THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
EUROPE

Embedded Linux Conference
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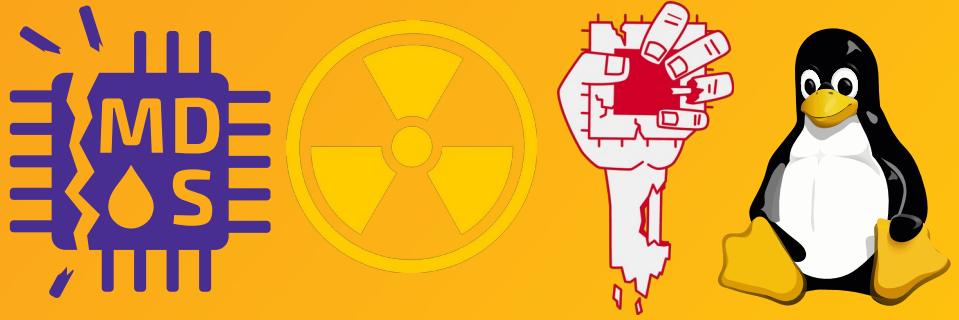


Greg Kroah-Hartman

THE LINUX FOUNDATION

Disclaimer

- This talk vastly over-simplifies things.
- See notes for full details and resources.

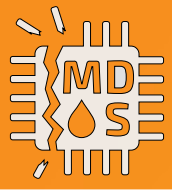
`https://github.com/gregkh/presentation-mds`

MDS

- Same “family” of bugs as Spectre/Meltdown
- Hardware bugs
- Exploits the speculative execution model of modern CPUs.
- Many different variants.
- Is going to be with us for a very long time!

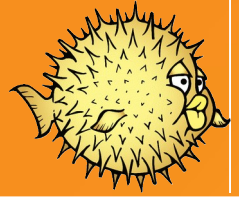
MDS

- MDS == “RIDL”, “Fallout”, “Zombieload”, and others
- CPU Hardware bugs
- Variants of the same basic problem
- Exploits the speculative execution model of Intel CPUs.
- Discovered by many different research teams
- Kernel and BIOS fixes required to fully solve



MDS

- One program can read another program's data
- Can cross the virtual machine boundary
- Exploits "hyper threading" (SMT) issues
- SMT are CPUs that usually share TLBs and L1 cache



OpenBSD was right

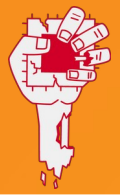
- Guessed more problems would be in this area
- Disabled SMT for Intel chips in June 2018
- Repeated the plea to disable this in August 2018
- Prevented almost all MDS issues automatically
- Security over performance
- Huge respect!

RIDL

- Rogue-Inflight-Data-Load
- Exploits CPU Line-fill buffers and Load ports
- Steal data across applications, virtual machines, secure enclaves
- Kernel fix by flushing CPU buffers/ports on context switch

Fallout

- Exploits CPU Store Buffers
- Read kernel data from userspace
- Breaks ASLR (random kernel addresses)
- “Meltdown” mitigation made this easier to exploit
- Kernel fix by flushing CPU buffers on context switch



Zombieland

- Exploits CPU Line-Fill buffers
- Much like RIDL
- Steal data across applications, virtual machines, secure enclaves
- Cool logo/name and demo
- Kernel fix by flushing CPU buffers on context switch

Other variants

- “Store-to-Leak forwarding”
- “Meltdown UC”
- All allow data to be stolen across security boundaries
- Kernel fix by flushing CPU buffers/ports on context switch

SWAPGS

- Yet-another-Spectre variant
- Found by reading Intel patents
- 1-5% performance hit
- Kernel fix by flushing buffers

Flushing CPU buffers is slow

- All of these mitigations slow down the system
- No way yet to schedule different security domains on different physical processors (gang scheduling)
- Disabling SMT mitigates most problems (not ALL!)
- Must disable SMT and enable mitigations to solve completely.

Flushing CPU buffers is slow

- Performance numbers depend on your workload
- Kernel build
  - -2% smt=on
  - -15% smt=off
  - Heavily multi-threaded, CPU bound
- Kernel creation, no decrease
  - Single threaded, I/O bound
- syscalls are now expensive
- Test your workload!

Do you feel lucky?

- Users must now choose between performance and security
- What choice did your cloud provider choose?
- https://make-linux-fast-again.com/
  - Kernel builds faster by 20%!

Linux's response

- Kernel fixes available on announcement date
- Intel notified some kernel developers in advance
- Worked together across OS vendors to solve
- Much better than Spectre/Meltdown
- Process still needs to improve, Debian notified 48 hours before release.
- More fixes came after announcement
- Update your kernel and BIOS!

Linux security fixes

- Happen at least once a week
- Look like any other bugfix
- Rarely called out as security fix
- Many bugfixes not known to be security related until years later
- No differentiation between bug types
  - A bug is a bug is a bug
- Very few CVEs ever get assigned for kernel security issues

Linux security fixes != CVEs

- Small fraction of kernel security fixes get CVEs
- If you only cherry-pick CVEs, you have an insecure system
- Some CVEs have follow-on fixes not documented anywhere
- How the Linux Kernel Security team works

Linux security fixes != CVEs

- Small fraction of kernel security fixes get CVEs
- 2006-2018 had 1005 CVEs assigned to the kernel
  - 41% (414) had a negative “fix date”
  - 12 never fixed
  - Average fix date, -100 days
  - Longest fix dates, -3897 and 2348 days
  - 88 fixed within 1 week
  - Standard deviation 405

Linux Longterm Kernels Fix Problems

- Bugs are fixed before you realize it is a issue.
- Google security team requests for Pixel phones in 2018:
  - 92% (201/218) problems were already fixed in LTS kernel
  - No need for cherry-picking or backporting
  - Remaining issues were due to out-of-tree code

If you are not using a supported Linux distribution kernel, or a stable / longterm kernel, you have an insecure system.

“Your talk is sad”

- Hardware has bugs
- Linux fixes those bugs before you realize it
- Disable hyperthreading (SMT) for now
- Always update your kernel / BIOS and all is well