Semiautomatic Security Requirements Engineering and Evolution using Decision Documentation, Heuristics, and User Monitoring

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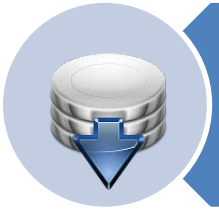
Overview

Motivation

Components for Our Approach



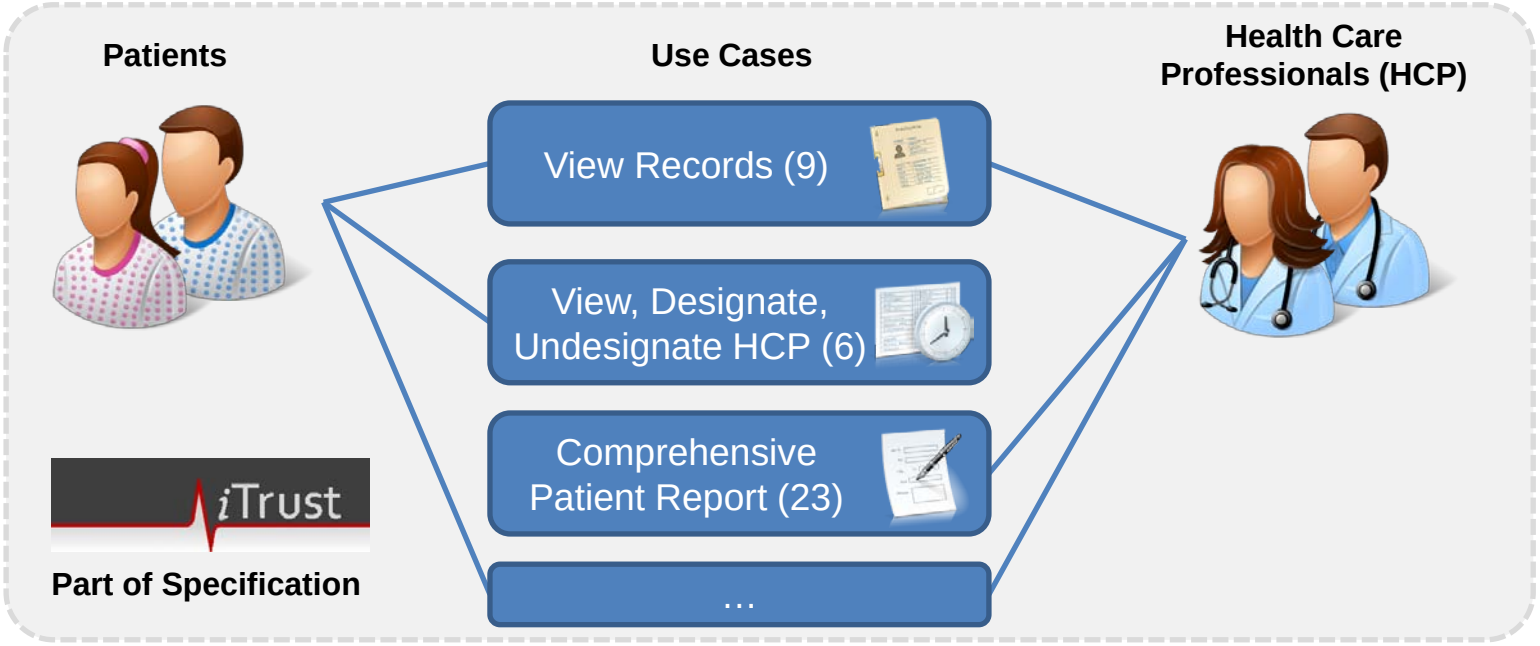
Incorporating Decision Knowledge from Different Sources

