Introduction for Seminar: Intrusion Detection Systems

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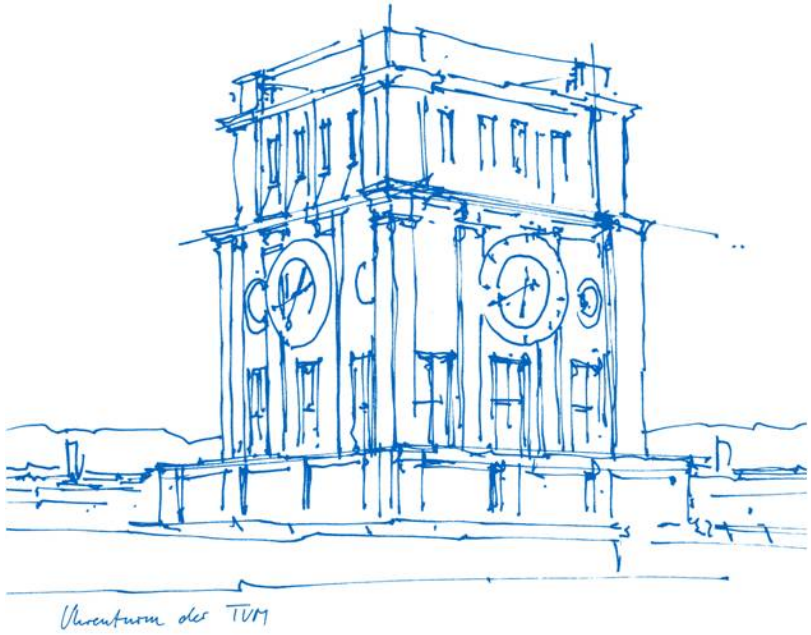


Outline

- Introduction to research area
- Student assignments
- Grading
- Time table
- Presentation guidance
- Report guidance
- FAQ

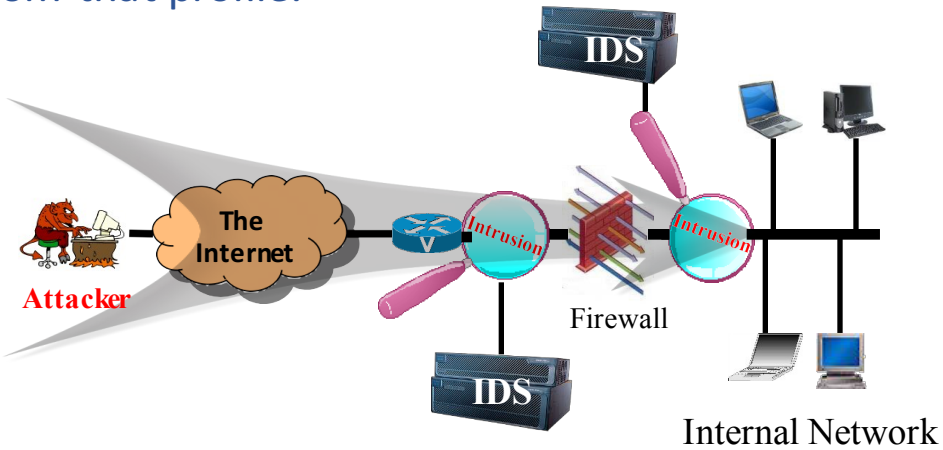
What's an Intrusion?

- Successful attack is usually (but not always) associated with an access control violation
  - A buffer overflow has been exploited, and now attack code is being executed inside a legitimate program
  - Outsider gained access to a protected resource
  - A program or file has been modified
  - System is not behaving "as it should"

- The goal of an intrusion detection system (IDS) is to detect that bad things are happening (intrusion)
  - Just as they start happening (hope so)
  - How is this different from a firewall?

Intrusion detection styles

- Misuse detection: precise descriptions of known malicious behavior.
- Anomaly detection: have a notion of normal activity and flag deviations from that profile.



- *Specification-based detection: defining allowed types of activity in order to flag any other activity as forbidden.

Detection Styles in Actual Deployments

- Striking imbalance deployments:
  - Almost exclusively only misuse detectors in use
  - Detect signatures (characteristic byte sequences)

- Question:
  - However, anomaly detection is extremely appealing (in the literatures)
    - Promises to find novel attacks w/o anticipating specifics
    - Machine learning works so well in other domains
  - But it's hard to find any machine learning NIDS in real-world deployments, why?

Misuse Detection (Signature-Based)

- Set of rules defining a behavioral signature likely to be associated with attack of a certain type
  - Example: buffer overflow
    - A setuid program spawns a shell with certain arguments
    - A network packet has lots of NOPs in it
    - Very long argument to a string function
  - Example: SYN flooding (denial of service)
    - Large number of SYN packets without ACKs coming back
    - …or is this simply a poor network connection?
- Attack signatures are usually very specific and may miss variants of known attacks
  - Why not make signatures more general?

