Representing decision-makers in SGAM-H: the Smart Grid Architecture Model Extended with the Human Layer

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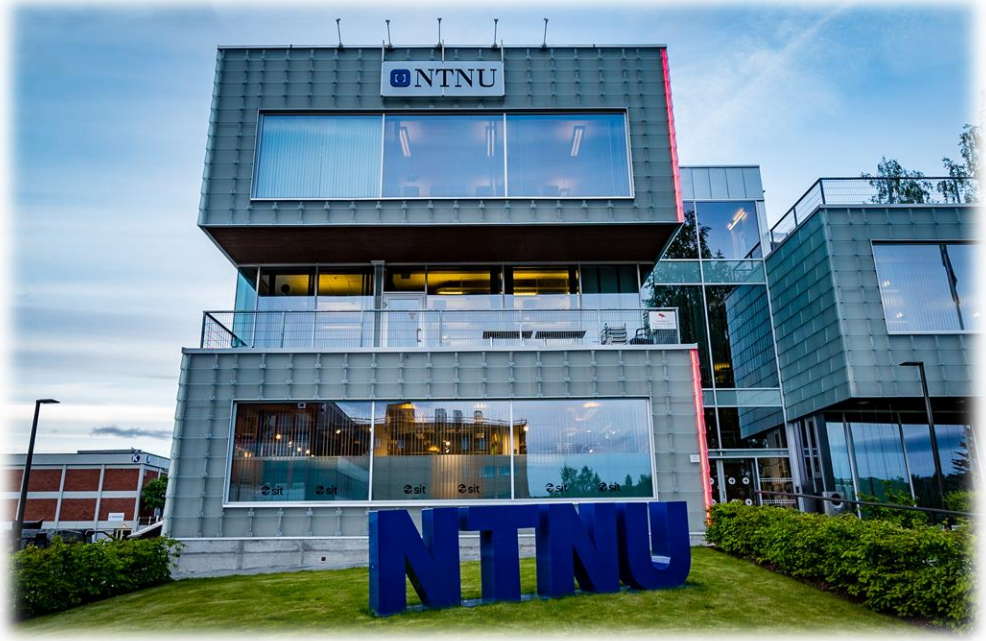

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Motivation

- Safety and security of societies depends on critical infrastructures
- Traditional electric grid enhanced by IoT devices has an increased attack surface
- Smart Grids are emerging, complex and dynamic systems which pose several challenges for most risk analysis methods
- Unrealistic expectation: comprehensive risk analyses can be conducted on real systems
- Security is about human motivation

Motivation – potential threats to Smart Grids

Human error
(weakest link)

Limited cognitive capacities
Forgetfulness
Task-related errors

Non-compliance

Lack of awareness
Lack of skills
Goal conflicts

Motivated attack(er)s

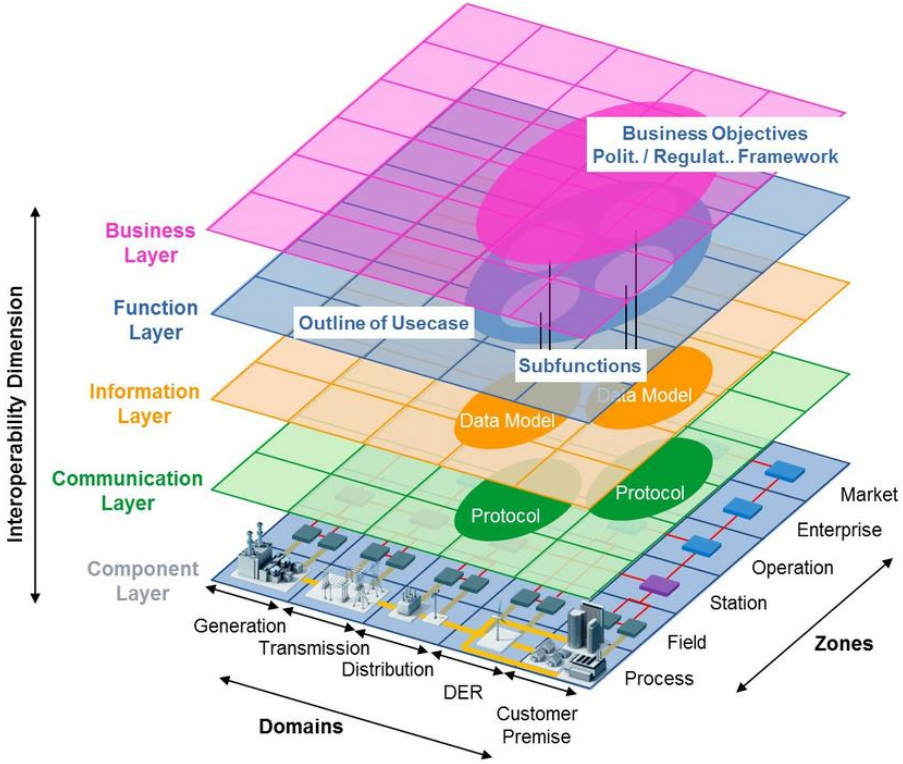
Insiders
Hackers
IoT botnets
Cyber-attacks
Ransomware
Sabotage
Espionage
DDoS
…

