Chair of IT Security
Department of Informatics
Technical University of Munich

Systems Hardening

Preliminary Meeting - SS 2022 - Season IV

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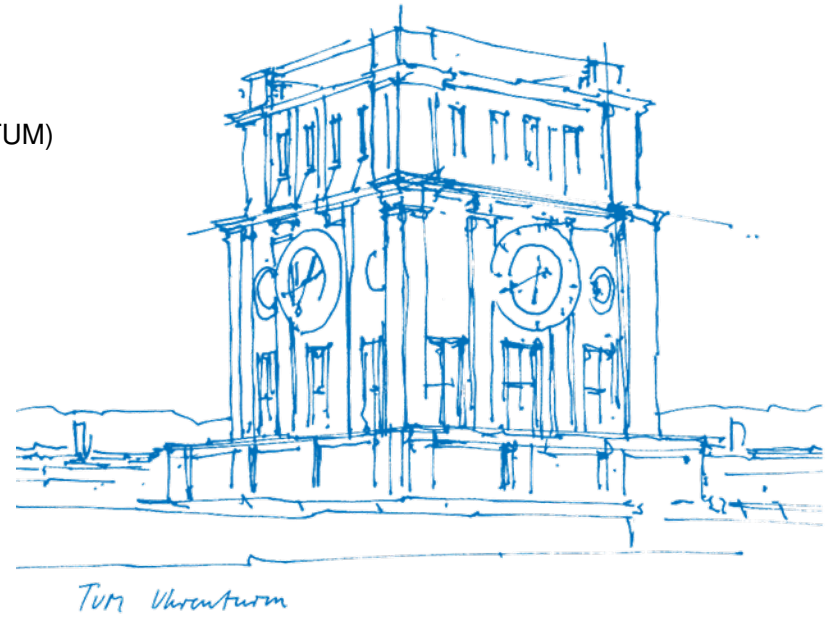
[2]BedRock Systems

January 28, 2022



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Intro

Your tutors:

- Marius Momeu[1] (momeu@sec.in.tum.de)

[1] I'm posting theses / guided research topics at: https://www.sec.in.tum.de/i20/people/momeu-marius

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Intro

Your tutors:

- Marius Momeu[1] (momeu@sec.in.tum.de)
- Sergej Proskurin (proskurin@sec.in.tum.de)

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Objectives

This seminar is structured **for preparing you** to publish research at scientific conferences or journals.

Thus, you will exercise and expand a broad spectrum of research skills, such as **formulating a clear (and potentially novel) hypothesis**, **validating it**, and, most importantly, **writing about and presenting your findings**.

To facilitate that, your tutors will propose state-of-the-art offensive and defensive topics in systems hardening research.

There will generally be two types of topics you can choose from[2]:

- **Prototyping topics** that require building and evaluating a prototype for limitations in existing research, and
- **SoK topics** require systemizing the knowledge on a popular concept/issue with lots of existing research.

Finally, you will gradually **build a paper** on the obtained results, and you will **present your findings** throughout the semester.

[2] you are welcome to propose a topic of your own

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Scientific Content

We are generally interested in researching ways to improve the security of software running in **IoT devices, cloud servers, and desktop environments.**

As such, the following list captures some high-level areas we will pick topics from:

- **Hardware security extensions**
  - such as *Intel VT-x/MPK/CET/HLAT* and *ARM PAC/MTE*
  - for hardening OS kernels, unikernels, μkernels
  - via code/data isolation, control-flow and data-flow integrity
- **Static program analysis**
  - for generating Control-Flow and Data-Flow policies
  - on closed- and open-source software (OS kernel and applications)
- **Confidential computing in Trusted Execution Environments (TEEs)**
  - such as *ARM TrustZone, Intel SGX/MKTME/TXT, AMD-SEV-**
  - both their security benefits and shortcomings
- **Remote (control-flow and data-flow) attestation**
- **Fuzzing low-level software** (e.g., OS kernels, device drivers, and hypervisors)
- **Microarchitectural flaws** and side-channels for leaking secrets, revealing stealthy monitors, etc.

Hands-On Format

Throughout this seminar you should expect to touch on hands-on stuff, including but not limited to:

- Remotely operating servers or IoT devices via the command-line terminal (bash on Unix systems)
- Reading and coding in *C/C++*, Assembly (*x86, ARM*), (maybe) *Rust*, and various scripting languages
- Understanding OS concepts, such as memory management (via paging or nested-paging[3]), interrupts, (bare-metal and emulated) device drivers, syscalls/hypercalls
- Using *LLVM*'s static analysis framework and *LLVM* binary lifters
- Examining various hardware extensions in architecture manuals (*Intel VT-x/MPK/CET/HLAT, ARM PAC/MTE, AMD-SEV-**)
- Computer architecture concepts (e.g., speculative execution, return stack buffers, caches, *TLBs*)
- Exploitation know-how: code-reuse attacks, data-oriented attacks, secret leaking via covert side-channels
- Compiling/building, dynamic or static linking, binary formats (mostly *ELF*)
- System administration (e.g., spawning VMs, managing partitions, compiling and deploying kernels/unikernels)

