Software Platforms for Automotive Systems

Lecture 6: Main Development Process

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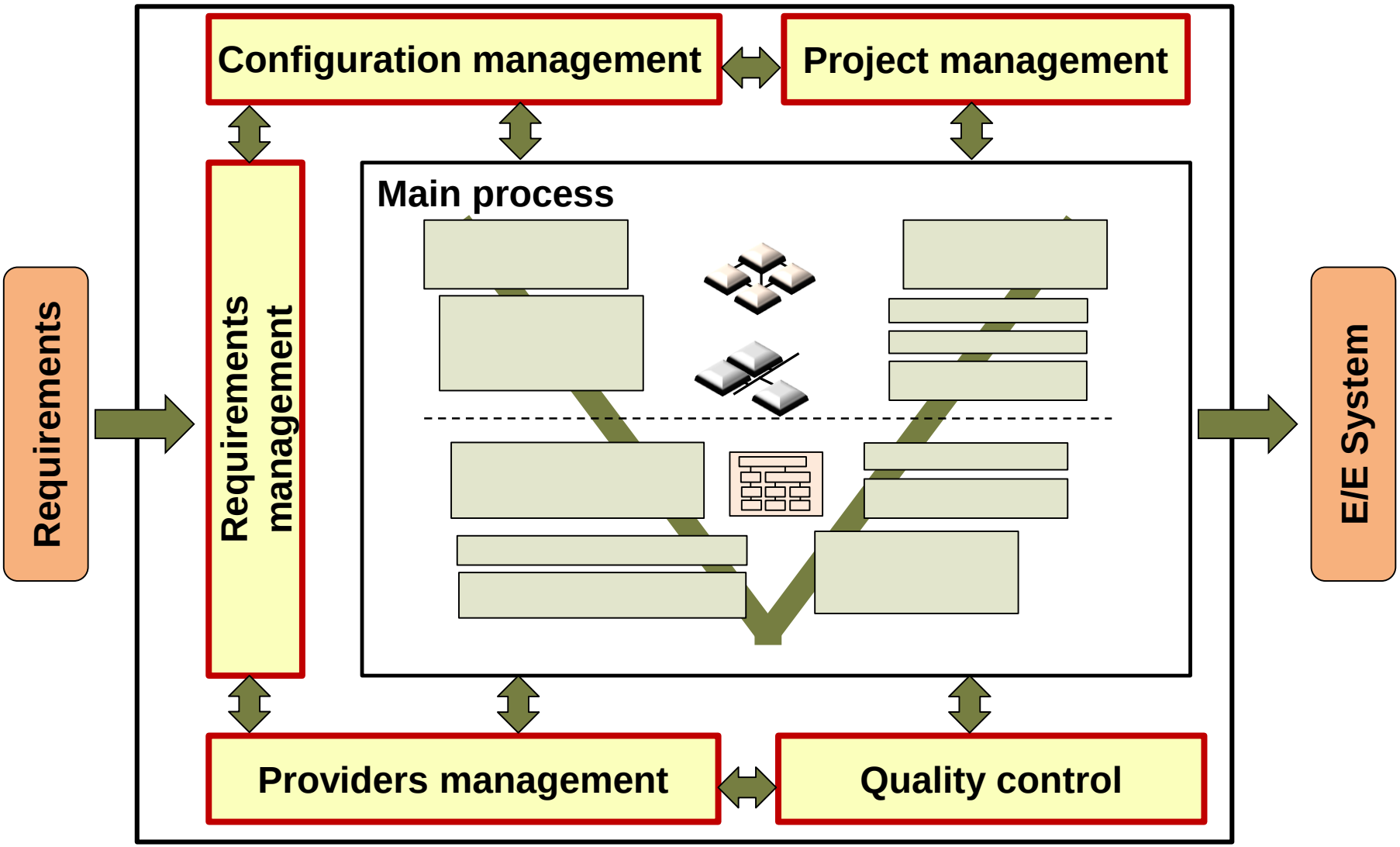
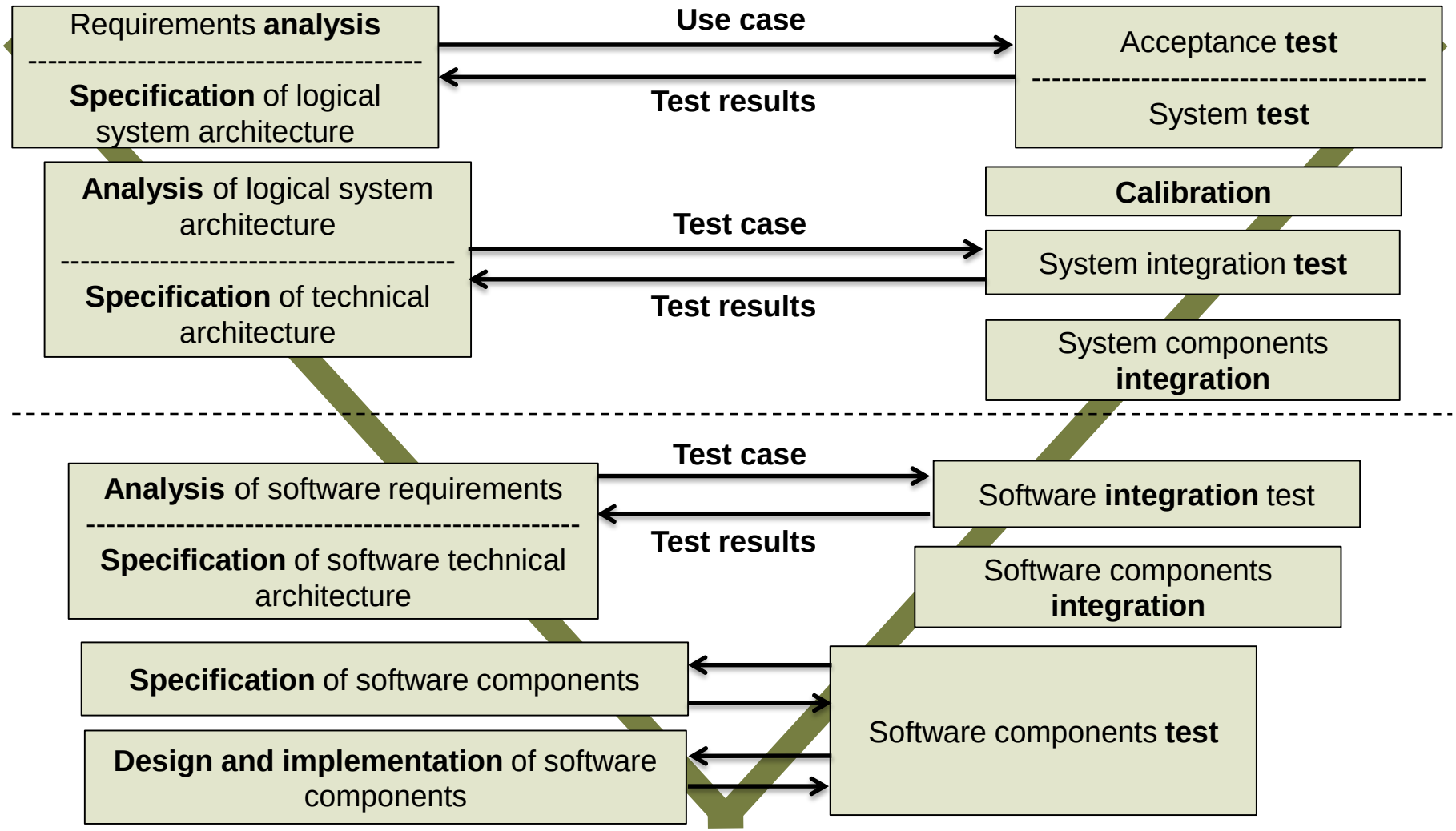
Development Process



