Shredding Your Garbage

Reducing Data Lifetime Through Secure Deallocation

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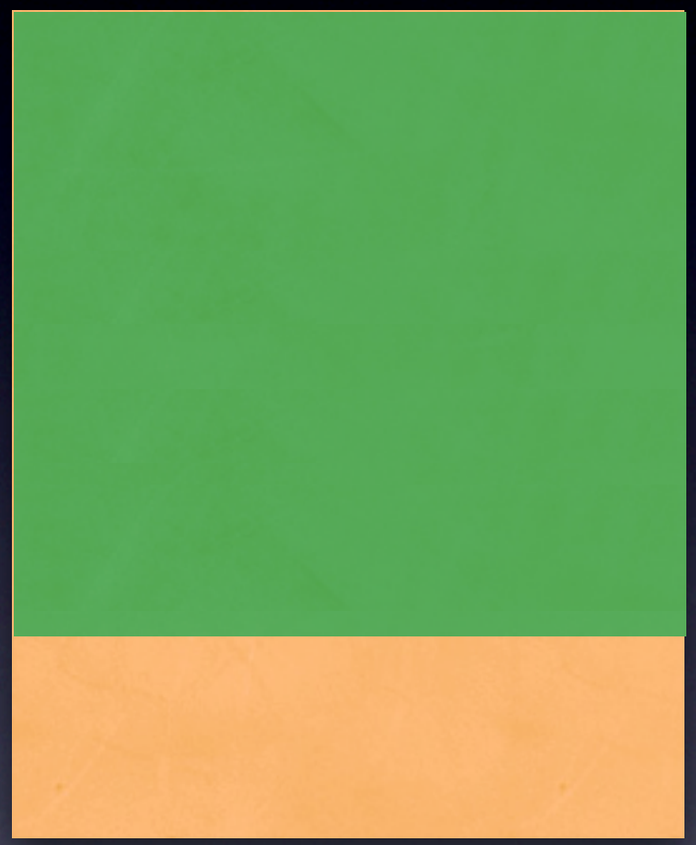
Problem

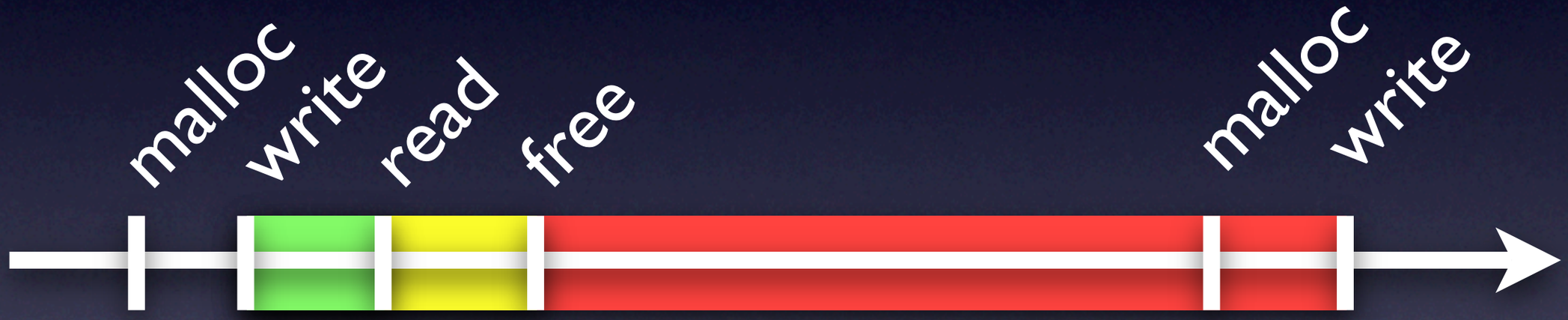
Most applications take no steps to minimize the amount of sensitive data in memory.

