# Visualizing Non-Functional Requirements Patterns

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## Outline

1. What is the problem?
2. How and why is visualization expected to help?
3. Who is visualization for? How are they expected to use it?
4. What visualizations have been created?
5. How are they derived and constructed?
6. How do they work?
7. Show and tell
8. Have the visualizations been used in practice?
9. Self-critique
10. Future work

UTD

# 1. What is the problem?

## When NFR knowledge is captured as text, it is hard to see the complex structure and relationships

Definition of information security and potential problems

"The term 'information security' means protecting information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction in order to provide—

(A) integrity, which means guarding against improper information modification or destruction, and includes ensuring information non-repudiation and authenticity;

(B) confidentiality, which means preserving authorized restrictions on access and disclosure, including means for protecting personal privacy and proprietary information; and

(C) availability, which means ensuring timely and reliable access to and use of information."

-- US Federal Information Security Management Act of 2002 (FISMA)

# 1. What is the problem? (cont.)

## Text cannot easily show structure and relationships

(2nd) Biggest credit card theft incident

[goal]

[criticality]

!!Security of credit card info

threaten

[problem]

Break-in wireless network
Masquerade user login
Steal credit card info

!Trustworthiness

mitigate

help/hurt?

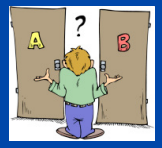
Cost

help/hurt?

[alternatives]

2-factor authen.
Password encryption
Biometric authen.

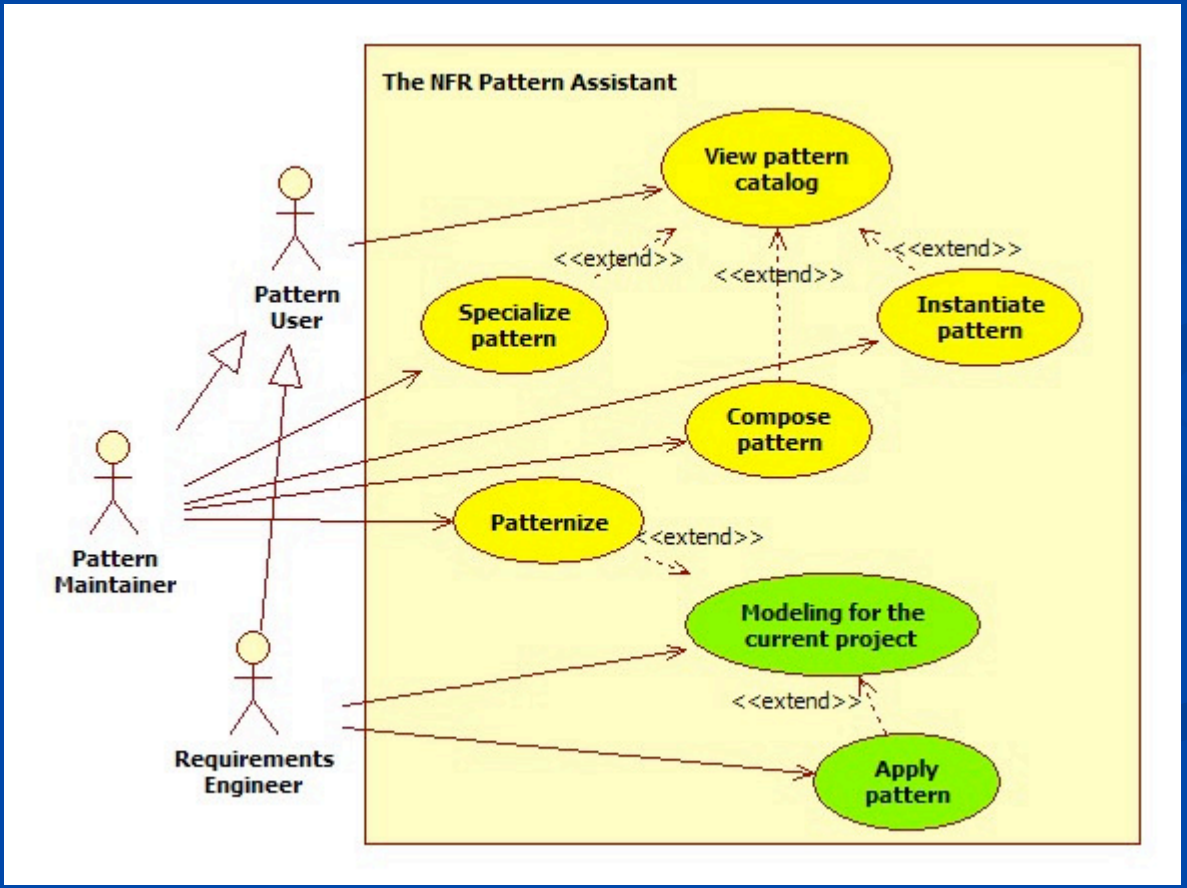
[selection]



## 2. How and why is visualization expected to help?

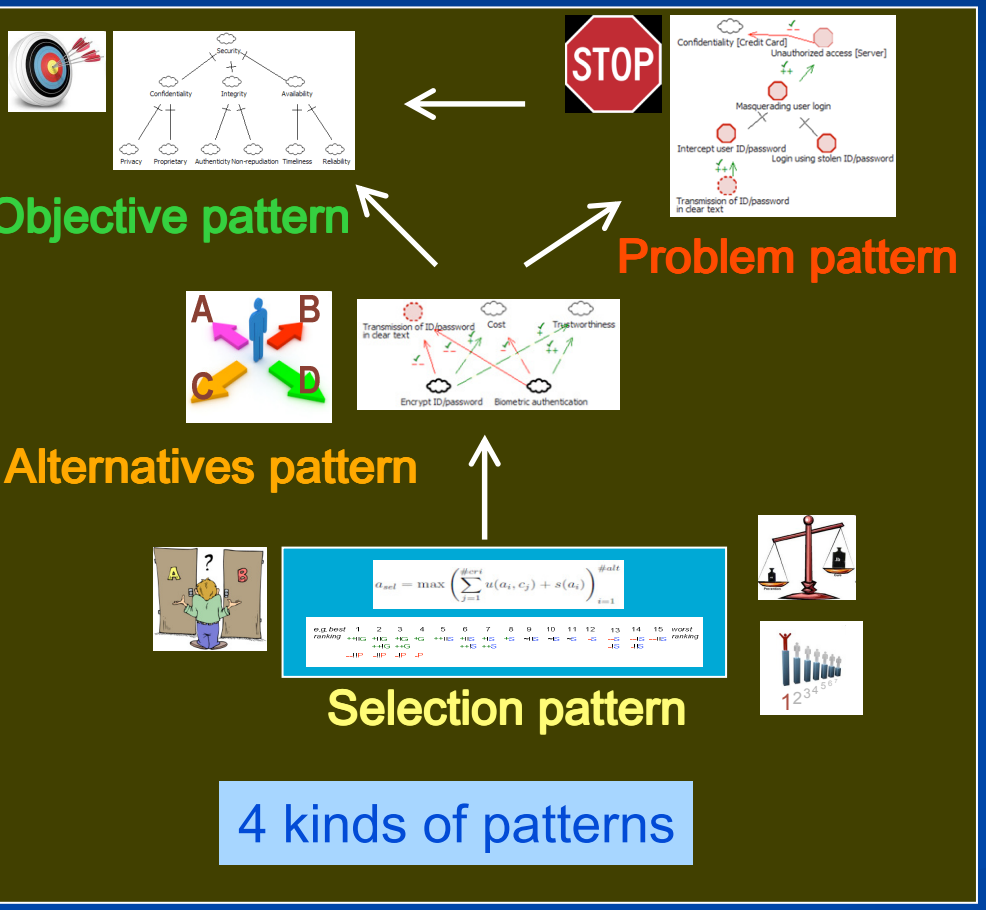
## 3. Who is it for? How is it to be used?