Main Development Process

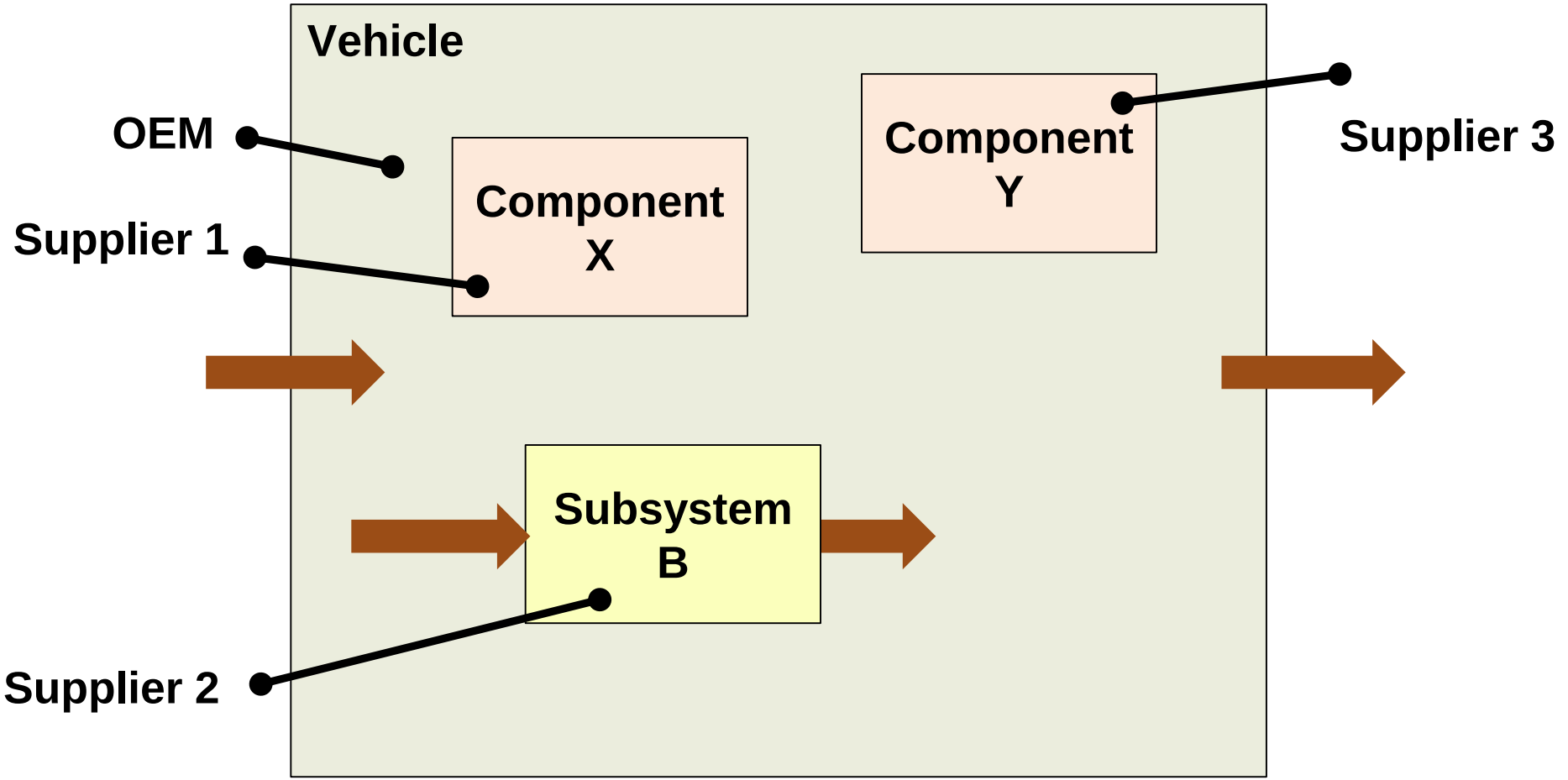


V-Model

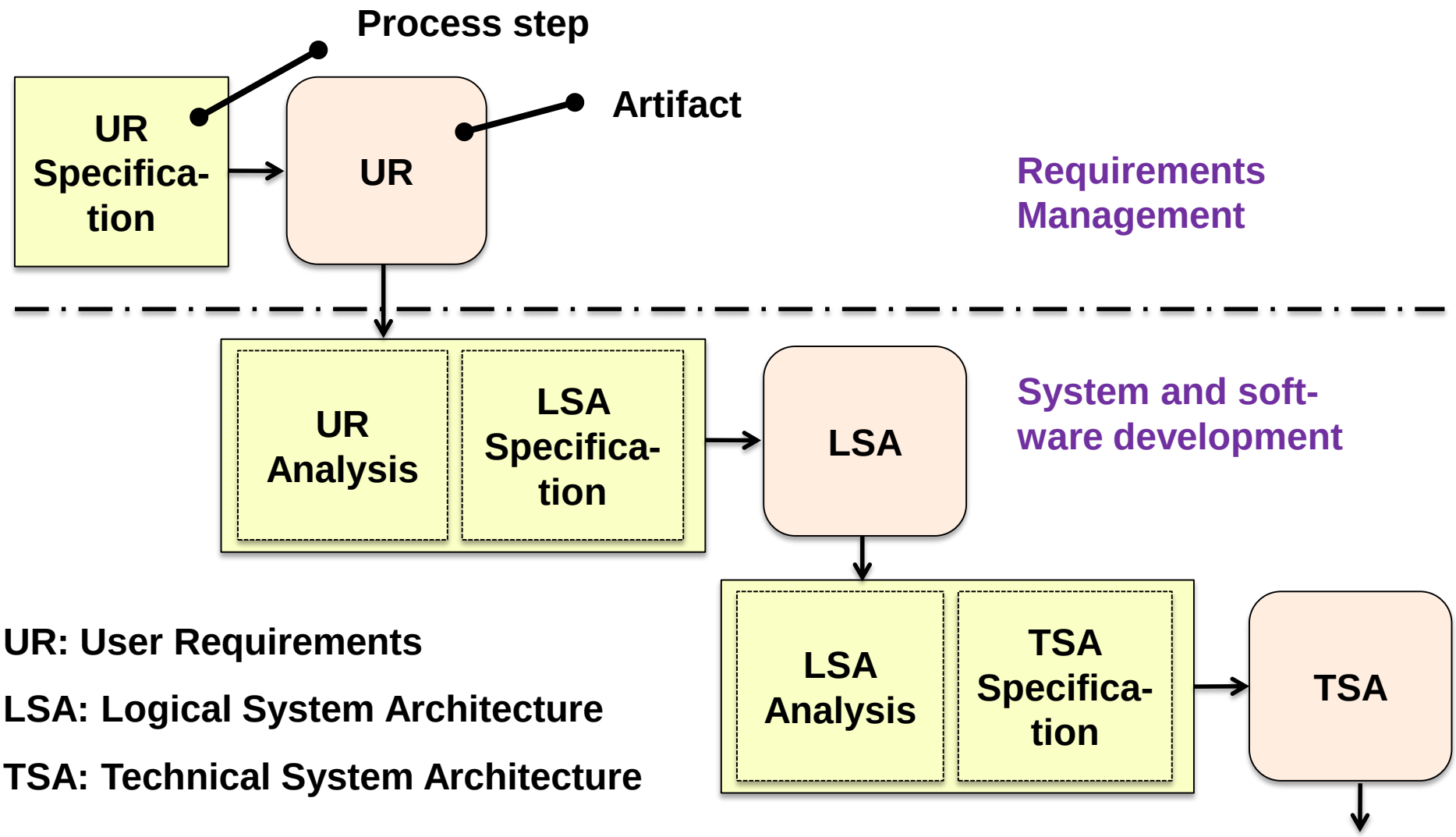
- **Two branches of sides (that's why it is called "V")**
  - **Left-hand branch: analysis and specification steps**
  - **Right-hand branch: implementation and testing steps**
- **Frequently used in the embedded domain**
  - **In particular, for safety and reliability requirements**
- **Disadvantage: lack of feedback to early phases**
  - **Late changes in the requirements = high costs**
- **That's why it is used in an iterative manner**
  - **A number of prototypes are developed first**