Negative externalities
(unintended side effects of operating in a complex environment, exposure to others' decisions)

Network convergence
Economic constraints
First to market vs. providing secure devices and software
Privacy violations
…

Stakeholders:
legislators,
governmental agencies,
standardizing bodies,
data protection authorities,
organizations focusing on the generation, transmission, distribution of electricity,
equipment manufacturers,
software and security providers
researchers,
consumers

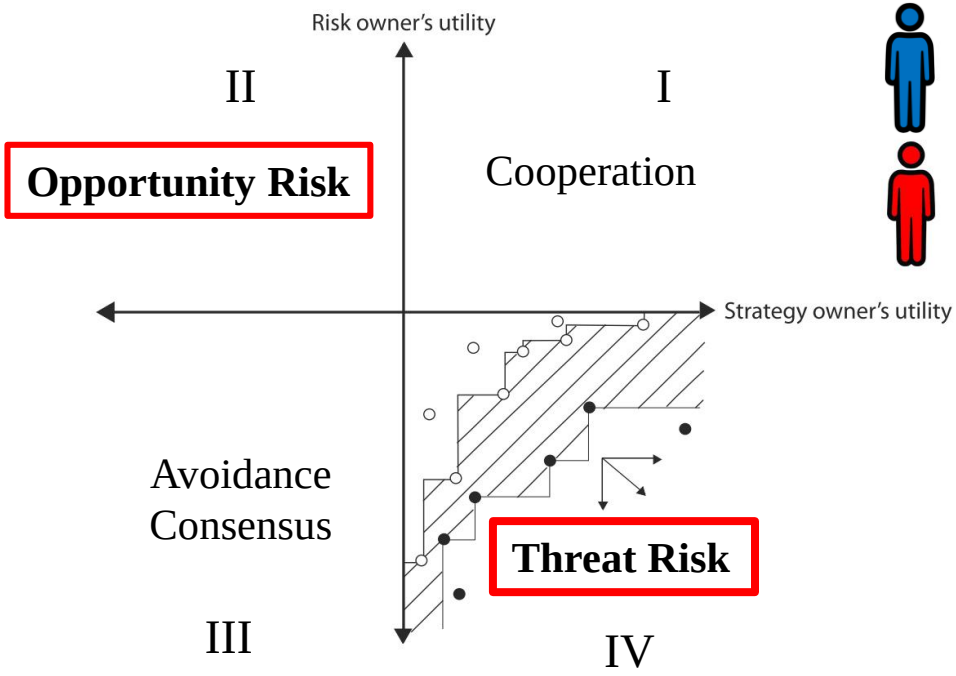
Smart Grid Architecture Model (SGAM)*



- Capture complexity of Smart Girds in a technology-neutral way
- Establish common understanding among stakeholders about the systems
- Represent stakeholders, applications, systems and components that will have to achieve efficient interdependent operations
- Human decision-makers are not represented in the model

*CEN-CENELEC-ETSI Smart Grid Coordination Group: Smart grid reference architecture (2012)

