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# Continuous Secure Software Development and Analysis

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# Problems

## Security is not considered from beginning

- Violations are detected late
  → costly
- Hard to retrace decisions
  → later analyses run independent from previous decisions
  → changing situations leads to … ?

# Problems

## Security is hard to evaluate

- Hard to evaluate/ systematically check security requirements
→ often done with threat models & scenarios

- Security is an evolving risk
→ Security must be observed over time
→ Necessary changes should be easy to detect

# Problems

## Security is difficult

- Multiple Aspects/ Topics
  - Confidentiality, Integrity, Availability, Authenticity, …
  - Security models often contain only few aspects
- Intrinsically dependent
  - Security leaks lead to other security lacks
  - Attackers often reach their goal by a sequence of attacks

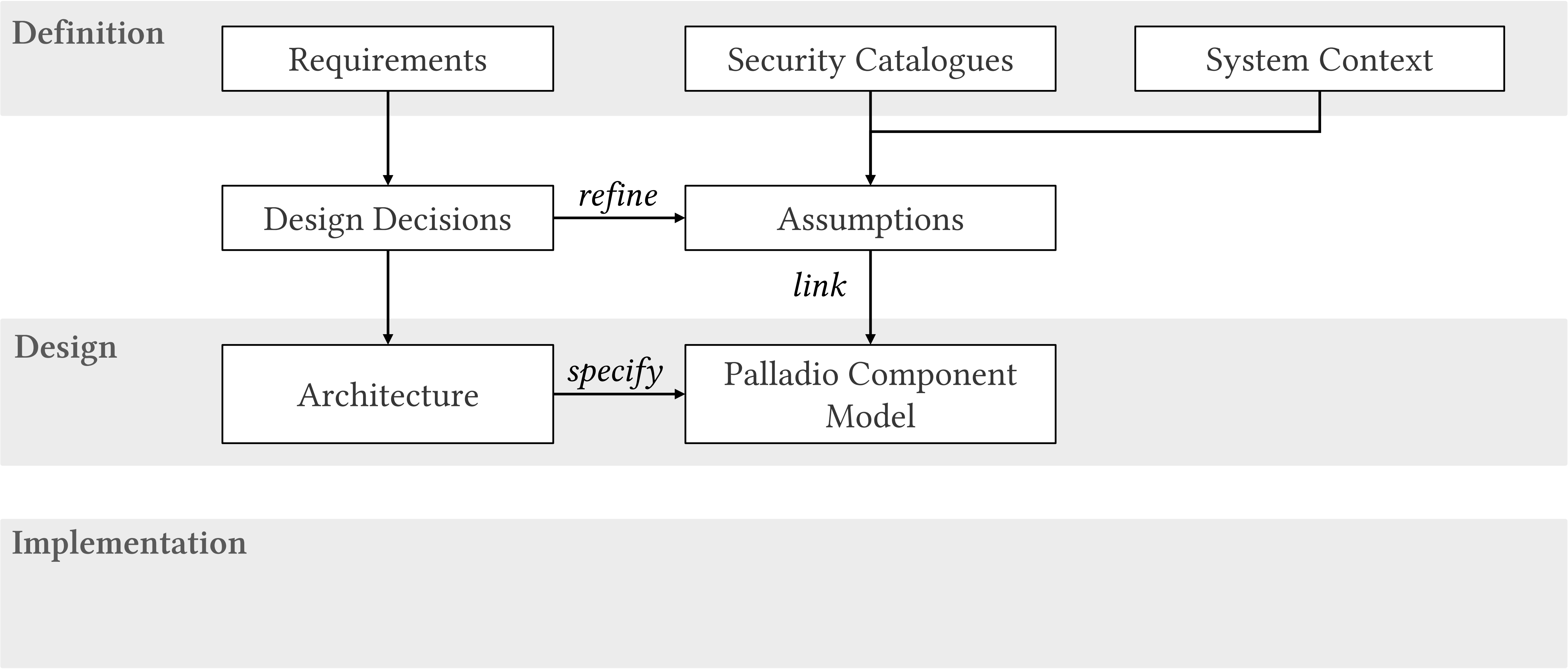
# Related Work

- Approaches
  - [Ryoo et al.]
    - 1) Vulnerability-oriented: Expert interview
    - 2) Pattern-oriented: Analyze design patterns regarding identified vulnerabilities
    - 3) Tactic-oriented: Investigate handling of attacks
  - [Khan]
    - In every development stage: Stage has issues → later stages will have issues
    - Requirement phase: Misuse case analysis to verify requirements
    - Design phase: Use misuse cases and vulnerabilities to perform threat modeling
    - → Adapt design
    - Coding phase: Tests with static analyses and code reviews

