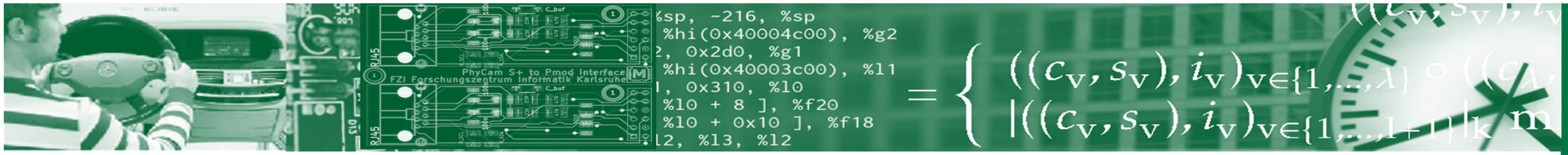

Security analysis of embedded systems using virtual prototyping

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- (Forschungszentrum Informatik), Germany since 2016
- Research Thema: security analysis for embedded systems

Problem

Foundation

Connected embedded systems

- Advantages
  - Efficient resource utilization
  - Minimizing human effort
  - Saving time

- Problems
  - Security
  - Privacy
  - Complexity

Secure embedded systems

Challenges facing secure embedded system design

- Security as add-on feature to embedded systems
- Weakness elimination efficiency
- Design decision verification from security aspects
- Security processing gap
- Entangled structure of embedded systems

Proposed solution

- Security by design
- model-orientation
- Security mechanisms estimation
- Refinement process
- Covering hardware architecture and network structure

Proposed Solution

Proposed approach

- **Security by design**
- **Model-orientation**
- **Security mechanisms estimation**
- **Refinement process**
- **Covering hardware architecture and network structure**

Security by design

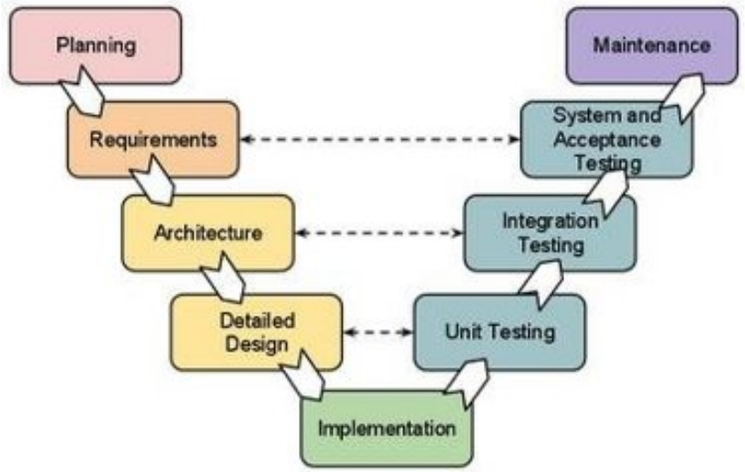
with the help of

virtual prototyping

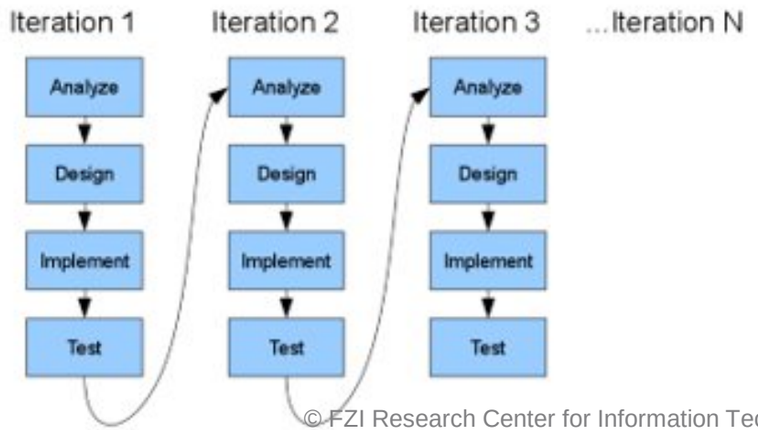
Security by design

SDLC (System Development Life Cycle) models:

- V-shaped model

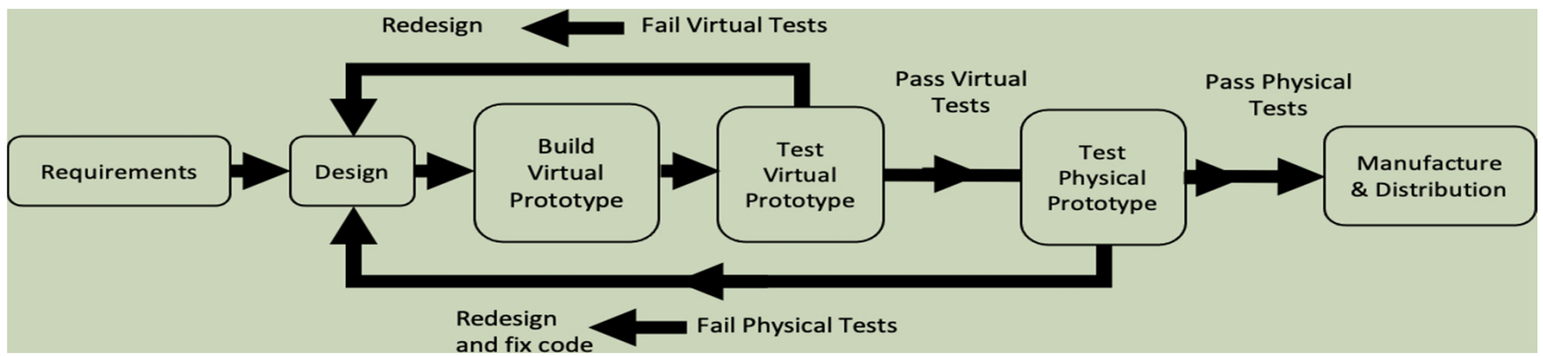


- Iterative model

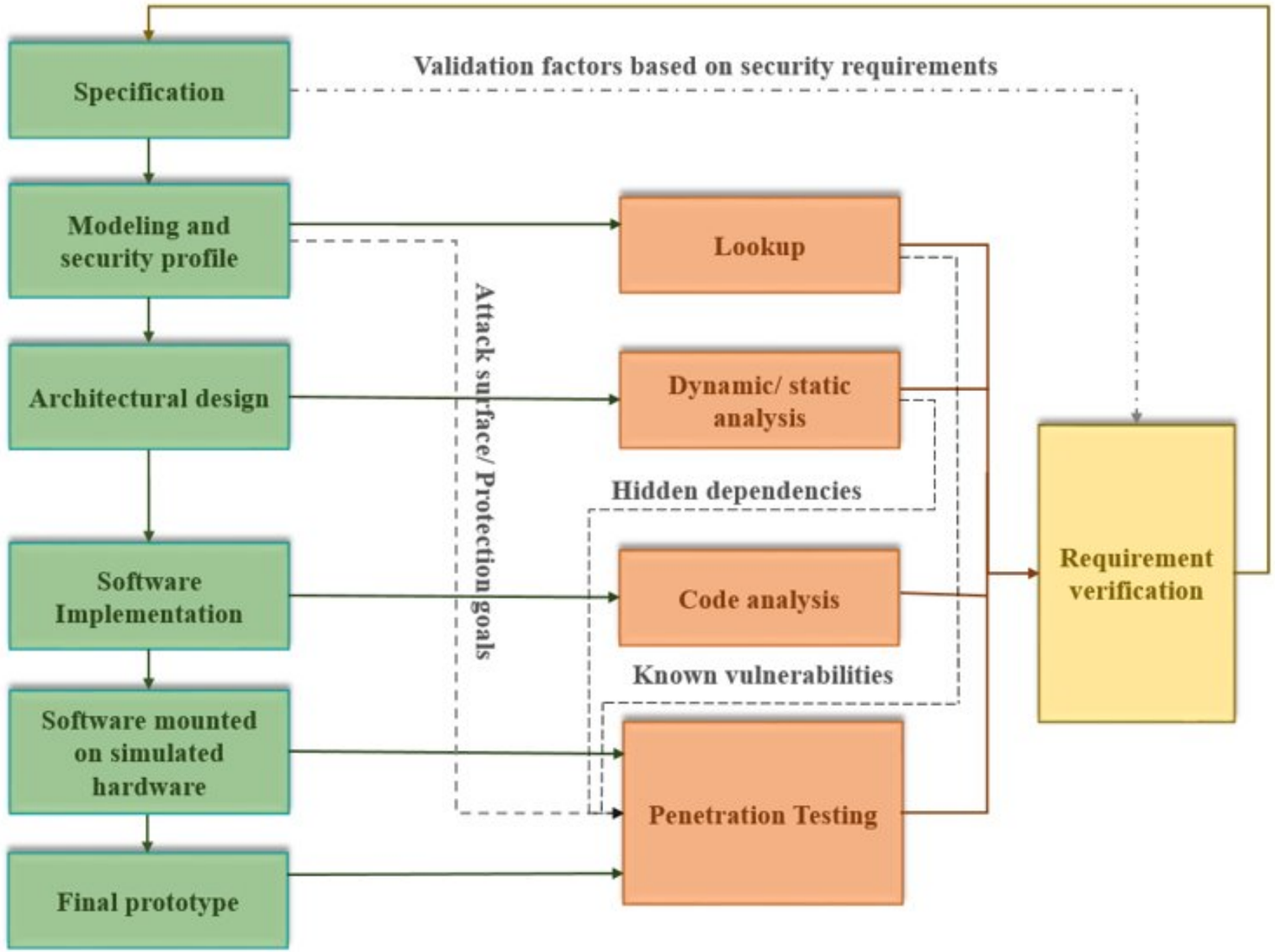


Virtual prototyping

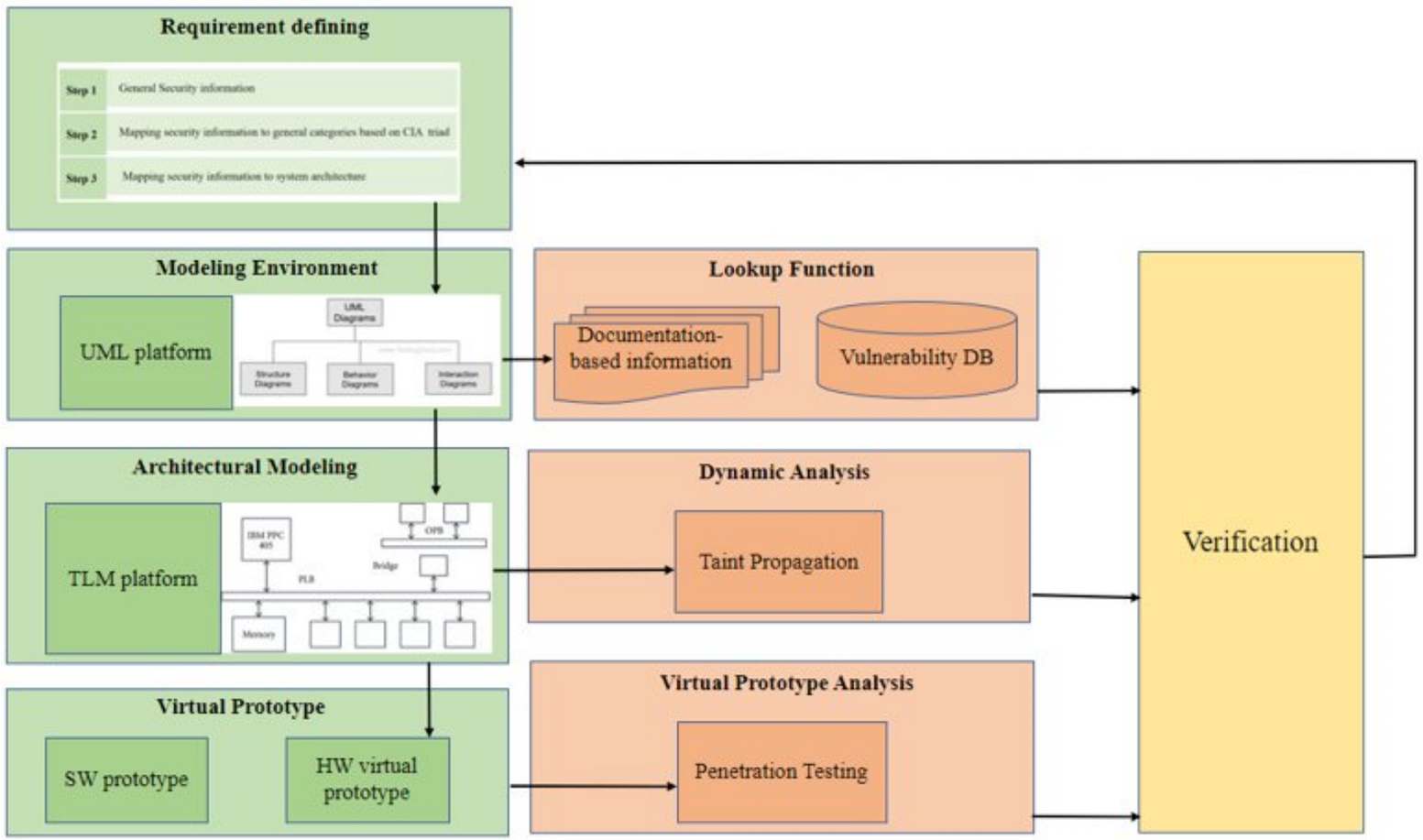
- Preliminary stage of physical prototype
- Completely or partial provision of subcomponents
- Executable model
- Widely used in product development and system analysis
- Simulation language : SystemC
  - Different abstraction level of SW/ HW
  - Modeling of SW application/ Digital and analog electronic components