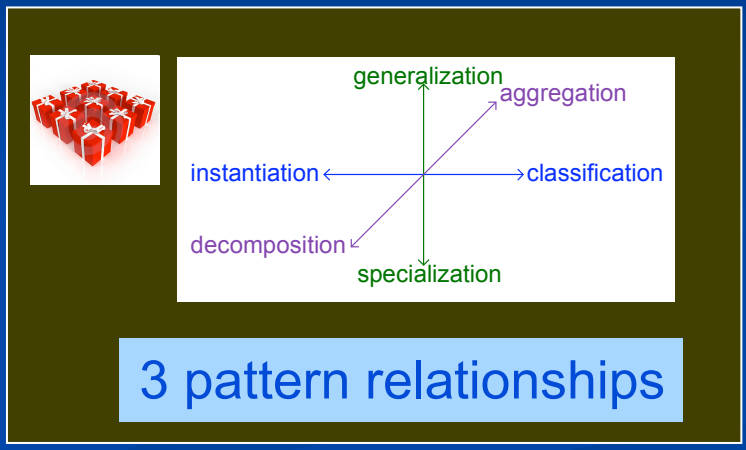
**NFR knowledge is captured as visual patterns that can be organized and reused in a tool-based environment**

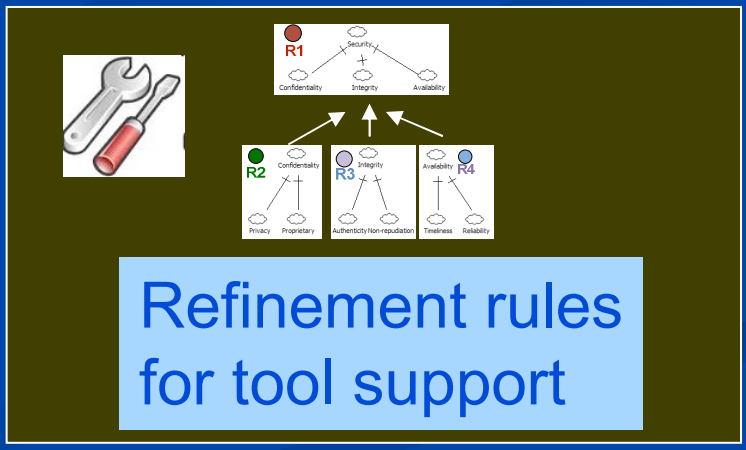


# 4. What visualizations have been created?

## 4 kinds of NFR patterns, 3 pattern relationships, 25 Refinement rules for tool support

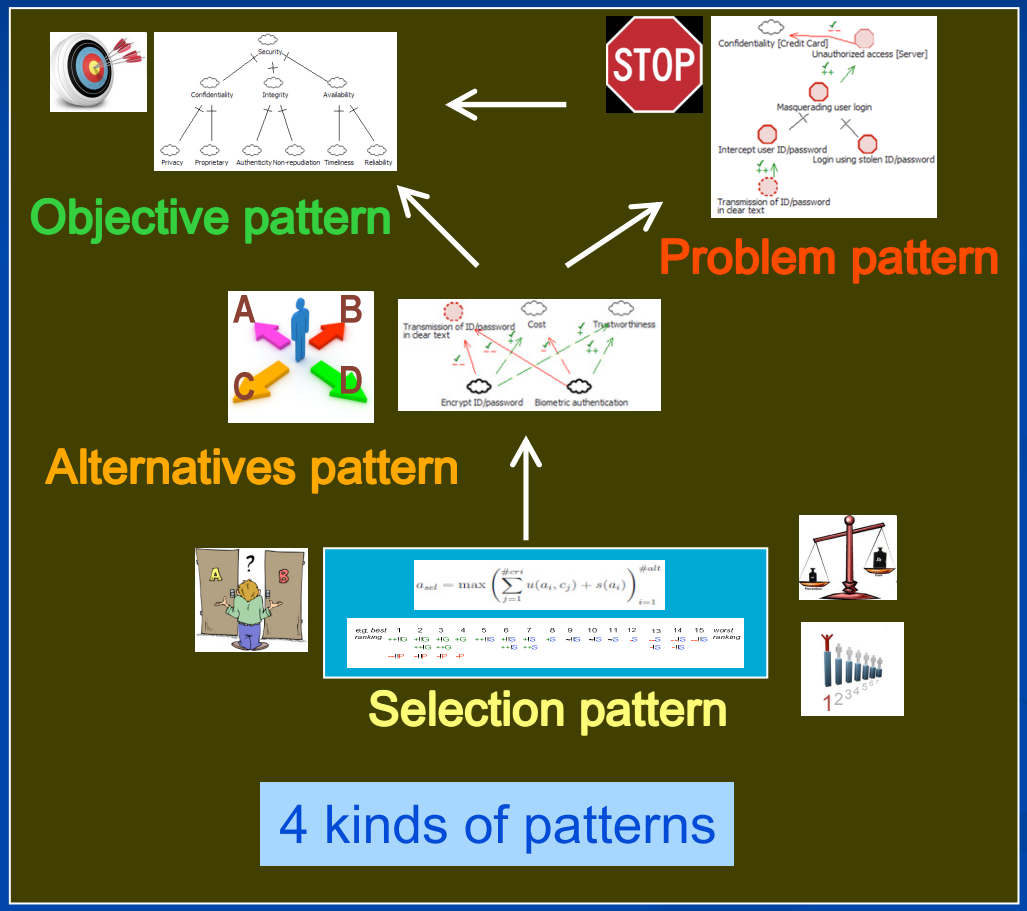


