CHERIvoke: Characterising Pointer Revocation using CHERI Capabilities for Temporal Memory Safety

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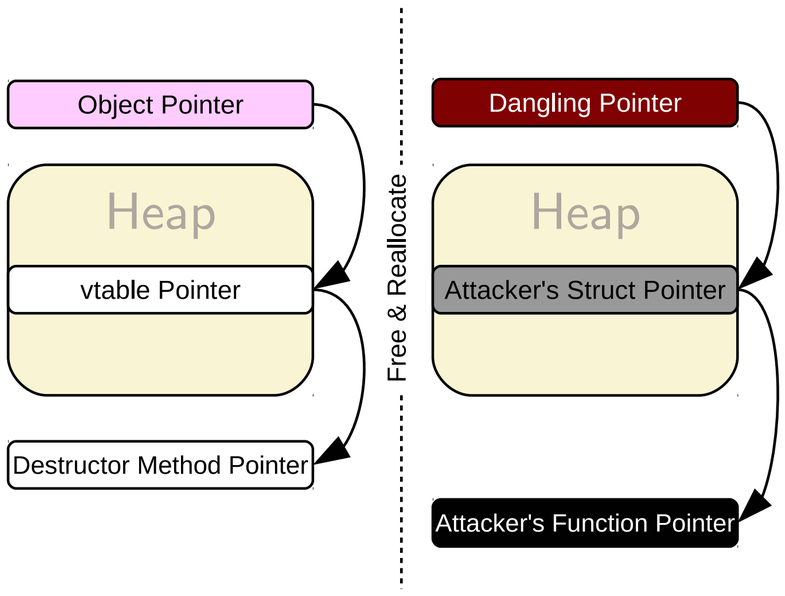
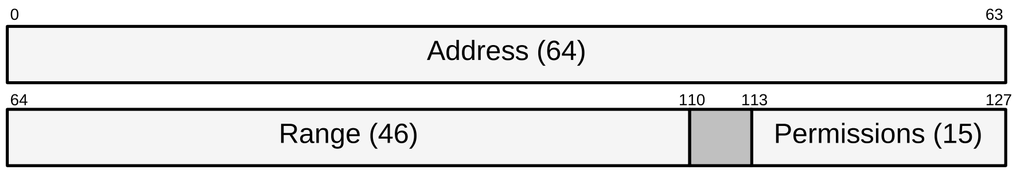
Use-After-Free Attacks



A lack of temporal safety in low-level languages has led to an epidemic of use-after-free exploits. These have surpassed in number and severity even the infamous buffer-overflow exploits violating spatial safety.