- scrubbing memory is used only for credentials like keys or passwords
- data may spill out via core dumps, logs, swapping, driver buffers, window manager
- most of this is outside application control

Holes



Data Life Cycle

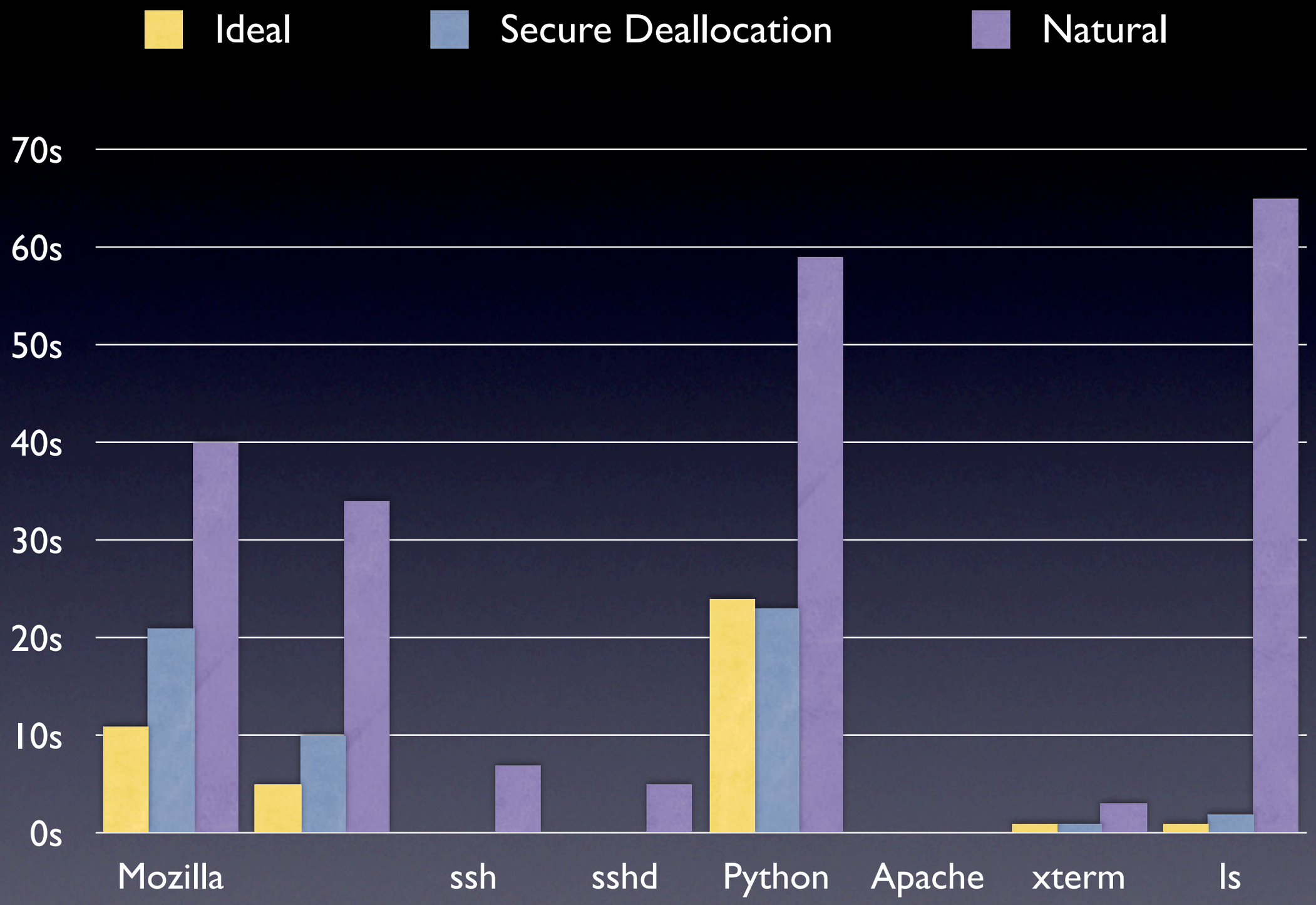


Secure Deallocation

- scrub on deallocate as a conservative heuristic
  - time of last use is generally unknown
  - should not introduce errors
- requires no a priori knowledge about data use in an application

Layered Clearing

- applicable at many levels
  - application-level
  - compiler-level
  - library-level
  - kernel-level
- clearing only on one level is insufficient


Ideal
Secure Deallocation
Natural
70s
60s
50s
40s
30s
20s
10s
0s
Mozilla
ssh
sshd
Python
Apache
xterm
ls