# 4. What visualizations have been created? (cont.)

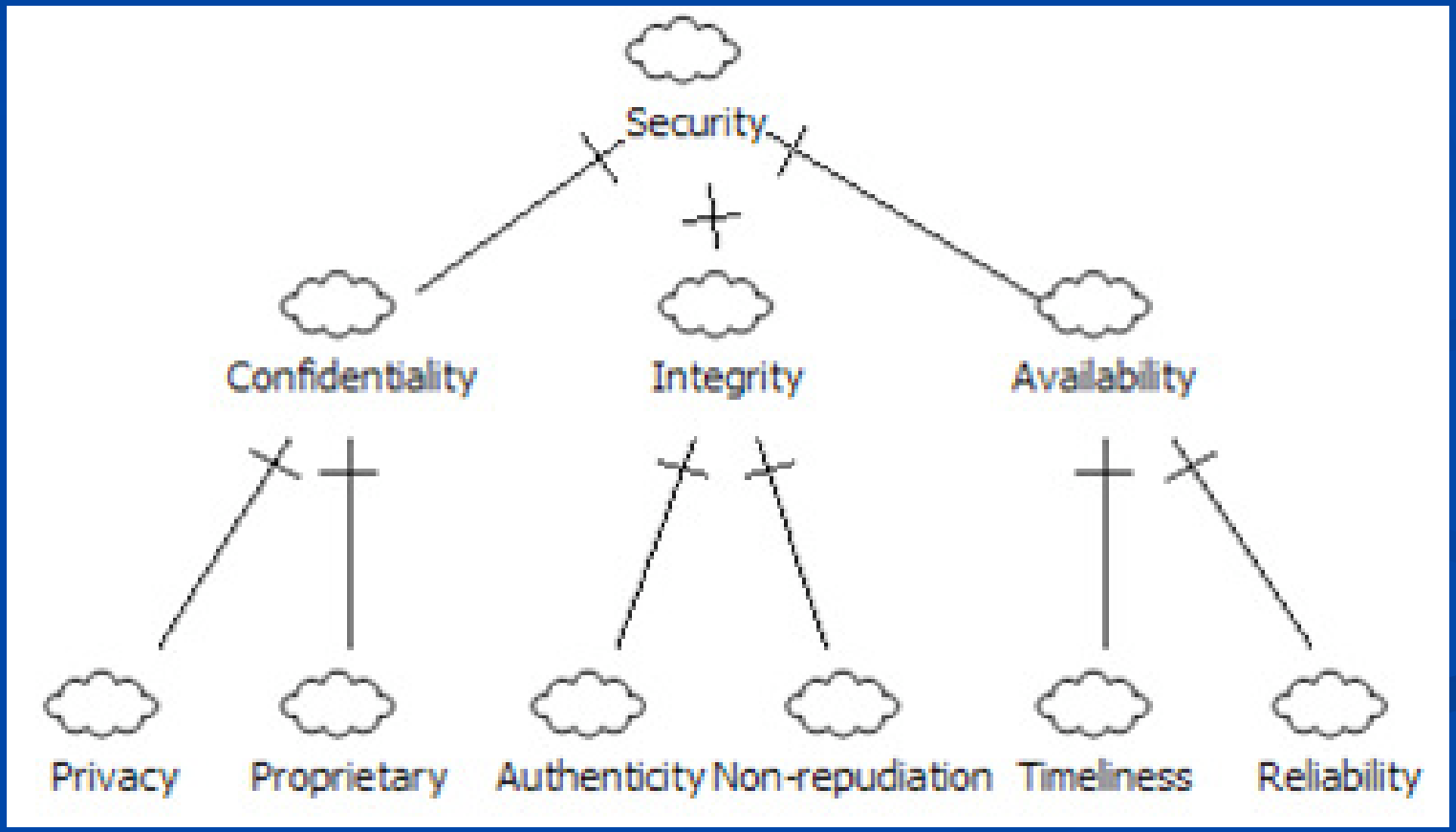
## 4 kinds of NFR patterns



# 4. What visualizations have been created? (cont.)

## 4 kinds of NFR patterns: a) objective pattern

An objective pattern captures a definition of an NFR as a softgoal (and sub-goals) to be achieved

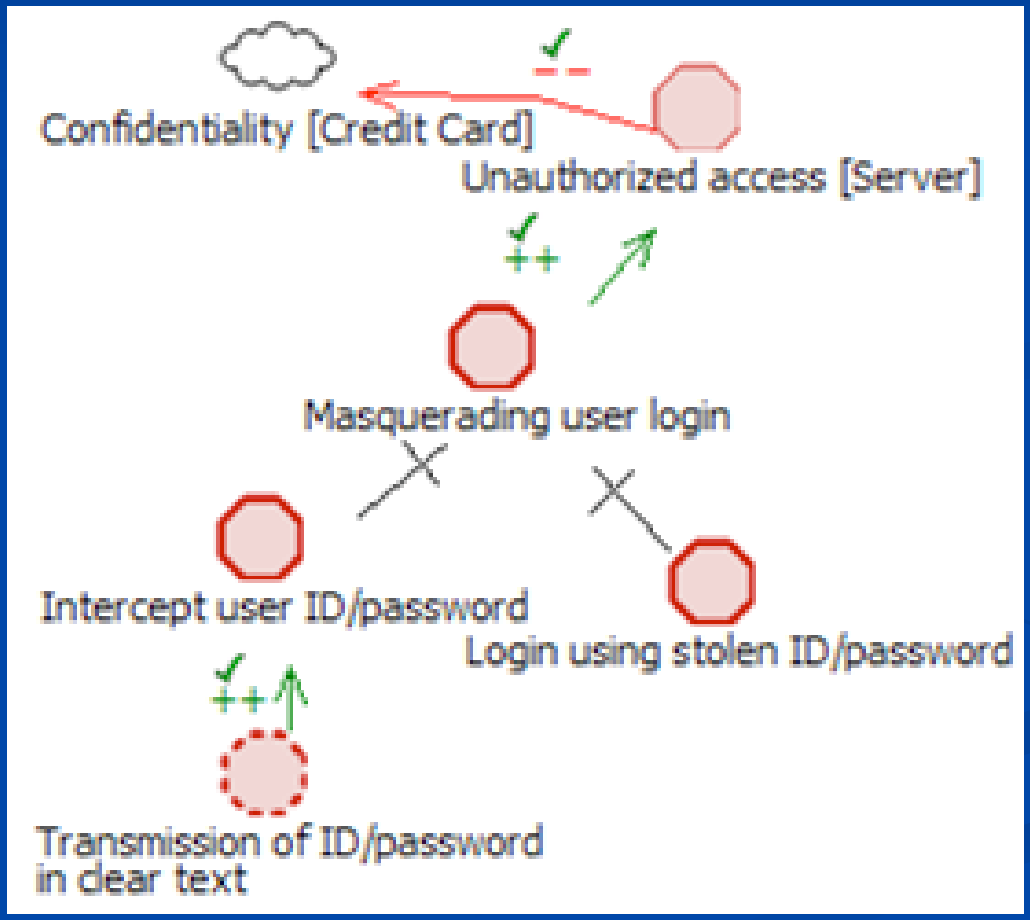



[US-FISMA law]