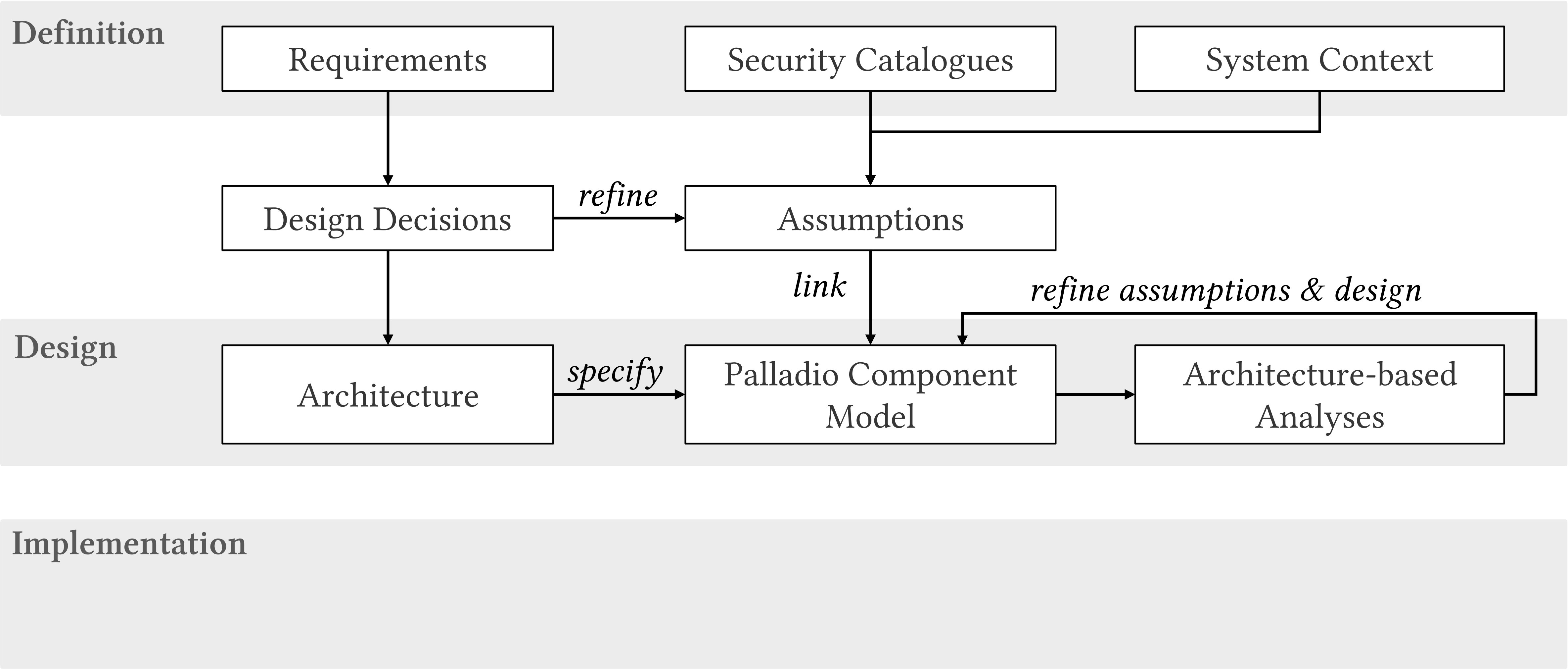
# Idea

- Holistic framework for multiple security aspects
- Appliable over time & react to changing requirements & contexts
- Blackboard principle: PCM
- Connect security and architecture
- Base on fine-grained, underlying assumptions

# Vision


Definition
Requirements
Security Catalogues
System Context
Design Decisions
refine
Assumptions
link
Design
Architecture
specify
Palladio Component Model
Implementation

# Vision



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refine assumptions & design
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Architecture-based Analyses
Implementation