Conflicting Incentives Risk Analysis (CIRA) method*



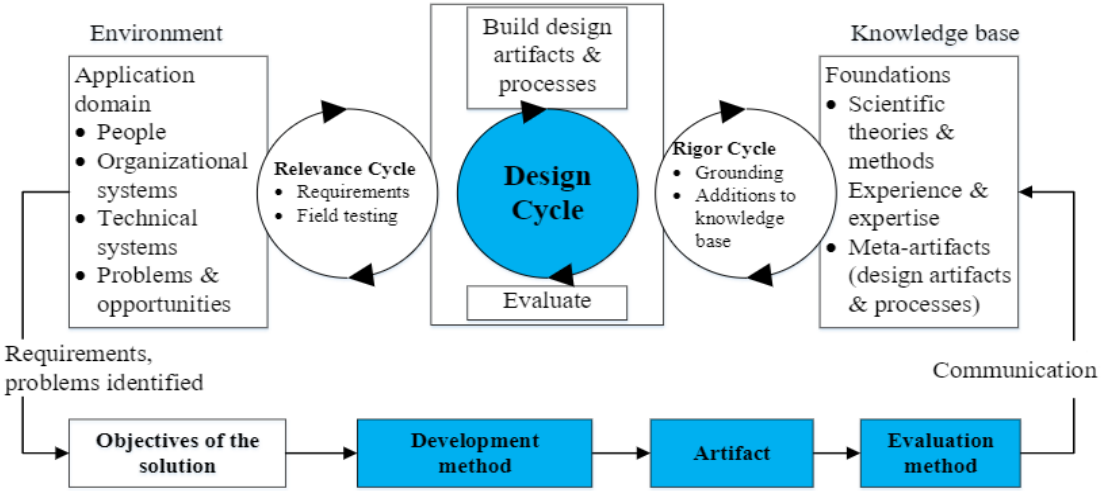
- risk owner

- strategy owner

- Risk is the result of misaligned incentives
- Replacement of incident probability/likelihood estimations with strength of human motivation
- Does not rely on historical data

*Rajbhandari, L. and Snekkenes, E. (2013). Using the conflicting incentives risk analysis method. In IFIP International Information Security Conference, pages 315–329. Springer.

Methodology – Design Science Research*



Establish connection between CIRA and SGAM

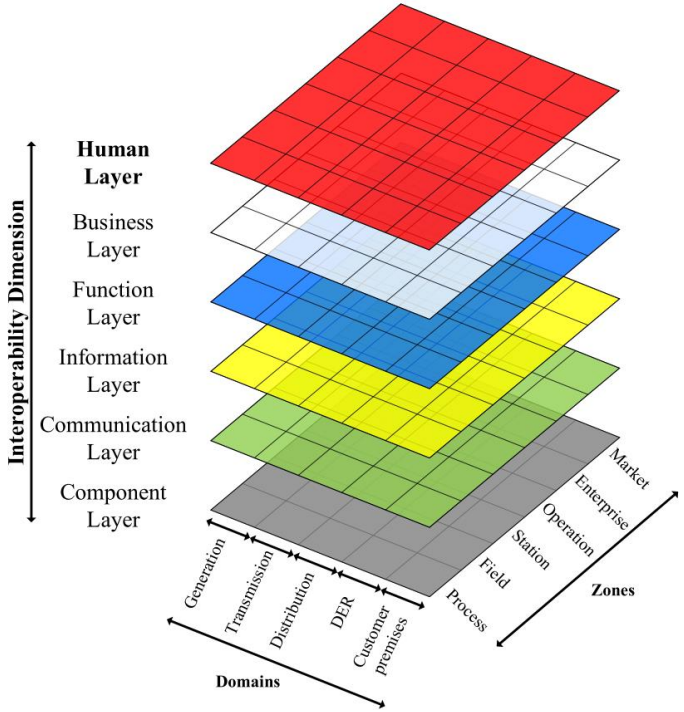
Literature review, Identification of existing solutions in need of improvement Concept extraction from relevant scientific articles

