Systems Hardening

Season II: Summer Semester 2021

Technische Universität München
Faculty of Informatics
Chair of IT Security (I20)

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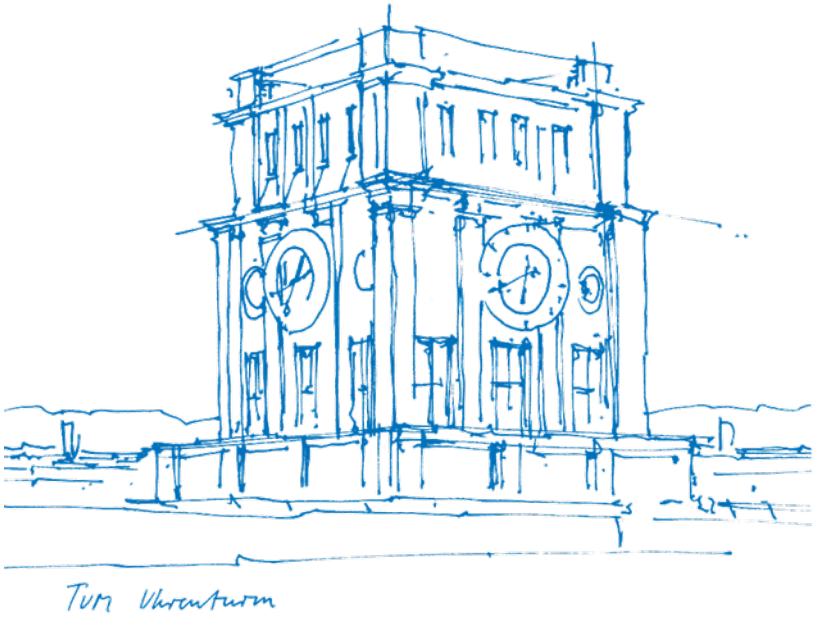

Intro

Who are we?

⇒ Short introduction of tutors

⇒ Research interests[1]

[1] https://www.sec.in.tum.de/i20/people/momeu-marius

Intro

Why should you do this?

⇒ Have you taken *Binary Exploitation* and want to learn advanced methods that mitigate *pwning*?

⇒ Have you learned cool low-level concepts in *Operating Systems* or *Root-Kit Programming* and want to apply them?

⇒ Would you like to find bugs and crash low-level software?

⇒ Are you curious how *Spectre* can be mitigated?

⇒ Are you merely interested in finding out more about *IT Security*?

⇒ Then **Systems Hardening** is the right course for you!

Intro
Objectives

⇒ In this seminar, you are going to **assess state-of-the-art**
- → **hardening mechanisms** (via memory isolation using *VT-x*, *MPK*, etc.),
- → **kernel and hypervisor fuzzing** agents,
- → **enclaved execution technologies** (*Intel SGX*, *AMD-SEV*, *ARM TrustZone*),
- → software mitigation against **microarchitectural flaws** (*Spectre*, *Forwshadow*, and/or variants).

⇒ **And most importantly**, you are going to
- → **write a paper** about your findings,
- → **give feedback** to (two of) your colleagues' papers,
- → **give a talk** at the end of the semester.

Technical Content
Overview

- ⇒ **Data & code memory isolation**
  - → using *Intel VT-x*, *MPK*, *HLAT*, etc.
  - → to mitigate code-reuse & data-oriented attacks
- ⇒ **Fuzzing low-level software**
  - → such as the *Linux* kernel or the *Xen* hypervisor via coverage-guided, symbolic execution, and hybrid fuzzers
- ⇒ **Attacks against TEEs**
  - → such as *AMD-SEV* or *ARM TrustZone*
- ⇒ **Confidential computing**
  - → using *Intel SGX, MKTME*
- ⇒ **Software mitigations for microarchitectural flaws**
  - → such as memory management tricks that neutralize *Spectre*
- ⇒ **Heap hardening**
- ⇒ **Memory safety via *Rust***
- ⇒ **Live patching**

Technical Content
Hands-On

⇒ Operating with command-line *bash* on *Unix* systems

⇒ Kernel & hypervisor development

⇒ Memory management & OS concepts

⇒ *C*, *Assembly* (*x86, ARM, AMD*), *Rust*

⇒ Hardware extensions (*VT-x, MPK*)

⇒ Computer architecture (speculative execution, cache buffers)

⇒ Binary exploitation

⇒ Various executable formats (mostly *ELF*)

Seminar Structure

Phases

Phase I	Choosing your topic	1 week
Phase II	Familiarizing with literature	1 week
Phase III	Writing (first draft with feedback from tutors)	4 weeks
Phase IV	Writing (final draft with feedback from tutors and fellow students)	4 weeks
Phase V	Peer reviewing	1 week
Phase VI	Writing ("camera ready")	1 week
Phase VII	Preparing the final talk	2 weeks
Phase VIII	*Dive deeper with research or thesis*	*optional (TBD)*

Seminar Structure

Sessions

Episode I	Introduction to Scientific Writing
Episode II	More on Scientific Writing
Episode III	Hints on Paper Reviewing
Episode IV	Hints on Public Speaking
Episode V	Final Talks

Seminar Structure

Grading

	50 %	Final Paper (Content, Style, Language, Scope, . . .)
	20 %	Presentation (Content, Speaking, Style, Timeliness, . . .)
	15 %	Prototype / Design / Experiments
	10 %	Peer Review
	5 %	Discussion
Σ	100 %	Total

Seminar Structure

Orga

⇒ **When?**
- → with presentations from tutors and optionally from you (updates on your findings)
- → online or hybrid (depending on the regulations)
- → exact weekday and time TBA
- → final talks at the end of the semester

⇒ **Capacity**
- → **14-16 students**: individual work or in groups of two
- → no qualification challenge
- → but see *Hands-On* slide to get an idea on what you will be working with during this seminar
- → don't forget to **register in the matching system!**

⇒ **Master's and Bachelor's students are welcome**

⇒ Language of instruction: **English**

⇒ **Moodle** for accessing seminar material

Resources
Infrastructure

⇒ access to our (resourceful) *x86* servers running *Xen*
  → we can assist you in extending *Xen*'s *hypercall* interface on demand

⇒ dedicated server for fuzzing the kernel

⇒ *AMD* and *ARM* servers TBA

⇒ **anything else you need, we're here for you and we'll find a solution**
  → don't be shy, ask us at any time :)

Resources
Reading Material

⇒ **Literature access**
- → https://scholar.google.com/
- → https://semanticscholar.org/
- → https://dblp.uni-trier.de/
- → https://arxiv.org/

⇒ **Get around paywalls** using: https://www-ub-tum-de.eaccess.ub.tum.de/datenbanken

⇒ **Researchers' homepages can be valuable!**
- → the paper, source code, raw data, instructions, technical information

Outro
Questions?

Thank you!

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