
Efficient Synchronization of Linux Memory Regions over a Network: A Comparative Study and Implementation (Notes)

A user-friendly approach to application-agnostic state synchronization

Felicitas Pojtinger (Stuttgart Media University)

2023-08-04

Contents

- Abstract: A comparative analysis and implementation of various methods for synchronizing Linux memory options over a network
- Introduction
 - Examining Linux's memory management and relevant APIs
 - Use cases for memory region synchronization
- Option 1: Handling page faults in userspace with `userfaultfd`
 - Introduction to `userfaultfd`
 - Implementing `userfaultfd` handlers and registration in Go
 - Transferring sockets between processes
 - Examples of handler and registration interfaces (byte slice, file, S3 object)
 - Performance assessment of this approach
- Option 2: Utilizing `mmap` for change notifications
 - Concept: `mmap` a memory region with `MMAP_SHARED` to track changes in a file
 - Method 1 for detecting file changes: `inotify`
 - Limitations: `mmap` does not generate `WRITE` events
- Option 3: Hash-based change detection
 - Comparing hashes of local and remote `mmaped` regions
 - Evaluation of hashing algorithms
 - Introduction to delta synchronization (e.g., `rsync`)
 - Custom protocol for delta synchronization
 - Multiplexing synchronization streams
 - The function of `msync`
 - Performance assessment of this approach
- Option 4: Detecting changes with a custom filesystem implementation
 - Intercepting writes to the `mmaped` region using a custom filesystem
 - Exploring methods for creating a new, custom Linux filesystem
 - * In the kernel
 - * `NBD`
 - * `CUSE`
 - * `BUSE`
 - * `FUSE`
 - * Upcoming options (`ublk`, etc.)
 - Detailed analysis of the `NBD` protocol (client & server)
 - Implementing the client and server in Go based on the protocol

- Server backend interface and example implementations
 - Asynchronous writeback protocol and caching mechanism
 - Performance assessment of this approach
- Summary:
 - Comparing options in terms of ease of implementation, CPU load, and network traffic
 - Identifying the optimal solution for specific use cases: data change frequency, kernel/OS compatibility, etc.