Assignment of Responsibility

- OEM focus on validation and integration

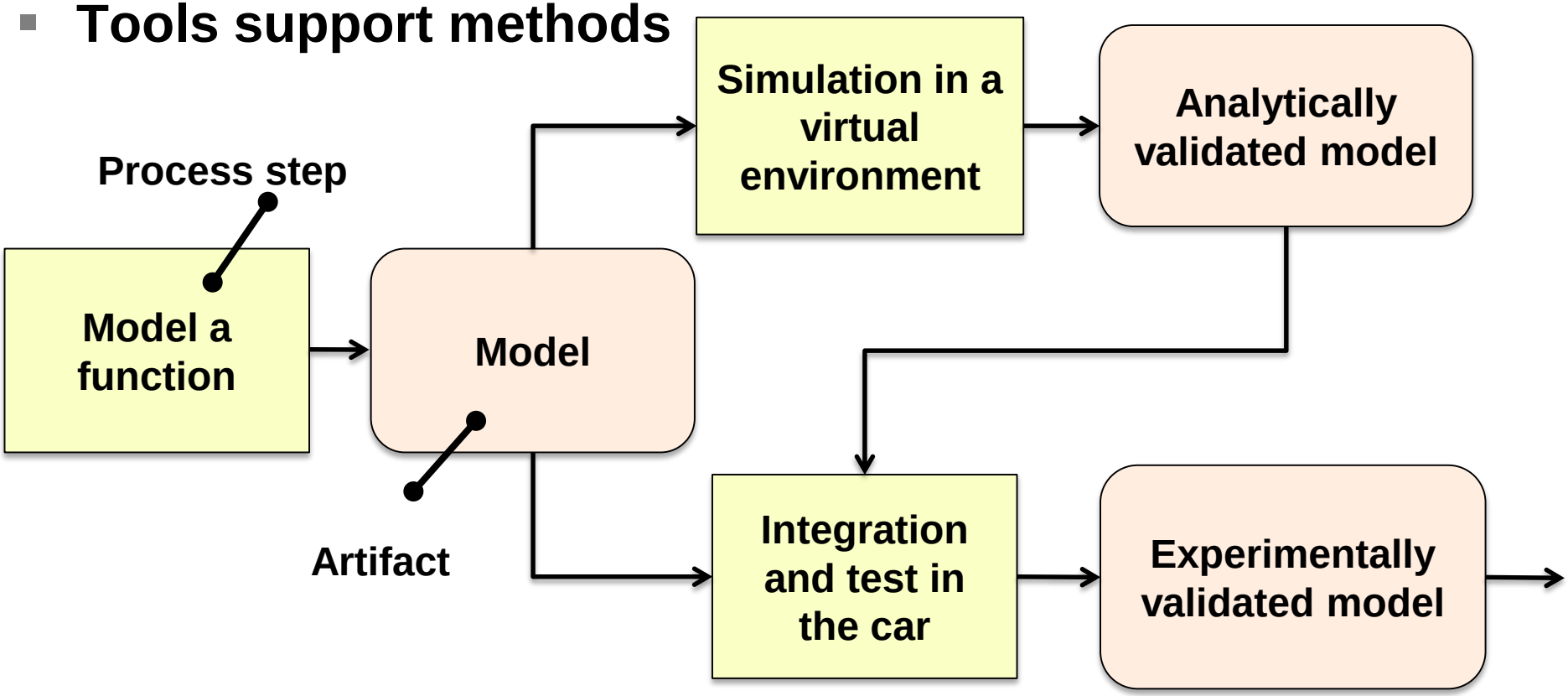


Process According to the V-Model

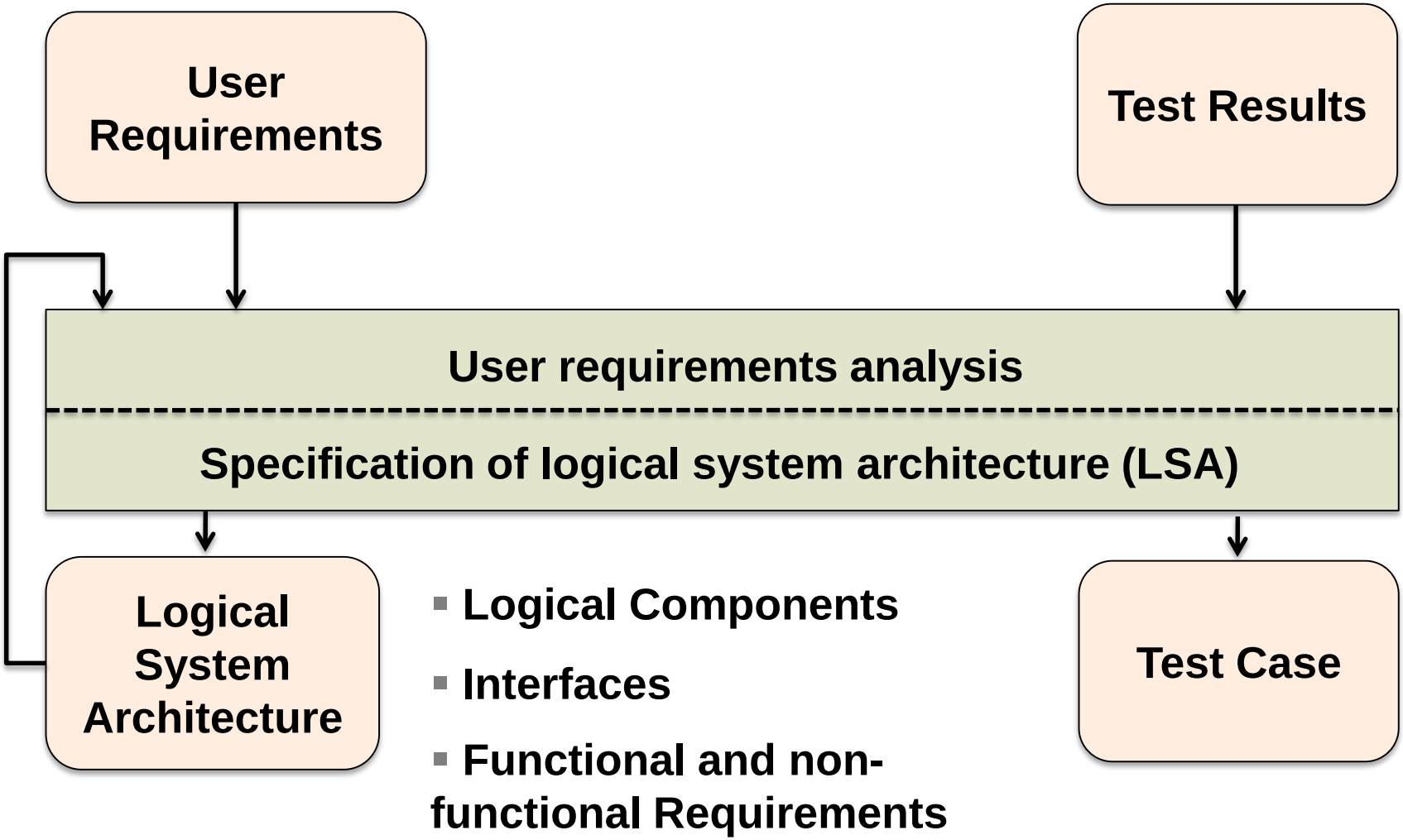


Methods and Tools

- **Methods: Simulation and Rapid prototyping**
  - **Early validation of specifications**
- **Tools support methods**