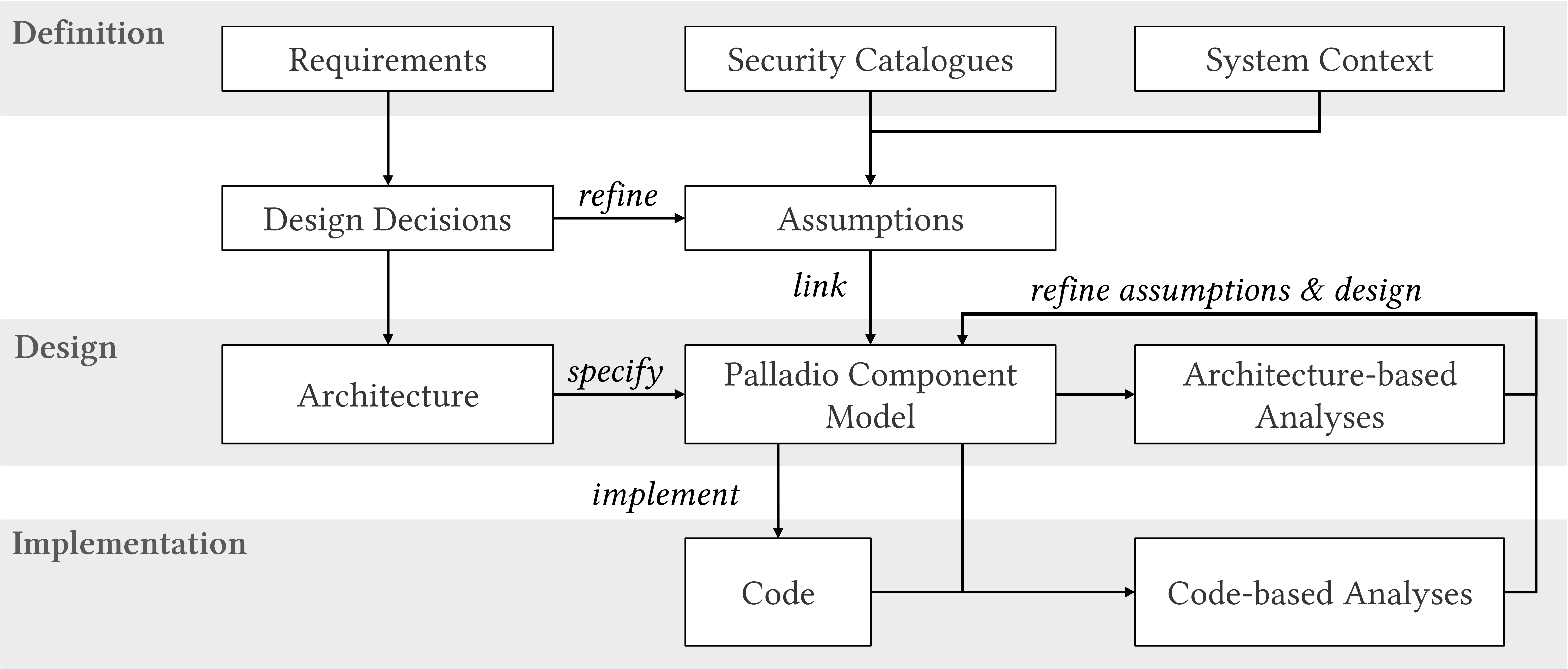
# Architecture-based Analyses

## Confidentiality Analysis

- Confidentiality
  - Information is not made available or disclosed to unauthorized individuals [ISO 27000]
  - Often ensured by access control

- Idea
  - Refine confidentiality assumptions to access control policies
  - Formulate policies as constraints
  - Verify policies through other analyses

# Vision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implement
Implementation
Code
Code-based Analyses

# Architecture- and Code-based Analyses

## Composition of architecture- and code-based analyses

- Some security aspects can only be verified on certain levels
  - I.e., correctness on code level

  → Others must base on assumptions

  → If assumptions are false, analysis results are false

- Idea
  - Compose static security analyses of system view and source code
  - Reduce failures through assumptions of analyzable aspects
  - Analyze assumed aspects (on architecture level) using code-based analyses

# Code-based Analyses

## Code-level Specification and Verification of Security

- Verification of underlying assumptions (of higher-level results)
- Verification of reusable building blocks

- Idea
  - Use formal verification to verify specification of components
  - Use protocol verification for security properties between components

# Example – Access Control

- Architecture level
  - Use access control to achieve confidentiality
  - How is the access control designed on architectural level?

  → Multiple assumptions

- Architecture- and code-based level
  - What are underlying assumptions?
  - Role model is applied correctly?

- Code-based level
  - Verify implementation of (parts of the) role model

# Benefits

- Overviewable security

→ Decisions & assumptions are explicit
→ Security patterns/ mechanisms & assumptions are annotated
→ Results of analyses are traced back to PCM

- Different analyses

→ Combination of different aspects

- Security from beginning and to the end

→ Early analyses are possible
→ Later analyses can refine/ verify the results of the previous ones

# Benefits

- Threat models / Attack scenarios / Attack models

→ I.e., attack needs some assumptions

→ are these negated by the assumed security mechanisms?

- Risk management & Quantification

→ I.e., risk of breaking some assumption

→ Risk of breaking some security mechanisms

# Sources

| Reference | Source |
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| Broadnax et al. | B. Broadnax, et al., Eliciting and refining requirements for comprehensible security, in: 11th Security Research Conference, Fraunhofer Verlag, Berlin, 2016, pp. 323–330. |
| ISO27000 | ISO, ISO/IEC 27000:2018(E) Information technology – Security techniques – Information security management systems – Overview and vocabulary, Standard, 2018. |
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