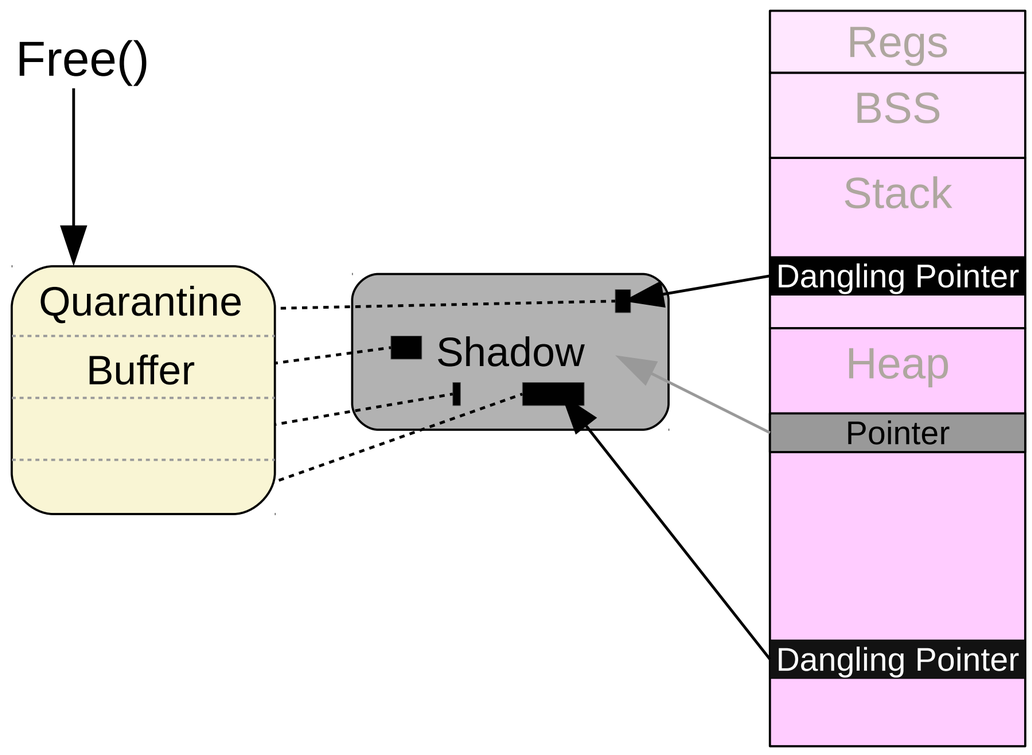
CHERI Capabilities

CHERI is an architectural extension to provide hardware capability addressing for *spatial* safety. It allows unique identification of pointers at the architectural level, with distinct access bounds, and identification of pointer-free cache lines and pages.



We develop CHERIvoke, a technique for deterministic and fast sweeping revocation to enforce *temporal* safety on CHERI systems. CHERIvoke quarantines freed data before periodically using a small shadow map to revoke all dangling pointers in a single sweep of memory.

CHERIvoke Algorithm



- Quarantine manual frees until we can clear dangling references.
- Fill 1/128-sized shadow region with "poison" bits, to tell us which capabilities to revoke.
- Fast sweep through memory region, to remove dangling capabilities based on shadow space and optimised to avoid capability-free pages and cache lines, once 25% of memory is in quarantine.

Acknowledgements

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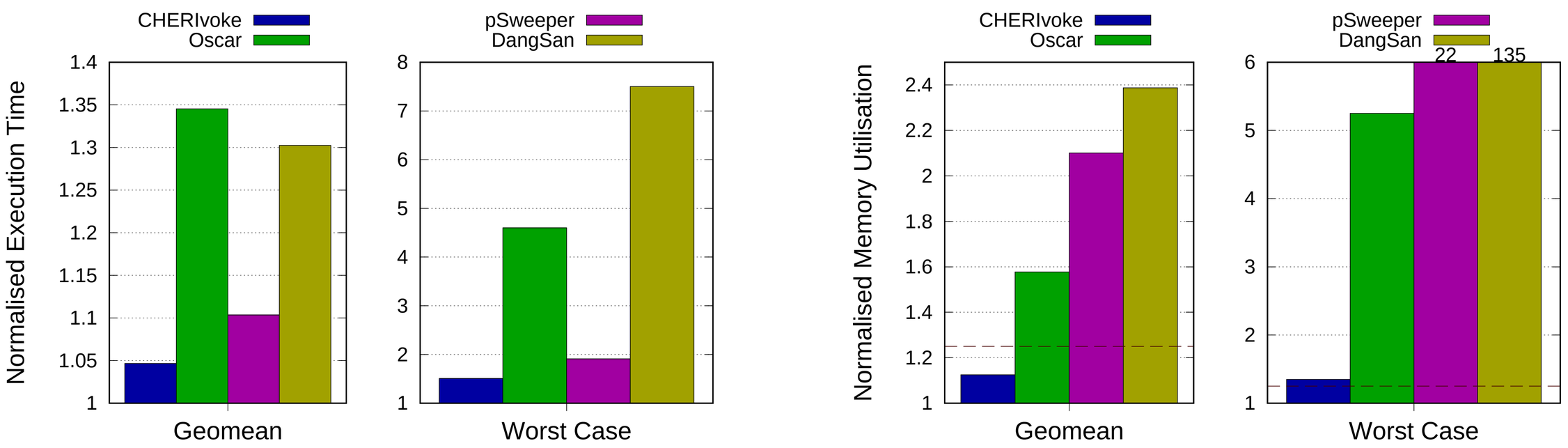
Low Overhead on Real Systems



We evaluate CHERIvoke using high-performance x86 processors, simulating the existence of capabilities. When configured with a heap-size overhead of 25%, we find that CHERIvoke achieves an average execution-time overhead of under 5%, far below the overheads associated with traditional garbage collection, revocation, or page-table systems.