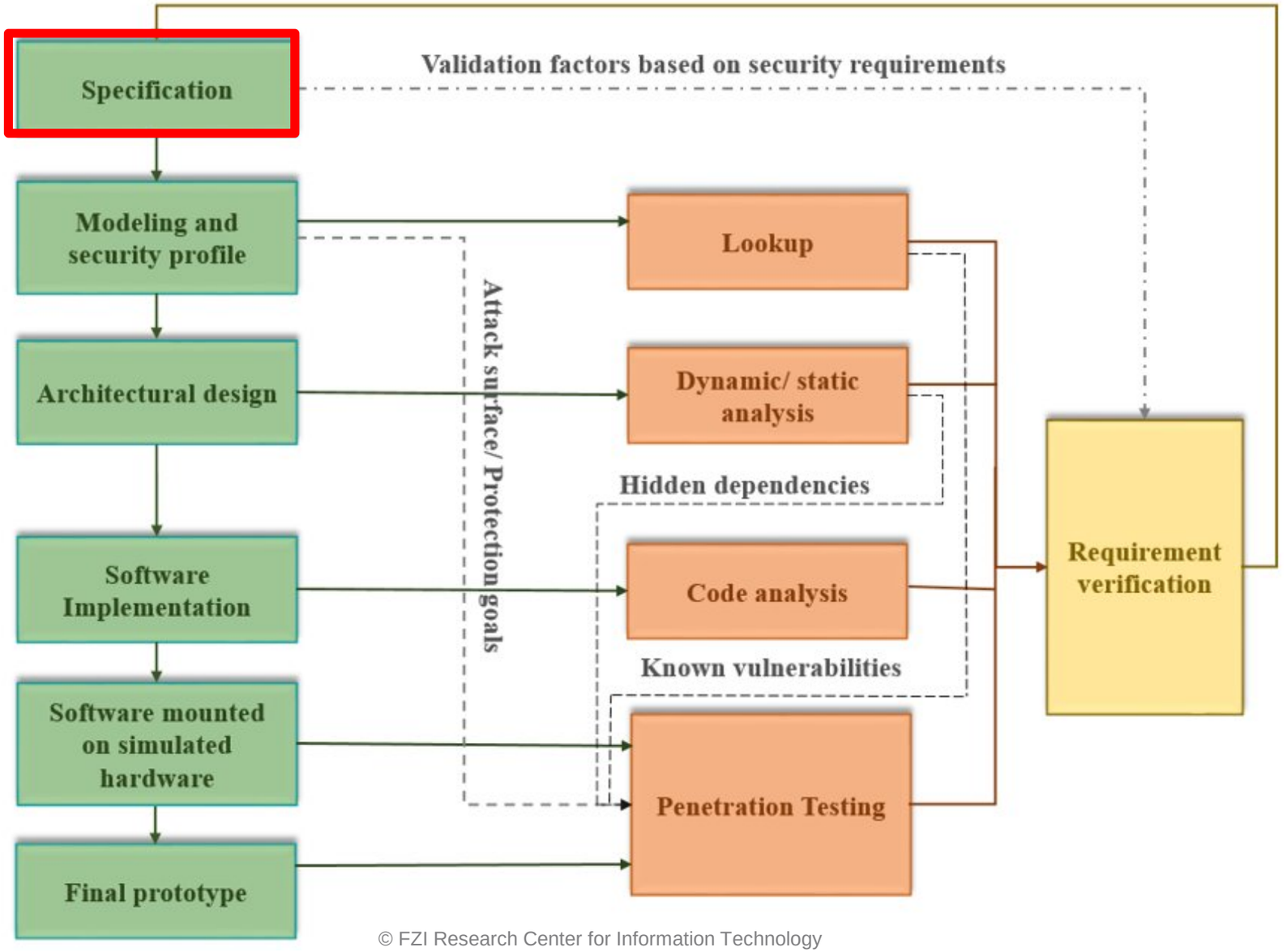
Proposed approach

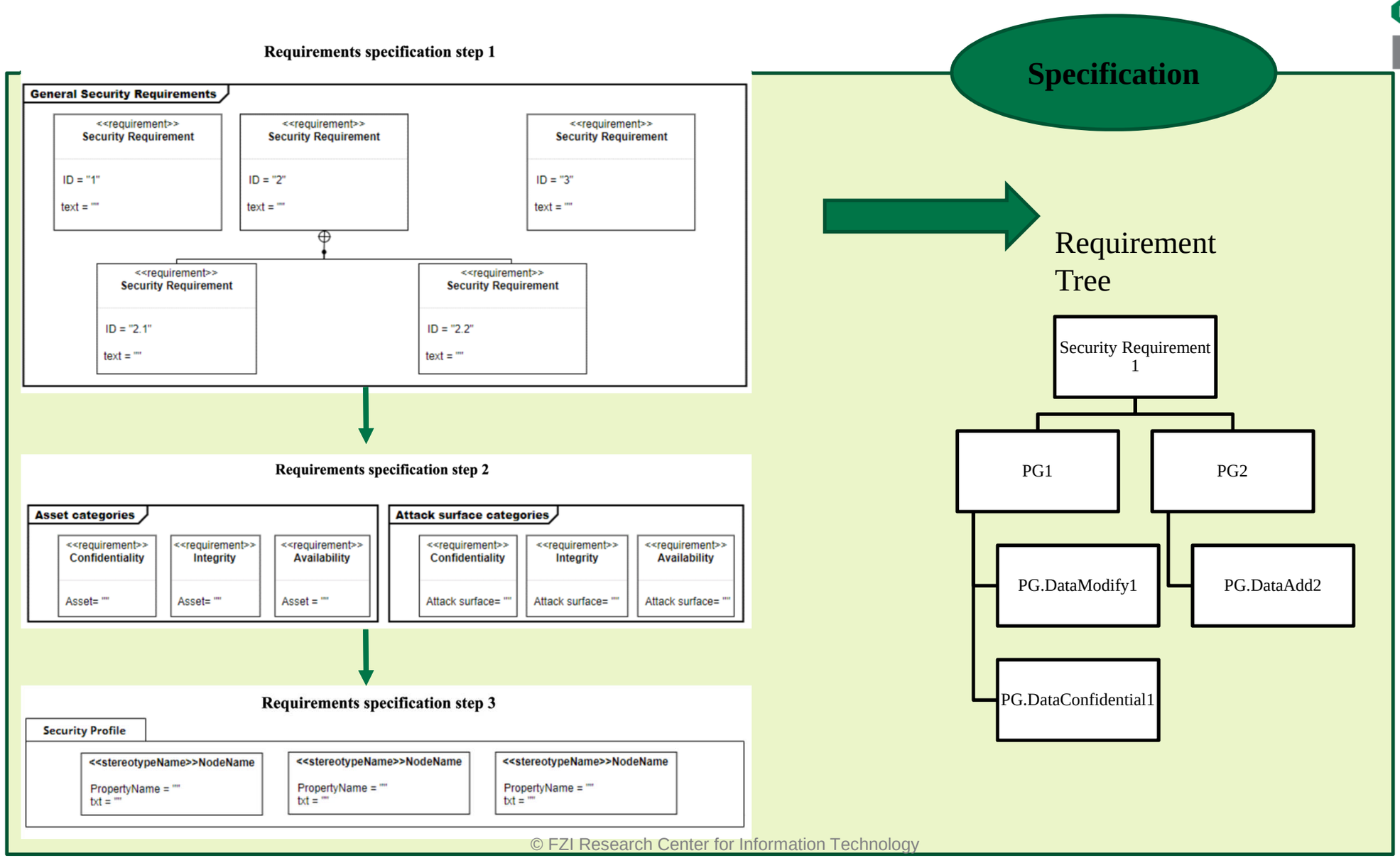


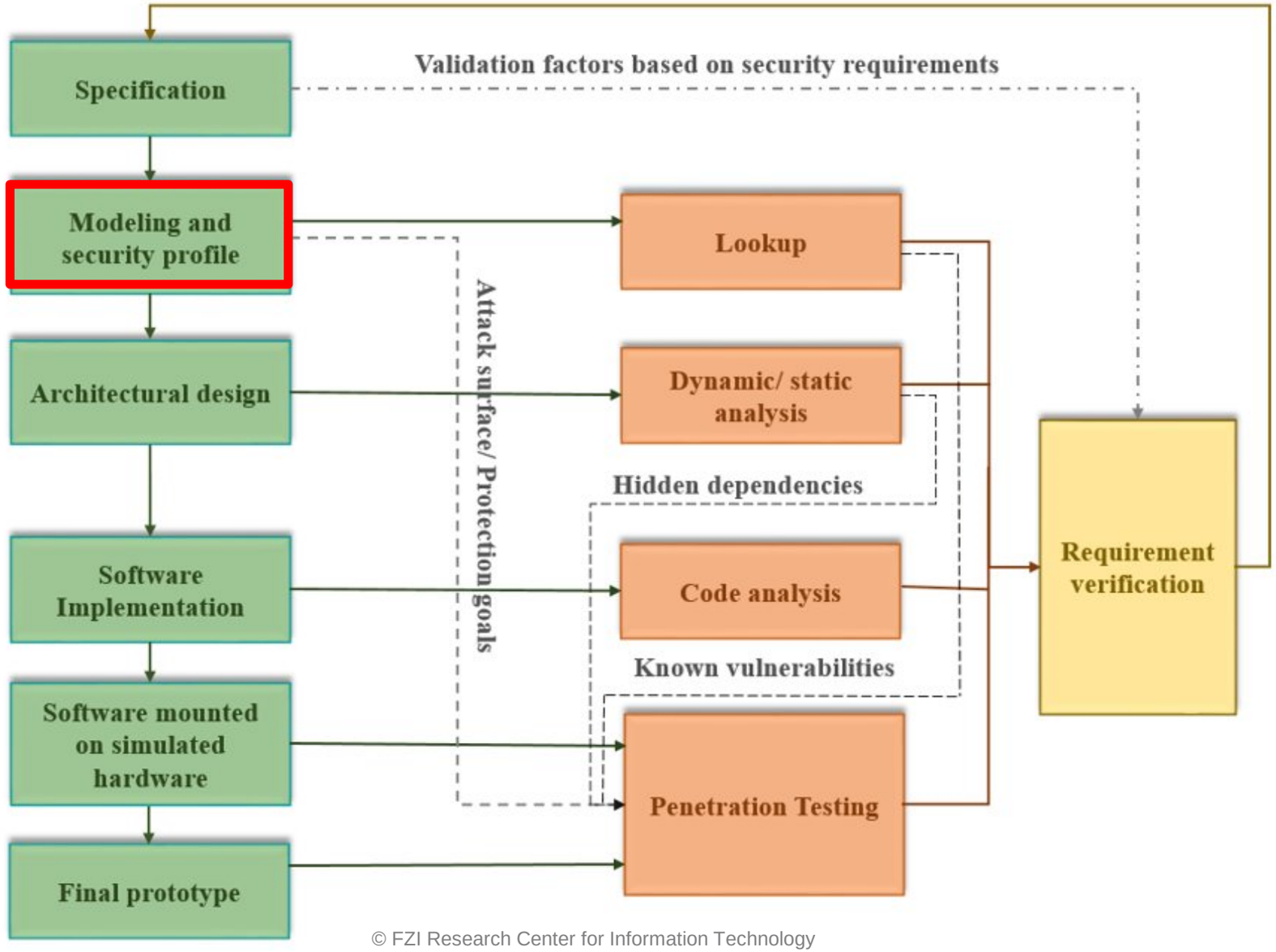
Implementing approach

