Managing Security Alignment of Socio Technical Systems

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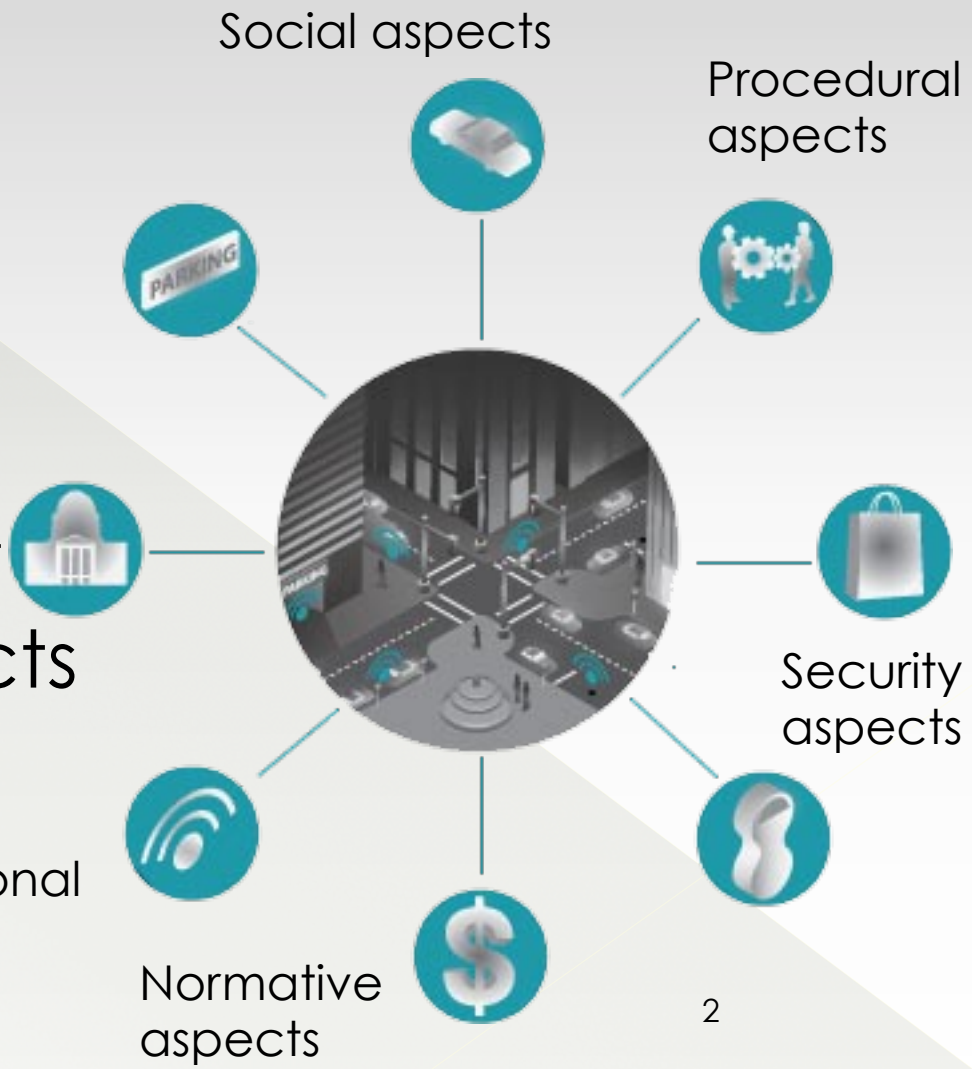
Socio-Technical Systems (STSs)

- Systems composed of
  - Social Actors
  - Technical components
- Examples
  - Smart cities
  - Health care systems
  - Smart houses
  - Air Traffic management
- Heterogeneous aspects



