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

The HyRiM Risk Management Process

A Short Overview

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AUSTRIAN INSTITUTE OF TECHNOLOGY
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- Motivation
- ISO 31000 and Hybrid Risk Management
- HyRiM Risk Management Process
- Conclusion

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Motivation

- Risk assessment and risk management is a core duty for utility providers
  - Utility providers operate critical infrastructures
  - Responsible for the supply of large number of people with different goods
  - Incidents within/affecting utility providers might have huge economic and societal impacts

- Numerous risk assessment and risk management tools already exist
  - Based on well-established standards and guidelines (e.g. ISO 31000)
  - Often focusing on a specific field (e.g. IT Security – ISO 27005, Supply Chain Management – ISO 28000, Port Security – ISO 20858)
  - Often designed for businesses and not the special requirements of utility providers or critical infrastructures
  - Mostly a matter of best practices

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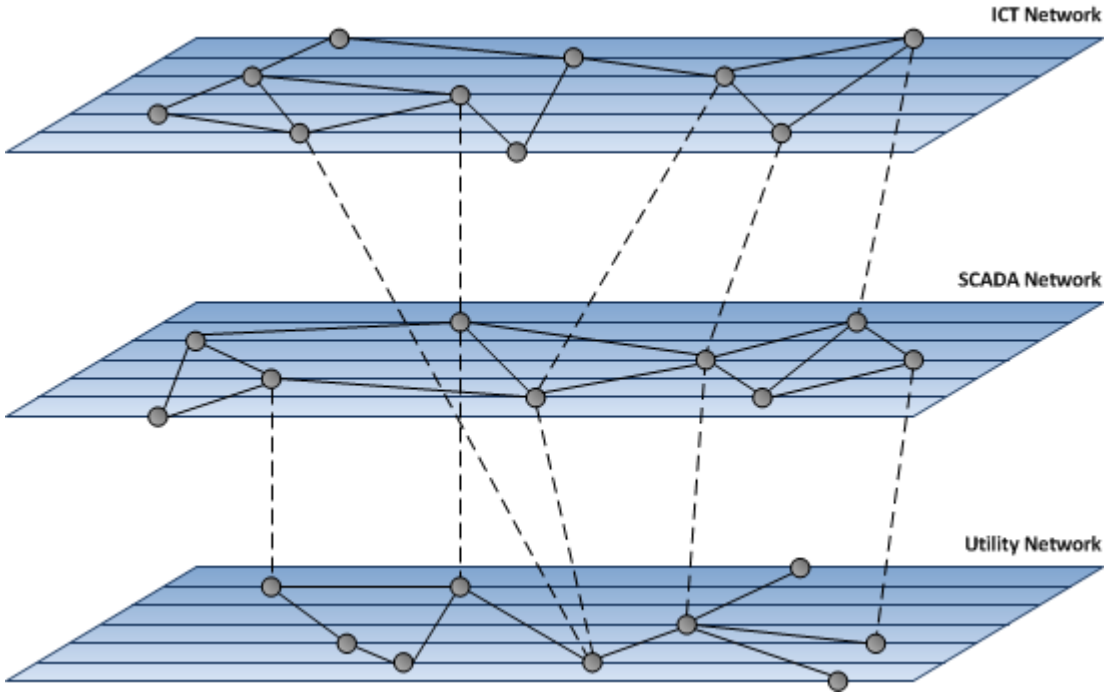
Motivation

- Networks operated by utility providers become more and more interconnected
  - Utility network (e.g. power lines, water pipes, oil pipelines, etc.)
  - Control networks (e.g. SCADA networks, smart grids, etc.)
  - ICT networks (e.g. office networks, communication networks, intranet, etc.)



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Motivation

- Requirements of utility providers have changed
  - Number of cyber-physical systems increases (e.g., SCADA networks)
  - Threats evolve more rapidly and become more complex (e.g., Advanced Persistent Threats – APT)
  - Intentional threats became more popular in recent years (e.g., terrorism, cyber-terrorism/hacktivists, espionage, etc.)