Anomaly Detection

- Originally introduced by Dorothy Denning in 1987
  - Assumption: attacks exhibit characteristics NOT observed for normal usage
  - Propose: host-based IDS
    - Host-level system building per-user profiles of activity
    - E.g., login frequency, session duration, resource consumption
- Machine learning (ML):
  - Training: trained with reference input to “learn” its specifics
    - Supervised or Unsupervised
  - Test: deployed on previously unseen input for the actual detection process

Anomaly Detection Cont'd

- Define a profile describing "normal" behavior
  - Works best for "small", well-defined systems single program rather than huge multi-user OS
- Profile may be statistical
  - Build it manually (this is hard)
  - Use machine learning and data mining techniques
    - Log system activities for a while, then "train" IDS to recognize normal and abnormal patterns
  - Risk: attacker trains IDS to accept his activity as normal - adversarial learning
    - Daily low-volume port scan may train IDS to accept port scans

Machine Learning in Other Domains

- Examples (for comparison):
  - Amazon/Netflix – product recommendation
  - OCR (optical character recognition) systems
  - Natural language translation
  - Spam detection

- Claim: the task of finding attacks is fundamentally different from other applications
  - Making it significantly harder for us to employ ML

Machine Learning in Intrusion Detection

- Some well-known problems:
  - High false positive rate
  - Lack of (attack-free) training data
  - Attackers can try to evade detection
- Goal:
  - Using anomaly detection effectively in the real world operational environments (for network intrusion detection)

Challenges of Using Machine Learning

- Outlier Detection
- Lack of Training Data
- High Cost of Errors
- Semantic Gap (interpretation of results)
- Diversity of Network Traffic
- *So, What could be the solutions?*

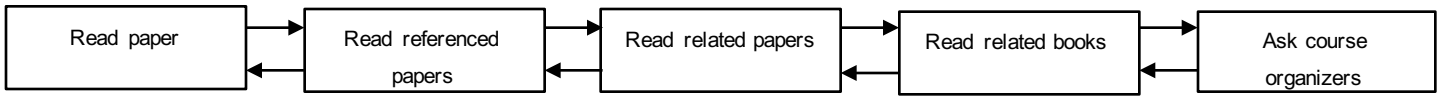
Student Assignments

- Pick 2 papers from the list (course homepage[1]), or propose papers
  - The deadline for topic selection is 24.04.19
  - First come, first served
- 1 paper used for a seminar presentation (20' + 10‘ discussion)
- Write a report about both papers (at least in 14 pages LNCS format)
- What to deliver:
  - 1 Presentation
  - 1 Report (for both topics)

1- https://www.sec.in.tum.de/i20/teaching/ss2019/intrusion-detection-systems

How to do your research

- Seminar - (kind of) simulation of scientific research



- Try to be independent, but also ask questions

Grading

- Grading consist of different parameters:
- Report (60%)
- Presentation (30%)
- Participation and discussion (10%)
  - Almost neglected!

Time Table

- 29.01.19 – Kick-off Meeting
- 23.04.19 – Introduction, Rules and Division of papers

- 28.05.19 – Students Presentation
- 04.06.19 – Students Presentation
- 11.06.19 – Students Presentation
- 18.06.19 – Students Presentation
- 25.06.19 – Students Presentation
- 02.07.19 – Students Presentation

Presentation

Needs to be:

- **C**orrect
- **C**omplete
- **C**omprehensible

Presentation - Correct

- Present information from the paper correctly
- Don’t speculate without a reason or proof
- Don’t claim something you cannot explain well

Presentation - Complete

- Explain all key points of the paper
- Be careful about time constraints and distribution
- Convey information without leaving out important insight

Presentation - Comprehensible

- Speak loud and clear
- Think about the audience - fellow students
- Motivate the audience for discussion
- Don’t fight your audience, answer all questions friendly

Presentation - Structure

- Introduction to the topic
- Present paper
  - Introduction
  - Main Point
  - Back up arguments
  - Conclusions (key takeaways)

Presentation - Audience

- Read papers, or at least abstracts, prior to each presentation day
- Listen carefully, write down questions
- Ask questions, comment
- Active participation is appreciated!

Presentation - Grading

- Presentation skills
  - General organization, use of slides
  - Language, slide text and graphics
  - Pace, use of time
- Subject-related competence
  - Subject knowledge
  - Staying on topic
  - Identifying interesting/important points

Report (Deadline 07.07.2019)

Report

- 14 Pages LNCS (minimum) - fit both papers, describe them separately
- Summarize key points of both papers - not an easy task
- Use a typical paper structure:
  - Abstract -> Introduction -> Methodology -> Results -> Discussion -> Conclusion

Report - Abstract

- Summarize the paper
  - Introduction to the problem
  - How was the problem solved? Methodology
  - Short insight in the results
  - What is the impact of the paper?

Report - Introduction

- Describe the context
- What is the preexisting work?
- What does the preexisting work lack?
- How does this paper close the gap?

Report - Methodology

- Describe the mechanisms used to tackle the existing problem
- Lead the reader through the problem solving procedures
- Give arguments for the choice of methods

Report - Results

- Give an overview of the important results
- Add tables, graphs... if you have space
- Shortly comment on the figures
- Avoid phrases like: It is obvious from this graph that ...

Report - Discussion

- What do the results actually tell us?
- Compare the results with related work
- What are the limitations of the paper?
- How can the limitations be addressed?

Report - Conclusion

- Summary of the paper in 3-4 sentences
- What are the most interesting results?
- What is the impact of the paper?

Report - Grading

- Paper organization
- Language and grammar
- Subject knowledge
- Ability to summarize
- Proper bibliography and citations

FAQ

- Allowed to miss a presentation day? Yes, if you have a very good reason.
  - Examples of good reason: health issues
  - Examples of bad reason: HiWi work, homework, football training, bad mood

- Can I set a meeting if I have problems with my papers?
  - Yes, but try to do as much as you can yourself.

References

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5. García-Teodoro, P., Díaz-Verdejo, J., Maciá-Ferná Ndez, G., & Vá Zquez, E. (2009). Anomaly-based network intrusion detection: Techniques, systems and challenges. *Computers & Security*, *28*, 18–28.