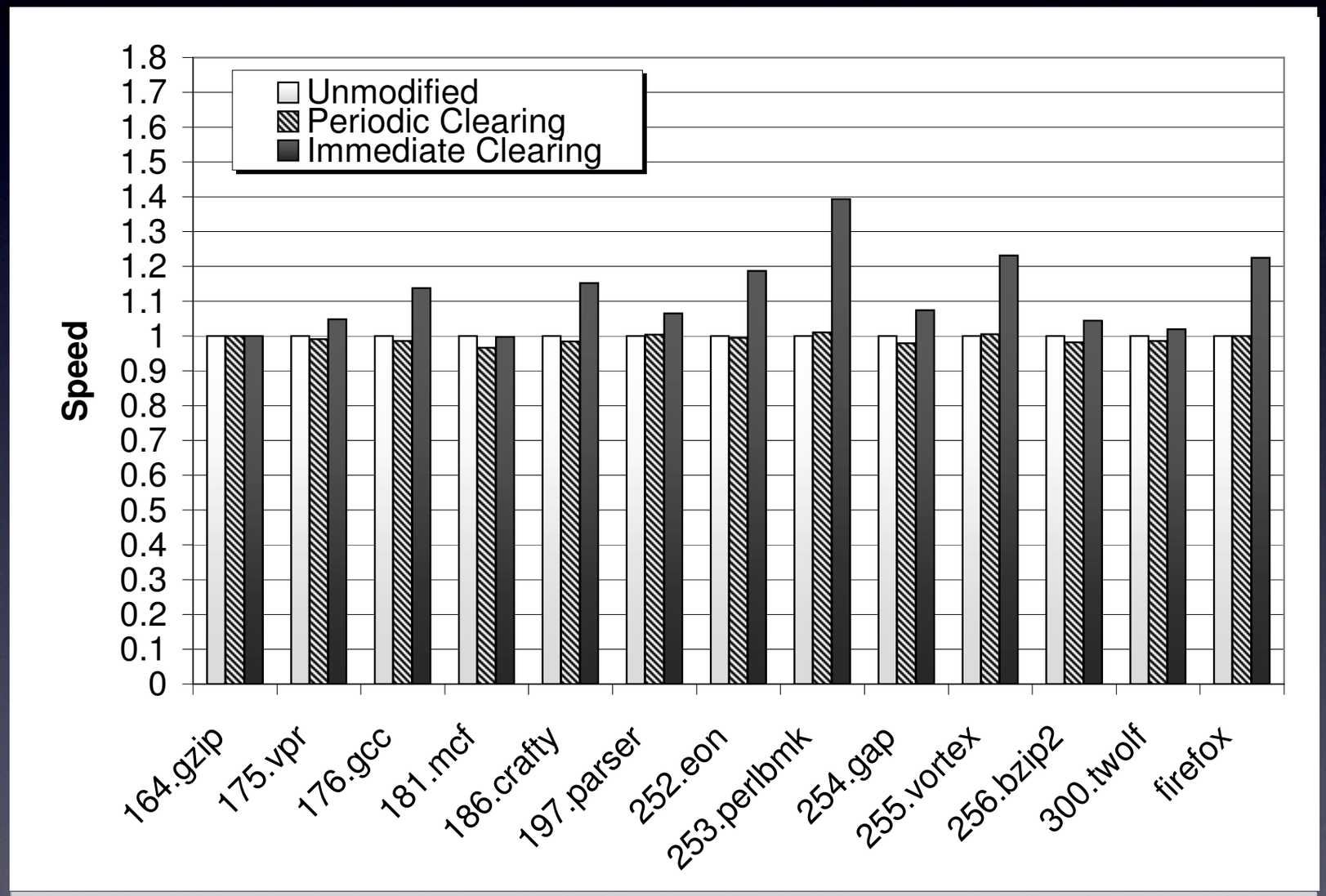
Kernel Clearing

- free pages divided into three pools
  - not-zeroed pool
  - zeroed pool
  - polluted pool
- zeroing daemon ensures pages do not stay in polluted pool longer than 5 seconds

Results

- Apache & Perl workload
  - CGI script checks a password
    - all tainted memory is cleared with some benign exceptions
- Emacs workload
  - all taints cleared except entropy pool

Performance Impact



Caveats

- some data is never deallocated
  - long-living data
  - memory leaks
- custom allocators

Discussion

- There is still a gap to the ideal lifetime.
- The data is still in memory while it is used.
- There is always a window of opportunity.
- You have to trust your memory anyway.
- Why bother shrinking the window when you can never close it for good?