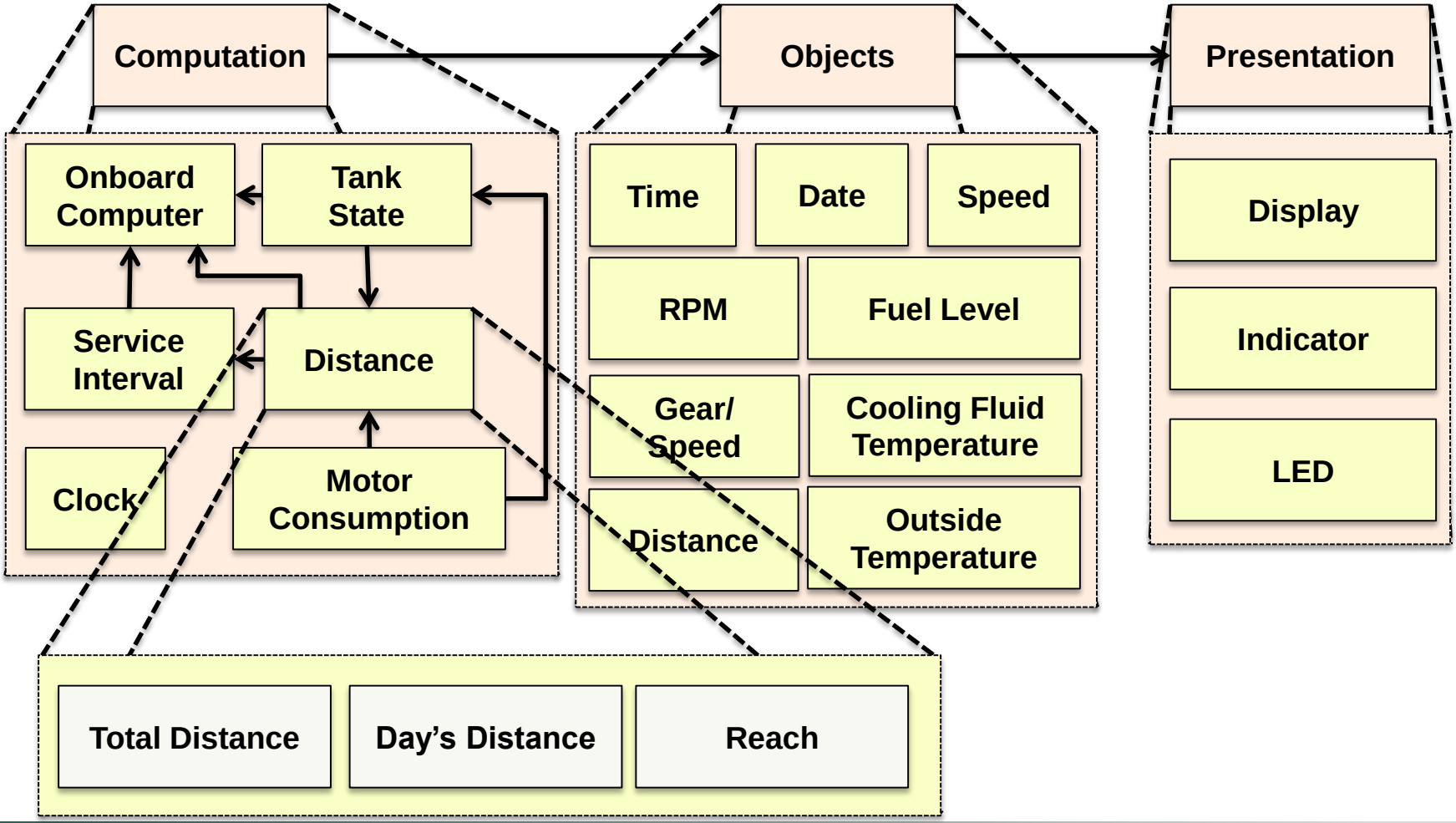


Requirements Analysis



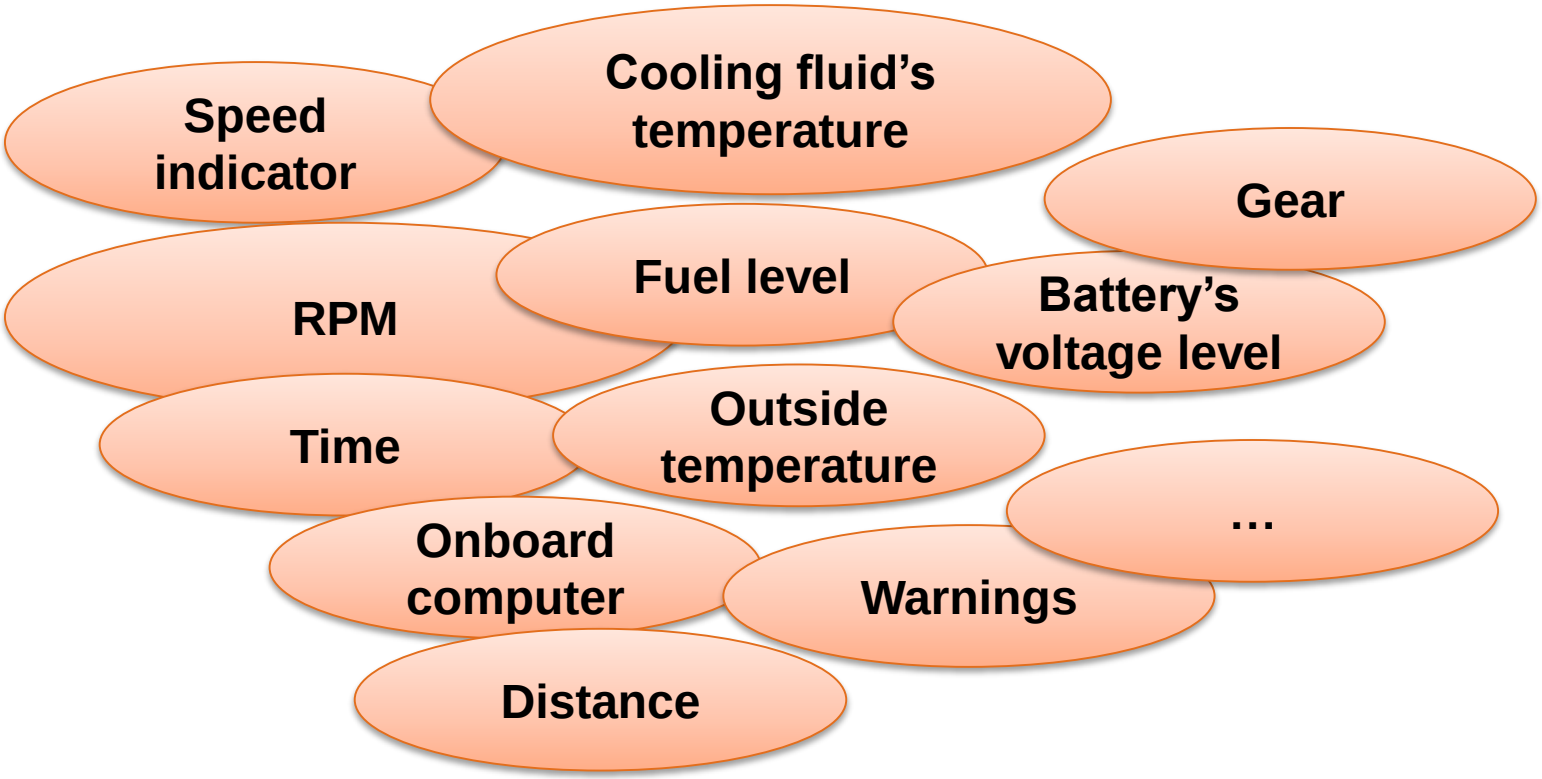
Instruments Panel

- **Logical System Architecture**

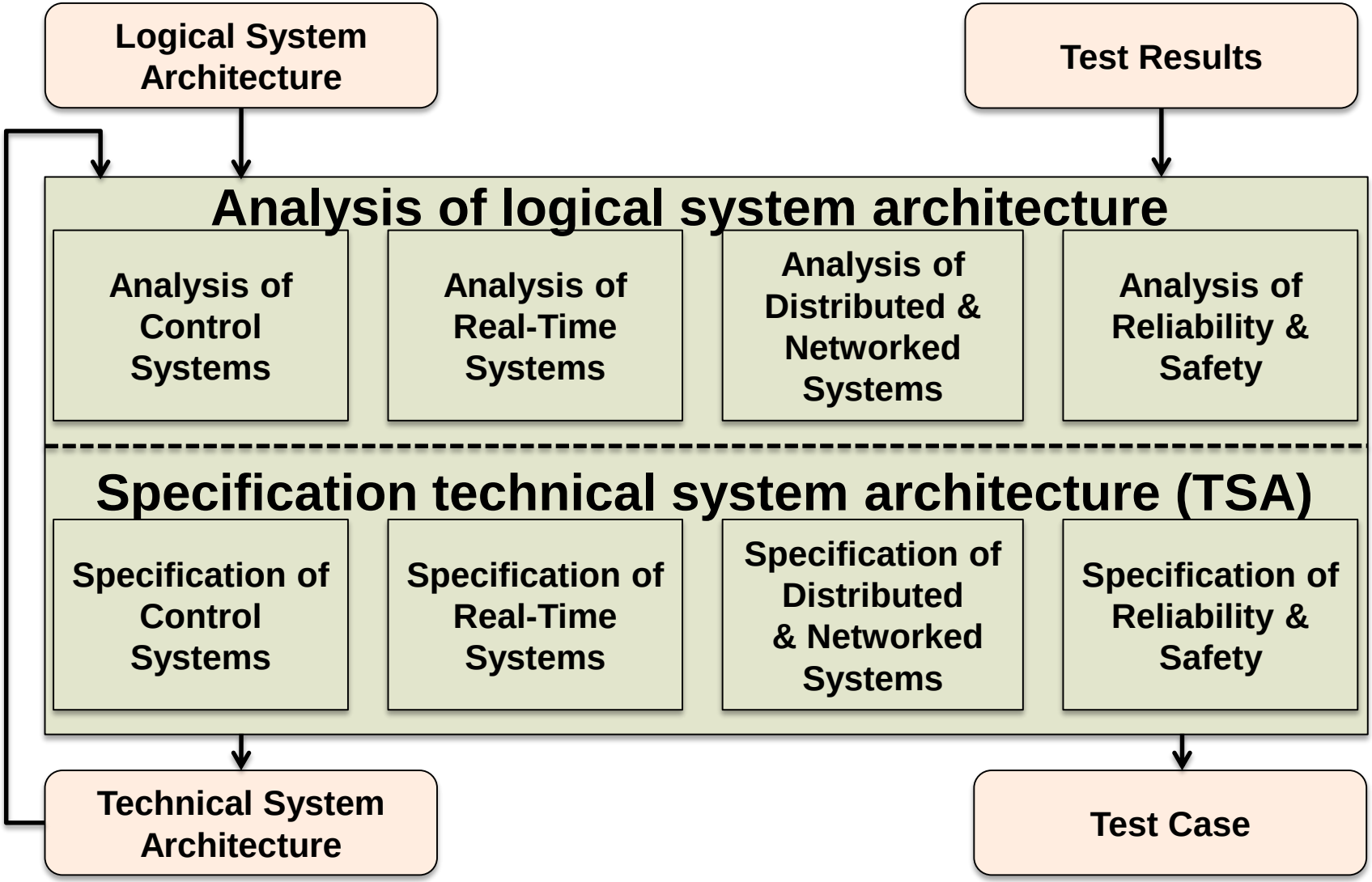


Instruments Panel

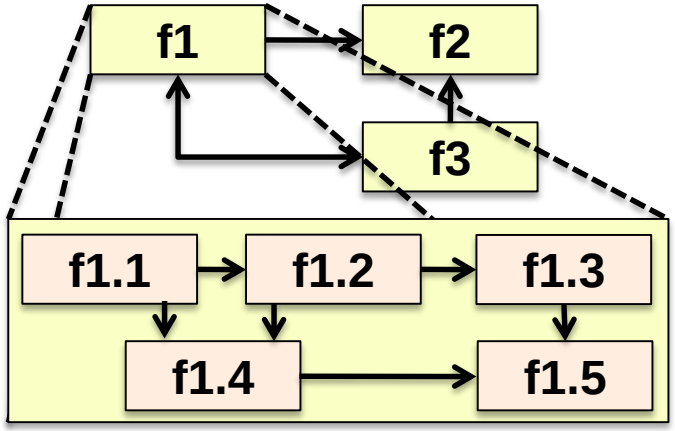
- **Accepted user requirements become requirements**