- Threats affecting one part of a utility provider can propagate through the network and affect other, distant parts, too
  - Malware infection on the ICT network might cause the failure of a SCADA system and thus affect the utility network itself
  - Security issue of a SCADA system might give access to business data handled in the ICT network
- Additionally, utility providers are interconnected and interacting with each other

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Motivation

- Novel approaches towards security and risk management have to be identified to address these issues
  - Solutions for each network level exist and are applied separately
  - "Hybrid" risk management methodologies are required, providing a holistic overview (i.e. looking at several networks simultaneously)
  - Interconnections and the related cascading effects need to be considered

- Sole focus on technical threats and technical solutions is no longer adequate
  - Social engineering is a major aspect in many attack strategies
  - Organizational factors are essential for every security measure or security strategy performed in an organization

- Security and risk management methodologies explicitly have to take societal factors into account

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ISO 31000

- World-wide leading standard for risk management is the ISO 31000
  - Follows a very generic approach on risk management
  - Ubiquitously applicable on every kind of organisation
  - More specific standards are building on and extending the ISO 31000 (e.g., ISO 27005, ISO 28000, ISO 20858, etc.)

- ISO 31000 describes a two-tier structure
  - Operative risk management process provides a generic description of the different steps towards risk management
  - Organizational risk management framework required to implement the risk management process within a company

- In HyRiM we extend the ISO 31000 towards a more mathematically-based approach, including concepts and algorithms developed in the project

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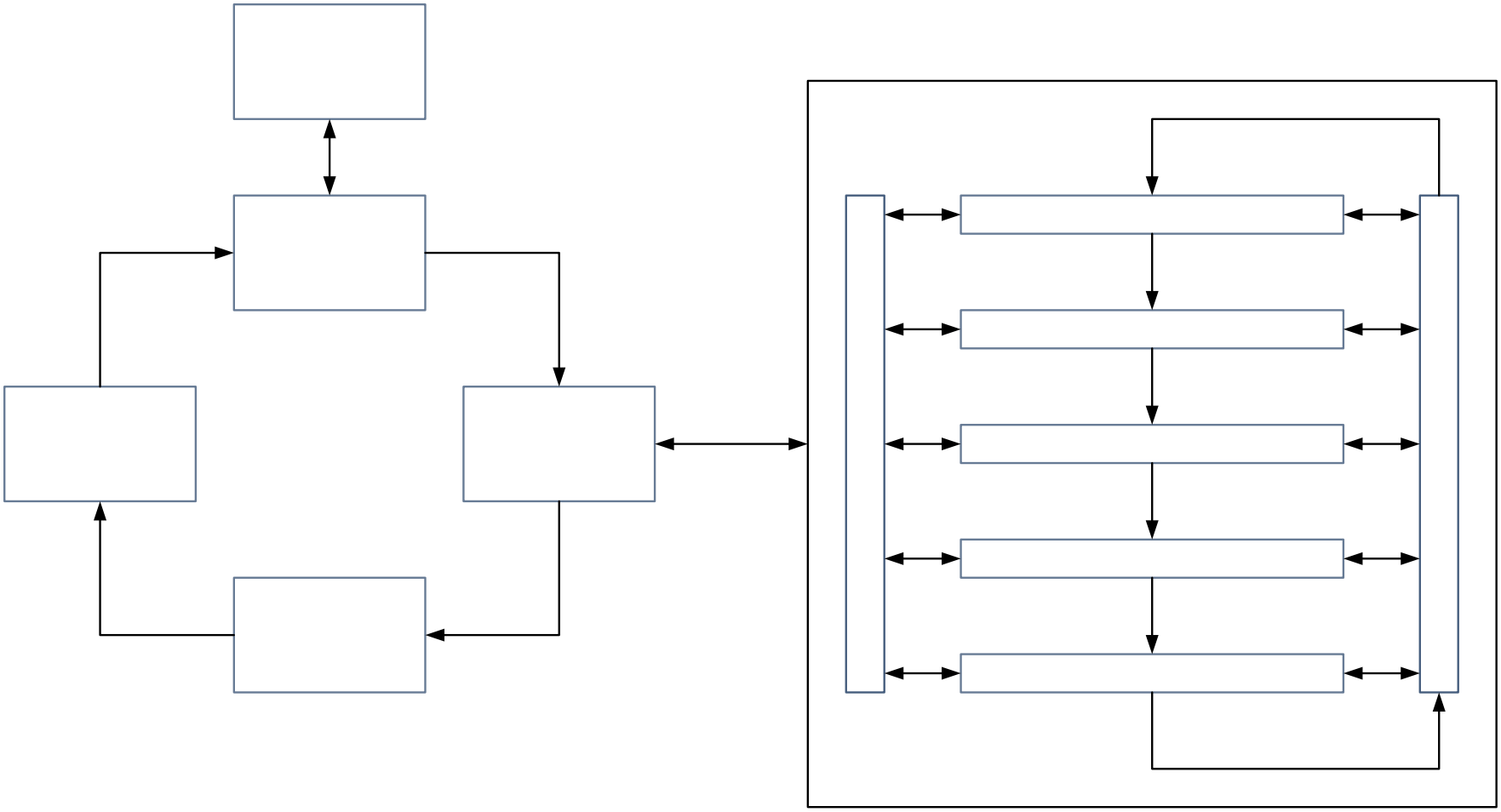
ISO 31000