Benefits, Related Work, Conclusion

Running Example iTrust

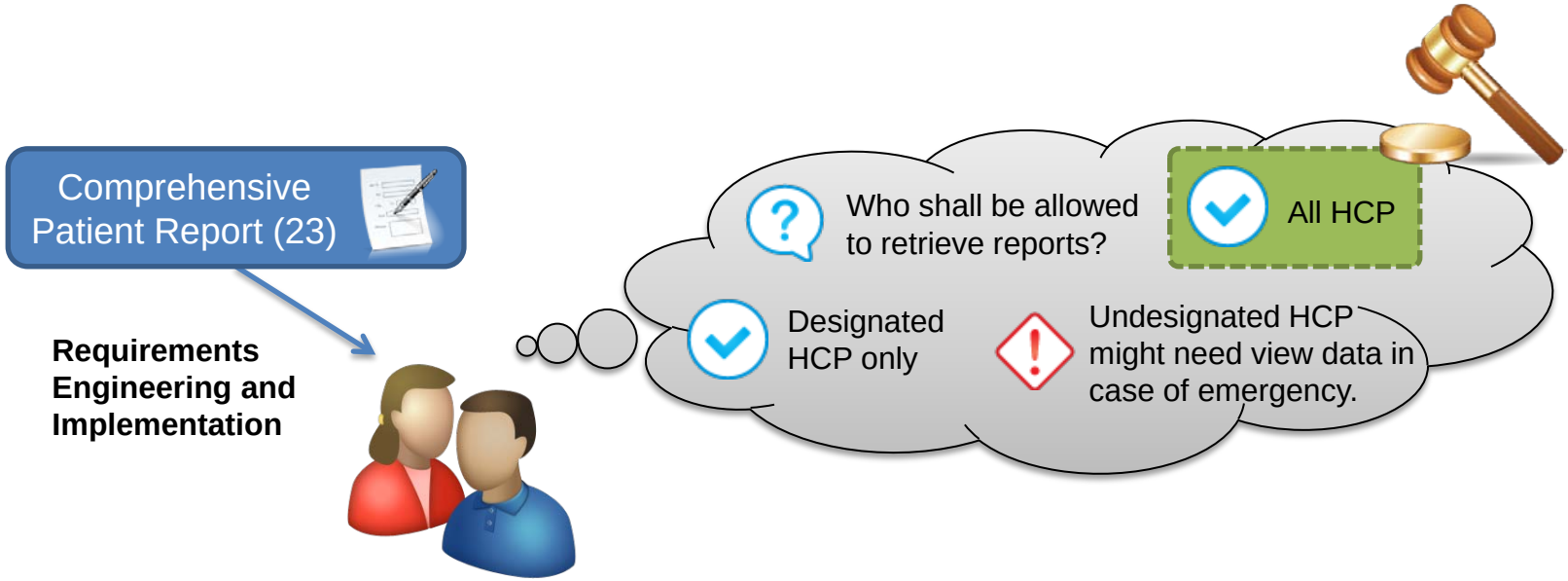
Running Example: Medical Information System iTrust

- Medical information system iTrust: Management of health records for patients and work schedule for staff
  - Specified in 55 use cases and implemented as web application by Realsearch Research Group (North Carolina State University)
  - Active evolution (23 versions of requirements, 17 versions of code)



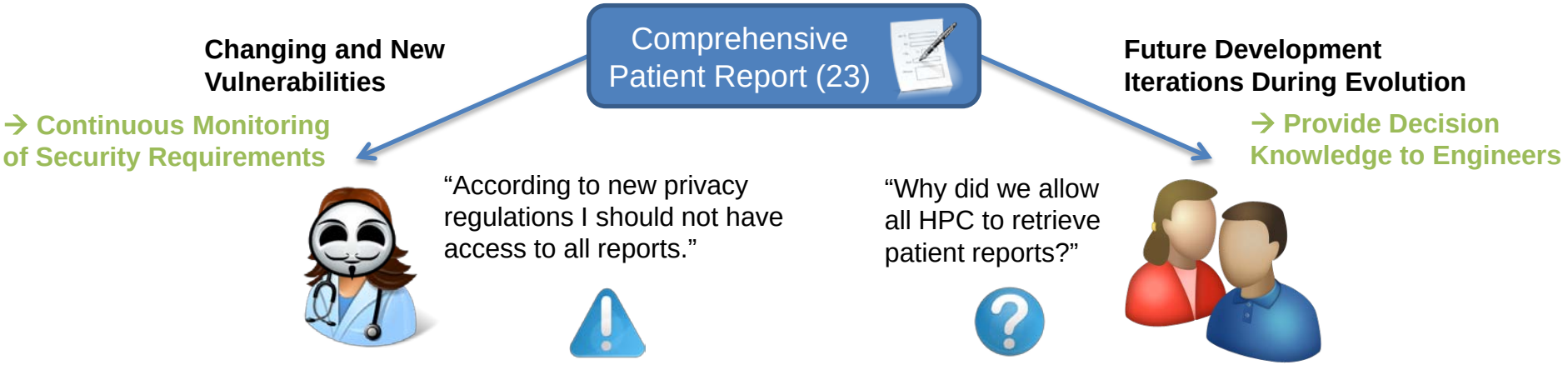
Motivation: Decisions on Security Are Important

