TEK5530 - Measurable Security for the Internet of Things

L10– Intrusion Detection

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TEK5530: Lecture plan

- 17.01 L1: Introduction
- 24.01
  - L2: Internet of Things
- 31.01
  - L3: Security of IoT + Paper list
- 07.02
  - L4: Smart Grid, Automatic Meter Readings
  - L5: Service implications on functional requirements
- 14.02
  - L6: Technology mapping
  - L9: Top 20 critical security controls
- 21.02 --- Winter holiday
  - «homework» see recording of

  L7: Practical implementation of ontologies
- 28.02
  - L8: Paper analysis with 25 min presentation
  - L10: Intrusion detection
- 07.03
  - L13: Communication and security in current industrial automation
  - L14: Cloud basics and cloud architecture
- 14.03
  - L11: Multi-Metrics Method for measurable Security
  - L12: Multi-Metrics Weighting of an AMR sub-system
- 21.03
  - L15: Cloud security, IoT and service examples from AWS
  - L16: Cloud monitoring, automation and incident response
- 28.03
  - L17: Selected recent topics from IoT security
  - L18: Wrap-up of the course
- 04.04 ---- No lecture, prepare for exam, consultation possibility
- 11.04 ---- No lecture, prepare for exam, consultation possibility or Exam (depending on what we agree on)
- 18.04 ---- Easter holiday, no lecture
- 25.04 ---- Exam

Intrusion Detection and Prevention

- What is an Intrusion Detection System
- Flavours of IDS
- Industrial case
  - Comparison to generic cases
  - Physical process and safety
- Industrial examples
- Conclusion

Definitions – as requested – both definitions by ISACA

- Information security: "Ensures that only authorized users (confidentiality) have access to accurate and complete information (integrity) when required (availability)
- Privacy: The rights of an individual to trust that others will appropriately and respectfully use, store, share and dispose of his/her associated personal and sensitive information within the context, and according to the purposes, for which it was collected or derived

- I think, both security and privacy is easier to see from the other way around:
- Compromised security and privacy.

- If you loose information security: then you loose confidentiality of important data or the possibility to check its integrity or just can't access it.
- Same with privacy: if you loose it, then you can not control any more what is happening with private information

What is an Intrusion Detection System

- This is a practical example on fuzzy evaluation of different criteria and taking decisions by evaluating multi-dimension problems
- What is an intrusion: an attempt to break or misuse the system
- Might be internal or external source and can be physical, system or remote
- It is typically a set of entities distributed in the network and monitoring some network parameters

How an intrusion works

- Exploit different programming errors (e.g.: buffer overflow, no input validation)
- Unexpected input (e.g.: tamper with TCP checksum, fragmentation)
- Combination with creating special circumstances
- IDS need a baseline to work properly
- Baseline creation very much depends on the use
- We always assume, that they who attack behave differently

IDS flavours

- IDS can be based on:
  - Anomaly detection (heuristics) – challenge is good training and right set of sensitivity
  - Signature-based – challenge is to deal with new attacks
  - Typically we use a combination
- Or by location:
  - Host-based: the host os or application is running the logging, no additional hardware
  - Network-based: filters traffic, independent of clients

IDS in industrial environments

- Two important factors: much more clean traffic baseline is possible and relation to physical process and safety
- We can't design a system to be secure forever – count with failure: fail-safe, fail-operational, graceful state changes
- Tamper detection and evidence
- The only difference between systems that can fail and systems that cannot possibly fail is that, when the latter actually fail, they fail in a totally devastating and unforeseen manner that is usually also impossible to repair(1)
- In an industrial environment the assumption that attackers will behave differently is not necessarely true

IDS in industrial environments

- IDS is a system: evaluation of logs, evaluation of network traffic, maintenance on firewall and IDS infrastructure (software+taps)
- Getting a reaction is actually easier in the industrial environment: typical to have 24 hours staffing somewhere, also physical security and safety
- Challenges with shared infrastructure and suppliers
- Possible approach: whitelisting, stateful payload analysis (operational envelope)

Example rules

- There are different ways, but take this snort rule as an example:

```
alert tcp !192.168.1.0/24 any -> 192.168.1.0/24 111 \
    (content:"|00 01 86 a5|"; msg:"external mountd access";)
```

- Dynamic rule example (both examples are from the snort manual):

```
activate tcp !$HOME_NET any -> $HOME_NET 143 (flags:PA; \
    content:"|E8C0FFFFFF|/bin"; activates:1;  \
    msg:"IMAP buffer overflow!";)
dynamic tcp !$HOME_NET any -> $HOME_NET 143 (activated_by:1; count:50;)
```

Industrial attacks

- No difference here: injection, man-in-the-middle, replay etc.
- Long life, high utilization of equipment and legacy support open for more attacks then in an office case
- SCADA compared to DCS/PCS
- Resilience and restoration
- Because of the use of COTS products, you actually might use the very same exploits, like windows on HMI

Industrial examples, from ICS-CERT (6)

Davis-Besse Nuclear Power Plant [2003]

- The Slammer worm penetrated a private computer network at Ohio's Davis-Besse nuclear power plant
- Disabled a safety monitoring system for nearly five hours
- Power plant was protected by a firewall
- In 1998 the same plant was hit by a tornado (natural disaster)

Industrial examples, from ICS-CERT (6)

Maroochy Shire Sewage Spill [2000]

- First recorded instance of an intruder that “deliberately used a digital control system to attack public infrastructure”
- Software on his laptop identified him as “Pumping Station 4” and after suppressing alarms controlled 300 SCADA nodes
- Disgruntled engineer in Queensland, Australia sought to win the contract to clean up the very pollution he was causing
- He made 46 separate attacks, releasing hundreds of thousands of gallons (264,000) of raw sewage into public waterways

Industrial examples, from ICS-CERT (6)

CSX Train Signaling System [2003]

- Sobig virus blamed for shutting down train signaling systems throughout the east coast of the U.S.
- Virus infected Florida HQ shutting down signaling, dispatching, and other systems
- Long-distance trains were delayed between four and six hours

Conclusions on Intrusion Detection

- Intrusion Detection is an example, where a collection of parameters will serve as an input to a fuzzy system
- Industrial systems might be quite well suited for «sharp» heuristics
- The main difference is the physical process back (both plus and minus)
- Evaluation of the detection system is very much in line with the classification examples shown in previous lectures: one can define a set of metrics and analyise which level the system is can reach.

References - Classification

- Cybersecurity classes: http://www.ssi.gouv.fr/uploads/2014/01/industrial_security_WG_Classification_Method.pdf
- IAEA: Computer Security at Nuclear Facilities: http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1527_web.pdf
- Red Tiger Security: mapping security controls to standards: http://redtigersecurity.com/services/scadaics-security-consulting/scada-security-maturity-model/
- Standards for Security Categorization of Federal Information and Information Systems, http://csrc.nist.gov/publications/fips/fips199/FIPS-PUB-199-final.pdf

References – Intrusion Detection

1. https://www.blackhat.com/presentations/bh-federal-06/BH-Fed-06-Zanero.pdf
2. http://www.digitalbond.com/tools/quickdraw/
3. https://www.sans.org/reading-room/whitepapers/ICS/challenges-ids-ips-deployment-industrial-control-systems-36127
4. http://commons.erau.edu/cgi/viewcontent.cgi?article=1071&context=discovery-day
5. https://www.truststc.org/conferences/10/CPSWeek/papers/scs1_paper_8.pdf