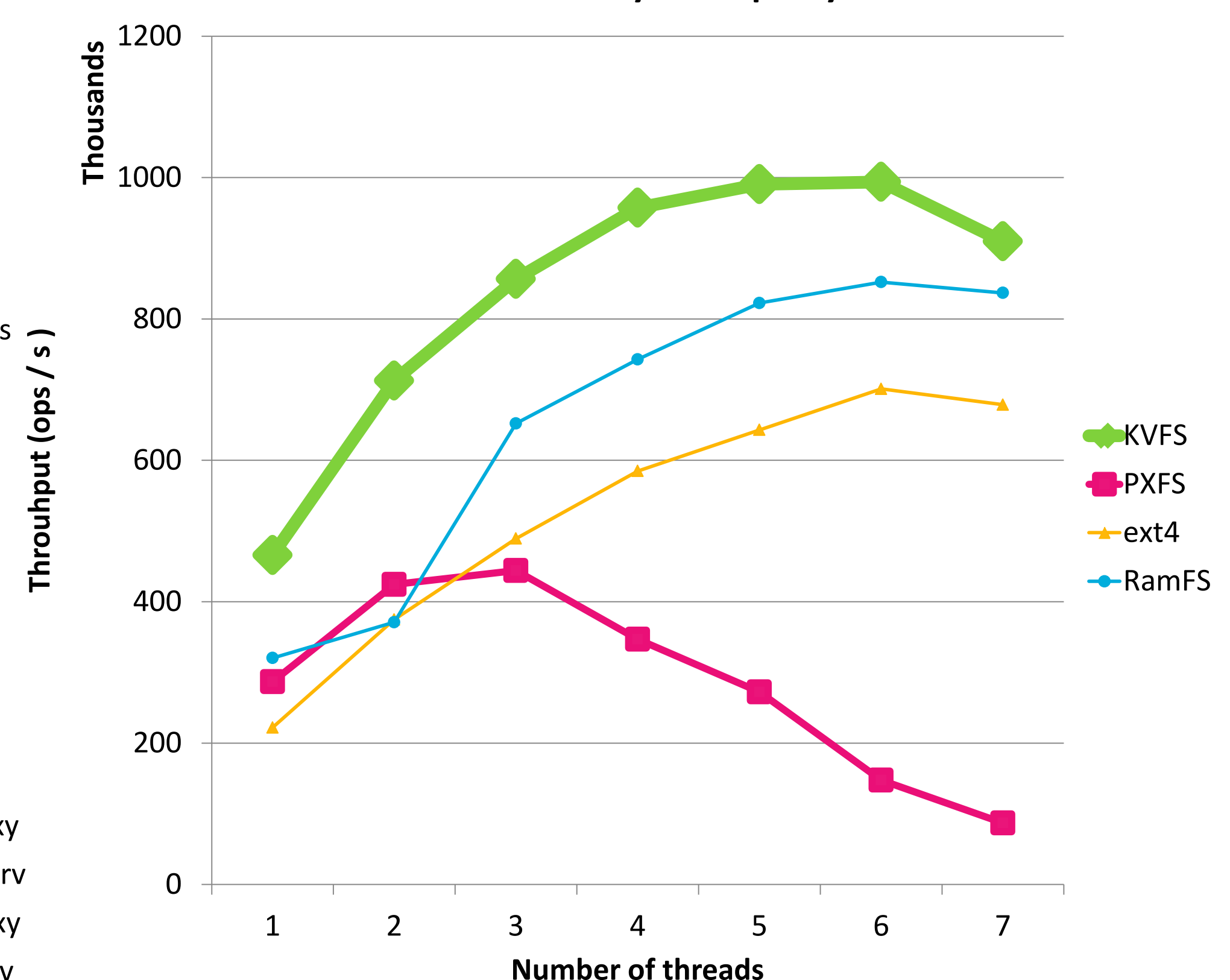
Client Scalability - Webserver



Sensitivity to SCM Performance



Client Scalability - Webproxy



★ Web-proxy workload performs best when there are no overheads of a hierarchical or kernel file system such as ext4 or PXFS !