# 4. What visualizations have been created? (cont.)

## 4 kinds of NFR patterns: b) problem pattern

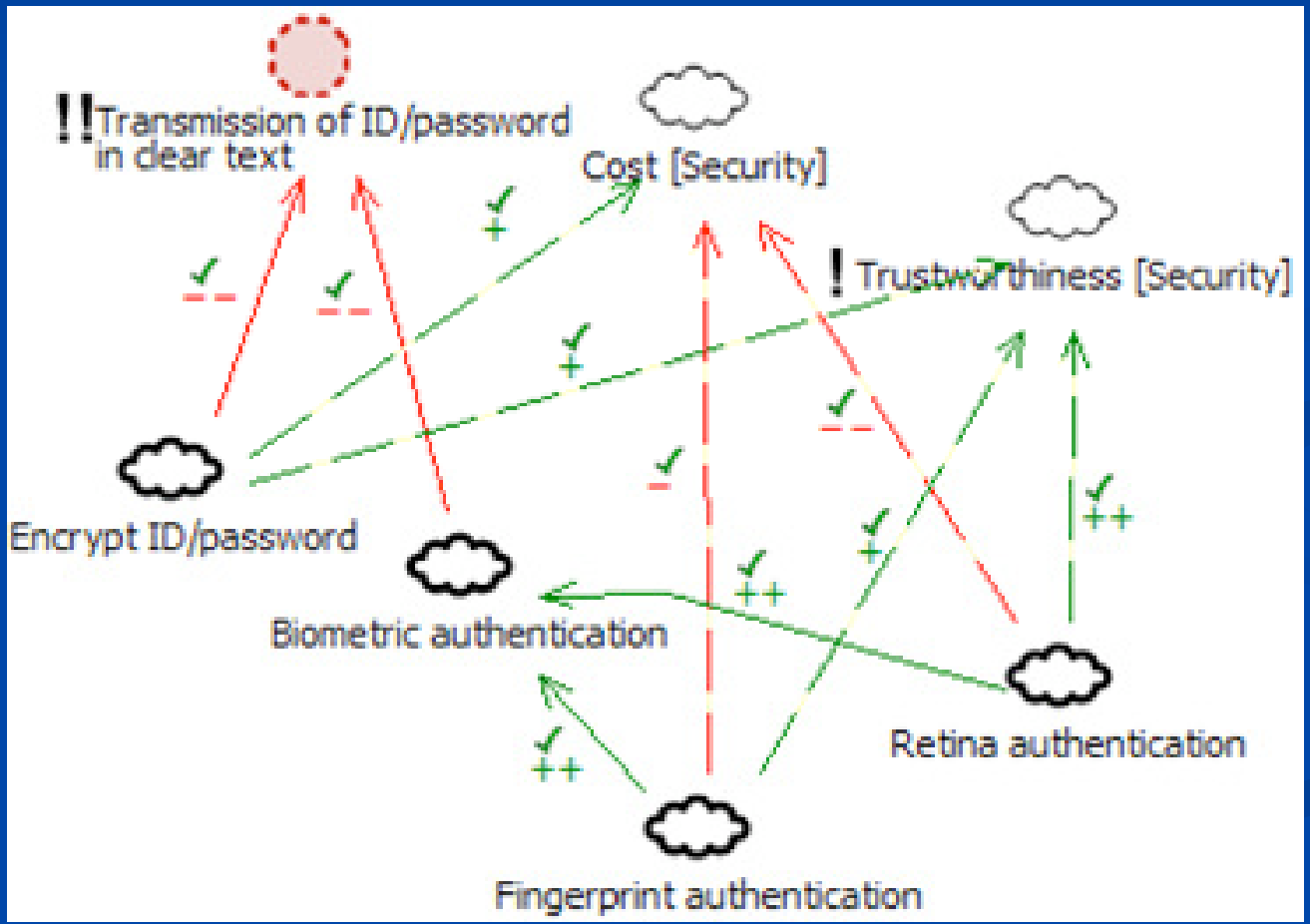
A problem pattern captures soft-problems or obstacles to achieving an NFR softgoal



# 4. What visualizations have been created? (cont.)

## 4 kinds of NFR patterns: c) alternatives pattern

**An alternatives pattern captures alternative means to achieving a softgoal or solutions to mitigating a soft-problem with side-effects**

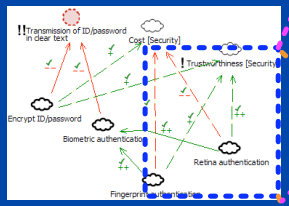


# 4. What visualizations have been created? (cont.)

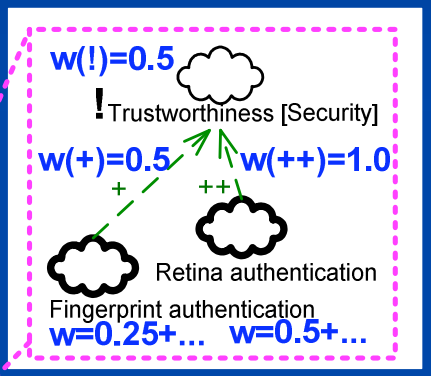
## 4 kinds of NFR patterns: d) selection pattern

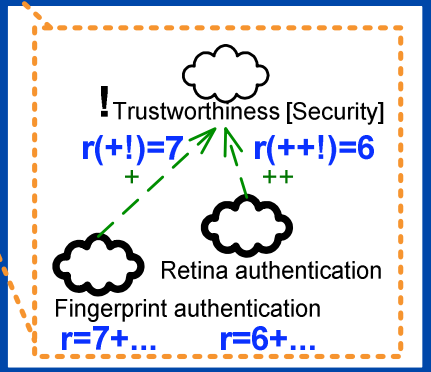
**A selection pattern captures an application independent selection scheme**

Weight-based quantitative selection




alternatives




**Weight-based**
**Selection = Highest** cumulative **weight**
criticality of goals/problems
contribution towards goals/problems

Widely used, but subjective

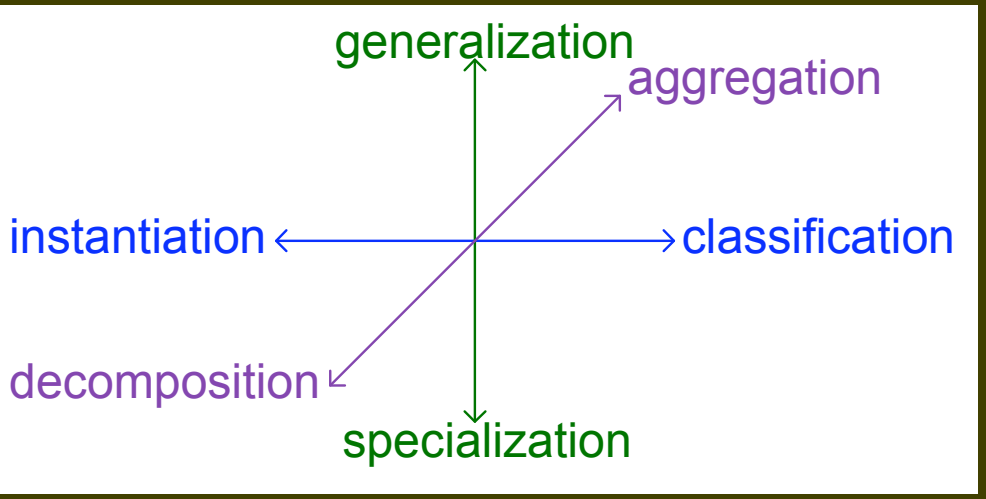
Rank-based
Selection = Best cumulative **ranking**
criticality-contribution combination

Less subjective, but need a ranking scale

**Rank-based** qualitative selection

# 4. What visualizations have been created?

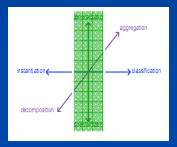
## 3 pattern relationships,




3 pattern relationships

# 4. What visualizations have been created? (cont.)

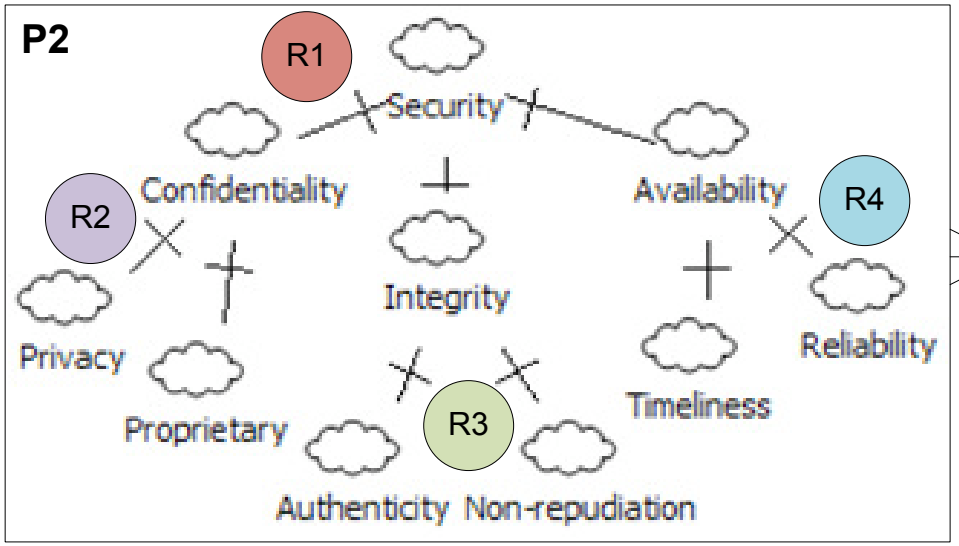
## 3 pattern relationships: a) specialization