- Great importance of security requirements for long-living information systems
- Many decisions on how to implement and prioritize security requirements



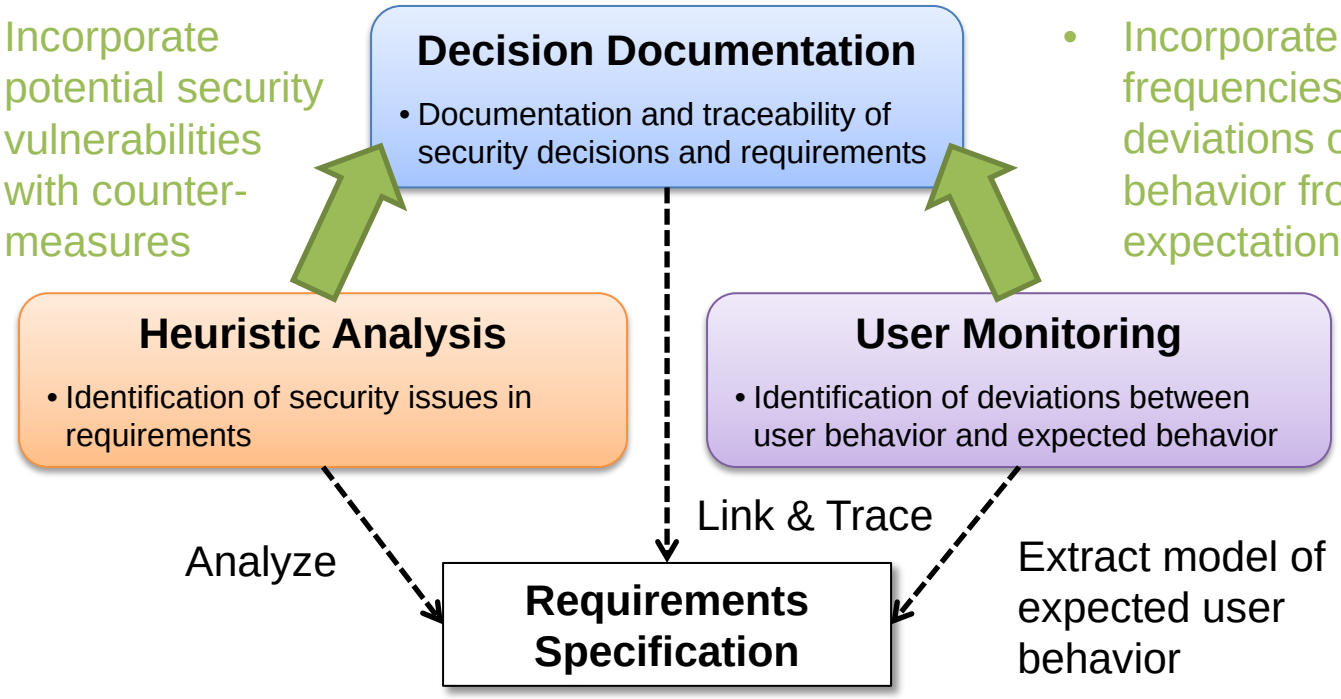
Motivation: Decision Knowledge Erodes Quickly