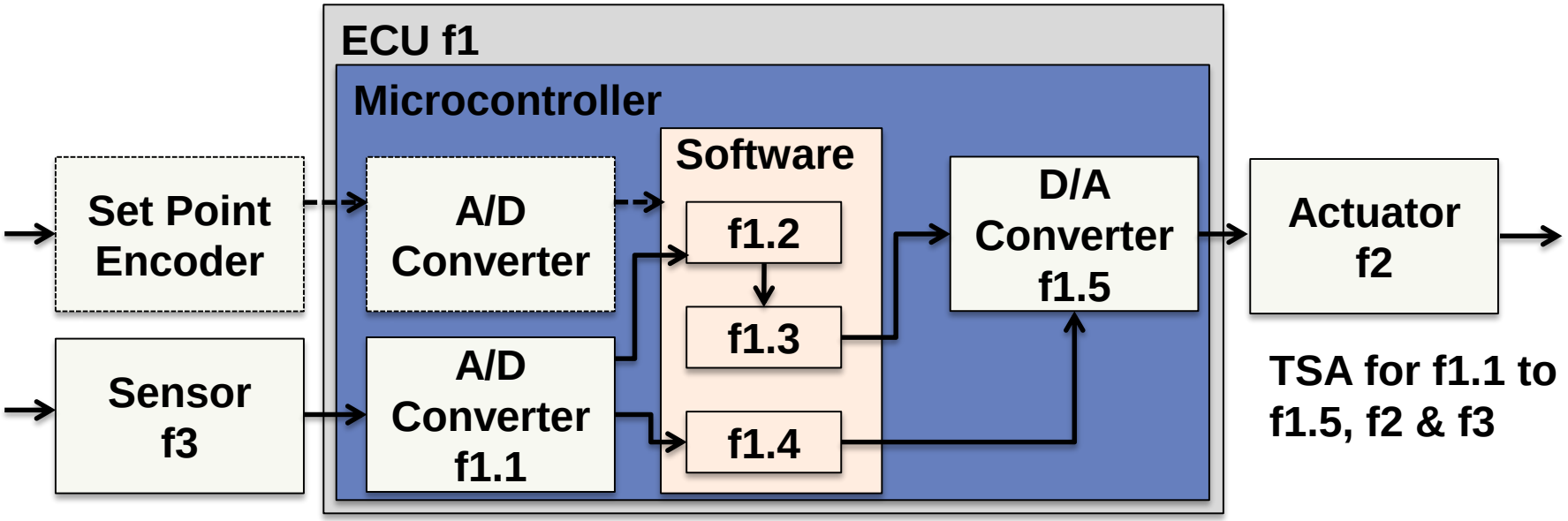
Analysis of LSA



From LSA to TSA

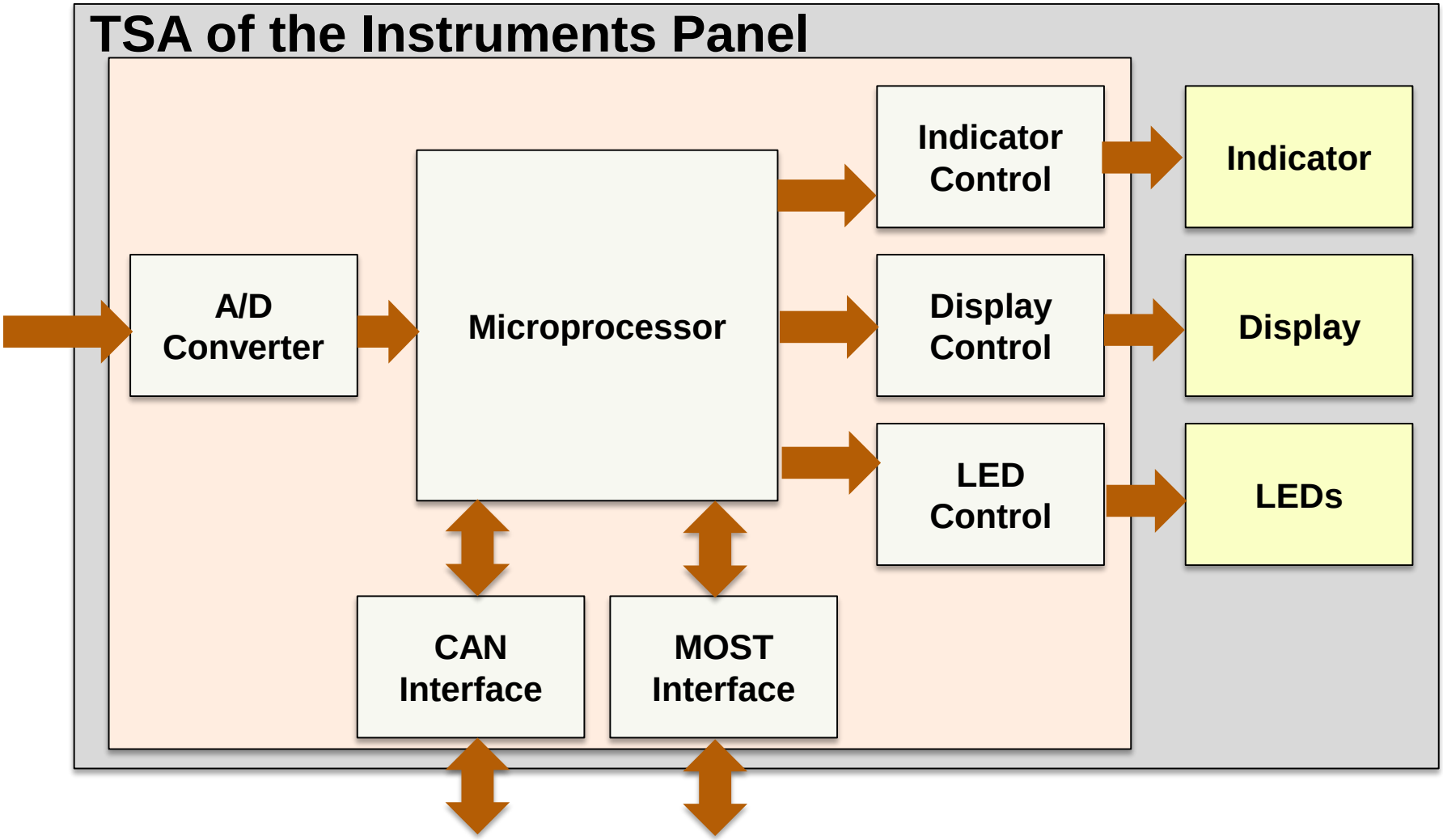


LSA for
f1, f2 & f3

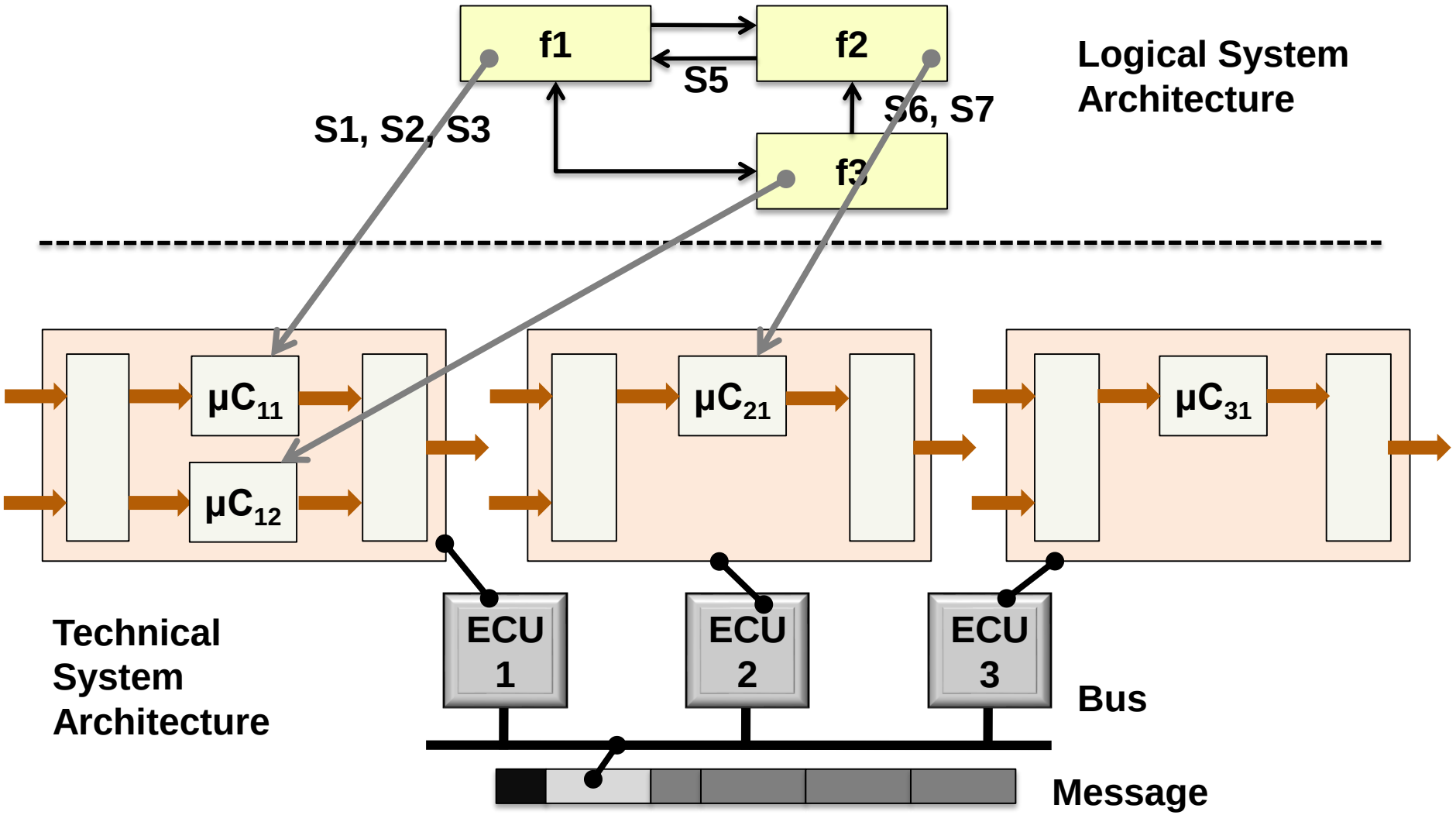


TSA for f1.1 to
f1.5, f2 & f3

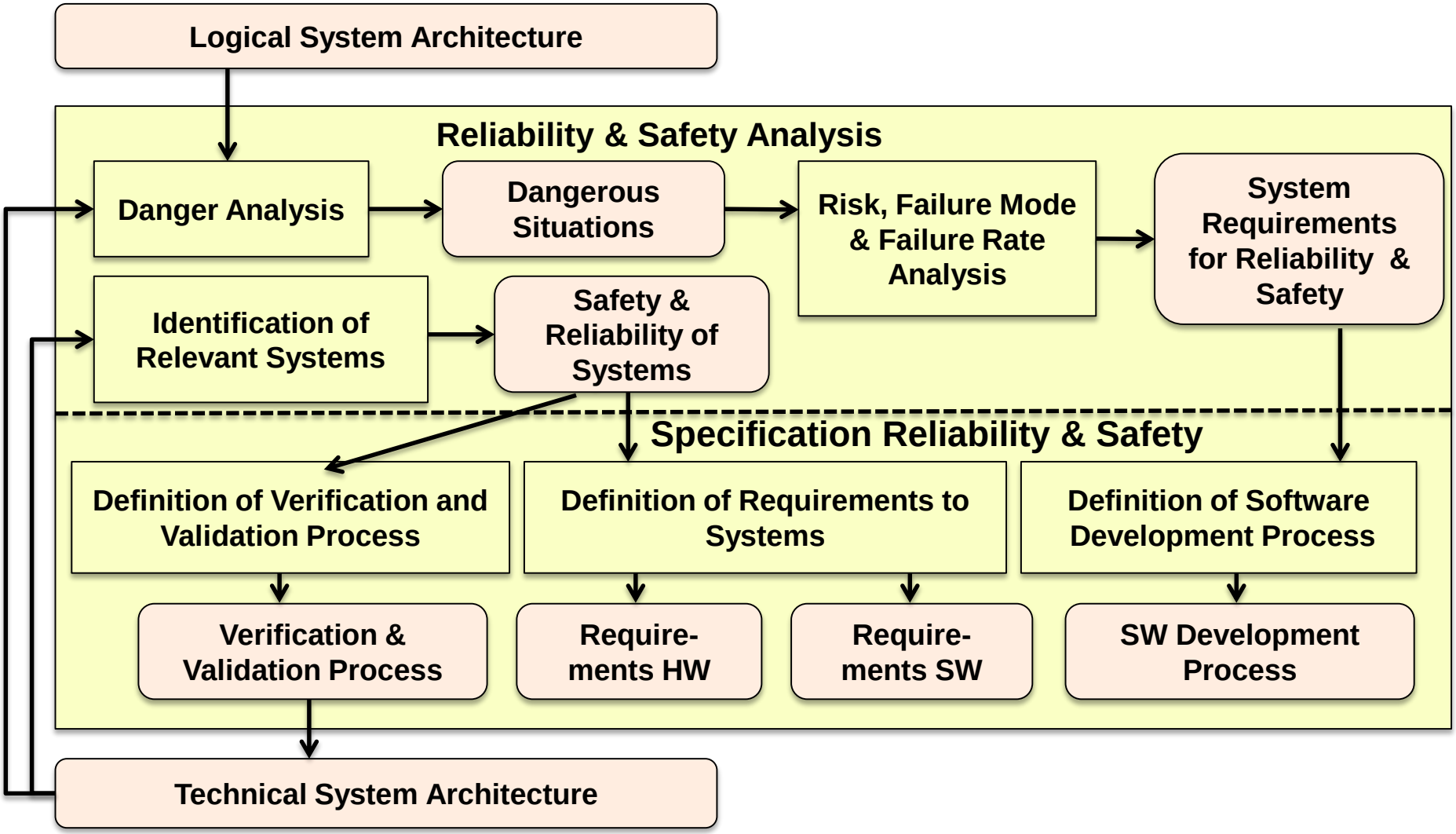
Instruments Panel



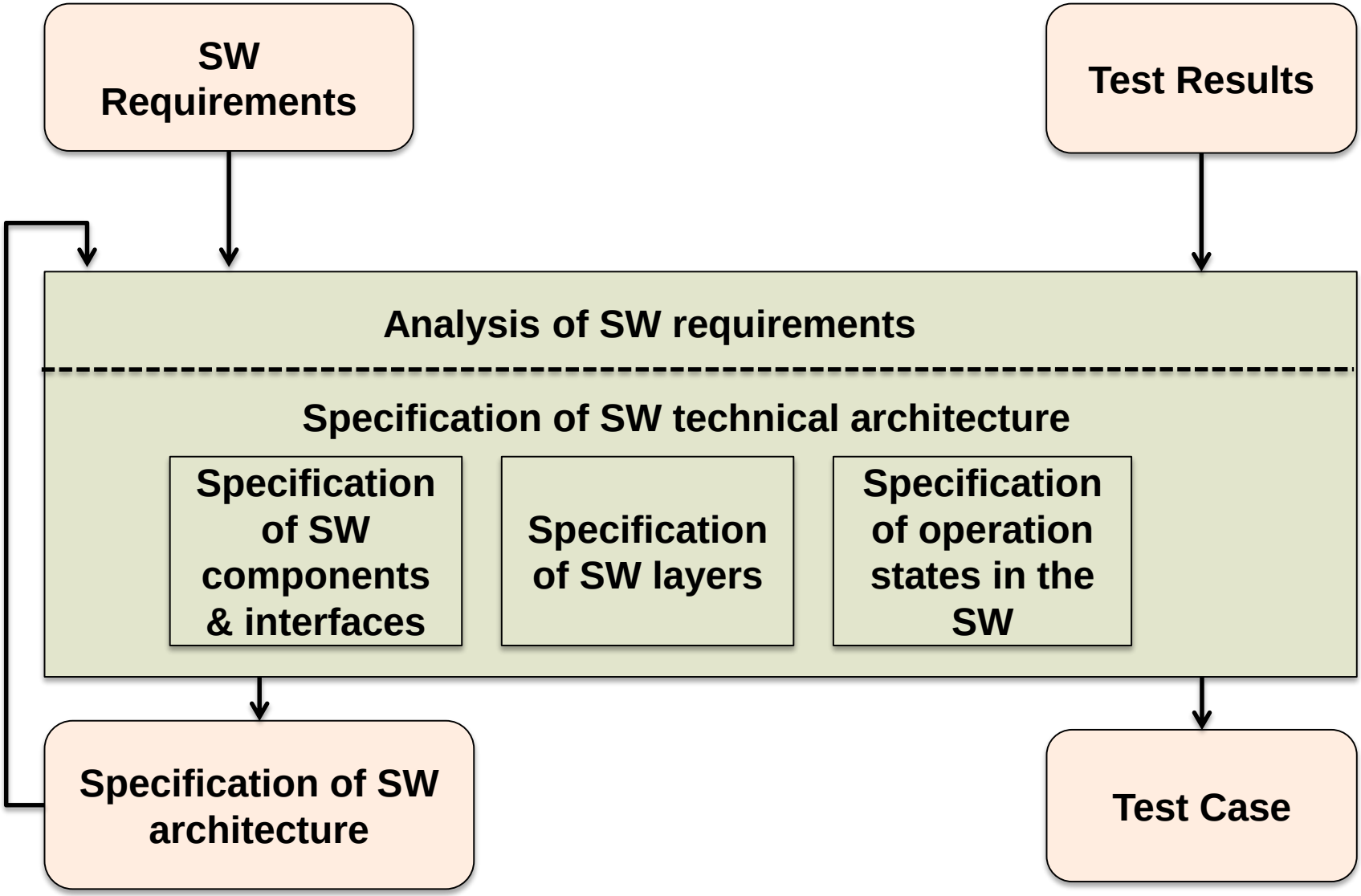
Analysis of Distributed Systems



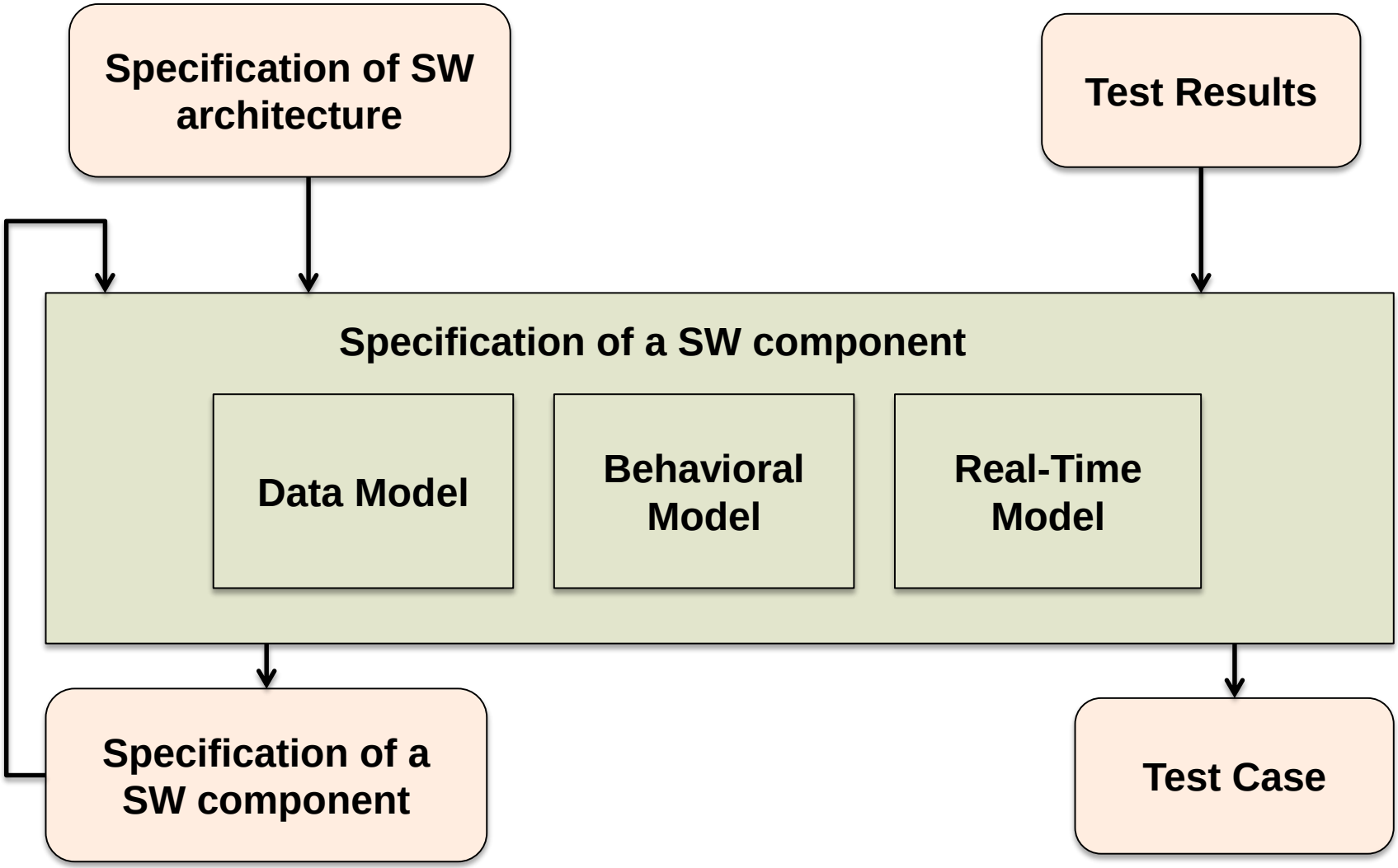
Safety and Reliability



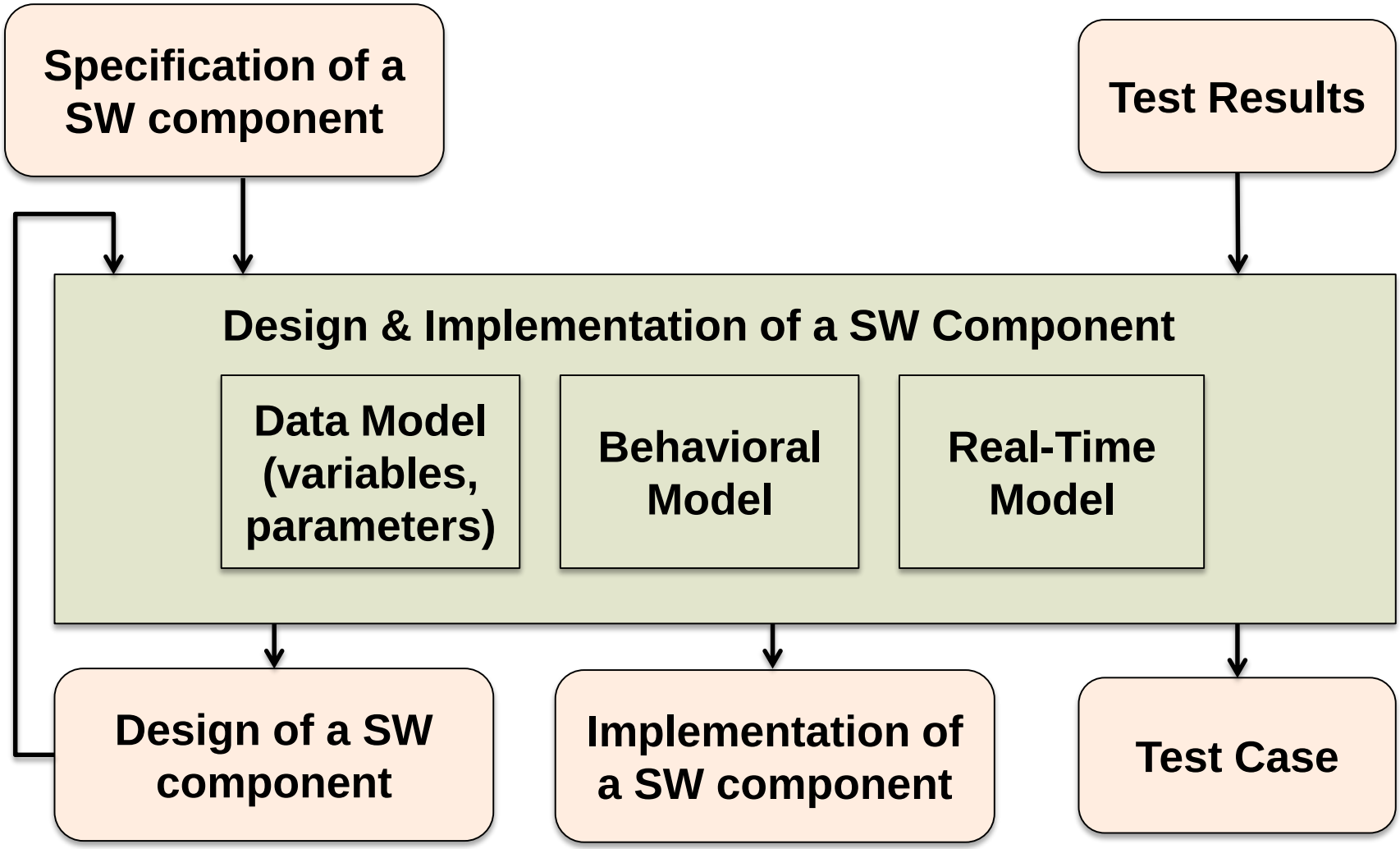