Generalization dimension

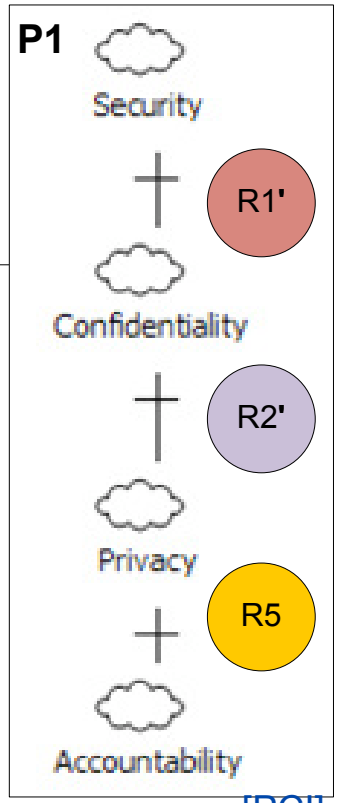
**A specialization relationship links a pattern with more specific knowledge to another pattern with more general knowledge**

super-pattern




[US-FISMA]

sub-pattern

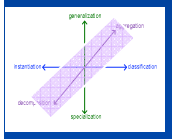



[PCI]

# 4. What visualizations have been created? (cont.)

## 3 pattern relationships: b) part-of

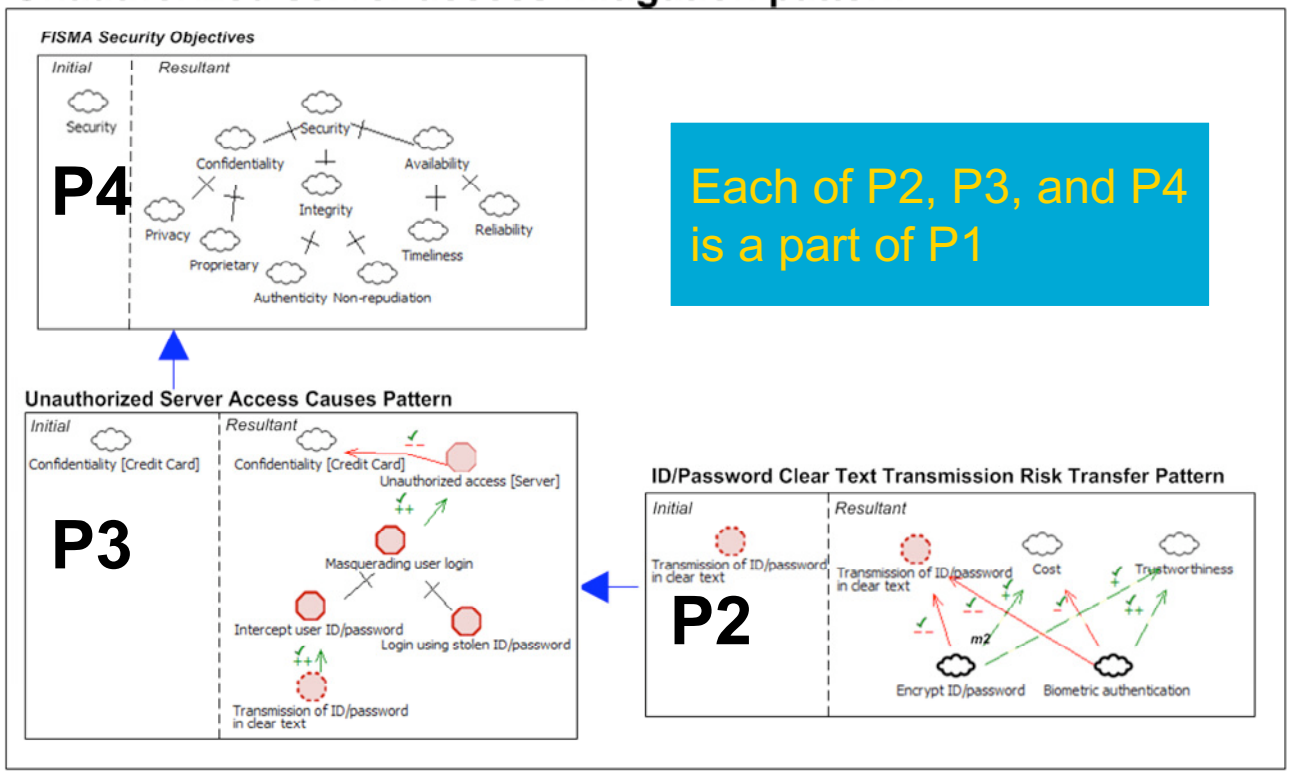
**A part-of relationship represents that a smaller pattern makes up a larger pattern.**



Aggregation dimension

**P1**

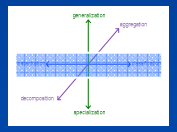
**Unauthorized server access mitigation pattern**



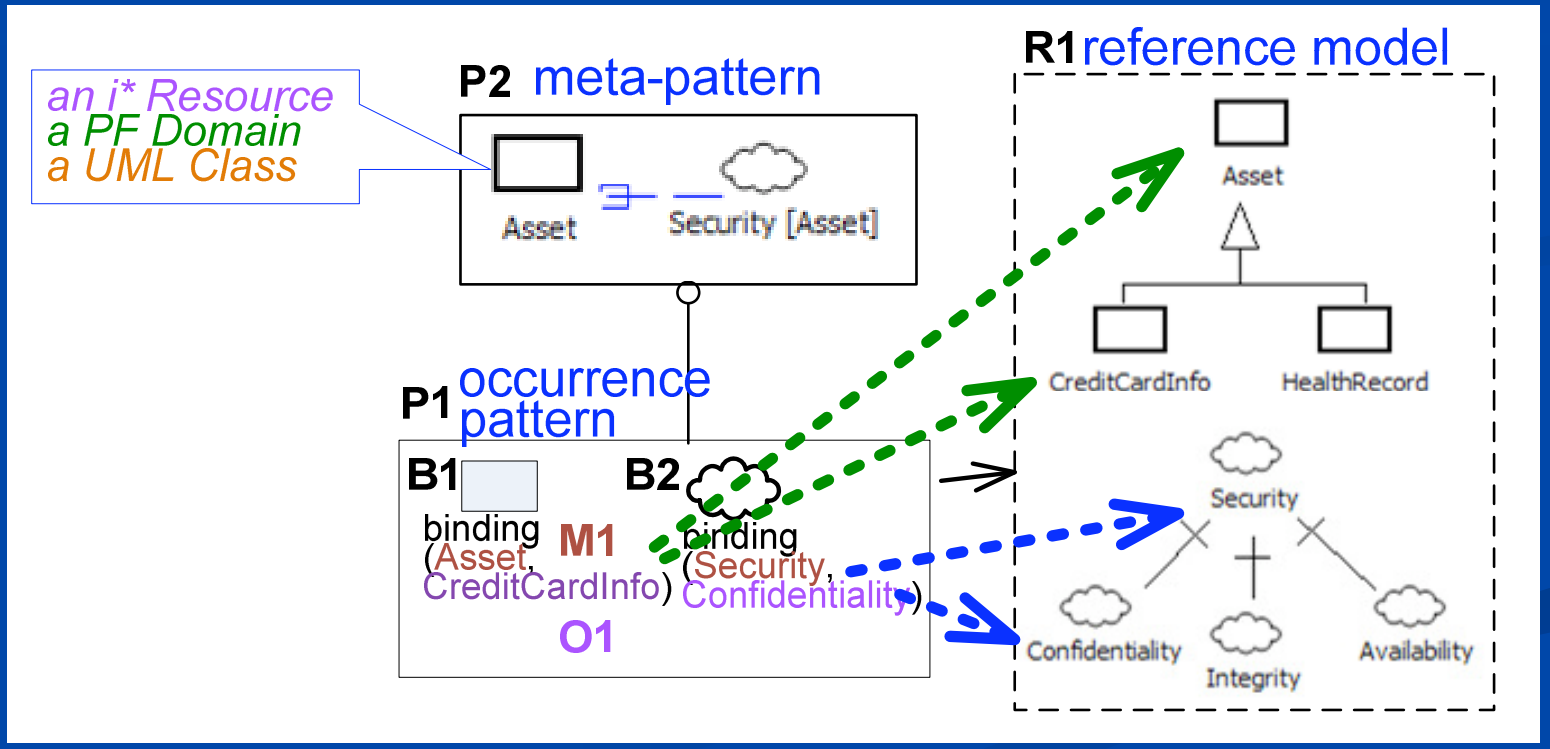
# 4. What visualizations have been created? (cont.)