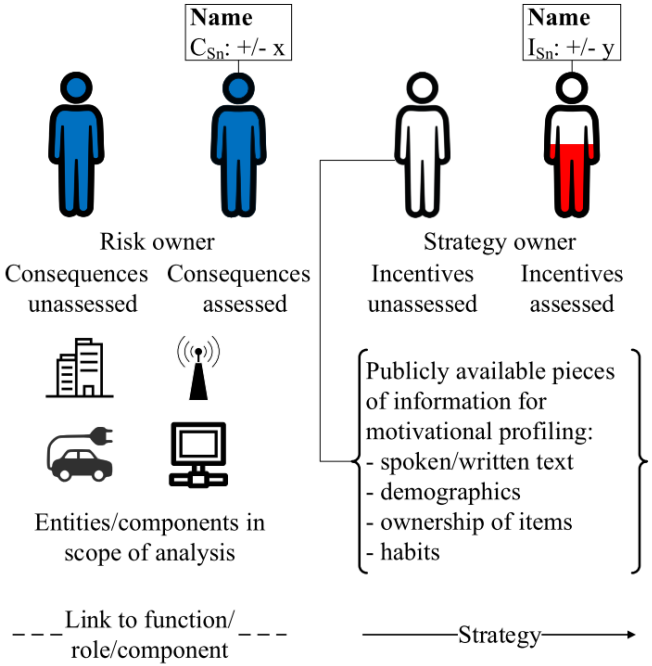
Graphical representation of extracted abstract concepts

Hypothetical case study (qualitative, descriptive method)

* Hevner, A.R.: A three cycle view of design science research. Scandinavian journal of information systems 19(2), 4 (2007)

Human Layer


Interoperability Dimension
Human Layer
Business Layer
Function Layer
Information Layer
Communication Layer
Component Layer
Generation
Transmission
Distribution
DER
Customer premises
Domains
Process
Field
Station
Operation
Enterprise
Market
Zones

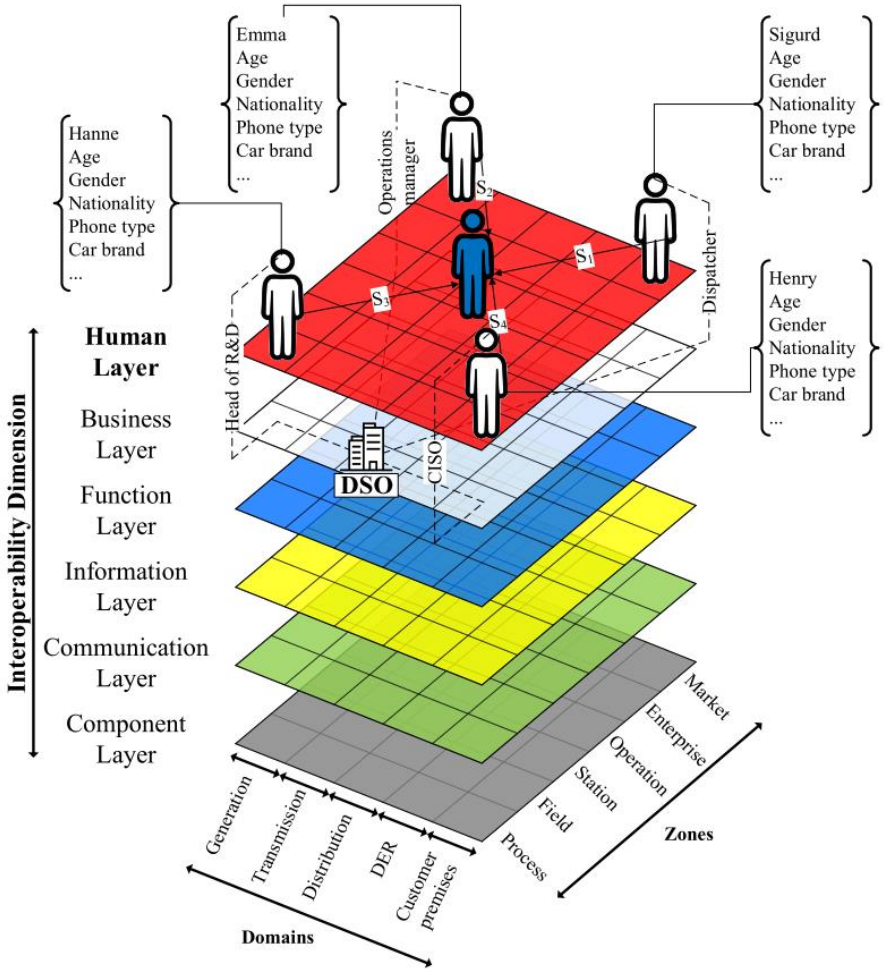

Name
C_{Sn}: +/- x
Name
I_{Sn}: +/- y
Risk owner
Consequences unassessed
Consequences assessed
Strategy owner
Incentives unassessed
Incentives assessed
Publicly available pieces of information for motivational profiling:
- spoken/written text
- demographics
- ownership of items
- habits
Entities/components in scope of analysis
Link to function/ role/component
Strategy

