



# EU MITRE ATT&CK® Community Workshops

Creating Attack Graphs for Adversary Emulation, Simulation and Purple Teaming in Industrial Control Systems (ICS) Environments

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# Agenda

1. Whoami, Motivation and Background
2. Approach
3. Solution and Graph Design
4. Summary and Future Work



## Whoami, Motivation and Background

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- Currently: Red Teaming and Penetration Testing
- Previously: Forensics and Incident Response, ...
- 10+ years of experience with infosec for critical infrastructures
- I ❤️ energy – mainly 🔌 on all ⚡ levels
- "🐿️ Rodents [still] cause more power outages than 😈 hackers"



## Disclaimer

This presentation is a result from personal research and interest.  
It is not related to or explicitly endorsed by my employer.

# Motivation



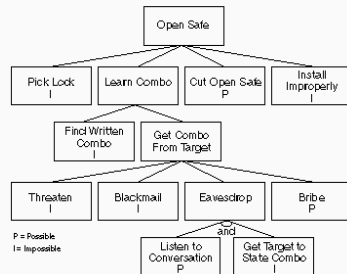
Ukraine Power Outages 2015 & 2016



Petrochemical Plant TRISIS Incident 2017

# Research Question

“Is it possible – and if yes to what extent – to algorithmically **generate attack graphs** that can be used for **practical adversary behavior execution** in ICS environments and can the process be supported by a **corresponding application**?”



## Attack Tree

(Schneier, Dr. Dobb's Journal, 1999)

## Foundation and Existing Work



ADTree  
(Kordy et. al)

[illegible]

ATT&CK Framework  
(Strom et. al / MITRE)

## 1. Attack Graphs

(Schneier, Kordy, LeMay, Ekstedt and many more)

- Attacks can be modeled intuitively with graphs/trees
- Focus mainly on assets less on the actions
- Used for modeling defenses and critical paths
- Automated generation has been shown to be possible

## 2. Ontologies, Kill Chains and MITRE ATT&CK

(Strom, Applebaum, Hutchins, Pols and many more)

- Common language to describe attacks/actions
- Attacks follow common sequences/patterns
- Large repository about information on attacks and behavior (TTP)
- Specific ICS related repositories available

# Approach

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## Exercises and Adversary Behavior Execution

### 1. Exercises

- Red and Purple Teaming
- Table-Top Exercises

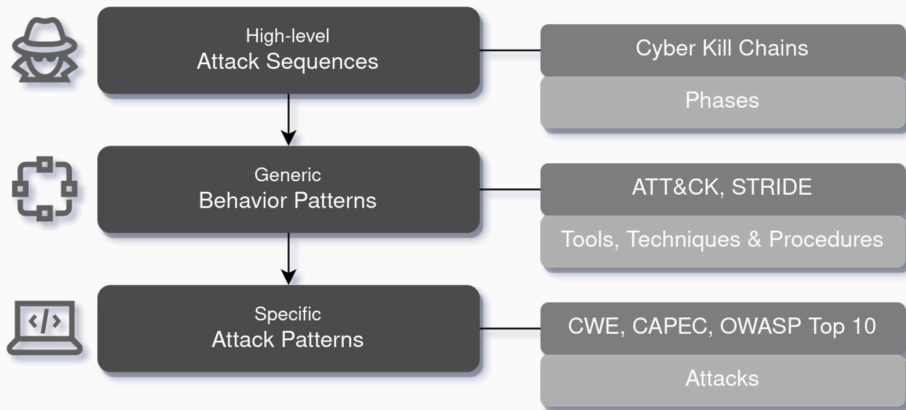
### 2. Automated execution

- Simulation
- Machine Learning

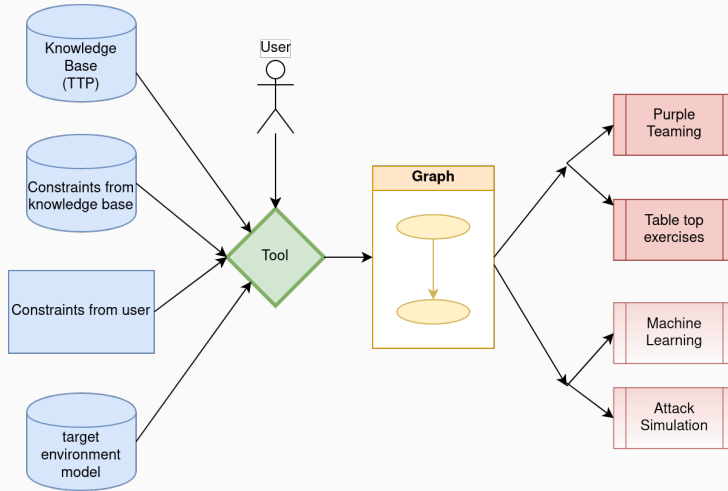


# Classification of Attack Models

Which **level of detail required** for designing attack graphs for adversary behavior execution?



