This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 608090.

HyRiM

A Game-Theoretic Risk Assessment Tool

A Short Demo

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AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

2nd HyRiM End User Workshop

Barcelona, 15.11.2016

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Contents

- Malware and Ransomware
- Percolation and Game Theory
- Demonstration of the Tool

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Malware and Ransomware

- ICT systems are facing an increasing amount of infection and attacks by malware
  - Simple adware like DeskAd creating annoying content
  - Creation of bot networks for Distributed Denial-of-Service attacks (DDoS)
  - Complex ransomware like CryptoLocker to blackmail organizations
  - Some rootkits can also be used as a starting point to APT attacks

- Ransomware has the potential to cause a significant damage to an organization

- Even advanced measure like IDS or SIEM solutions are often not effective against malware attacks
  - Malware infection often relies on social engineering
  - Triggered by "soft factors" (e.g., phishing mails)
  - Propagation is possible over various ways (also including user interaction)

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Malware and Ransomware

- Besides preventive actions it is important to assess the potential consequences of a malware infection
  - Especially utility providers operate highly sensitive networks
  - A failure of a small number of systems (or even a single system) might have significant effects
  - Damage can be caused to the organization as well as the population depending on the utility provider (societal effects)

- In HyRiM, we developed a novel framework for modeling and assessing the propagation of malware within a network
  - Framework is based on sound mathematical concepts
  - Special focus on the interconnection of different networks (ICT, SCADA, etc.)
  - Simulations are performed to obtain realistic data

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Percolation Theory

- Infection of an ICT infrastructure with a malware can be seen similar to an infection of a biological system with a virus
  - One small part of the system becomes infected
  - This part then tends to infect his neighbors
  - Based on the strength of the system‘s defenses (immune system) the virus can propagate through the entire system

- In medicine, percolation theory is a standard framework to model the spread of epidemics
  - General assumption of a “homogenous outbreak”
  - Infection is equiprobable for any pair of nodes
  - Irrespectively of the nature of the two entities

- Percolation theory is rarely used in the field of security and risk management

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Percolation Theory

- Interconnected networks are not homogeneous
  - The probability of forwarding an error is not constant for each link
  - Highly dependent on the type of link between two nodes
  - Different types of connections have different probabilities of infecting their neighbor

- Percolation theory can be used to describe the propagation of failures in a network
  - Taking the "type" of a connection into account (not all failures are equally probable to propagate over a certain link)
  - Incorporating different probabilities of failure for each type
  - Taking interconnections (e.g., SCADA and utility network) into account
  - Taking cascading effects (how many nodes are "infected" after 2, 5, 10 time steps) into account

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Game Theory

- Goal is to define a mathematically sound framework for risk assessment
  - Special focus on interplay between IT, control and utility networks
  - Special focus on cascading effects and error propagation

- Game Theory seems to be a very good candidate
  - Describes a competitive situation between two parties
  - Known and finite action space
  - Known, deterministic consequences determined by actions of all players
  - Gameplay with known rules and repeatable actions

- Problem: the setting for interconnected networks is not quite standard
  - External influences can occur (which are uncontrollable)
  - We have no information about the opponent's incentives and payoffs
  - We have random payoffs (instead of a single number)