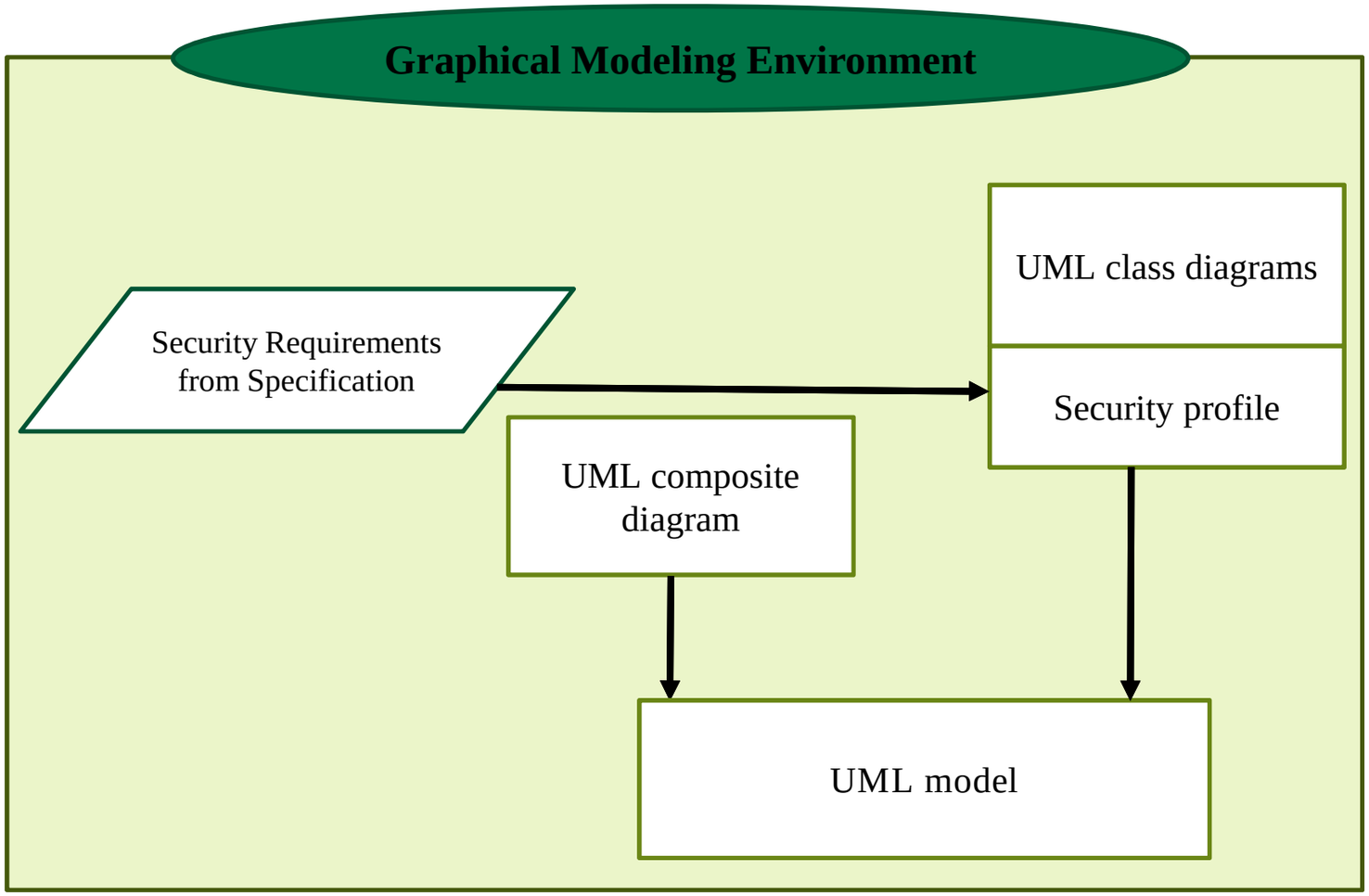


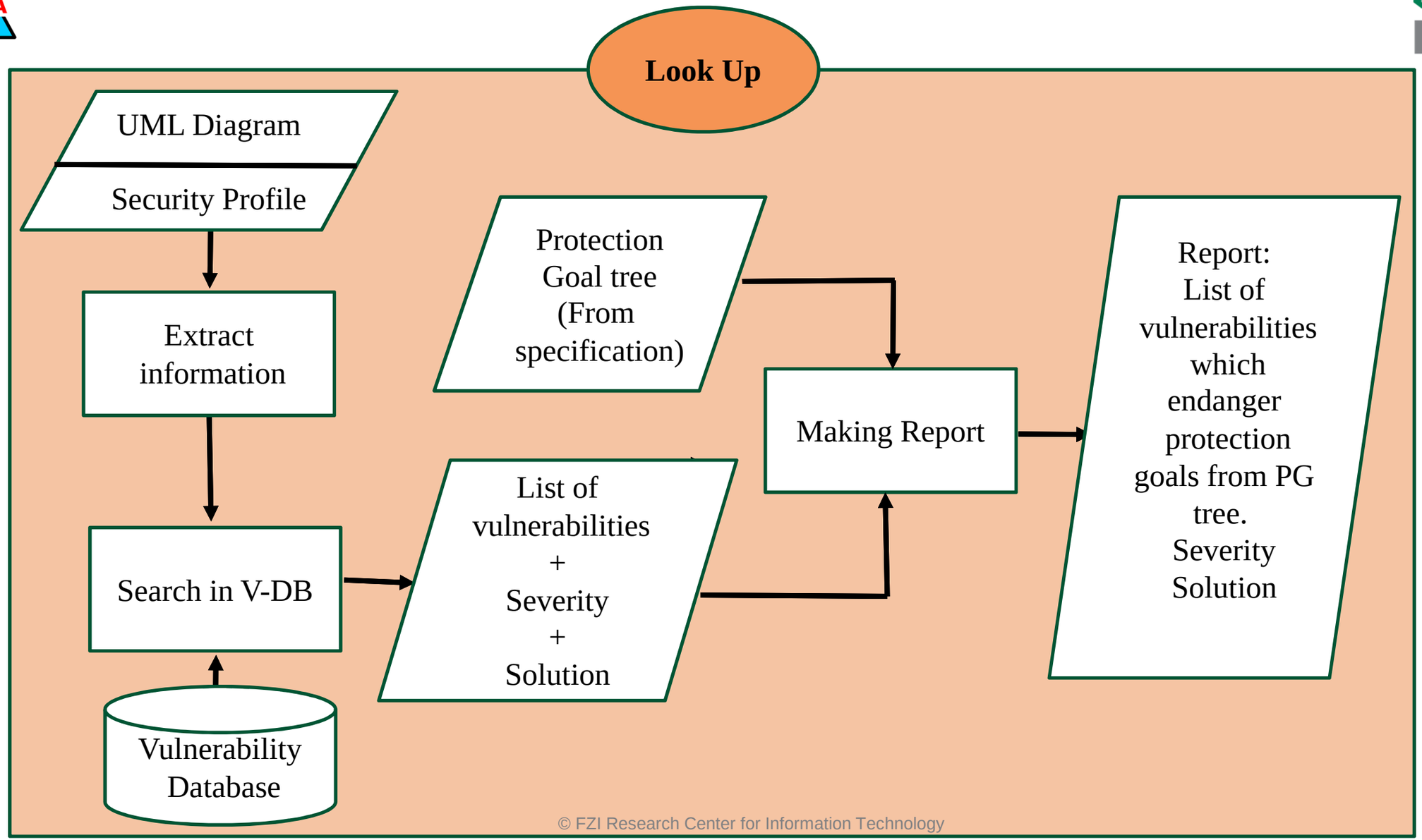
Implementation

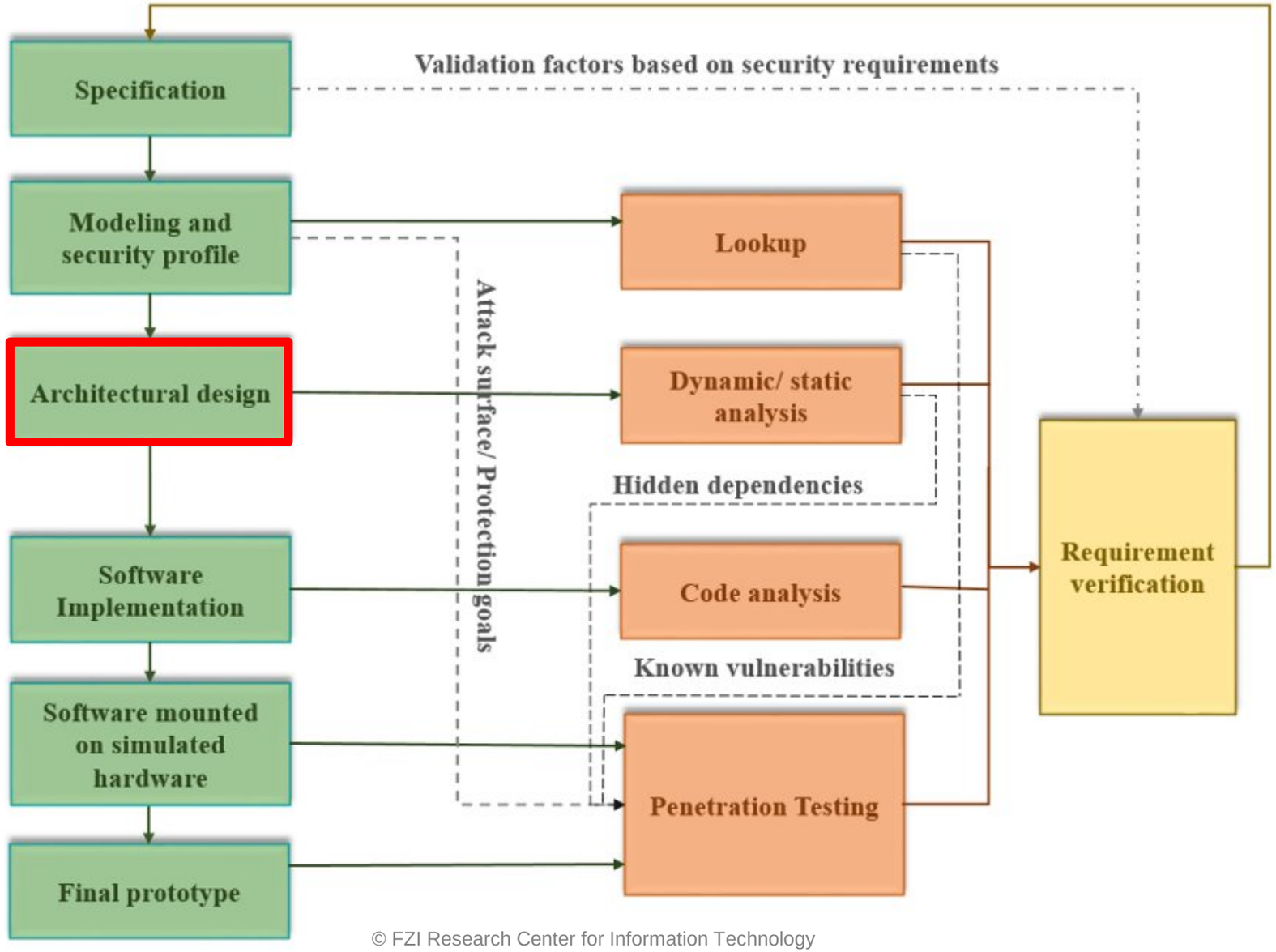


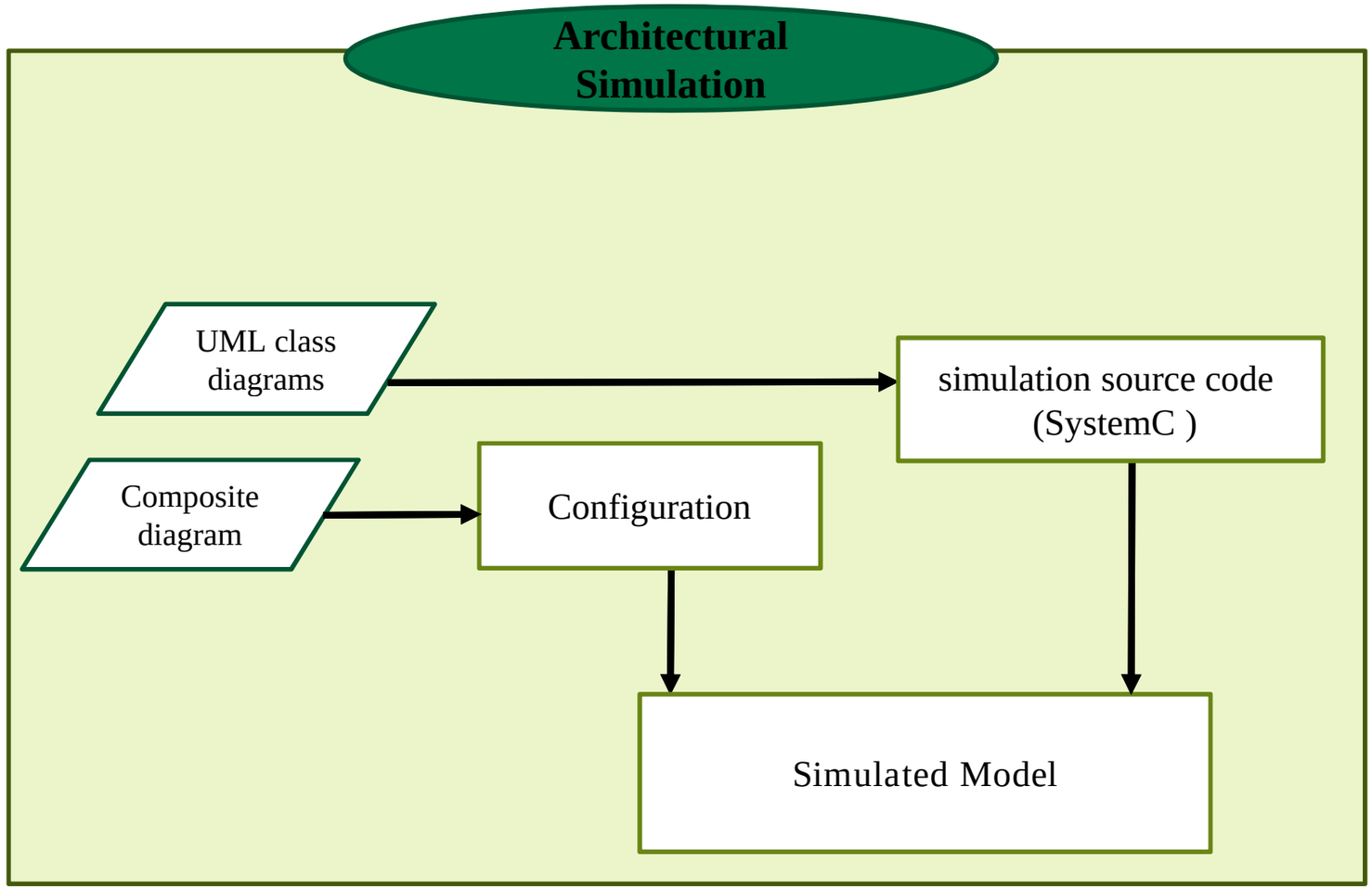