Security in STS

Example:
protect municipality sensitive data

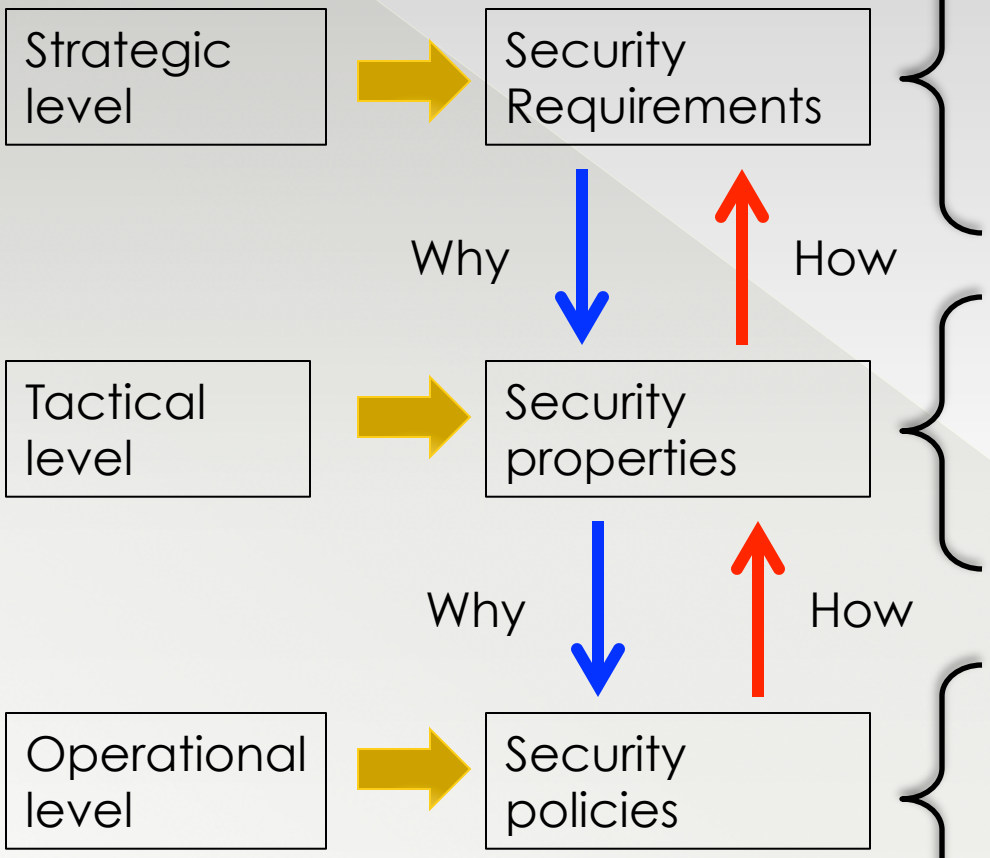
- **communication**
  - PGP cryptographic algorithm
  - The mayor may print the sensitive data and forget them in a public space
- **procedure**
  - Municipality send data –> Mayor use data –> mayor delete data
  - Relatives of the mayor can access and manage data
- **social organization**
  - The wife can receive data but not the son

Security is not only a technical problem

Modeling STSs

Strategic Level	**Social aspects**: social interactions, legal impact, organizational structure.	UML Use case [20] Tropos [19] *i**[18] KAOS[21]
Tactical level	**Procedural aspects**: Business processes, flow of actions, flow of messages, protocols.	BPMN[15] YAWL [12] EPC[25]
Operational level	**Technological aspects**: methods calls, quality of service, cryptographic algorithm parameters.	UML Class diagram [20] UML Component diag. [20] WSAg [16] WSLA[17]