- But: Security requirements engineering is often performed manually → Erosion of knowledge about decisions on security requirements
  - Incomplete documentation
  - Quickly outdated decisions and documentation



Our Approach: Semiautomatic Decision Documentation

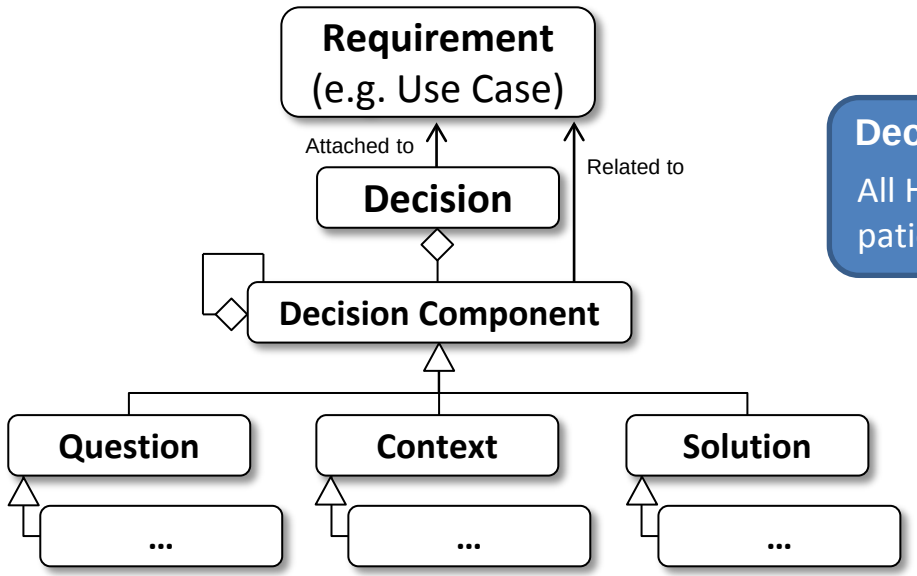
- Incorporate potential security vulnerabilities with counter-measures



- Incorporate use case frequencies and deviations of user behavior from expectations

Component: Decision Documentation

- Decision knowledge is knowledge about all decision-related questions, solutions, context information/rationales
- Benefit of documentation: Support software engineers in finding and exploiting previous security-related decisions



Decision
All HCPs can retrieve patient reports.

Question: Issue
Who shall be allowed to retrieve patient reports?

Solution: Alternative
Designated HCPs should be able to retrieve reports.

Context: Constraint
Undesignated HCPs might need to view data in case of emergency.