Analysis of SW Requirements



Specification of SW Components



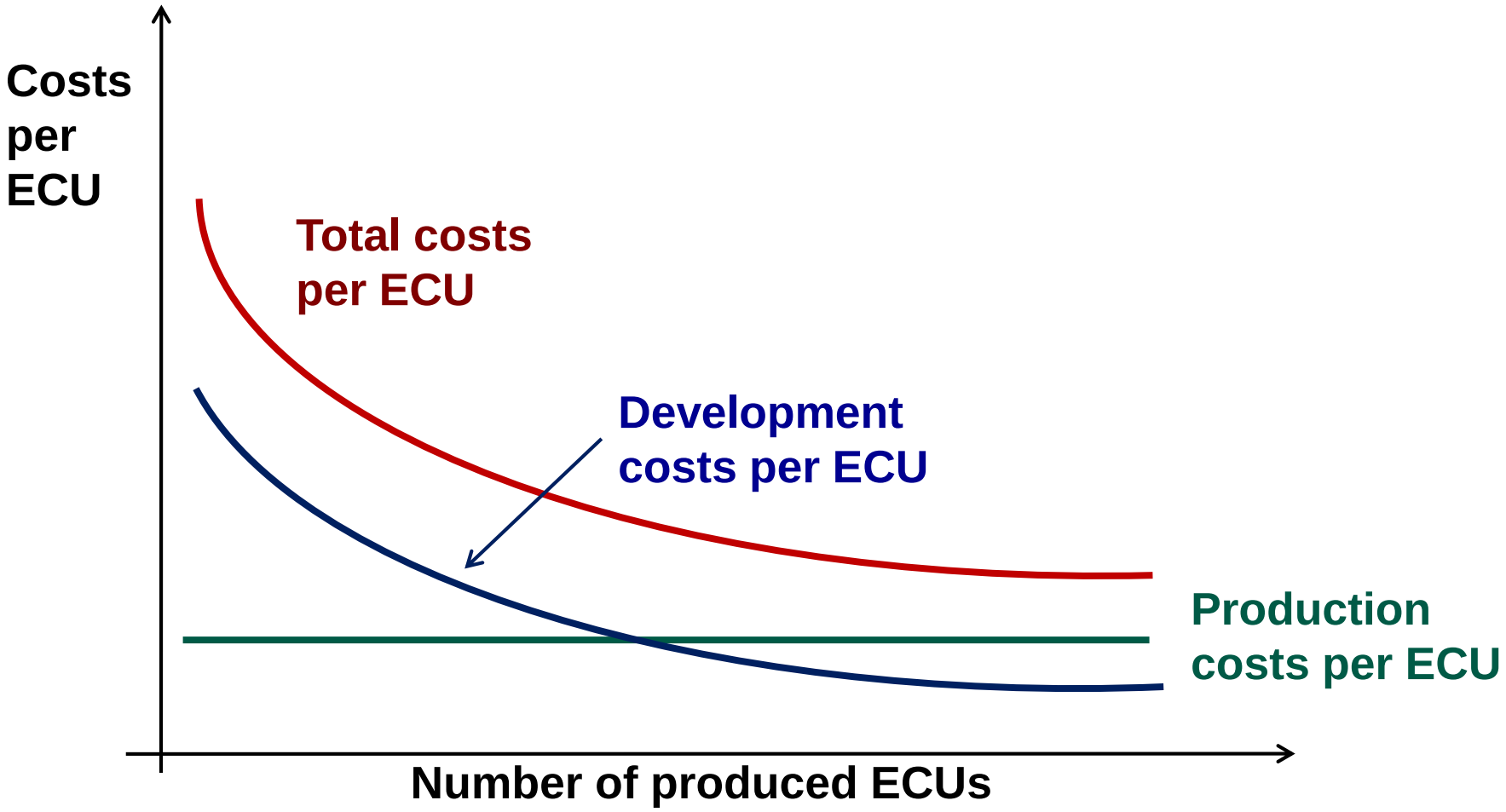
Development of SW Components



Development of SW Components

- **Need to consider non-functional requirements**
  - **Separation between data and code**
  - **Limited hardware resources**
    - **Less RAM available as in the desktop domain**
      - **Normally because of costs restrictions**
    - **Use of specific hardware platforms**