## 3 pattern relationships: c) occurrence-of

**An occurrence-of relationship links between an instance to its meta-pattern**

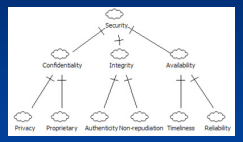


Classification dimension



# 4. What visualizations have been created? (cont.)

## Refinement rules for tool support




Before

After

Security

Transform

Security
Confidentiality
Integrity
Availability
Privacy
Proprietary
Authenticity
Non-repudiation
Timeliness
Reliability

NFRDecomposition refinement rule

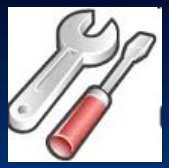
Before
After
Security
Security
Confidentiality
Integrity
Availability

succeed
succeed
succeed

Before
After
Confidentiality
Confidentiality
Privacy
Proprietary

Before
After
Integrity
Integrity
Authenticity
Non-repudiation

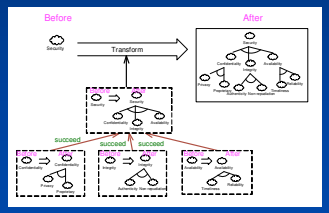
Before
After
Availability
Availability
Timeliness
Reliability

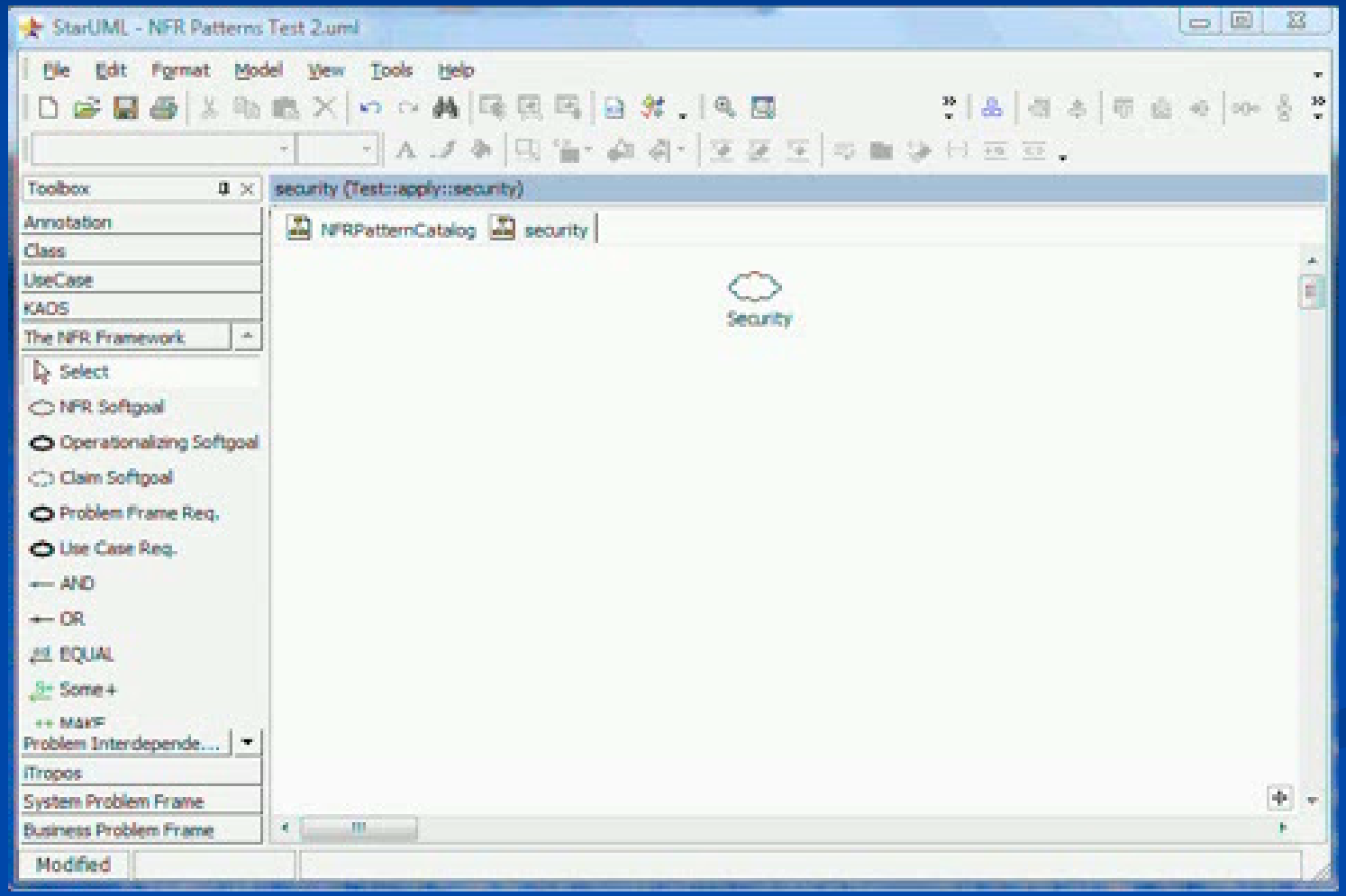


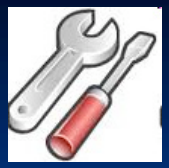
# 5. How was they derived and constructed?