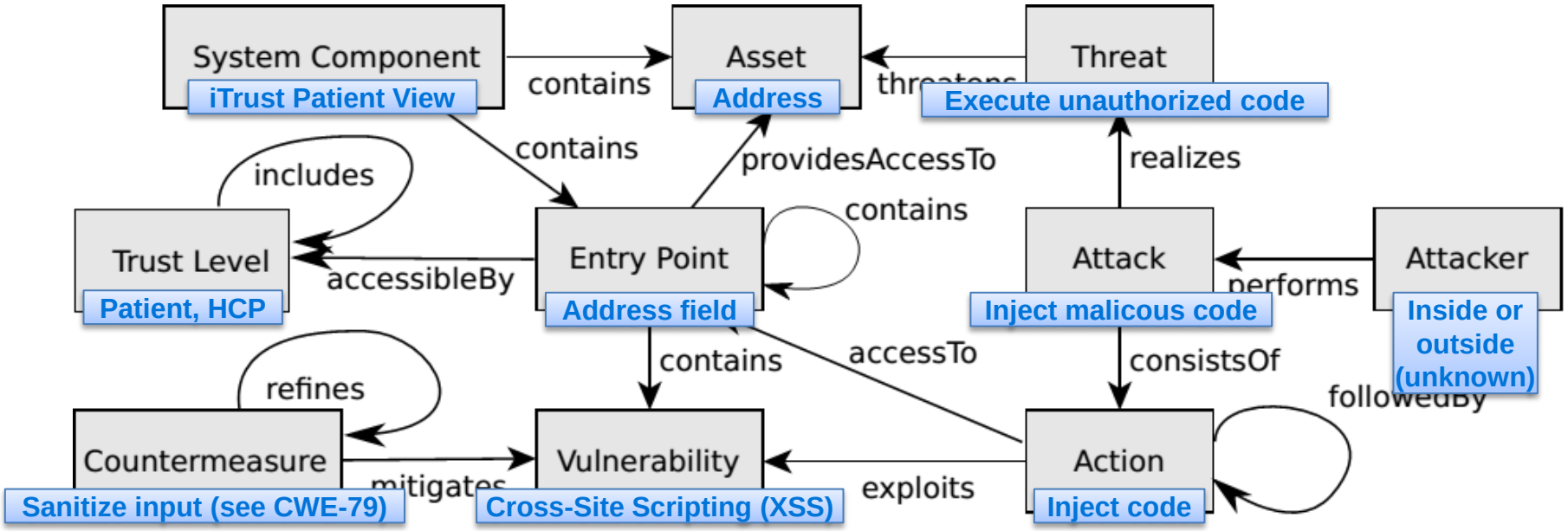
Component: Security Heuristics

- To decrease effort and support evolution, natural language requirements need to be assessed automatically
- Attack-centric approach:
  - Transform requirements in analysis model using NLP
  - Search for suspicious interactions by incorporating general attack patterns and reported security incidents
  - Retrieve potential vulnerabilities and countermeasures from the security knowledge base

- Example for use case 6:
  - The patient types a last name or partial last name, and/or providing the specialty or address.

Component: Security Heuristics

- Modeling security knowledge (e.g., incidents, security guidelines and policies, …)
  - Example for cross-site scripting in iTrust patient view



Component: User Monitoring

End users

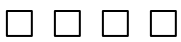
interact

Software

1. Monitor user interactions with software sensors

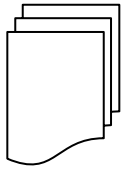
Result:
Use case frequency
→ Prioritization

