NETWORK DEFENCE USING ATTACKER-DEFENDER INTERACTION MODELLING

Wednesday 22\textsuperscript{nd} June, 2016

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Research Problem

Automated selection of response actions
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- The cyber attacks grow both in number and speed
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Automated selection of response actions

- The cyber attacks grow both in **number** and **speed**
- Network security still lacks an efficient attack response system capable of running autonomously
Research Problem

Automated selection of response actions

- The cyber attacks grow both in number and speed
- Network security still lacks an efficient attack response system capable of running autonomously
- Cyber attack and defence is very complex
  - We are always uncertain about the state of the network
  - We don’t know the attacker’s objectives and previous actions (and whether he is an attacker at all)
  - The number of attack vectors is ever growing
Attack Response
Attack Response
Attack Response

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Attack Response

Decide

Orient

security event

reconfiguration

Act

Observe

History

Knowlegde

Logs
Attack Response

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Logs

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security event

Act

Observe

IDS

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Attack Response

- Observe
- Act
- Decide
- Orient

Security
- Event
- Logs
- History
- Knowledge

reconfiguration

security event

IDS

SIEM

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Attack Response

Orient
- History
- Knowledge
- Logs

Decide
- reconfiguration

security event

Act
- SDN

Observe
- IDS

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Research Goal

Utilizing a model of interaction between an attacker and a defender to create more refined network defence strategy
Research Goal

Utilizing a model of interaction between an attacker and a defender to create more refined network defence strategy

- Select response based on received security events and knowledge of the network
- Include the attacker’s motivation in the decision process
# Research Topics

<table>
<thead>
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<th><strong>Research Question I</strong></th>
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<td>How can we model the interaction between an attacker and a defender?</td>
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Research Topics

Research Question I
How can we model the interaction between an attacker and a defender?

Research areas
- Modelling the interaction between an attacker and a defender
  - model the interaction
  - reasonable input parameters
  - optimal actions for defender and attacker
  - computational feasibility for large networks
Research Question II

How can we use the model to form a network defence strategy?
Research Topics

Research Question II

How can we use the model to form a network defence strategy?

Research areas

- Network defence strategy
  - response action based on observed security alerts
  - unknown state of the network
  - unknown objective and past actions of an attacker
Research Question II

How can we use the model to form a network defence strategy?

Research areas

- Network defence strategy
  - response action based on observed security alerts
  - unknown state of the network
  - unknown objective and past actions of an attacker

- Strategy verification
  - KYPO - cloud-based testbed for simulation of cyber attacks
Research Topics

Research Question III
Can the human instinct and experience be included in the defence strategy?
Research Areas

**Research Question III**

Can the human instinct and experience be included in the defence strategy?

**Research areas**

- How can the response selection benefit from human input
  - **what** in the model or strategy can be made more accurate
Research Topics

**Research Question III**
Can the human instinct and experience be included in the defence strategy?

**Research areas**
- How can the response selection benefit from human input
  - *what* in the model or strategy can be made more accurate
- Merging the human intuition into decision output
  - *how* can we make it more accurate
Proposed Approach

Modelling the interaction between an attacker and a defender

- Game theory toolset
- Use existing or modified model
- Optimal attacker’s and defender’s strategy
Proposed Approach

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Estimating model parameters

- Formal network description
  - the topology of the network
  - the hosts and services present in the network
  - the required levels of confidentiality, availability and integrity
  - interdependence of services

- Formal description of attacks and responses
Proposed Approach

**Network defence strategy**
- Maintain beliefs to manage uncertainty
  - the current state of the network
  - the attacker’s past actions
  - the attacker’s objective
- Precomputed optimal responses
- Best response action in a given situation
Proposed Approach

**Strategy verification**

- Cloud-based testbed for simulating cyber attacks
- Computer Security Incident Response Team (CSIRT) training exercises
Proposed Approach

**Strategy verification**
- Cloud-based testbed for simulating cyber attacks
- Computer Security Incident Response Team (CSIRT) training exercises

**Adding human intuition to decision output**
- Black-Litterman model in economy
- Formal description of human input
- Updating beliefs based on input
Network security requires an efficient autonomous system which would select a response action based on observed security events.
Summary

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- Currently automated network defence systems react only in unambiguous situations and the rest of the events must be investigated by security experts.
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Summary

- Network security requires an efficient autonomous system which would select a response action based on observed security events.
- Currently automated network defence systems react only in unambiguous situations and the rest of the events must be investigated by security experts.
- We propose to model the interaction between an attacker and a defender to comprehend how the attacker’s goals affect his actions and use the model as a basis for a more refined network defence strategy.
THANK YOU FOR YOUR ATTENTION!

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