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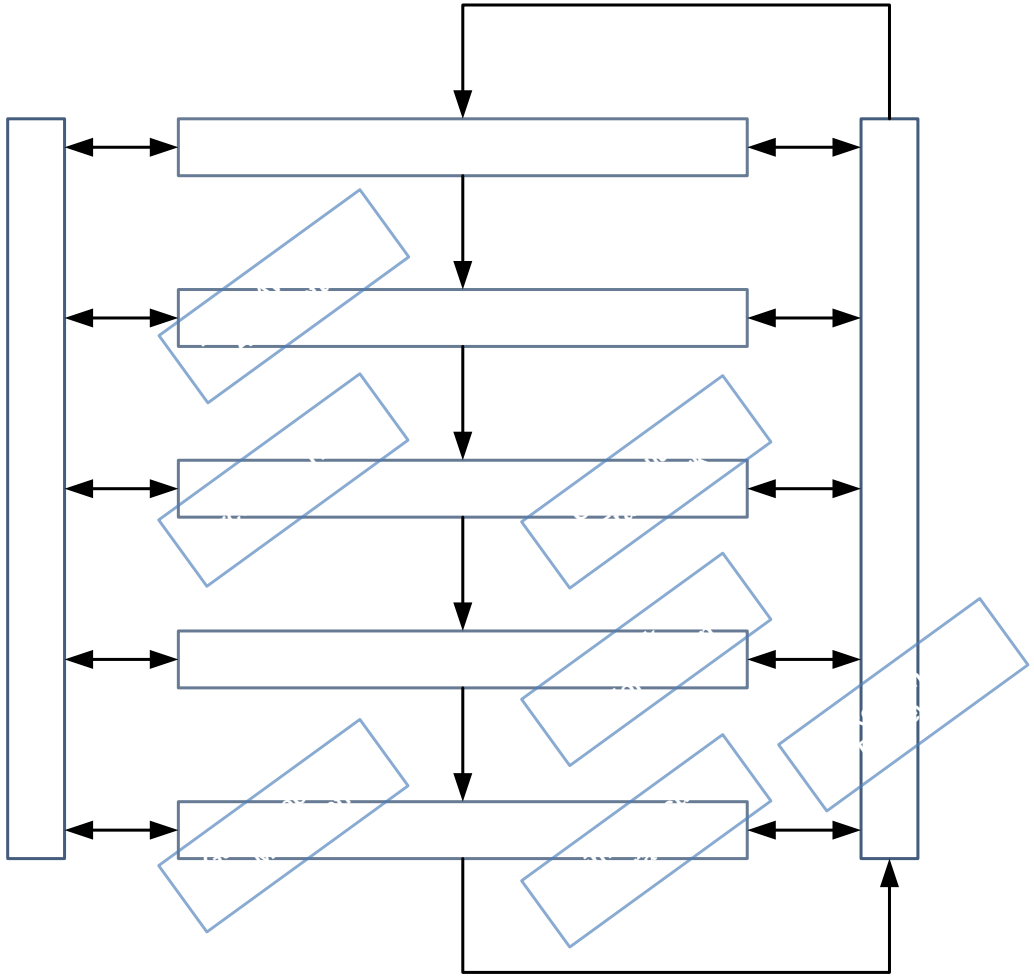
HyRiM RM Process