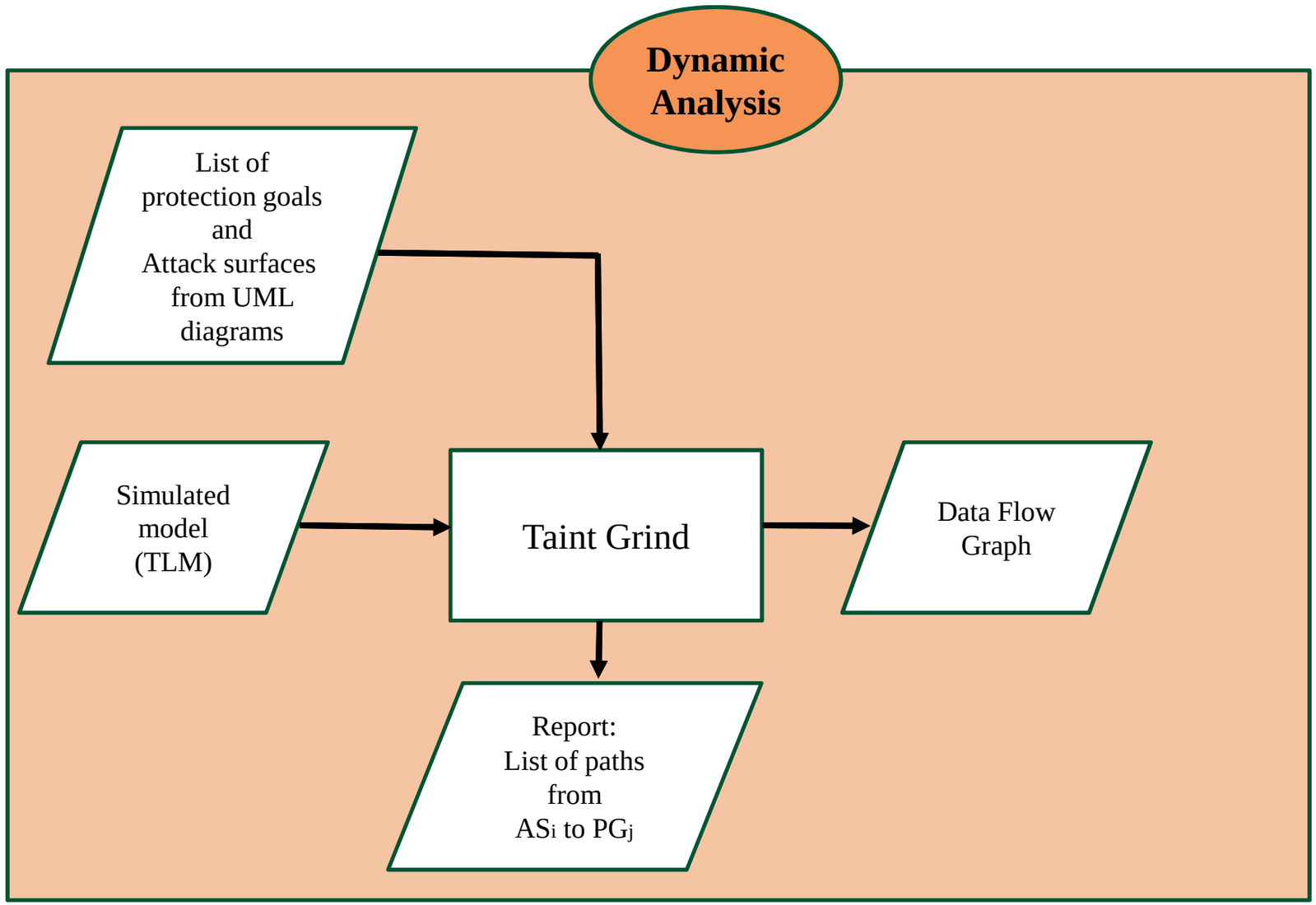


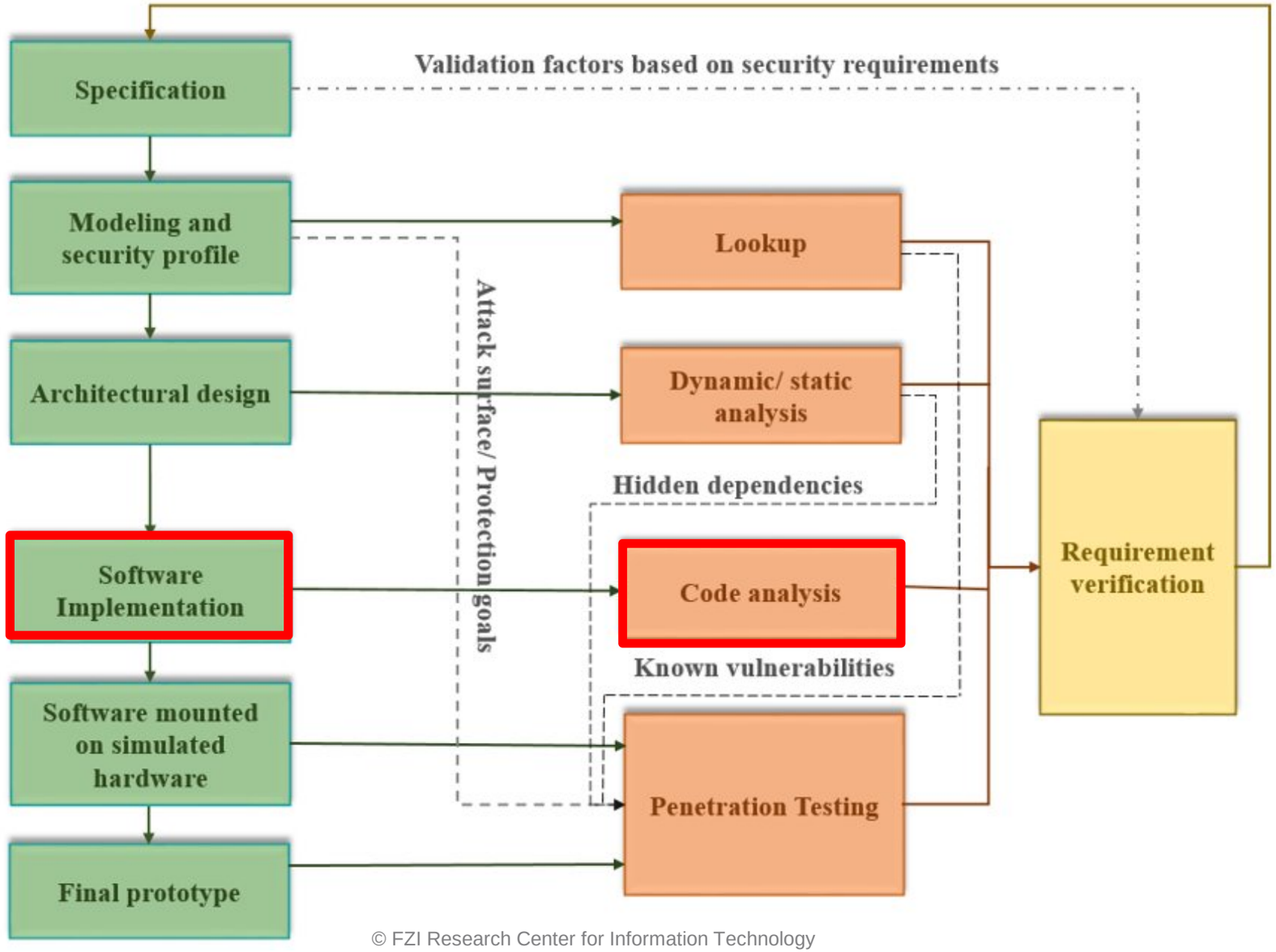








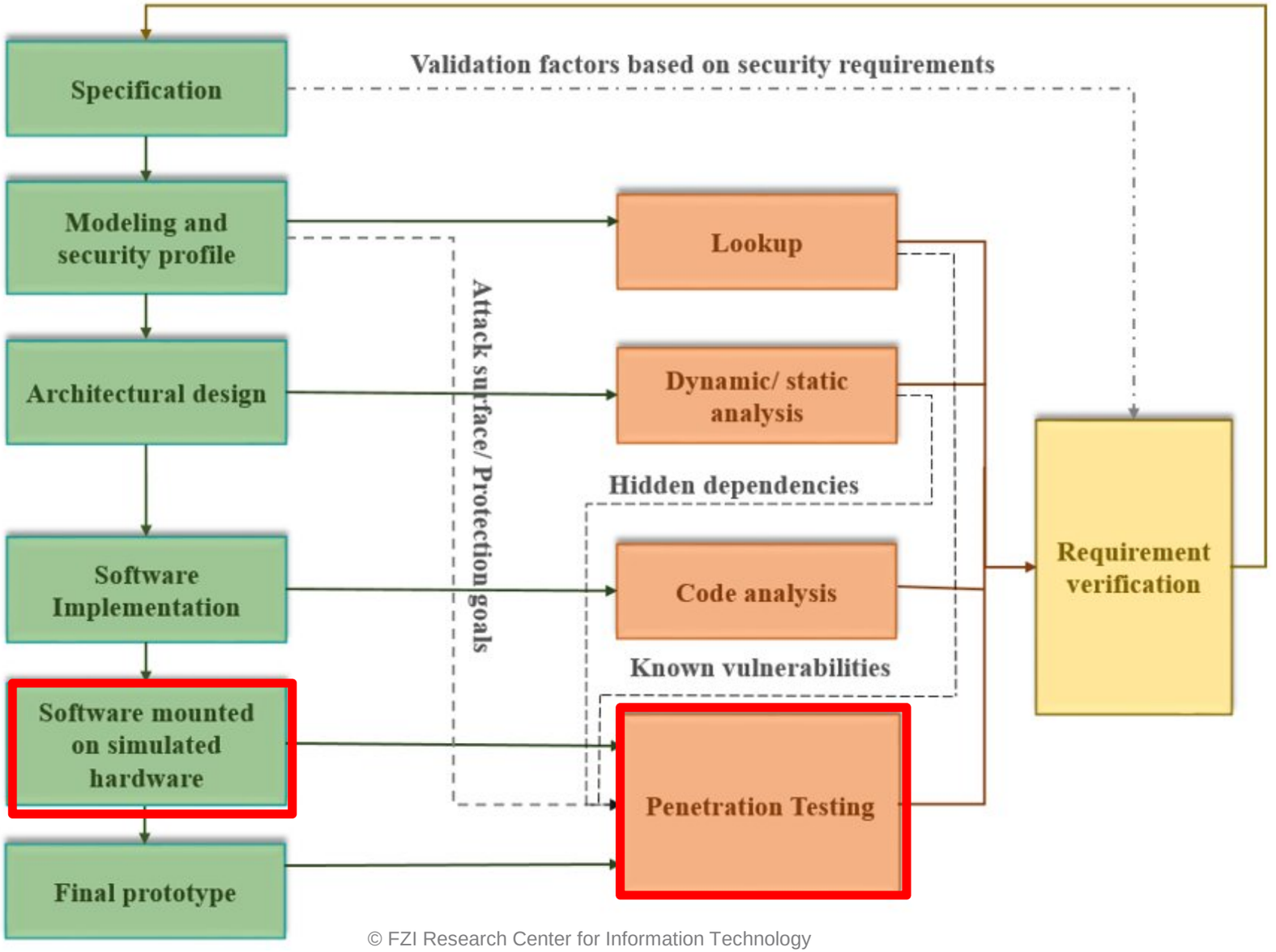


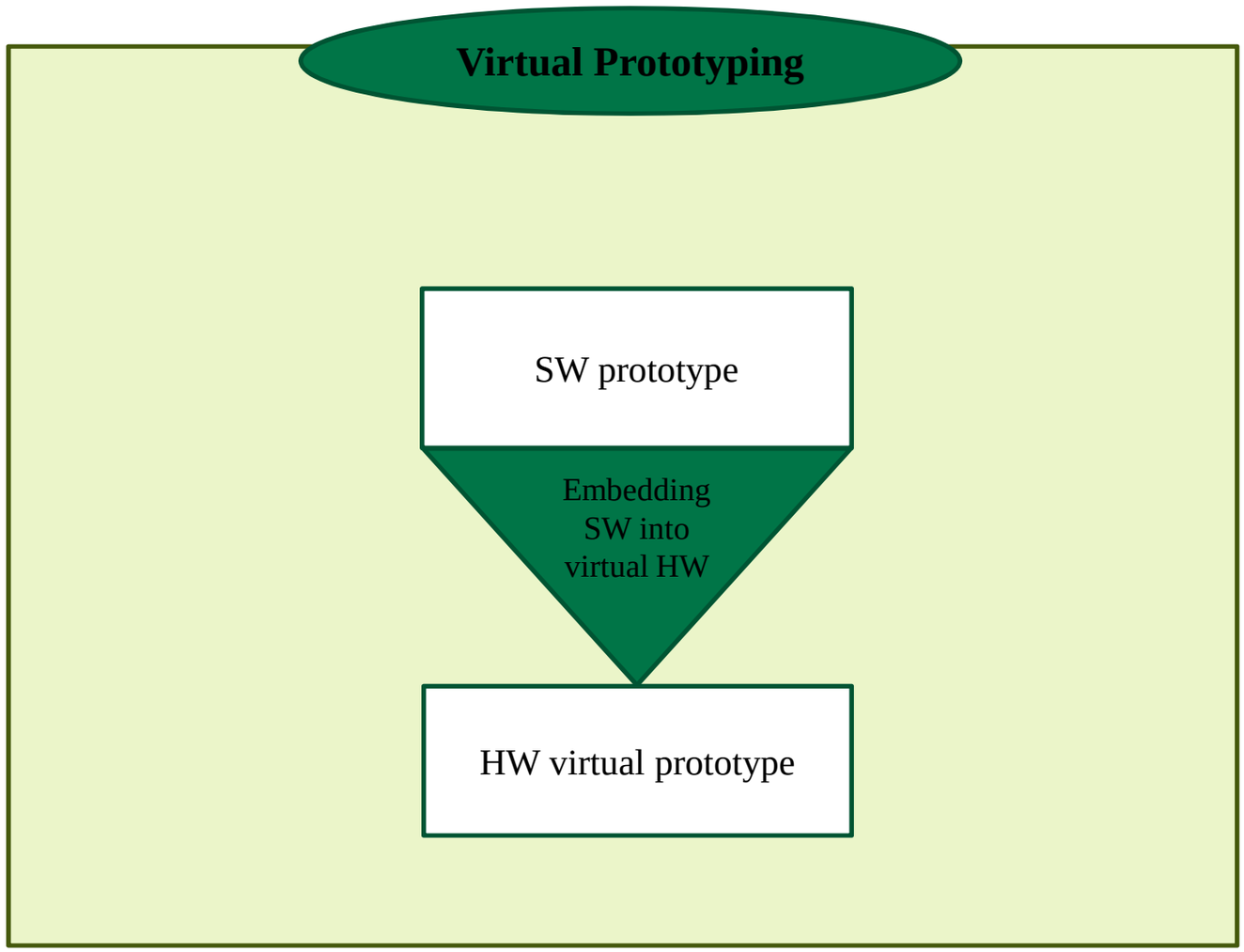


Code analysis