# 6. How do they work?

## Demo video: applying an objective pattern



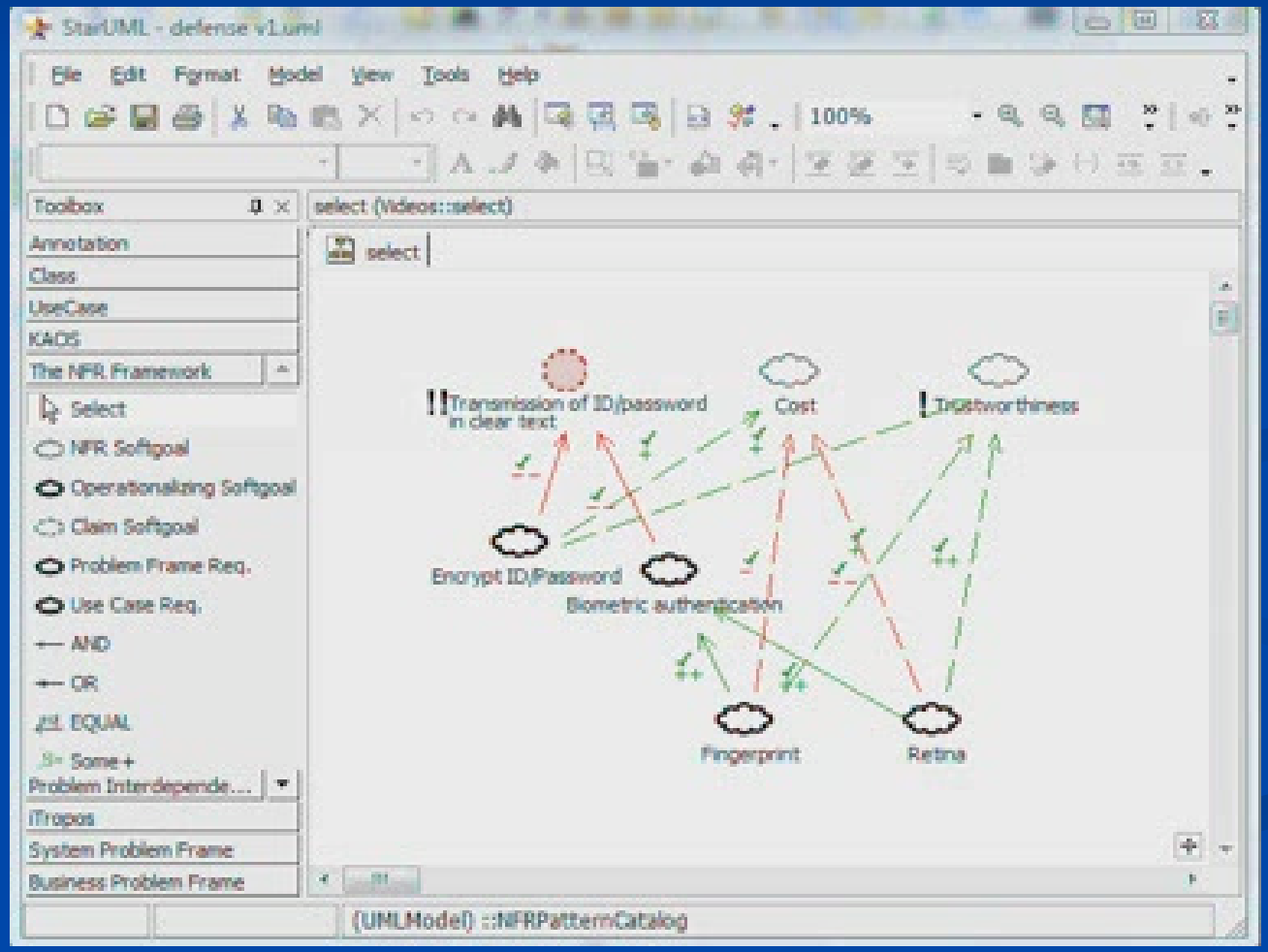





# 5. How was they derived and constructed?

# 6. How do they work?

## Demo video: applying a selection pattern



# 7. Show and tell

# Poster

## Visualizing Non-Functional Requirements Patterns

**Sam Supakkul** and **Lawrence Chung**

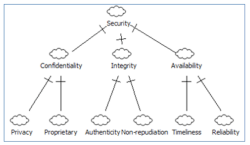
### Motivation

- Knowledge of NFRs can have complex structure and relationships
- The structure and relationships are hard to see when knowledge is captured using text
- Captured knowledge should be conveniently reusable during requirements engineering

### Objectives

- Knowledge of NFRs captured as visual patterns
- NFR patterns captured, organized, and reused in a tool-assisted environment

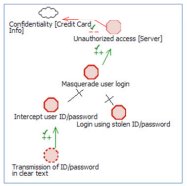
### NFR Patterns



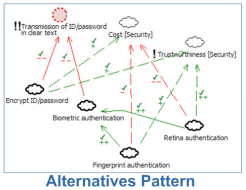

An objective pattern captures a definition of an NFR as a softgoal and its sub-goals to be achieved

**Objective Pattern**

A problem pattern captures obstacles and their causes that hurt the achievement of a goal.




**Problem Pattern**




An alternatives pattern captures alternative means to achieving a goal or solutions to mitigating a problem.

**Alternatives Pattern**

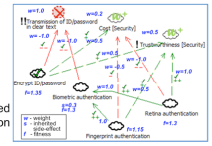
Quantitative Weight-based Selection = max( ∑weight(criticality) x weight (contribution))

Qualitative Rank-based Selection = best( ∑rank(contribution, criticality))

**Quantitative and Qualitative Selection Rules**

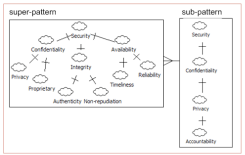
A selection pattern captures an application independent selection scheme, consisting of a series of weight/ranking assignments and a selection rule.

**Selection Pattern**




An example of a weight-based selection pattern application

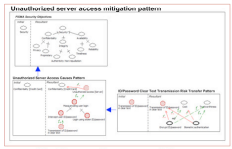
### Pattern Organization



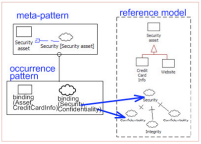

A specialized pattern captures a more specific definition of an NFR

**Pattern Specialization**

A composite pattern assembles smaller patterns to capture a larger chunk of knowledge



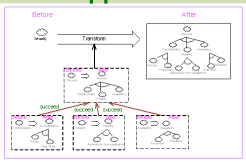

**Pattern Composition**




A pattern can be used as a template to create new patterns with customizations specified by the binding specifications

**Pattern Instantiation**

### Tool Support




Each pattern is captured with single-step model refinement rules that can be applied by a tool to transform a target model when the pattern is applied

**Model Transformation with Refinement Rules**

UTD The University of Texas at Dallas, USA

Acknowledgement: Julio CSP Leite, Thein Than Tun, Tom Hill

# 8. Have the visualizations been used in practice?

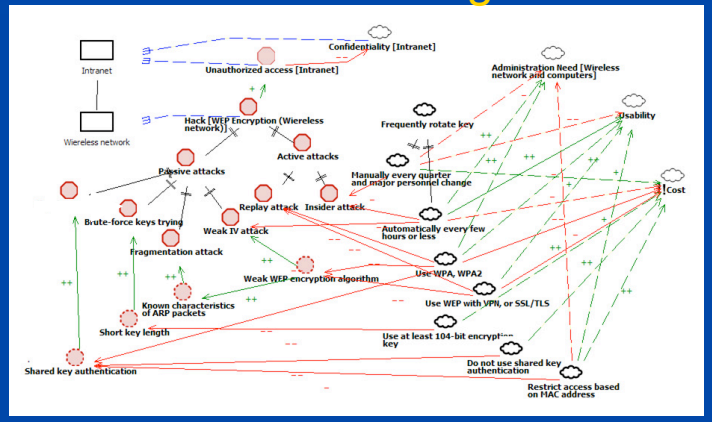
## Partial results from the TJX case study