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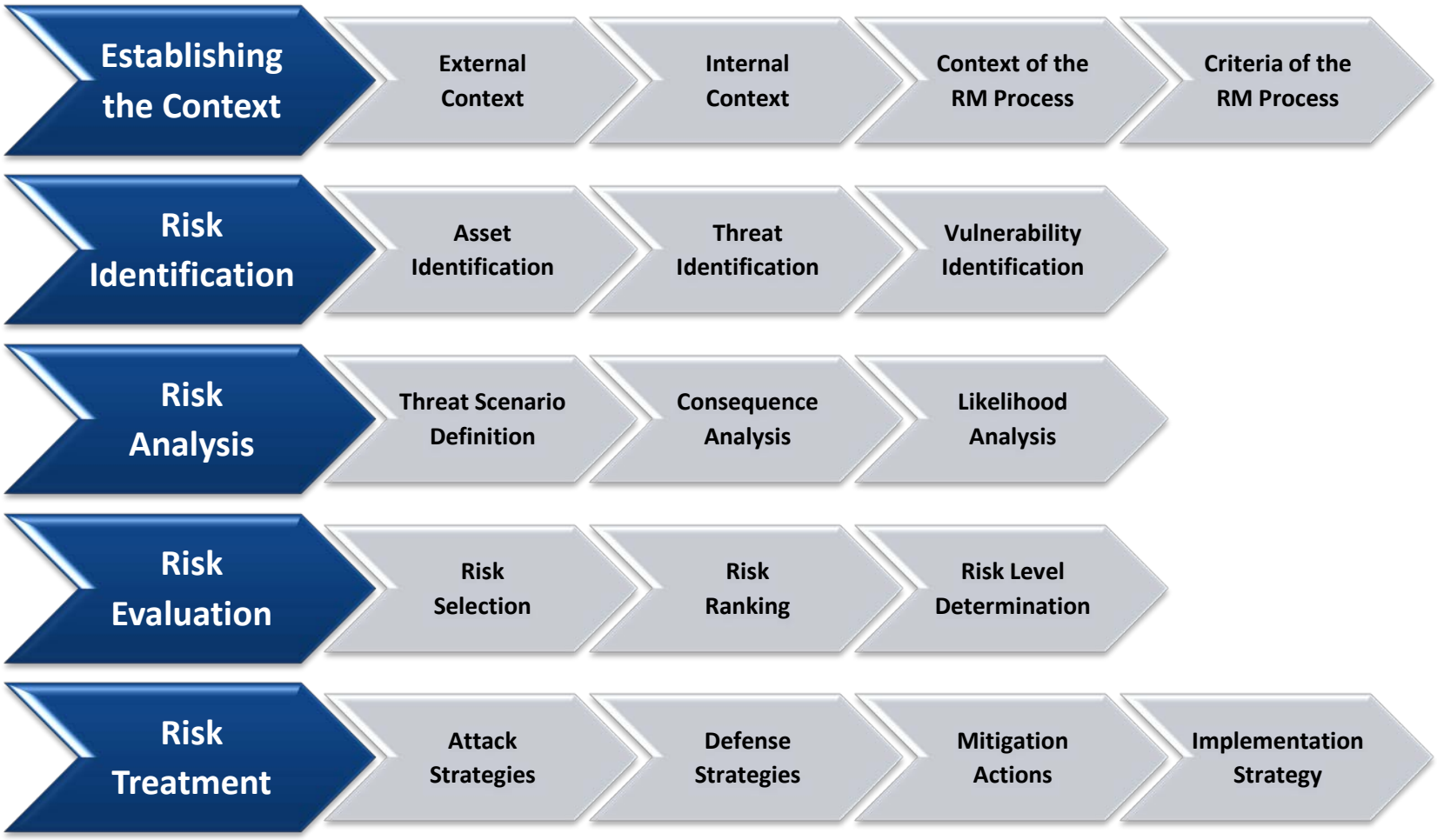
HyRiM RM Process



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Establishing the Context

- Identify all interrelations with internal and external stakeholders
  - Internal technical, organizational and social aspects
    (e.g., communication channels, dependencies between different technical and social networks)
  - External interrelations and interdependencies
    (e.g., external organizations as resource providers or regulatory bodies)

- Identify the relevant framework for the risk management process
  - Parts of the organization which are covered in the risk management process
    (e.g., organizational units, depth of the risk assessment process)
  - Criteria to evaluate the significance of a specific risk based on organization's resources, objectives and goals or general characteristics
    (e.g., definition how the likelihood or the impact of an event is characterized)

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Risk Identification

- Identify the relevant assets of the organization's infrastructure
  - Based on the internal context (cf. "Context Establishment")
  - Focus on the interconnections between assets