- Code vulnerabilities:
  - Security-injection flaws
  - Security-configuration flaws

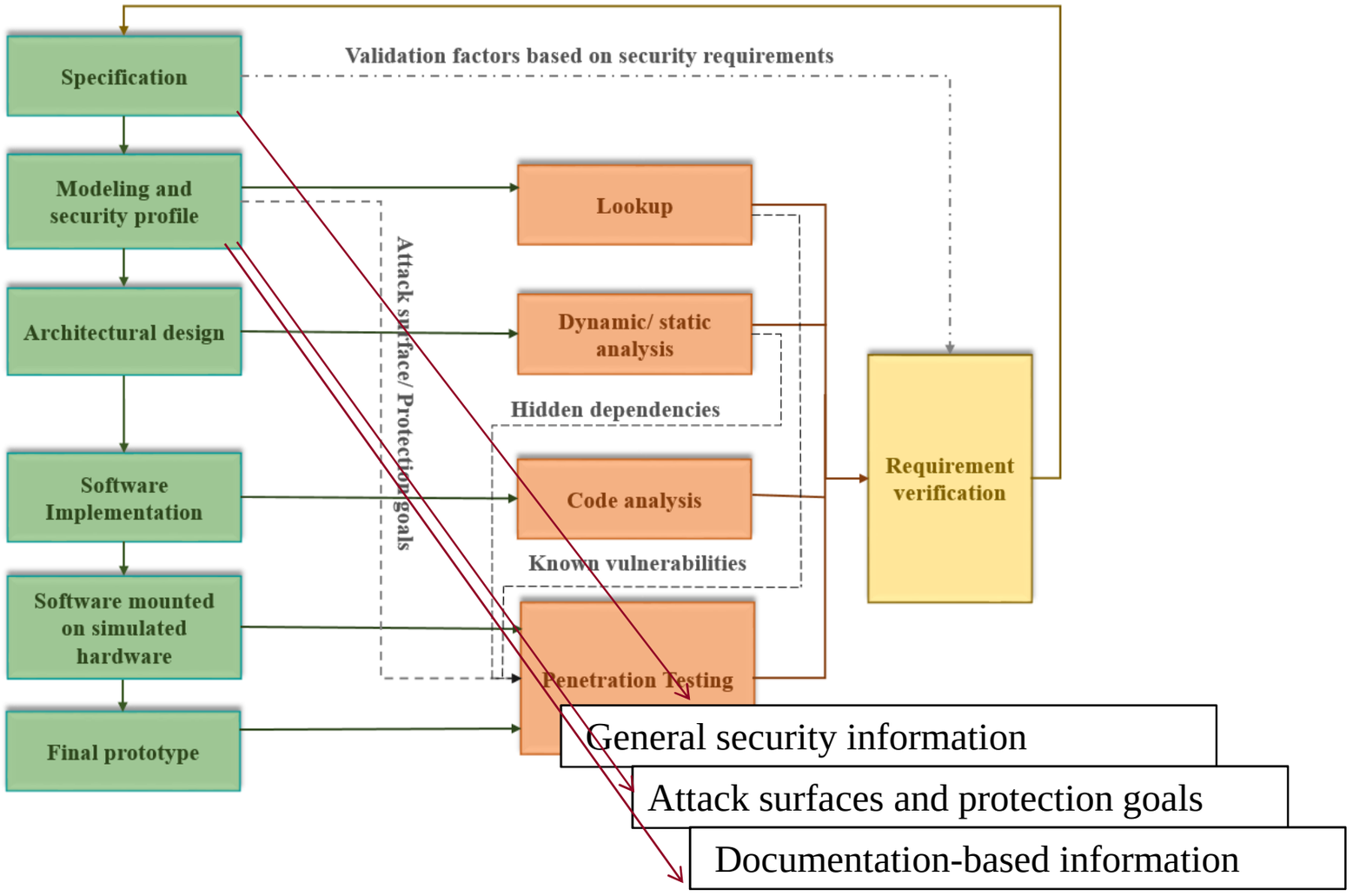
- Code analysis tools:
  - SonarQube
  - Deepsource
  - Veracode