Modeling security in STSs



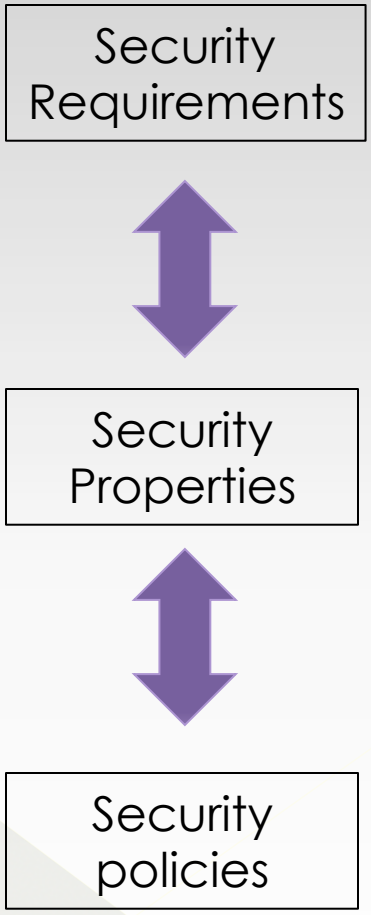
- Stakeholder needs about security
- E.g. the need of avoiding unauthorized disclosure of sensitive data

- Restrictions on modalities of procedures execution
- E.g. use a cryptography protocol for sensitive data communications

- Patterns on system specification
- E.g. how to pre-process parameters of a cryptography algorithm

STSs dynamism

- STSs adapt to external changes
  - Eg: a new law imposes that all communication cannot be encrypted
- Misalignment of security aspects
  - Eg: **security properties** of the traffic management system are adapted, but there still is a **security requirements** that sensitive data have to be protected



Misaligned security aspects may lead to severe consequences

PhD Objective

Define a run time and design time semi-automated framework which:

Objective 1:

checks alignment of STS security aspects

- Check if security aspects are coherent

Objective 2:

reestablishes alignment STS security aspects

- If security aspects are misaligned, it proposes STS adaptation so to reestablish alignment.

Objective 3:

It is **supported by a software**

Objective 4:

It is **validated** with industrial case studies

State Of The Art

Requirement Engineering
+check alignment (Bauer et al. [1], Ghanavati et al. [6])
+link different modeling languages(Massacci et al. [23])
-security alignment not covered in all abstraction levels
OBJ1 OBJ2

Co-evolution
+check alignment (D'Hondt et al. [2], Etien and Salinesi [3])
+reestablish alignment (Potter and De Jong [24])
-security alignment not cover all abstraction levels
OBJ1 OBJ2

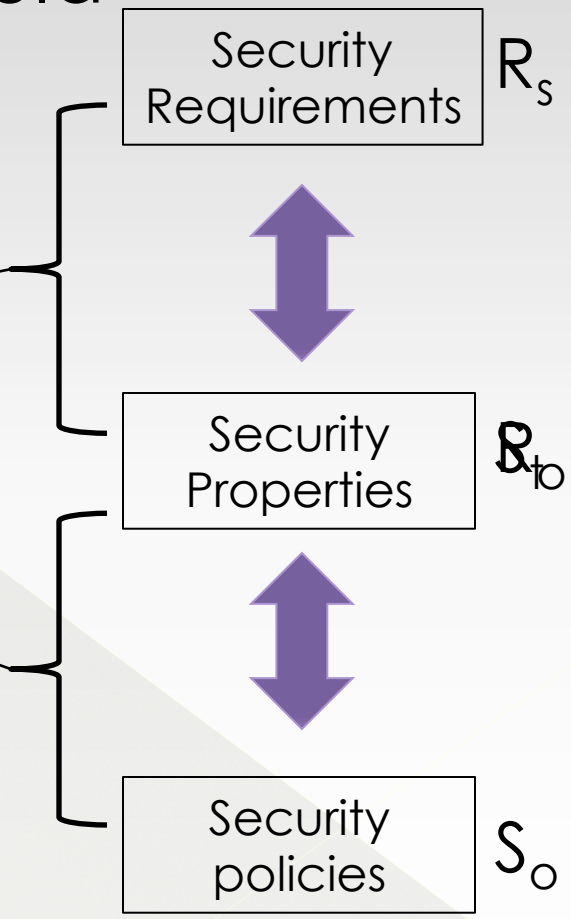
Model Transformation
+link concepts of different modeling languages (Evans and Kent [4])
+transform models to models in different abstraction levels (Anastasakis et al.[27], Rodriguez et al. [28])
+generated models are aligned with security aspects of original models (Fox and Jurjens [5])
OBJ1 OBJ2