- Identify all potential threats and respective vulnerabilities affecting the organization's infrastructure
  - Obtain a structured view on all potential threats and vulnerabilities
  - Application of a specific Threat Awareness Architecture

- Information can/should be collected from different sources
  - External (e.g., existing threat catalogues or online threat databases)
  - Internal (e.g., expert knowledge or information on past incidents)

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Risk Analysis

- Identify a fine-grained list of potential threat scenarios
- Determine the potential consequences for the manifestation of all threat scenarios
  - Quantitative (e.g., using percolation theory or a co-simulation approach)
  - Qualitative (e.g., by experts from within the organization or external advisors)

- Determine the potential likelihood for the manifestation of all threat scenarios
  - In general fully qualitative estimation supported using information from external sources (e.g., reports containing statistical information on the likelihood of specific events)

- All information is gathered in histograms or distribution functions
  - Capturing of uncertainty and preventing loss of information

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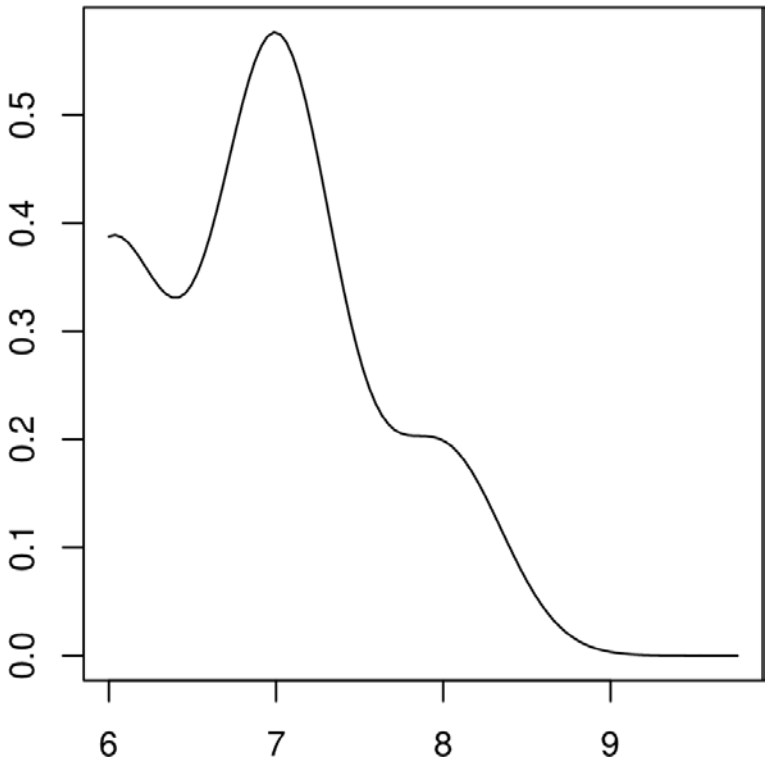
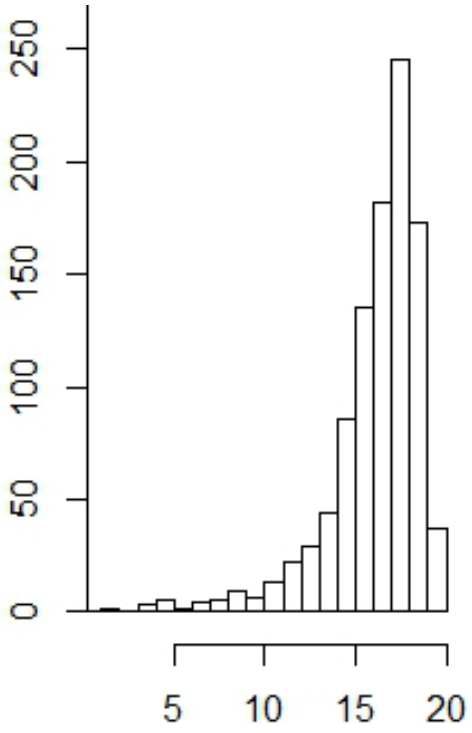
Risk Analysis

Damage (Distribution)



Damage (Histogram)



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Risk Evaluation

- Select a list of most relevant risks (based on threat scenarios)
- Determine a ranking of the identified risks
  - Ordering according to their respective consequences and likelihood
  - Comparing histograms is non-trivial (novel approach has bee identified)

- Create a graphical representation and a priority list of the identified risks
  - Each risk is placed within a risk matrix based on its consequences and likelihood
  - Risks having the most severe consequences together with the highest likelihood are located at the upper right corner of the matrix