Penetration Testing

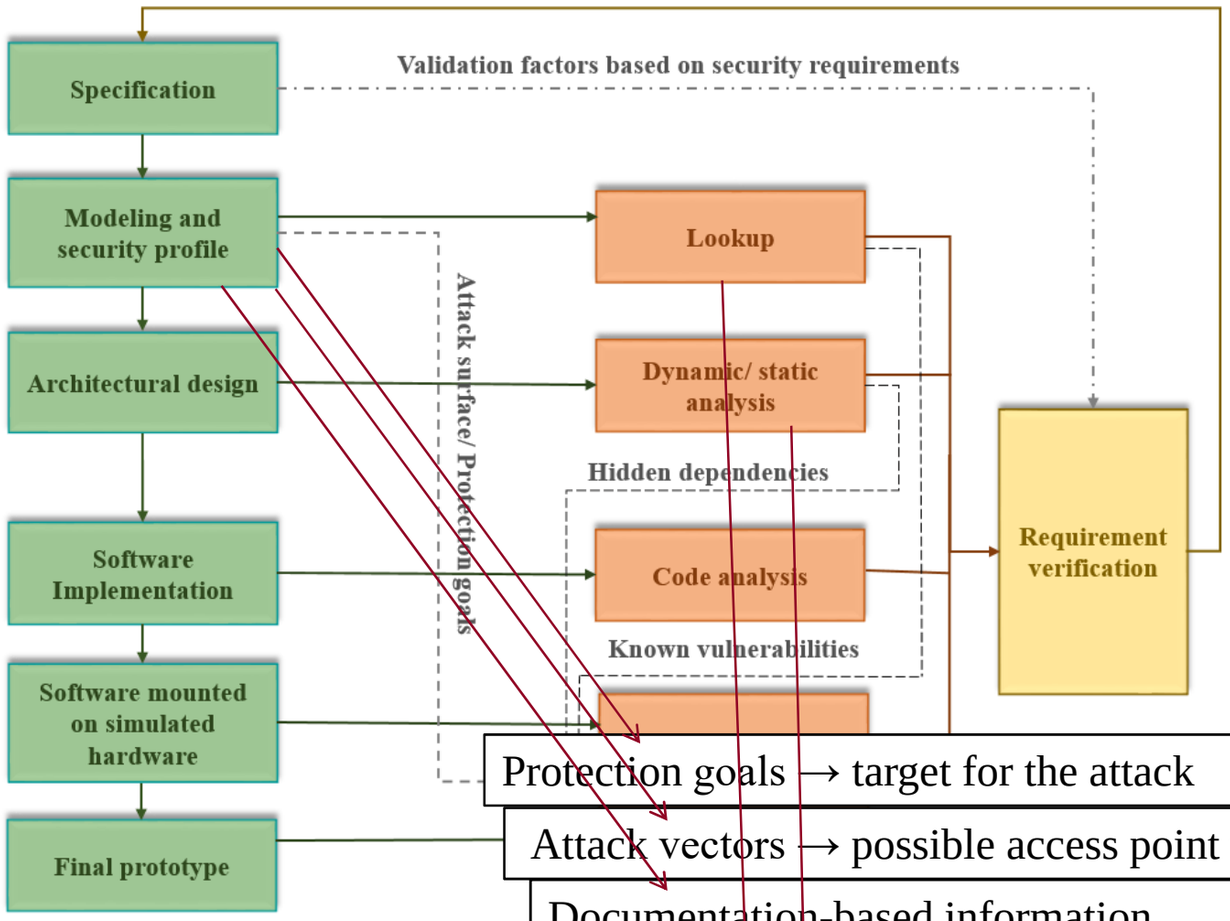
Recognition



Penetration Testing

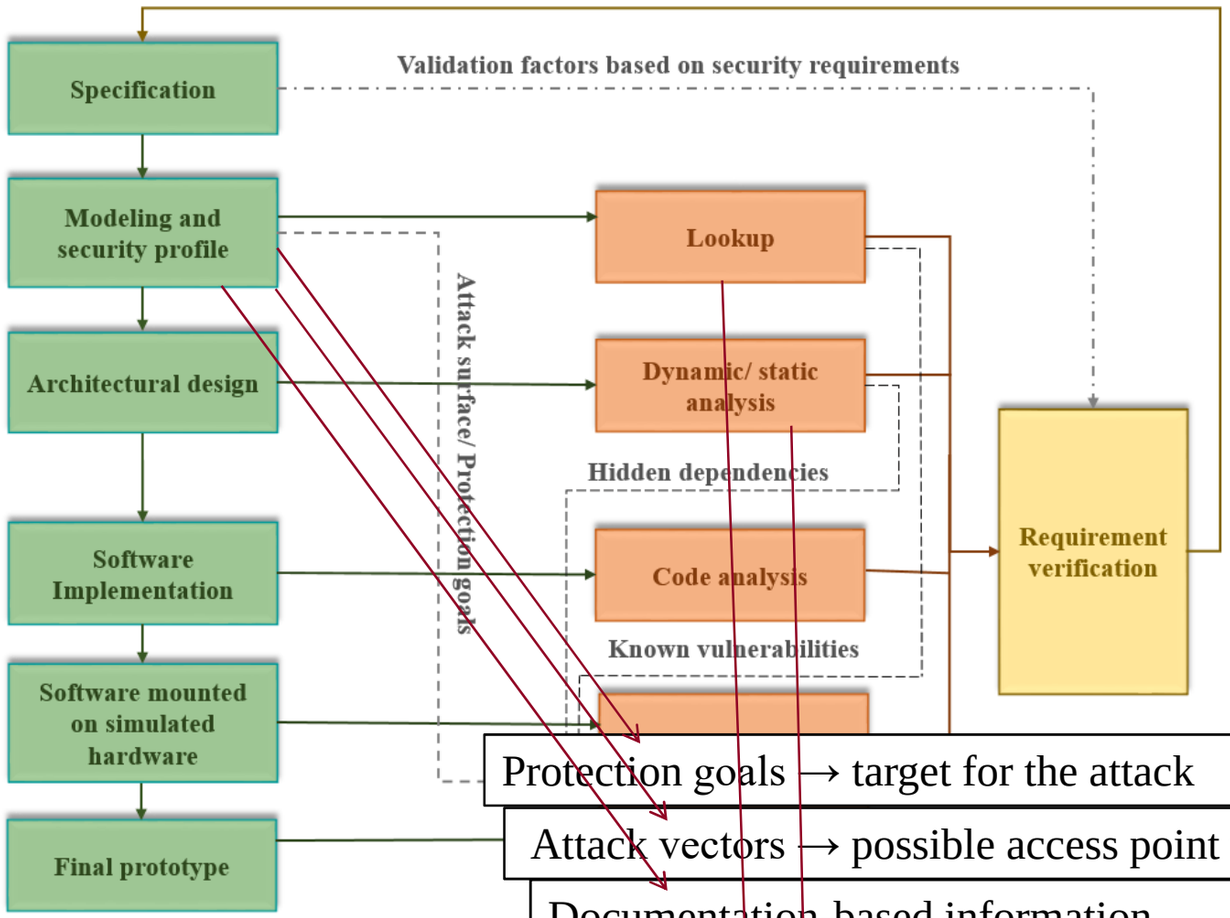
Recognition

Scanning



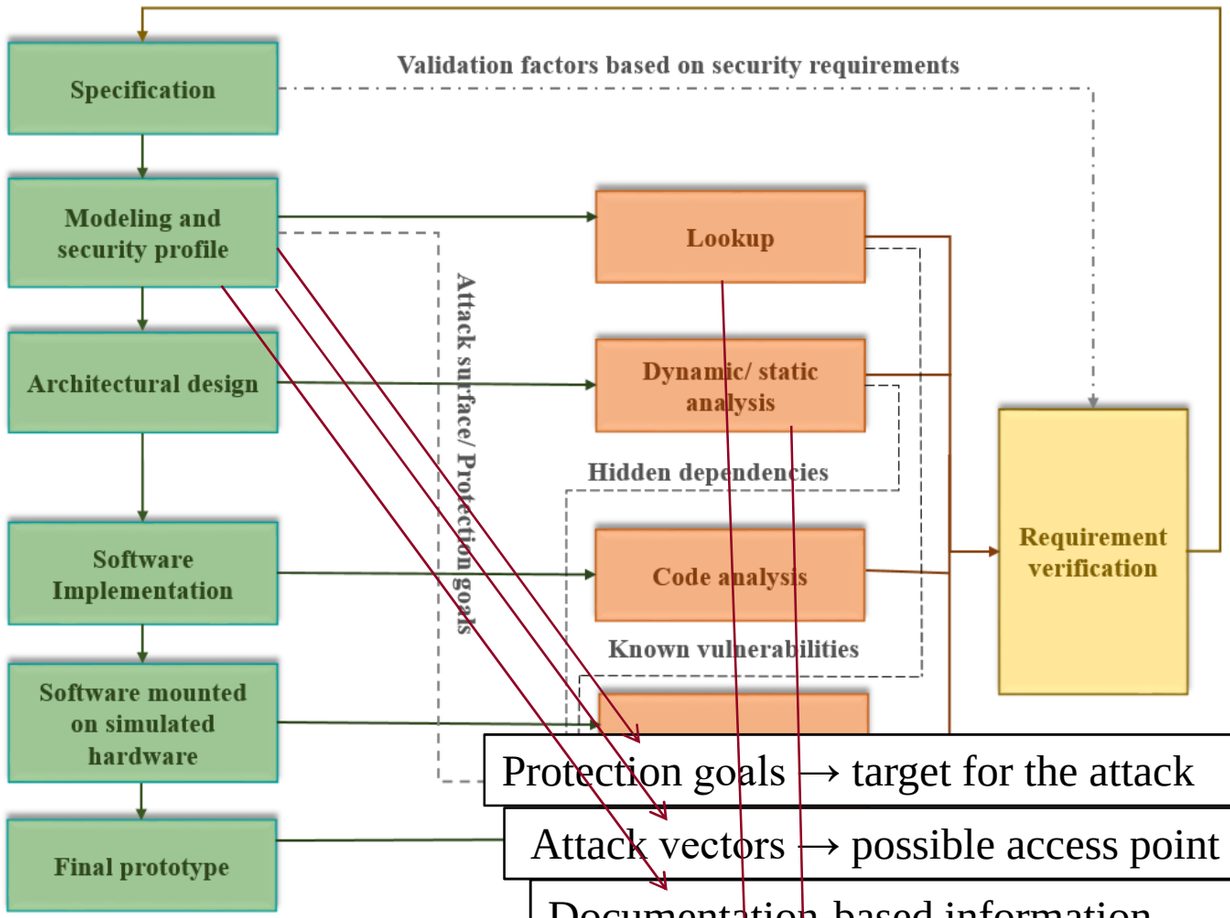
Penetration Testing

- Recognition
- Scanning
- Gaining Access



Penetration Testing

- Recognition
- Scanning
- Gaining Access
- Exploitation



Protection goals → target for the attack

Attack vectors → possible access point to the system

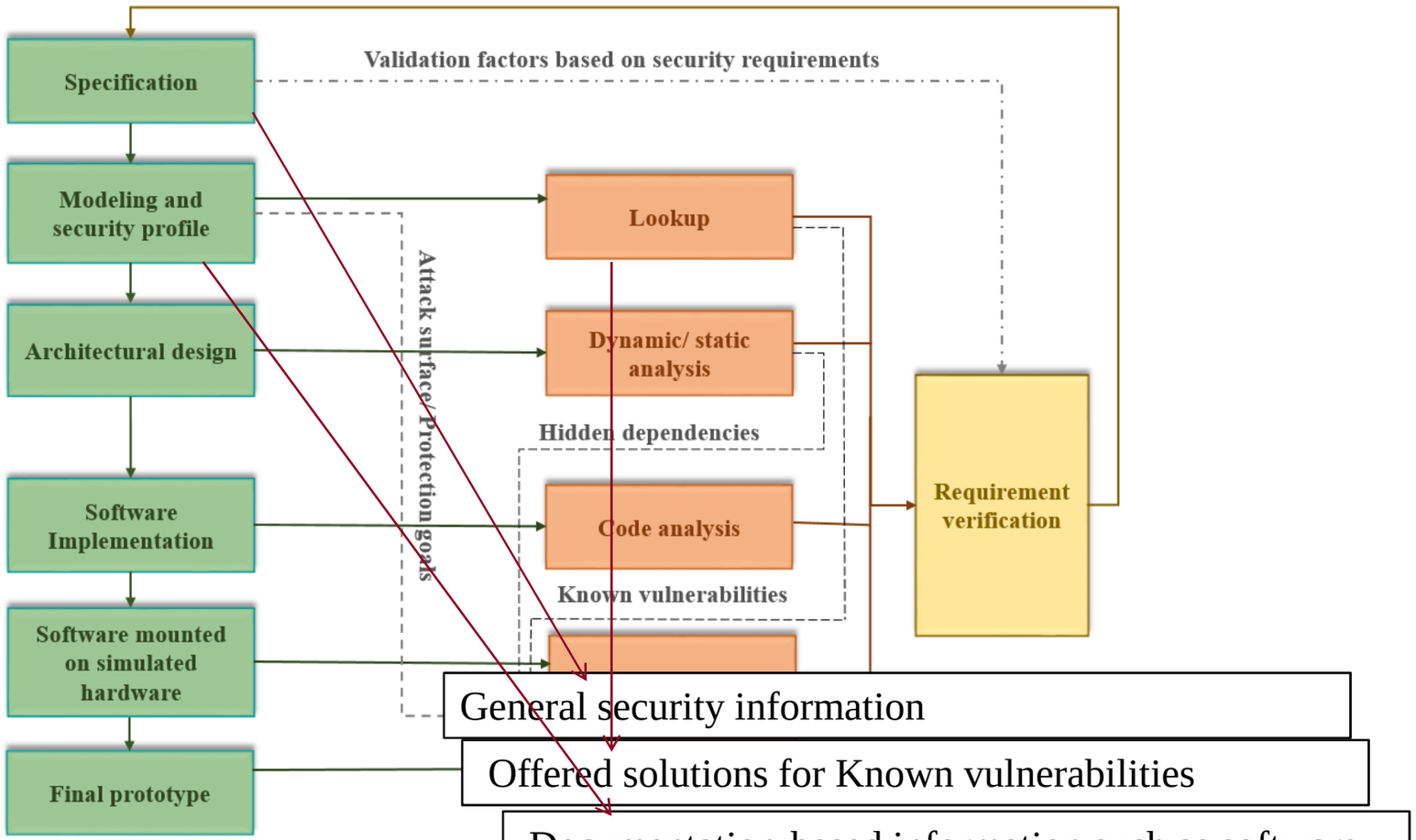
Documentation-based information

Known vulnerabilities → exploit the system