Case study

Focusing on intra-organizational risk experienced by CEO of a Distribution System Operator (DSO)

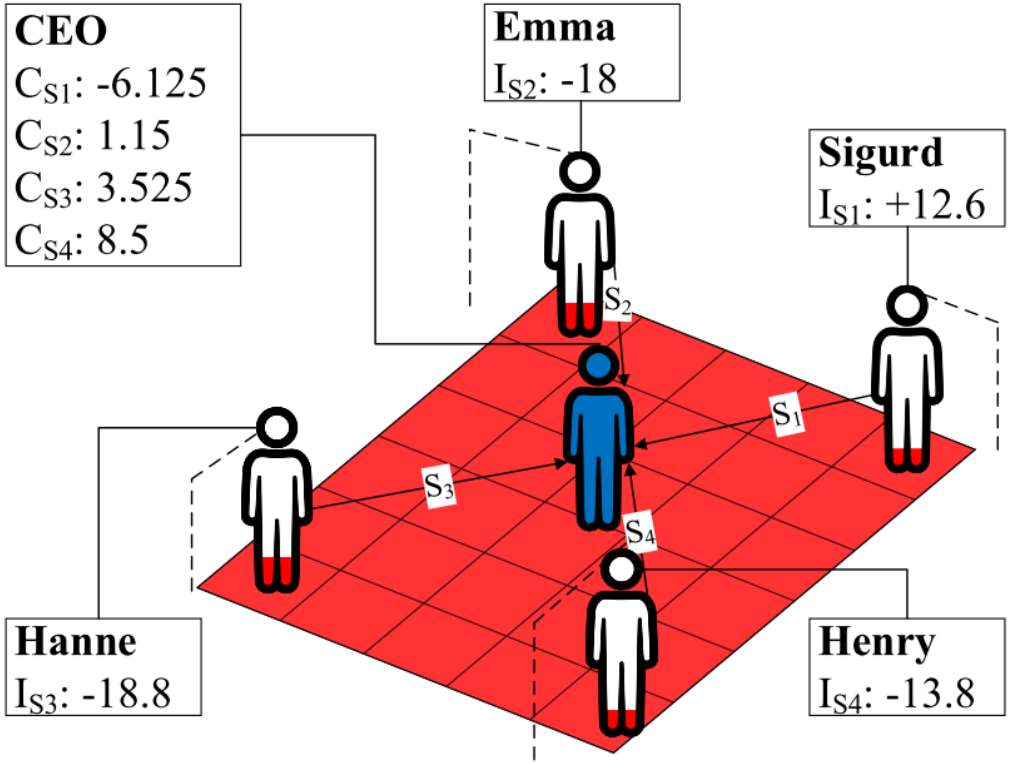
Balanced Scorecard (BSC) method used for identifying key utility factors (KPIs) of the CEO

Strategy identification by analyzing key processes and functions at DSOs.
Key issues covered:
- privacy,
- fulfillment of societal roles (education and safe streets),
- conflict between goals of information security and business objectives



Case study

Strategy	Incentive	Consequence
Help a friend (S_1)	12.6	-6.125
Fix street lights (S_2)	-18	1.15
Recruit research applicants (S_3)	-18.8	3.525
Support system integration (S_4)	-13.8	8.5



Conclusions

- Internal evaluation of the artifact (1-5):
  Efficacy (fulfillment of specified goal): **5**
  Ease of use: 3
  Completeness (representing key CIRA concepts): **5**
  Homomorphism (correspondence with original SGAM): **4**
- Facilitate construction of a common understanding among stakeholders about the importance of including people in Smart Grid models
- Improve context establishment, risk communication

Conclusions

- Future work: increase compatibility with original SGAM objects, software tools to improve scalability, simulations with a higher number of stakeholders populating the SGAM-H, field experiments to refine the models

Important step towards a more balanced understanding of risks in complex systems by focusing on conscious human decisions and establishing the methodology for assessing key attributes of people

Thank you for your attention!

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