

Kernel side channel security project

Kristen Accardi

No license (express or implied, by estoppel or otherwise) to any intellectual property rights is granted by this document.

Intel disclaims all express and implied warranties, including without limitation, the implied warranties of merchantability, fitness for a particular purpose, and non-infringement, as well as any warranty arising from course of performance, course of dealing, or usage in trade.

This document contains information on products, services and/or processes in development. All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest forecast, schedule, specifications and roadmaps.

The products and services described may contain defects or errors known as errata which may cause deviations from published specifications. Current characterized errata are available on request.

Copies of documents which have an order number and are referenced in this document may be obtained by calling 1-800-548-4725 or by visiting www.intel.com/design/literature.htm.

Intel, the Intel logo, are trademarks of Intel Corporation or its subsidiaries in the U.S. and/or other countries.

*Other names and brands may be claimed as the property of others

© Intel Corporation.





Mission Possible

Help prevent future side channel attacks on the kernel, and harden the kernel against other potential exploits.

- ★ *not addressing specific CVEs or security gaps*



A few of our projects

- Make existing kernel address space randomization finer grained.
- Implement module address space randomization
- Allow security modules to selectively apply security mitigations when switching tasks
- Allow applications to protect memory areas containing secrets
- Remove cache breadcrumbs when returning error from system calls

Kernel boot address randomization

Objective:

Increase kernel address space randomization by relinking the kernel object files at every boot.

Description:

- Leverage existing module loading code as in kernel linker
- Break the kernel up effectively into many modules and possibly leverage our randomized module text/vmalloc allocation algorithm.
- Create new section for modules to load at boot time pre-fs.
- Modify startup to link in modules at boot

Status:

Still in the Research phase, not committed yet to a design.

Possible Benefits

- KASLR increases the difficulty of side channel attacks
- KASLR is already merged, and this strengthens what we've already adopted

Possible Challenges

- Even fine grained KASLR can be worked around
- A single vulnerability in a module might be exploited to find the kernel
- Increases complexity and reduces reproducibility of bugs.

Module text randomization

Objective:

Improve kernel address space randomization for module text sections

Description:

- Split the 1GB module text range into 2 - a randomized(fragmented) area, and a linearly allocated area.
- Randomize each loaded module with respect to each other
- If we fail to find adequate space in the randomized area, fall back to original algorithm in the linearly allocated space.

Status:

Under review upstream

Possible Benefits

- Better load time performance in randomized memory locations
- Increased randomness (17 bits)
- If one module address leaks, the others cannot be immediately inferred

Possible Challenges

- One address leak in a single module might be sufficient for an exploit
- Increased memory usage
- Increases complexity and reduces reproducibility of bugs.

Protect pages with secrets

Objective:

Allow user space applications to indicate that a page contains a secret that needs special protection

Description:

- Add a new flag to the `mlock2()` syscalls: `MLOCK_SECRET`
- Apply mitigations to both the memory area, and the process that mapped it
- Mitigations may include: make not dumpable, do not copy or fork, disable caching

Status:

PoC under development

Remove cache breadcrumbs

Objective:

Make it harder to perform cache timing attacks on data left behind by system calls

Description:

- When a system call would return an error, randomly perturb the cache before returning back to userspace
- Only apply to specific set of errors (for example, -EPERM)

Status:

PoC under development

Possible Benefits

- Cache contents will not be as easy to guess
- Pretty simple implementation

Possible Challenges

- Performance will be impacted in the case of an error - assumption is that errors are not the fast path.
- Increased memory consumption with current PoC

LSM interface for side channel mitigations

Objective:

Make it possible for an LSM module to determine if a particular security mitigation can be applied

Description:

- Create a LSM Hook which will allow a module to recommend whether to apply IBPB when switching tasks.
- Make a side channel LSM
 - Check effective UID, capability sets, or namespaces
 - Option to just always apply

Status:

PoC under development

INTEL OPEN SOURCE TECHNOLOGY CENTER | 01.org

 @kcacardi