[3] via *PTs* and *EPTs* on Intel's architecture

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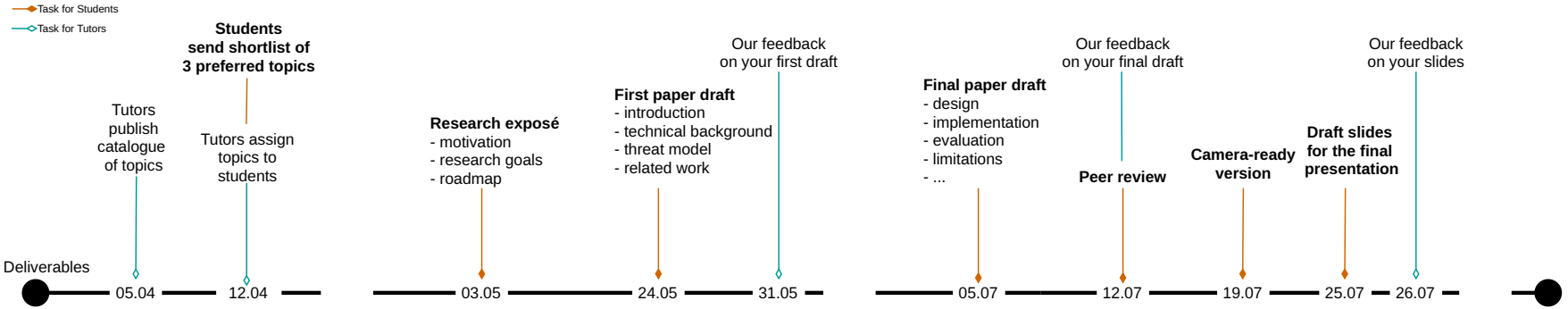
Tentative Timeline | Deliverables



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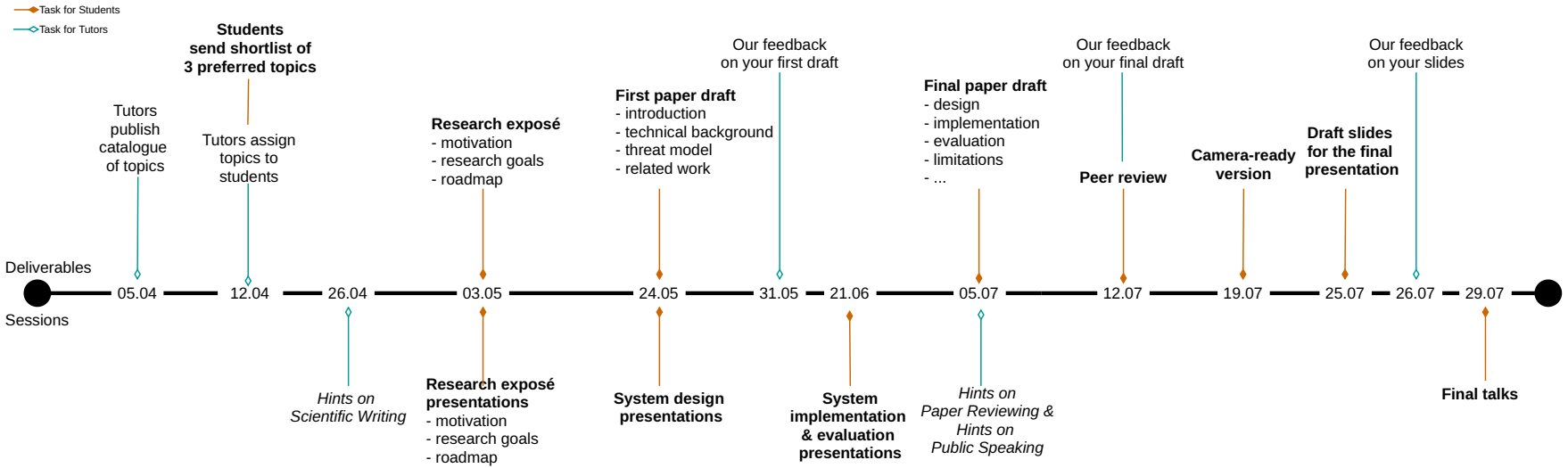
Tentative Timeline | Sessions