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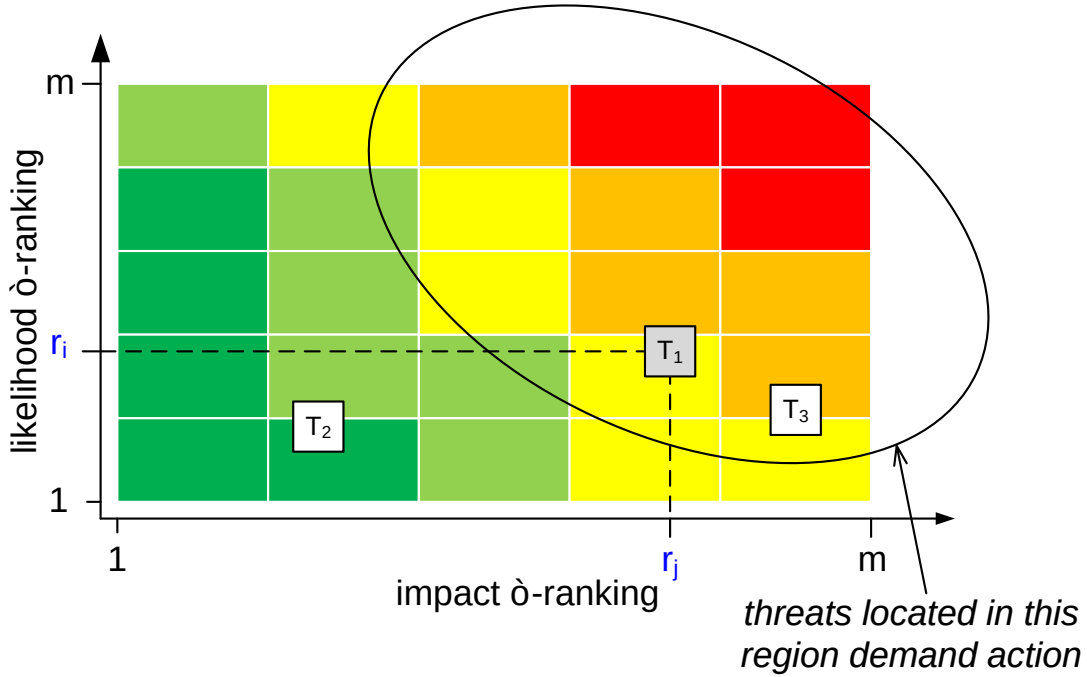
Risk Evaluation

ranking (w.r.t. ò-ascending order)

	1	2	...	r_i	...	r_j	...	m
Impact:			T_2			T_1	T_3	
Likelihood:			T_2	T_1	T_3			



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Risk Treatment

HyRiM

- Identify the risks that need to be mitigated
  - Usually these are the highest-ranked risks
  - Threat scenarios describe potential attack strategies for these risks

- Identify possible mitigation actions (defense strategies) to counter the respective attack strategies
  - Reducing the consequences of the specific risk (e.g., by lowering the number of affected assets)
  - Reducing the likelihood of the specific risk (e.g., by making it harder to exploit specific vulnerabilities)
  - Letting a risk vanish completely (e.g., by closing specific vulnerabilities)

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Risk Treatment

HyRiM

- Determine the effect of a specific defense strategy on a single attack strategy
  - Rerunning the consequence analysis for the organization's asset structure (assume that the specific defense strategy has been implemented)
  - Evaluate all possible combinations of attack and defense strategies
  - Results are fed into the game-theoretic framework

- Game-theoretic framework provides an optimal security strategy
  - In general a mixture of the single mitigation actions
  - Describes the different frequencies at which these mitigation actions have to be performed
  - Organizational structure (job scheduling) is required to support the correct implementation of the mitigation actions

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Conclusion

- Utility operators live in a highly uncertain environment
  - More complex and rapidly changing threat landscape
  - Consequences of events are not assessed easily (e.g., cascading effects)

- Standard risk assessment and risk management process are not enough
- Novel risk management process developed in the HyRiM project
  - Extension of the standard ISO 31000 process
  - Strongly relying on qualitative data/information
  - Application of mathematical tools and structured approaches
  - Implementation of game theory to identify optimal mitigation actions

- Goal is to support the operational and management level to make better decisions

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