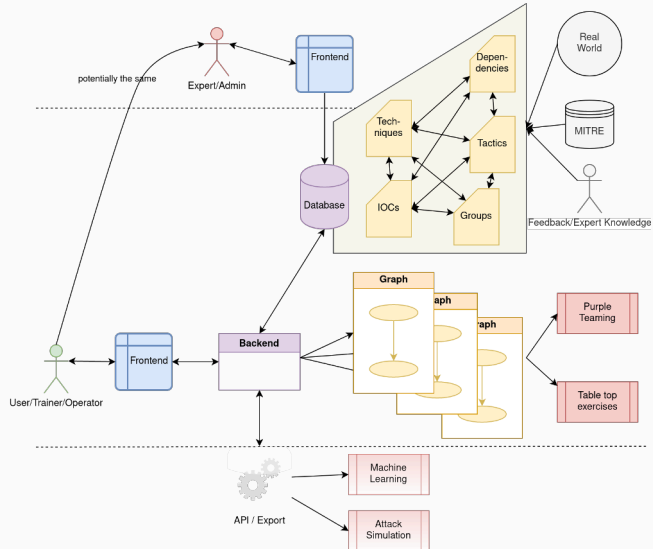
# Use Cases and Input/Output



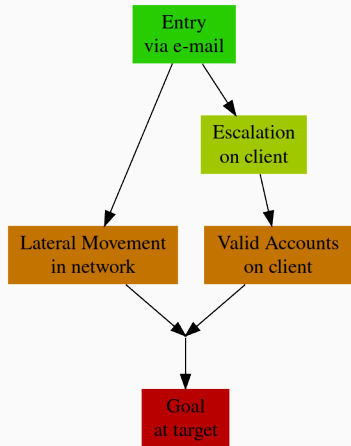
# Solution and Graph Design

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# System design



# Graph Design



## 1. Graphs

- Set of nodes and edges describing the adversary profile
- Focus on emulation/simulation of attack Techniques
- Sequential along MITRE Tactics (the “what”)

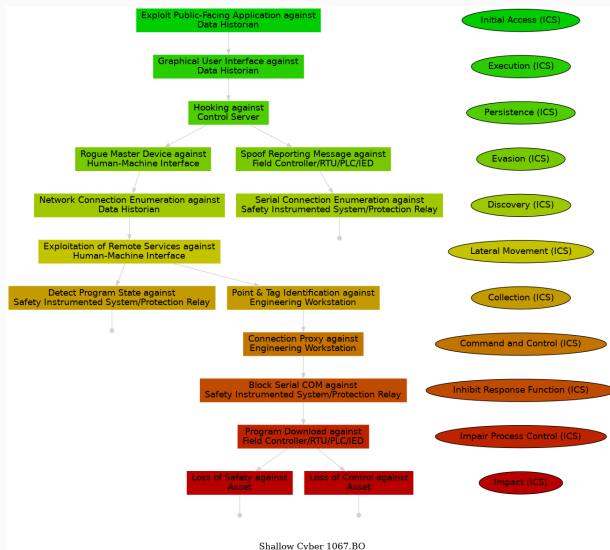
## 2. Nodes

- Instantiated Techniques as individual hacking steps (the “how”)
- Associated with targets and indicators

## 3. Edges

- Technique’s results and status

# Example Generated Graph



## Example Generated Graph







Live Demo?



Just deploy it on your own!

## Summary and Future Work

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# Summary and Future Work

- Conclusion
  - Automated attack graph generation for adversary behavior execution is possible
  - Experts confirm viability of approach and prototype
- Future work
  - Detailed node generation (IOC level) and integration with formal models/languages
  - Machine learning use cases and Bayesian networks
  - Defender profile mapping with threat and defense modeling





# Further Reading

Get the full text and source of the application from

 <https://www.pull-the-plug.net/thesis/>

Get in touch at

 <https://www.linkedin.com/in/jahoff/>

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Creating Attack Graphs for  
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in Industrial Control System (ICS) Environments

Master Thesis  
zur Erlangung des akademischen Grades  
M.Sc. Praktische Informatik

der Fakultät  
Mathematik und Informatik  
der FernUniversität  
in Hagen von

Jan Hoff

Thank you

## References and Credits

1. Latex beamer template: <https://github.com/matze/mtheme>
2. "Ukraine" power lines: <https://unsplash.com/>
3. Petro Rabigh plant: [https://www.meed.com/petro-rabigh-\[...\] -owners](https://www.meed.com/petro-rabigh-[...] -owners)
4. All other photos: <https://unsplash.com/>
5. Further references and a complete bibliography can be found at:  
<https://www.pull-the-plug.net/thesis/>

Thanks to my supervisors and all interview participants for providing guidance and input.