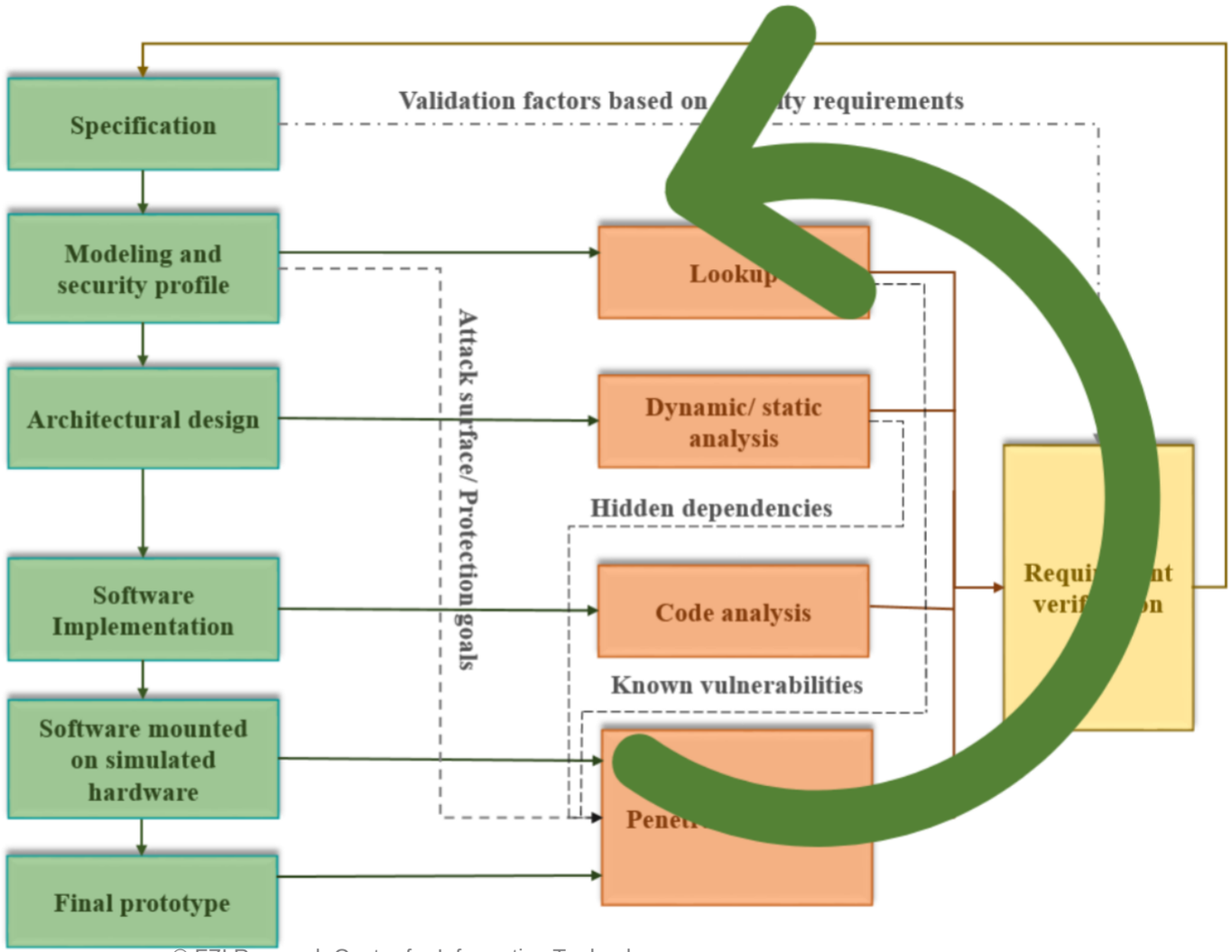
Hidden dependencies → exploitation

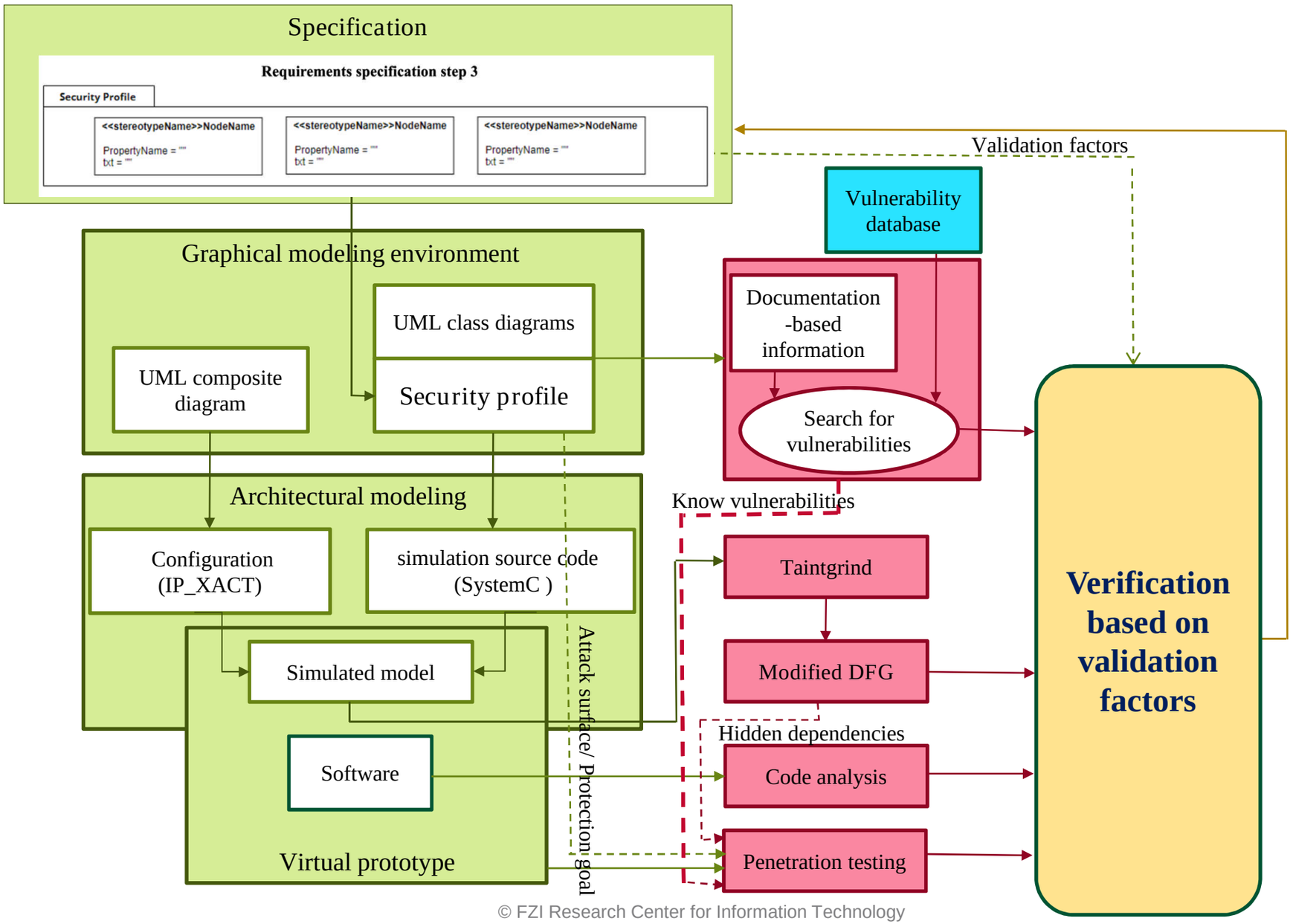
Penetration Testing

- Recognition
- Scanning
- Gaining Access
- Exploitation
- Reporting



Closed loop





Advantages of presented methodology

- Cost efficient early penetration testing
- Design decision verification
- Model verification
- Evaluation of security mechanisms performance
- Prevention strategy instead of reaction strategy
- Compliance with UMLsec

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Thank you for your attention