2. Detect current use case



Log of User Interactions

3. Compare log and specification

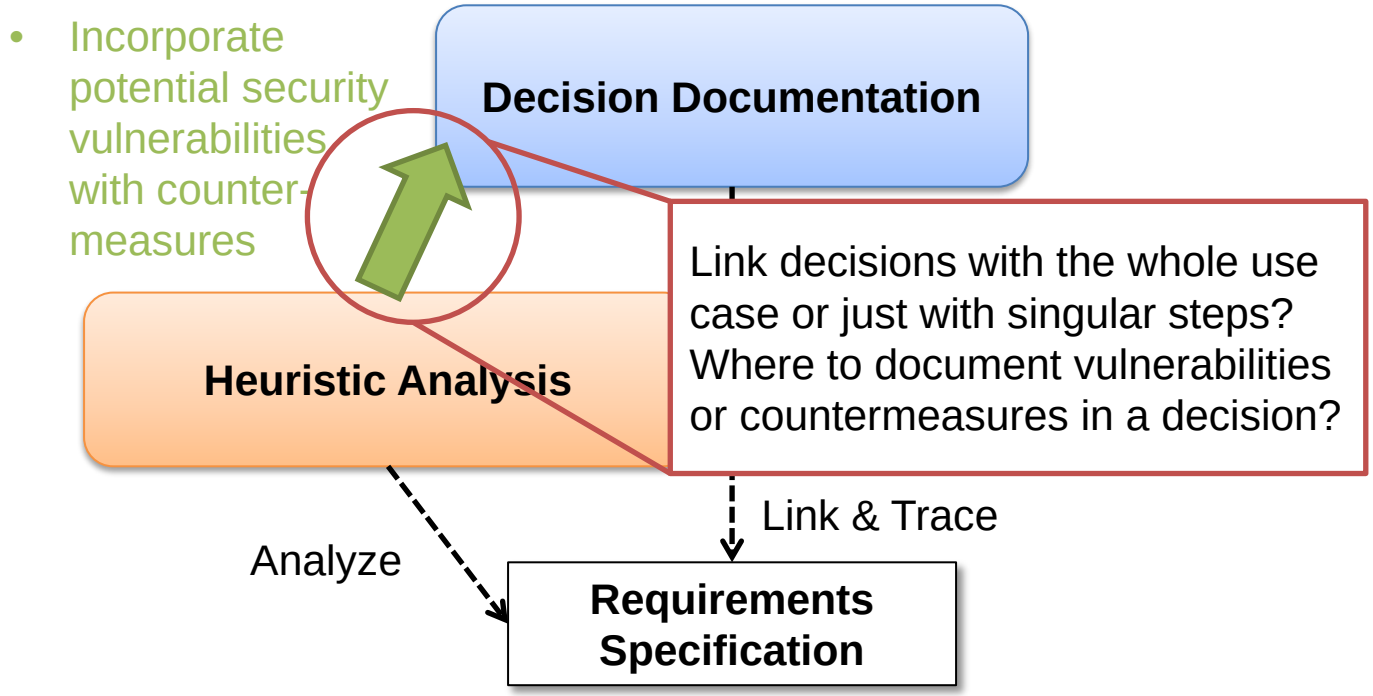


Use Case Specification

Result:
Difference between log and specification (e.g. missing logout)
→ Indicator for software improvement?

Incorporating Security Knowledge

- Now: How to incorporate security knowledge into decision documentation?



Incorporating Security Knowledge
Step 1: Group Potential Decisions

Group potential decisions → Map findings to decision knowledge → Elicit missing decision knowledge

- Step 1: One decision is created automatically for each issue with links to all steps of the usage scenario it was found in
  - Potential XSS vulnerability for step 3 of use case 6

Use Case 6: View, Designate, Undesignate HCP
1. Dislapy HCP‘s name, specialty, address.
2. Toggle to designate/undesignate an HCP.
3. Search an HCP by name or address.

- In some cases: Adjust decision grouping or discard them

Incorporating Security Knowledge
Step 2 and 3: Generate Decision Knowledge

- Step 2: Default rules are provided for mapping heuristic knowledge with decision knowledge and generate texts

Heuristic Knowledge	Decision Knowledge	Generated Content for XSS Decision on Use Case 6, Step 3
Vulnerability, System Component	Decision	Prevent *Cross-Site Scripting* in *iTrust Patient View*
Counter-measure	Alternative	*Sanitize input (link to mitigation strategies of CWE-79)*
…		