Formal approaches
+check alignment(Liu et al. [8], Rushby [9])
-not usable at runtime
-considerable amount of effort by specialists
OBJ1 OBJ2

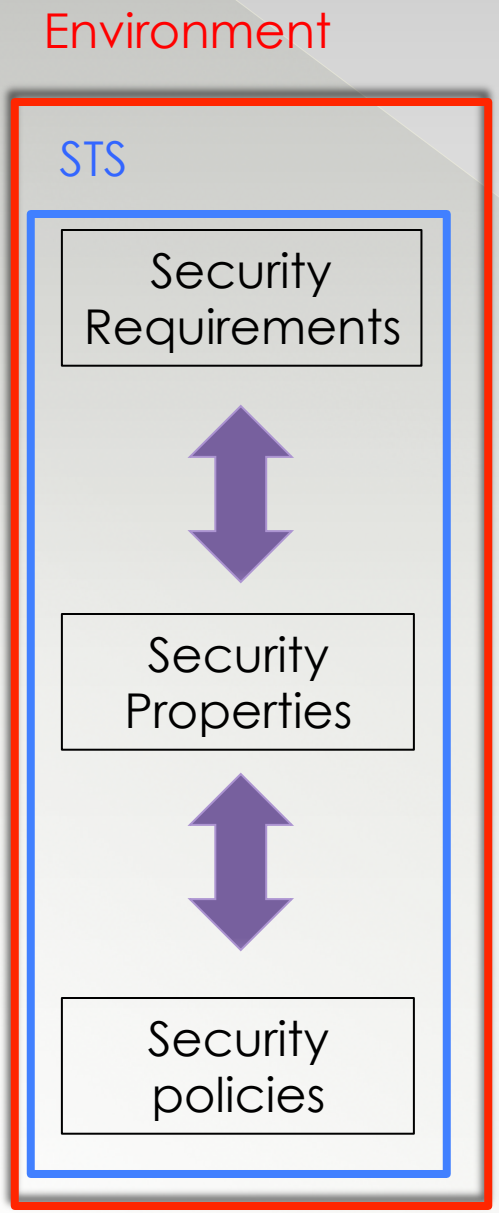
We need an approach that
-covers all abstraction levels
-usable ad design-time and run-time

Problem formalization

- Zave and Jackson [10] formula
  - $S, K \vdash R$
- Extension
  - Changed definition of **S**
  - $S_t, R_o \cup K' \vdash R_s$ }
  - $S_o, K'' \vdash R_o$ }



Problem formalization



$S_t, R_o \cup K' \vdash R_s$

$S_o, K'' \vdash R_o$

R_s: Customer needs to avoid disclosure of data about his financial investments

S_t: Secure Cash-in-Transit (CiT) transfer from A to B;
No communications of financial data to unauthorized users;