      - **Normally because of company-wide decisions**
  - **Safety requirements**
  - **Reliability requirements: redundancy**
  - **Real-time requirements**

Development of SW Components



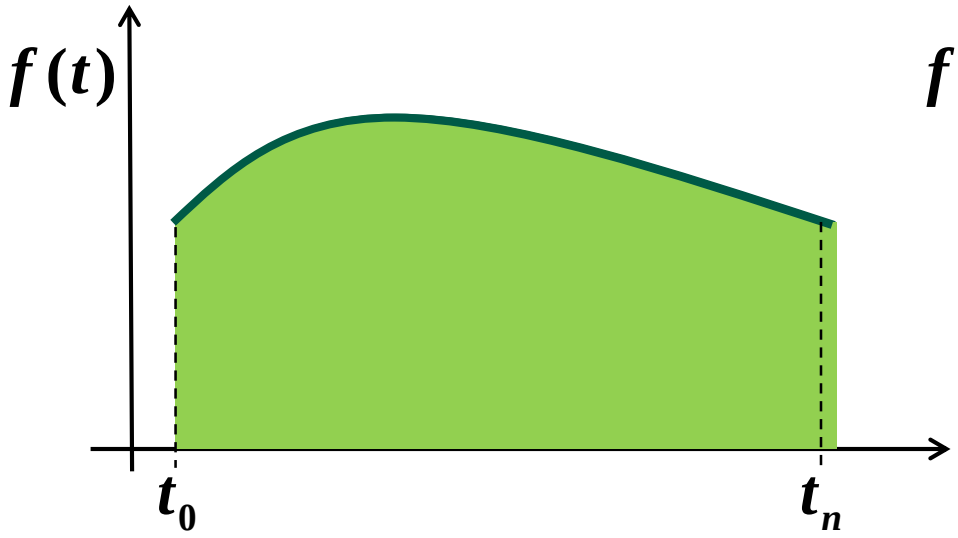
Development of SW Components

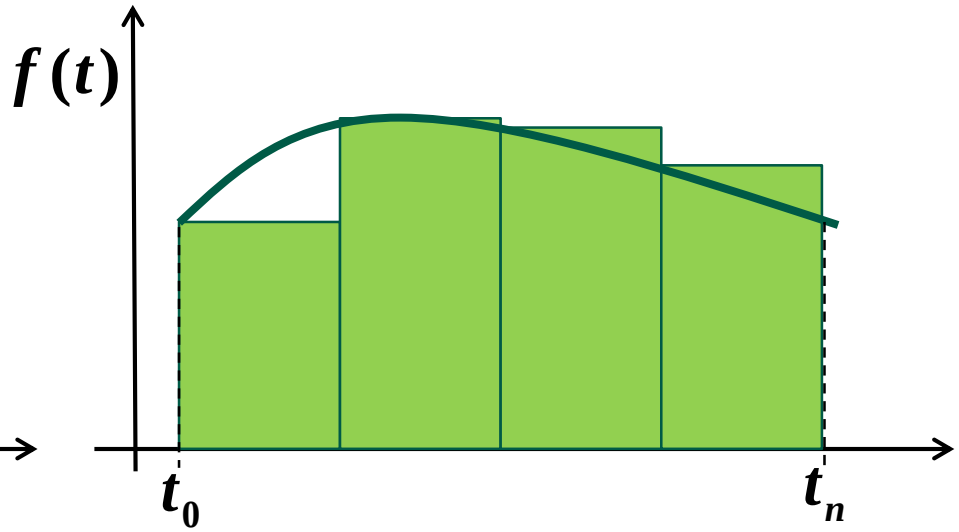
- **Implementation concerns**
  - **Quantification errors due to A/D conversion**
    - **Limited number of bits**