- Step 3: Add or adapt generated contents, if necessary

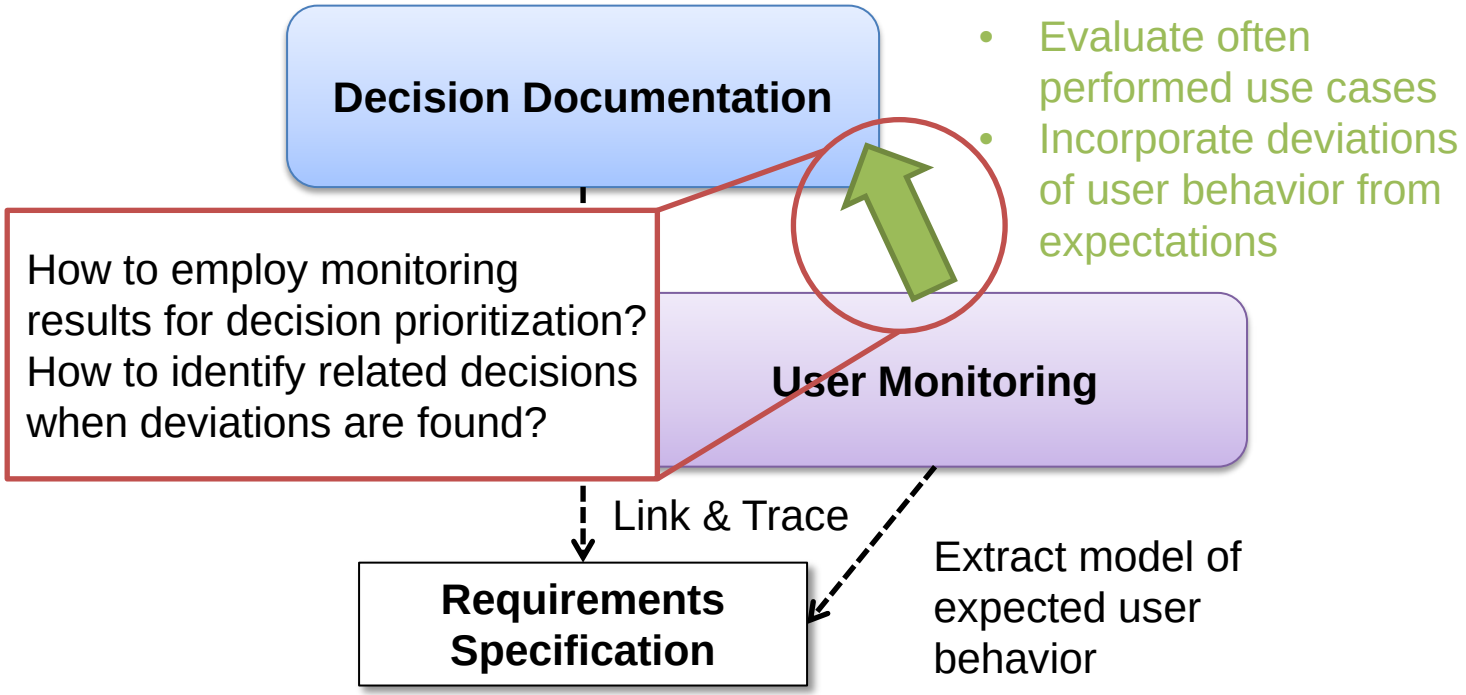
Benefits

- Comprehensive and fast access to knowledge on security-related decisions for software engineers and project managers
  - Decision knowledge is incorporated from heuristic findings by a semiautomatic transformation process

- Awareness for security issues in decision-making without requiring software engineers or project managers to be security experts