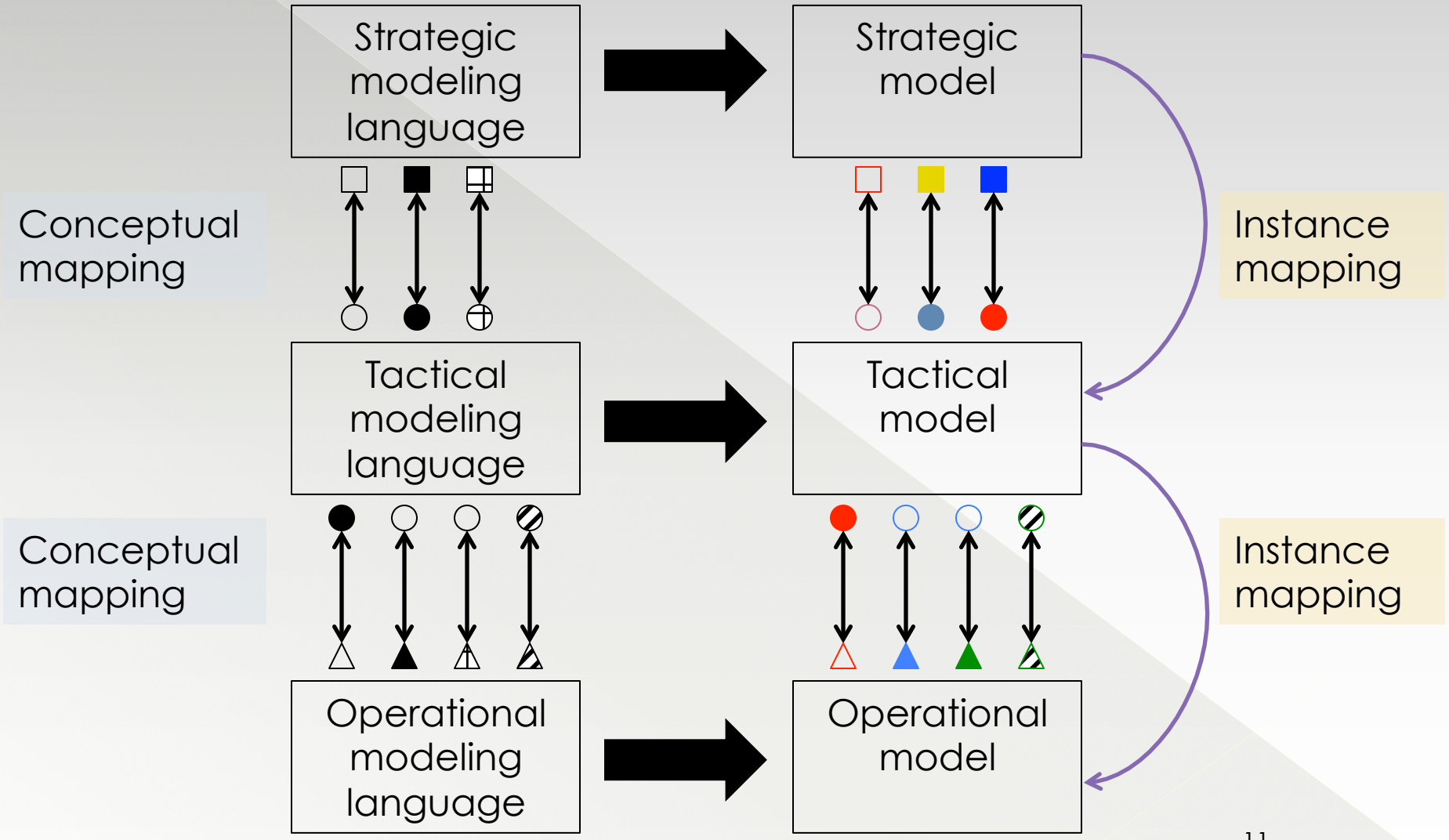
K': Exists CiT; Exists Bank A,B; B is reachable from A

R_o: Secure CiT transfer;