Break-in wireless network
Masquerade user login
Steal credit card info

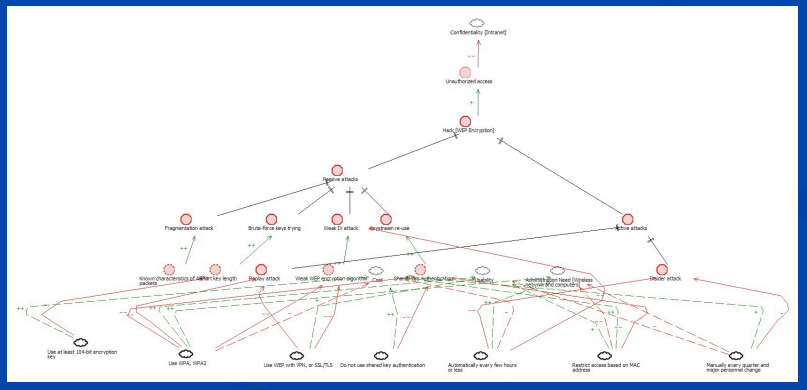
for

Sample results

modeled knowledge

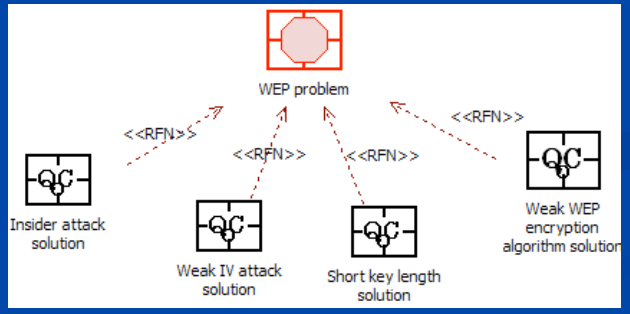



generated by application

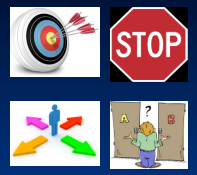


capture

1 composite, 5 primitive




reuse




# 9. Self-critique
# 10. Future work

**Strengths**

Structure and relationships among goals, problems, and alternatives are visually captured

Specialization, part-of, occurrence-of relationships among chunks of knowledge are visually captured

NFR knowledge is captured, organized, reused in a tool-assisted env.

**Weaknesses (with possible solutions)**

Costly and time-consuming to learn the notation and the tool

- Dedicate few highly skilled subject matter experts as librarians

Quantitative weight-based selection is too subjective for some

- Qualitative rank-based selection is available

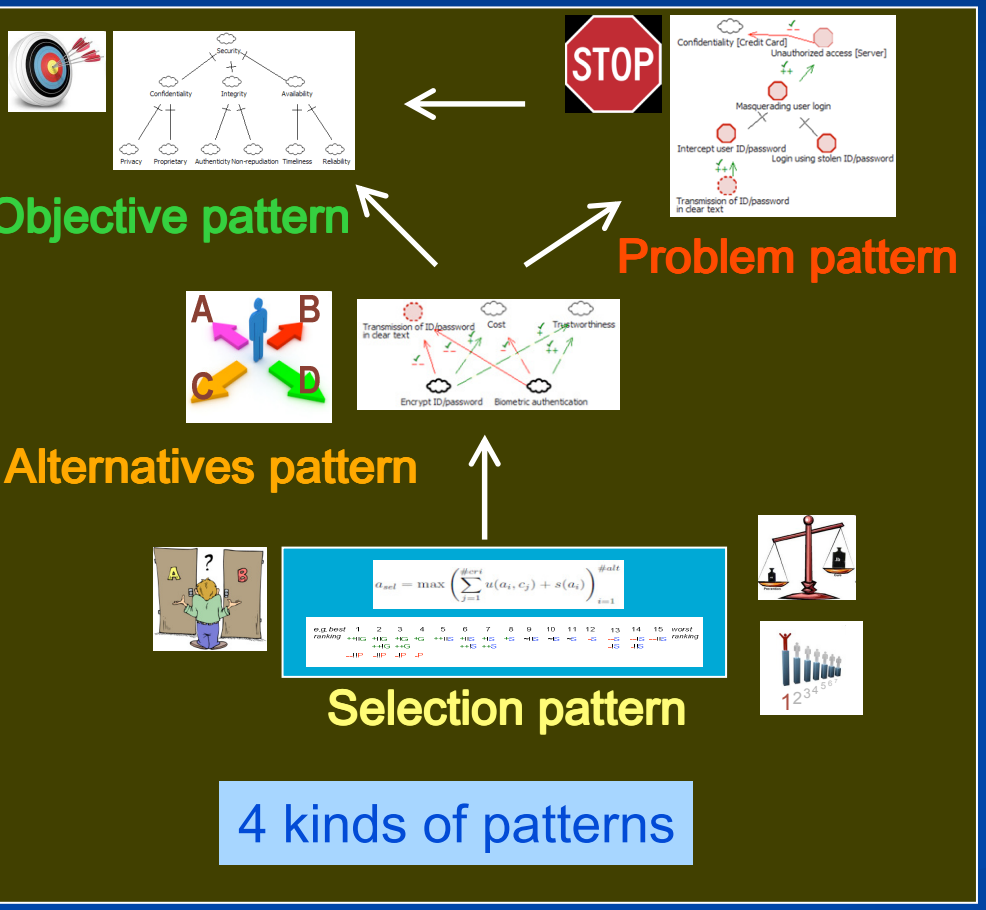
Resulting models do not resemble the source models

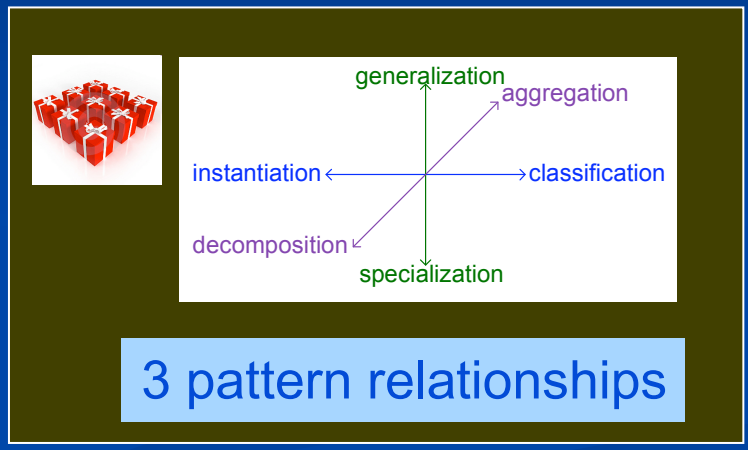
- Future visualization enhancement

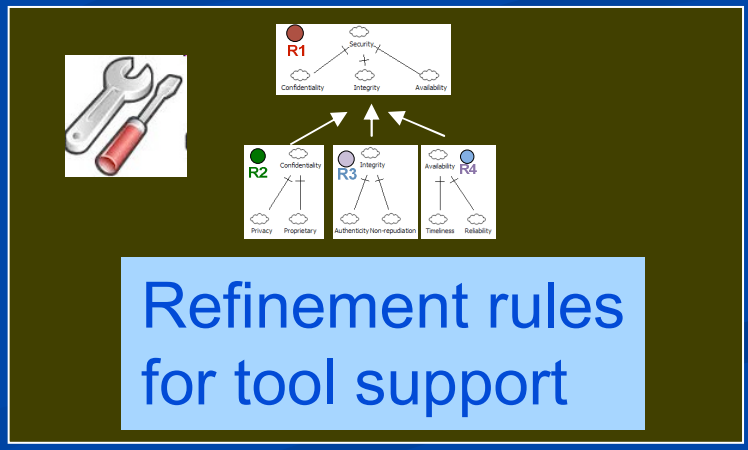
Sharing patterns across groups?

- Currently file-level locking/sharing supported

# Thank you…


Objective pattern
Problem pattern
Alternatives pattern
Selection pattern
4 kinds of patterns


generalization
aggregation
instantiation
classification
decomposition
specialization
3 pattern relationships


R1
R2
R3
R4
Refinement rules
for tool support