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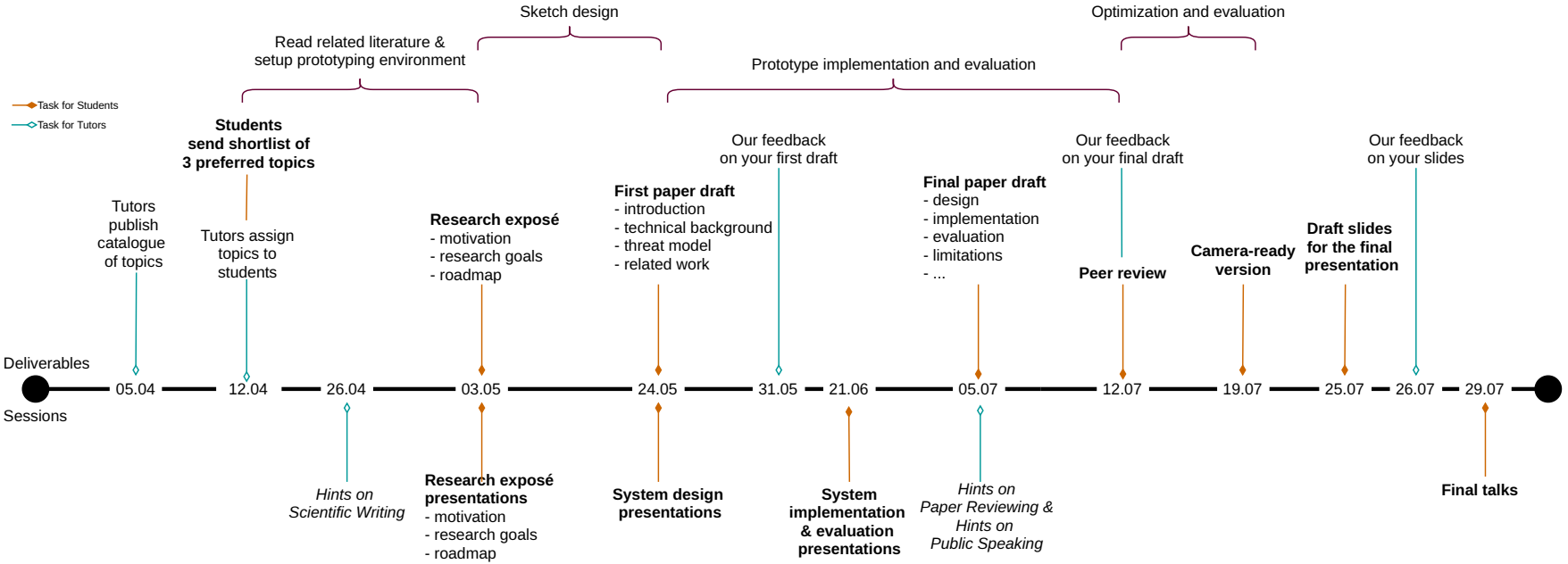
Tentative Timeline



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Grading

Graded deliverables:

- Final "camera-ready" paper
- Final presentation
- Design/ prototype / experiments

Mandatory ungraded deliverables:

- Research exposé
- Paper drafts
- Intermediate presentations
- Peer review

Optional deliverables:

- Draft for the final presentation

	50 %	Final Paper (Content, Style, Language, Scope, . . .)
	40 %	Final Talk (Presentation and Q&A)
	10 %	Design / Prototype / Experiments
Σ	100 %	Final Grade

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Deliverables' Format

Research exposé:

- 2-3 pages
- one-column
- **note:** focus on the motivation for your topic and on the research goals that you will address in this seminar

Presentation:

- TUM presentation template[5]
- custom templates can be used as well
- 16:9 aspect ratio

Generally, we encourage you to use LaTeX for writing.

Paper:

- IEEE conference proceedings template[4]
- maximum 10 pages, excluding References and Appendix
- two-column

Peer review:

- format similar to peer reviews in scientific conferences
- one page with summary, strengths, and weaknesses of reviewed paper

[4] https://www.ieee.org/conferences/publishing/templates.html
[5] https://latex.tum.de/templates/608c2650db4bc7007f58c931

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Orga

When? irregularly, on Tuesdays, at 10:00 h (subject to change)

Where? Onsite or online (via BBB) depending on the regulations

Capacity: 8 students

Language: English

Course of study: both Master's and Bachelor's students

Registration: via the matching system

Seminar Resources

We will setup a **Moodle**[6] page for announcements, for submitting deliverables, and for uploading lecture slides.

We will create **Gitlab**[7] **repositories** on LRZ's git server for versioning the paper's and prototype's source code.

Depending on the topic, we can configure accounts for you in our chair's test network and let you access our **hardware for prototyping**.

Matrix[8] for instantaneous communication.

[6] https://www.moodle.tum.de/
[7] https://gitlab.lrz.de/
[8] https://matrix.tum.de/

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Task for Matching Prioritization

Please send us a **letter of motivation of maximum two pages** stating **up to 3 topic areas** from slide *Scientific Content* that you would like to work on during the seminar. In your letter, describe **why do you want to work with these and why do you find them important for systems security?**

Send it to: momeu@sec.in.tum.de and proskurin@sec.in.tum.de
In your email, use the subject: *Matching - Systems Hardening - SS 2022*

Deadline: Sunday, 20th of February, EoD

Also, please mention in your report if you have attended any of the following courses:

- Rootkit Praktikum, Binary Exploitation
- Software Security Analysis, Trusted Execution Environment, Reverse Engineering
- IT Security, Secure Mobile Systems
- Computer Architecture, Operating Systems
- Any other course where you have tackled the topics / technologies we have mentioned above

Questions?

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Sergej Proskurin
proskurin@sec.in.tum.de