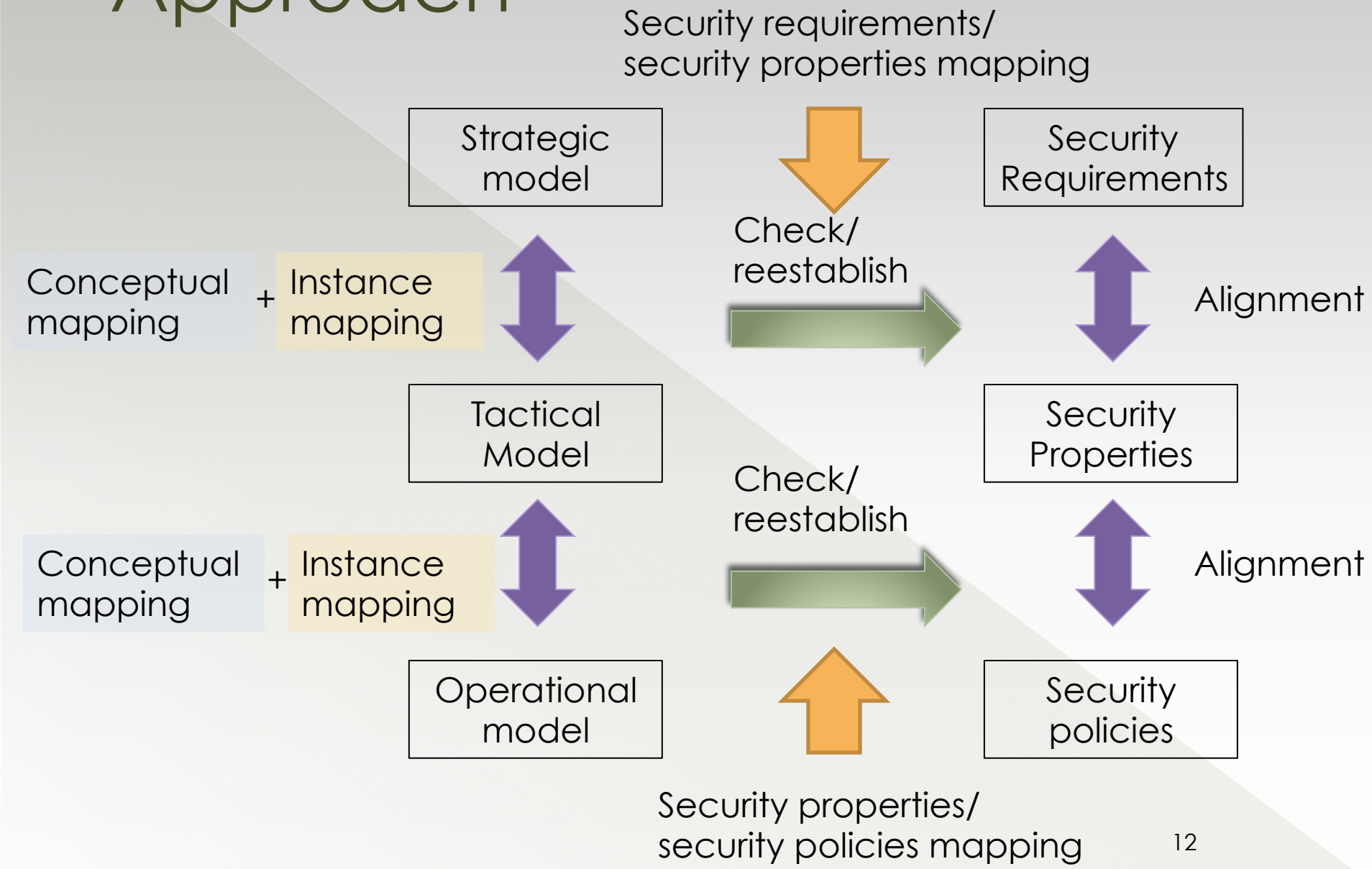
S_o: CiT max value 1mln E;
CiT max speed 50 Km/h

K'': CiT service is available

Approach


Strategic modeling language
Strategic model
Conceptual mapping
Instance mapping
Tactical modeling language
Tactical model
Conceptual mapping
Instance mapping
Operational modeling language
Operational model