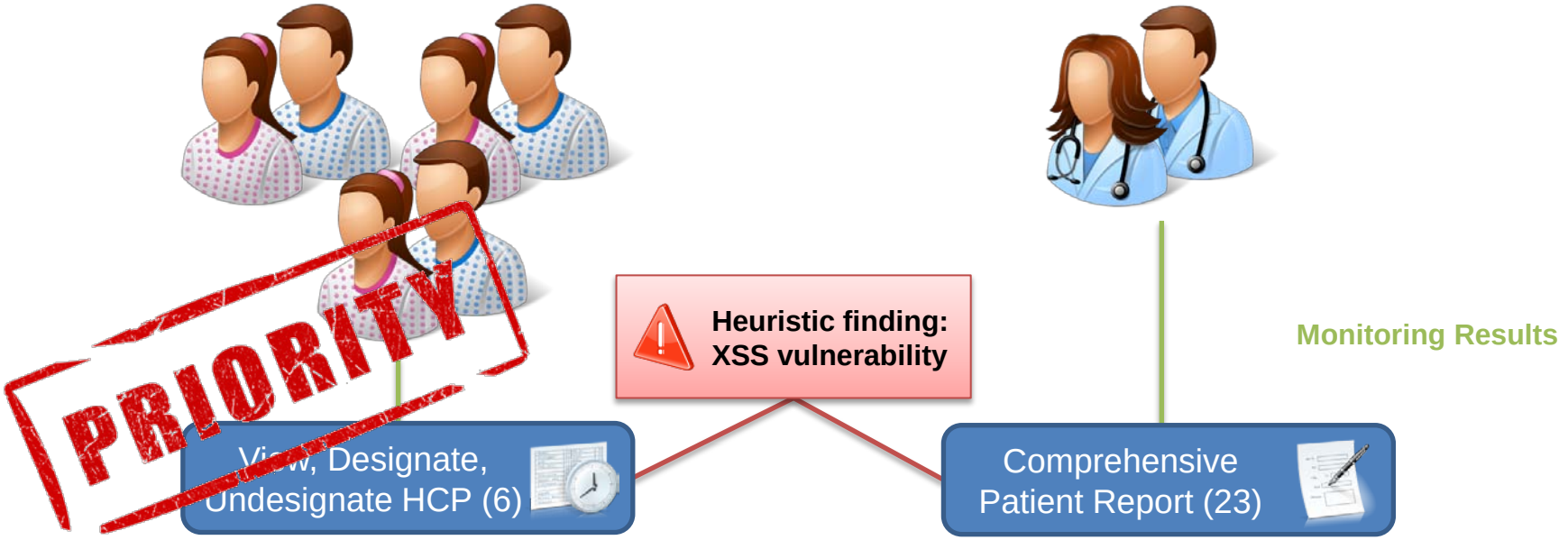
Incorporating User Monitoring Data

- Now: How to incorporate results from user monitoring?



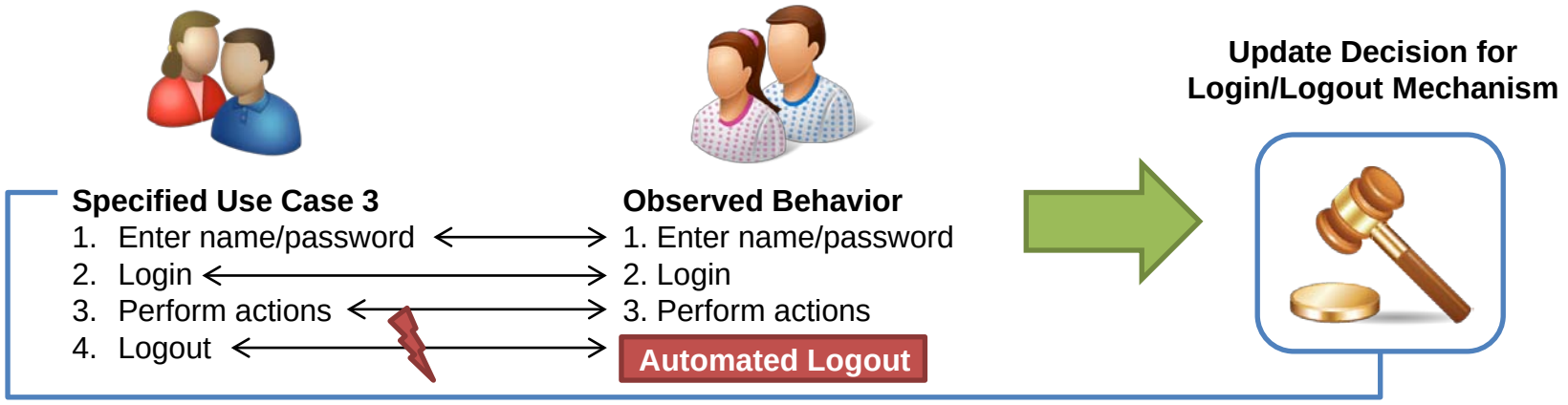
Incorporate User Monitoring Data Prioritize Decisions

- Case 1: Prioritize heuristic findings
  - Decisions on security requirements, which concern frequently performed usage scenarios, should be handled with priority
  - For instance, if patients perform use case 6 more often than use case 24, an XSS vulnerability should be handled first for use case 6



Incorporate User Monitoring Data Uncover Required Updates

- Case 2: Uncover required knowledge updates
  - Deviations are uncovered between specified (use cases) and monitored user behavior
  - Documentation component retrieves all decisions related to the use case for which the deviation was found
  - Software engineers can then decide how to update the given documentation



Benefits

- Prioritization of decisions helps software engineers to manage large amounts of potential decisions uncovered by heuristic analysis

- Updates on security-related decisions and their documentation can be located easily by software engineers
  - Deviations between specified and observed end user behavior indicate needed updates

Conclusion and Future Work

- We propose to document decisions on security requirements by incorporating different knowledge sources
- Our approach improves the documentation quality and completeness for decisions on security requirements
- We are currently developing a prototype to demonstrate our approach within the knowledge management tool UNICASE
- Directions for future work:
  - Evaluation of our approach in a controlled experiment
  - Integration of further knowledge sources for documentation

The End

Thank you for your attention!

Do you have any questions?

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