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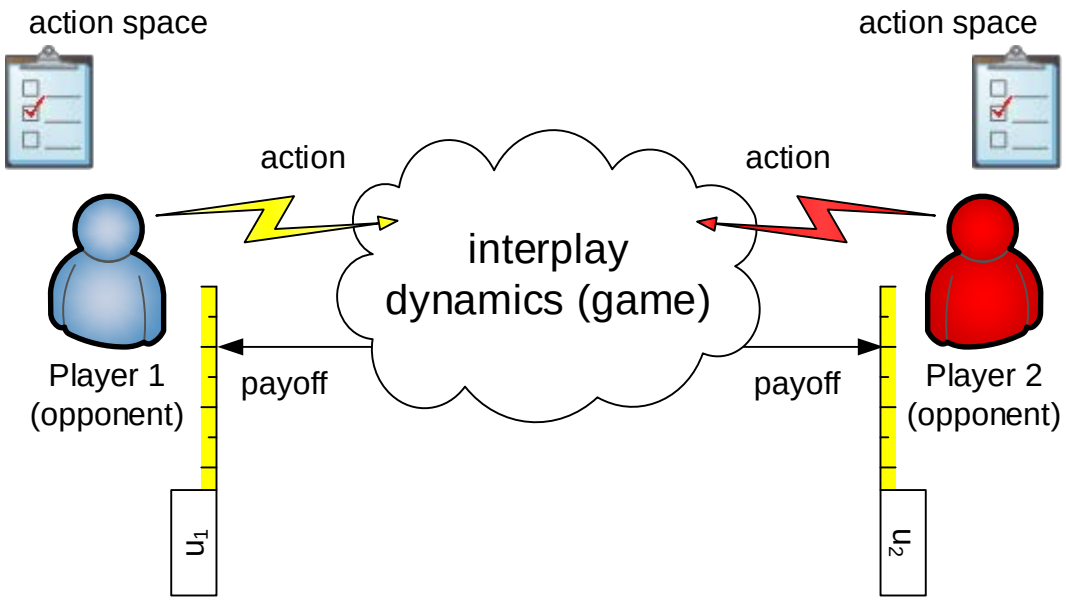
Game Theory

- In the general setting, two parties engage in a competitive situation
- Action space
  - Known
  - Finite
- Consequences
  - Known
  - Determined by actions of all players
  - Deterministic
- Gameplay
  - known rules/dynamics
  - Repeatable – players seek to maximise payoffs
- Solution: equilibrium = behavior that simultaneously maximizes the average payoffs for all players



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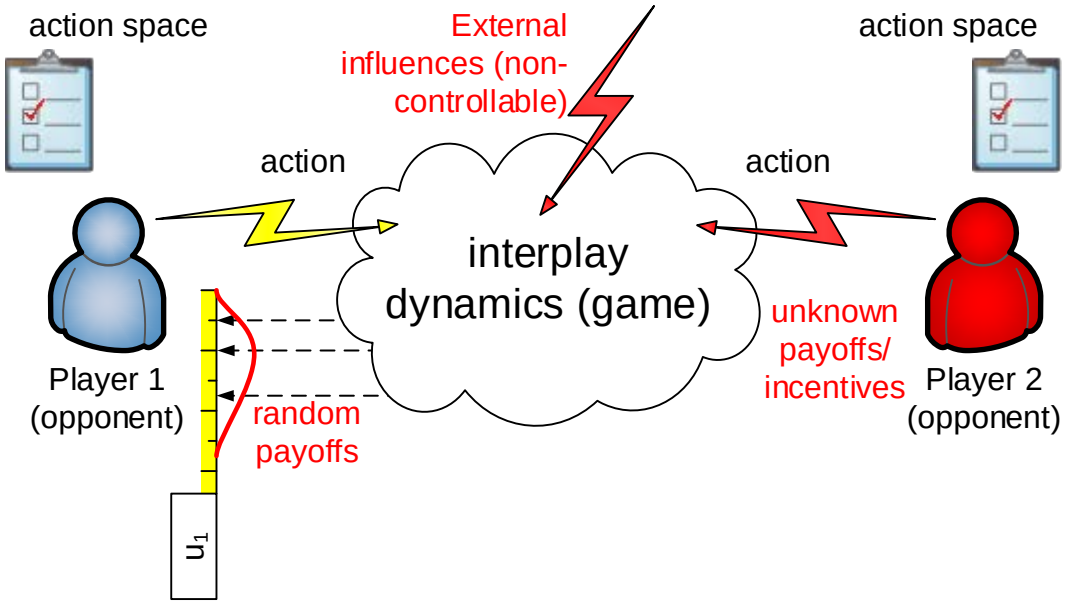
Game Theory

- In our approach, we engage in a competition against "the unknown"
- Action space
  - Known
  - Finite
- Consequences
  - Partially unknown
  - Determined by actions of all players
  - Stochastic
- Gameplay
  - (un)known rules
  - Repeatable – players seek to maximise payoffs
- Solution: define a series of actions (security strategy) with maximal payoff, no matter how the opponent behaves



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