NTNU | Norwegian University of Science and Technology

COURSE SUMMARY

TTM4205 – Lecture 18

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The Aim of the Course

My goal was to show you a variety of different attacks and mitigations for cryptography systems that we use today. I wanted you to learn how to think as an attacker, so that you better can protect your own schemes going forward.

We went through a lot of material. You are not supposed to remember everything. But you are expected to know what to look for, how to find resources to learn more, have a basic understanding that you can apply to similar issues, and have ideas for how to protect against these attacks.

Course Content

The course covers how to implement, analyse, attack, protect and securely compose cryptographic algorithms in practice. It goes in depth on how to

- implement computer arithmetic
- attack implementations using side-channel attacks and fault injection
- exploit padding oracles and low-entropy randomness
- utilise techniques to defend against these attacks
- securely design misuse-resistant APIs

Learning Outcome

Knowledge

Advanced knowledge about the mathematical building blocks underlying modern cryptography, properties of and applications of cryptographic primitives, challenges and common mistakes when implementing cryptography, side-channel attacks and countermeasures, and high level design principles for secure use of cryptography in practice.

Learning Outcome

Skills

Able to implement the underlying mathematics and high-level protocols used in symmetric key and public key cryptosystems, perform simple side-channel attacks and implement countermeasures, analyse side-channel countermeasures and design misuse resistant APIs for cryptography.

Guest Lectures

We have three upcoming guest lectures in this course:

- Tuesday November 14 at 12:15-14:00 in R92: Håkon Jacobsen (Thales Norway) – “FPGAs and Cryptography”
- Thursday November 16 at 10:15-12:00 in B3: Oskar Goldhahn (IMF, NTNU) on “Formal Verification”
- Tuesday November 21 at 15:00-16:00 in G1: Vadim Lyubashevsky (IBM Zurich) – “Post-Quantum Crypto”

Project Presentations

I am planning to organize the presentations so that 3 projects are presented on Tuesday November 21st and 8 projects are presented on Thursday November 23rd.

Martin Reimer will present on November 21st. I need two more groups to volunteer so that the schedule works out.

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- Security is based on the best attack against a scheme
- Today we require 128 bits of security in cryptography
- We need to ensure access to high entropy randomness
- Pseudorandom Number Generators (PRNGs) expand true randomness into pseudorandom bit streams

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- Faulty parameters easily breaks a cryptographic scheme

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- DualEC and standardized schemes with backdoors

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- Constant time code, randomization, fault protection,...

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- We can use bit-slicing and masking to protect AES

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- Must always verify output values for faults

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- Efficiency depends on how strict checks

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- If you must, then use RSA-OAEP padding
- We studied the Bleichenbacher attack
- Use encrypt-then-authenticate if possible

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- The Schnorr signature is a ZKP of discrete log

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- How schemes (AES+RSA) are composed matters
- We need very concise protocol descriptions
- Always (try to) prove security of a protocol
- Make code open source and pay for audits

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- Have integrity checks for all messages
- Do not re-use keys across applications
- Do not design your own schemes / protocols
- Use up-to-date modern primitives and libraries

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From what I can see, you have learned a lot and performed very well this semester. I am 100% sure that the way of thinking, our discussions, and the problems you have solved in this course will be useful for all of you going forward.

I hope that you enjoyed the course, that it was challenging but interesting, and that you see the value of your effort.

Questions?