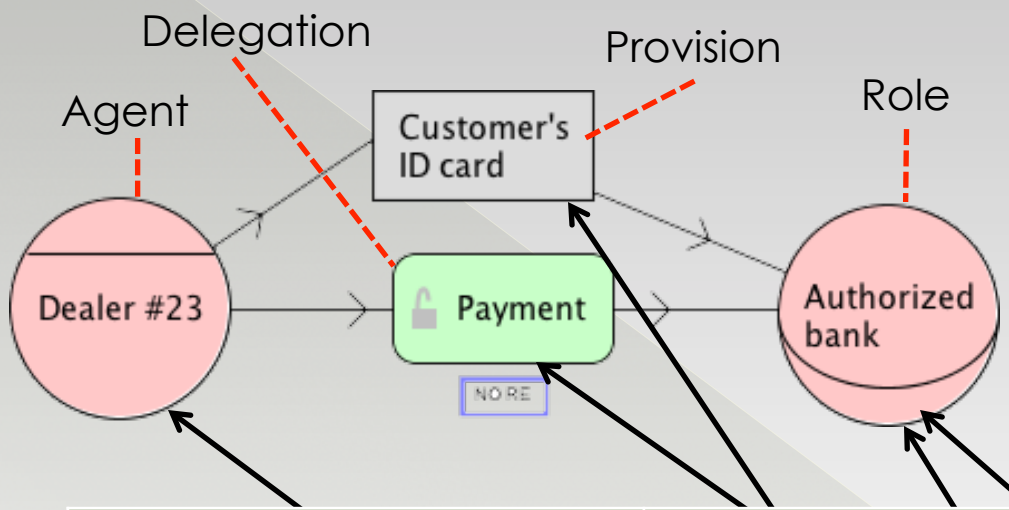
Approach


Security requirements/
security properties mapping
Strategic model
Security Requirements
Check/
reestablish
Conceptual mapping
+
Instance mapping
Alignment
Tactical Model
Security Properties
Check/
reestablish
Conceptual mapping
+
Instance mapping
Alignment
Operational model
Security policies
Security properties/
security policies mapping

Preliminary results

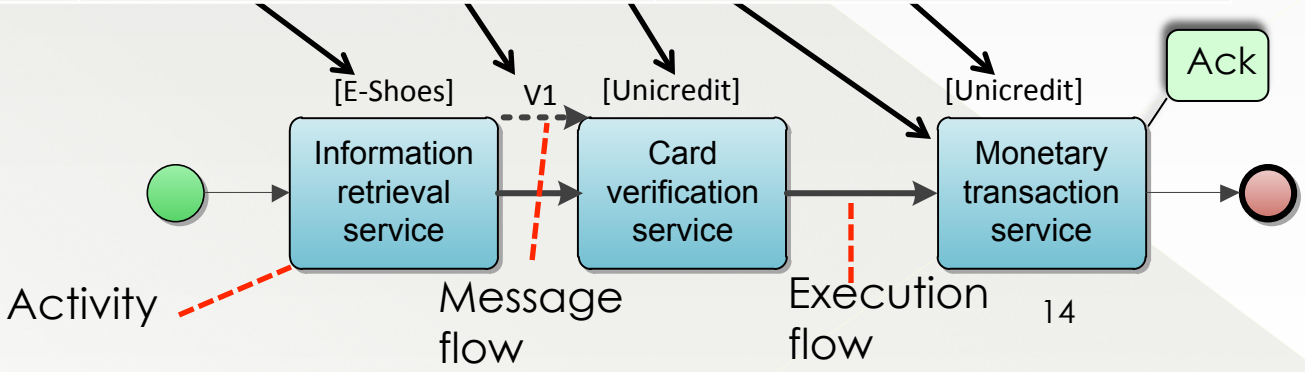
- We developed algorithms to check alignment between **strategic** and **tactical** security aspects **[Obj 1]**
- We chose
  - STS-ml[29] as strategical modeling language
    - Created for modeling STS
    - Focused on security
  - SecureBPMN[13] as tactical modeling language
    - Extends BPMN standards
    - Focused on security
- We implemented a software that uses the algorithms we created **[Obj 3]**

Conceptual mapping example



SecureBPMN concept	Relation	STS-ml concept
Participant	Is-a	Actor
Participant	Plays	Role
Data Object	Represent	Document
Activity	Relates-to	Goal

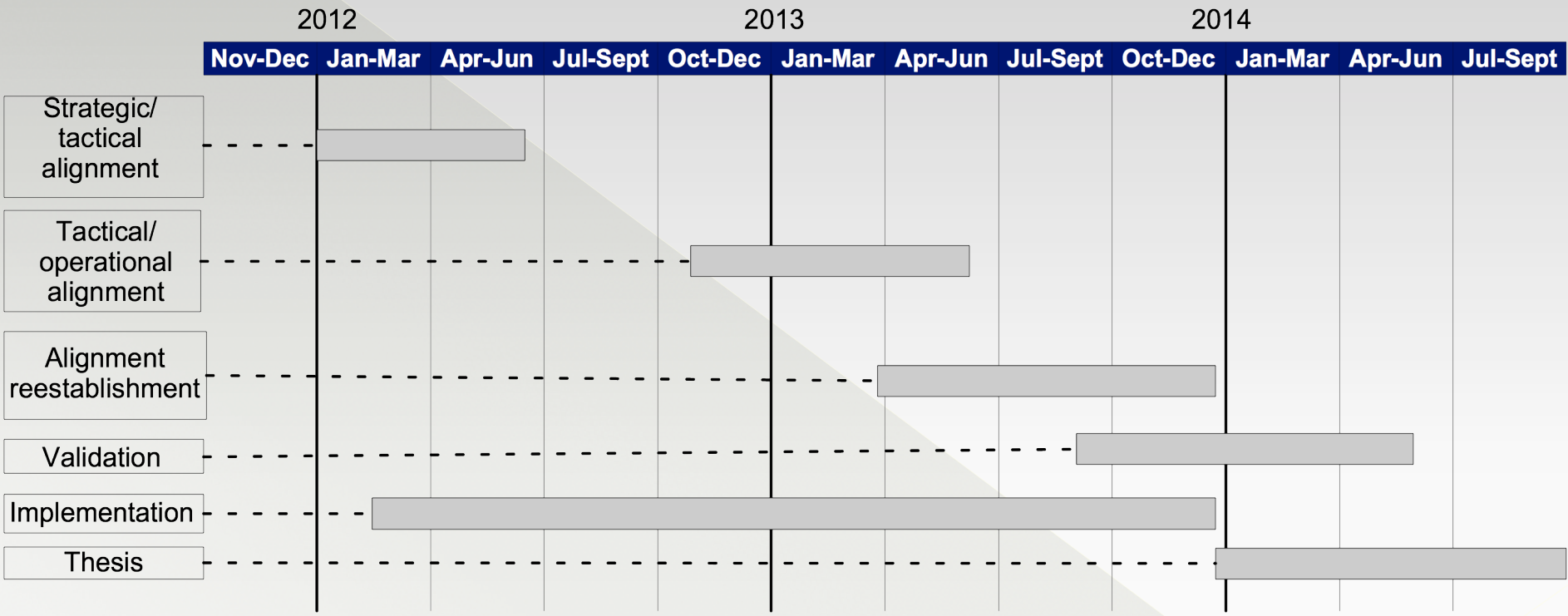
SecureBPMN Element	Relation	STS-ml Element
Unicredit	Is-a	Authorized bank
E-shoes	Is-a	Dealer#23
Money transaction	Relates-to	Payment
V1	Represents	CustomerID



Ongoing and future work

Objective	First results	Future work
OBJ1: Alignment check	-strategic and tactical alignment	-tactical and operational alignment
OBJ2: Alignment reestablishment		-use model transformation techniques
OBJ3: Tool support	-support STS-ml and SecureBPMN file formats -support alignment checking strategic and tactical level security aspects	-support alignment checking of tactical and operational level security aspects -support re-alignment
OBJ4: Validation	-first analysis on case studies	-validation with case studies -FP7 Aniketos

PhD plan


2012
2013
2014
Nov-Dec
Jan-Mar
Apr-Jun
Jul-Sept
Oct-Dec
Jan-Mar
Apr-Jun
Jul-Sept
Oct-Dec
Jan-Mar
Apr-Jun
Jul-Sept
Strategic/ tactical alignment
Tactical/ operational alignment
Alignment reestablishment
Validation
Implementation
Thesis

Conclusions

- Expected outcome
  - Semi-automated framework which helps analysts in managing alignment of security aspects
- Limitations
  - Modeling languages chosen
  - Focused on security
  - Heavily depends on human skills
- Novelty of our proposal
  - Check and reestablish alignment of security aspects in different abstraction levels
  - Usable both at design time and run time

Thank you!

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