  - **Rounding errors**
    - **Precision is never unlimited**
    - **Need to go from a floating to fixed point**
  - **Approximation errors**
    - **Integration**
    - **Derivation**
- **Implementing real-time behavior: real-time OS**

Development of SW Components

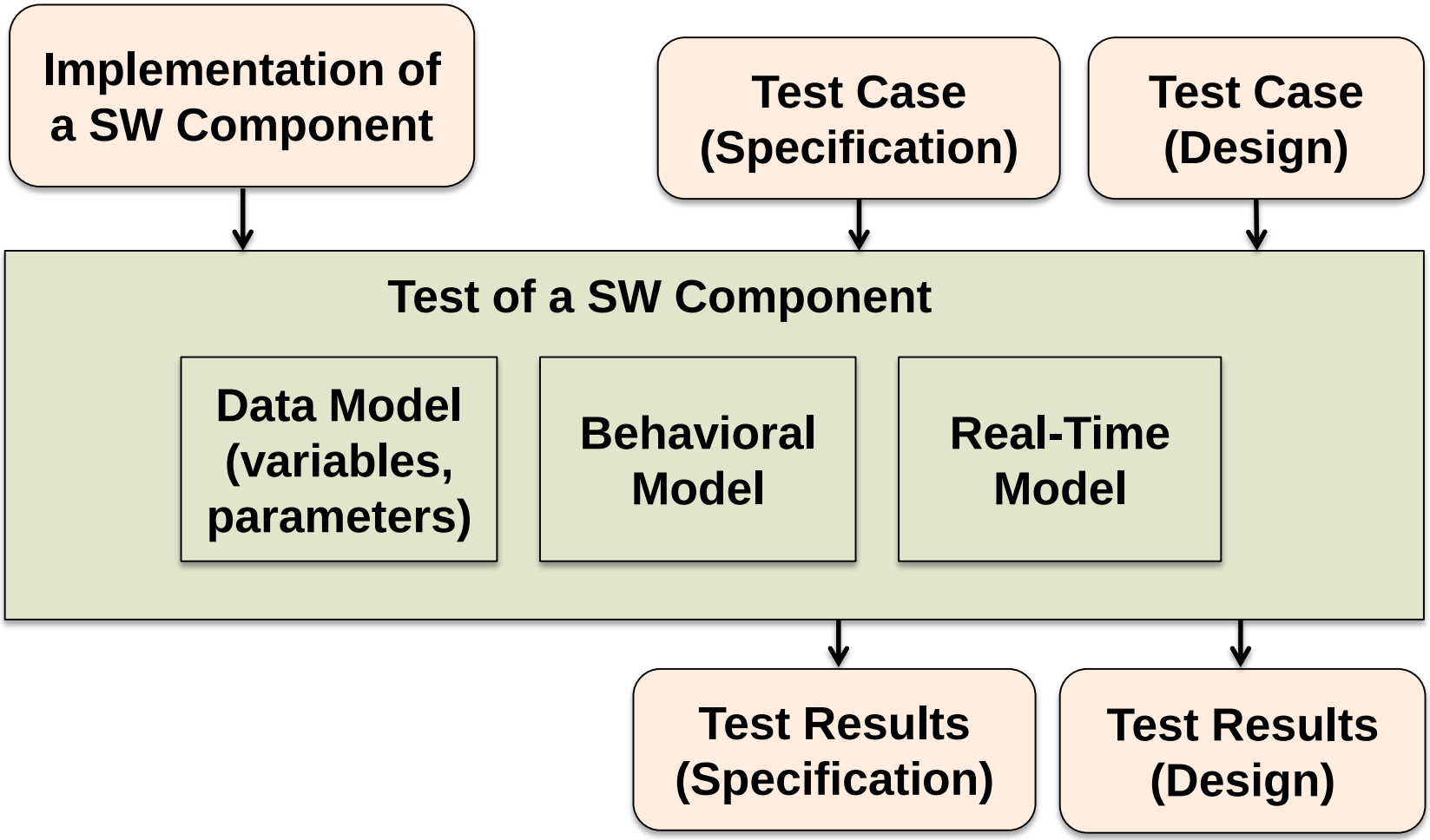
- **Approximation errors**
  - **Integration**

$$I = \int_{t_0}^{t_n} f(t)dt \qquad \Rightarrow I^* = \sum_{i=0}^{n-1} (t_{i+1} - t_i) f(t_i)$$

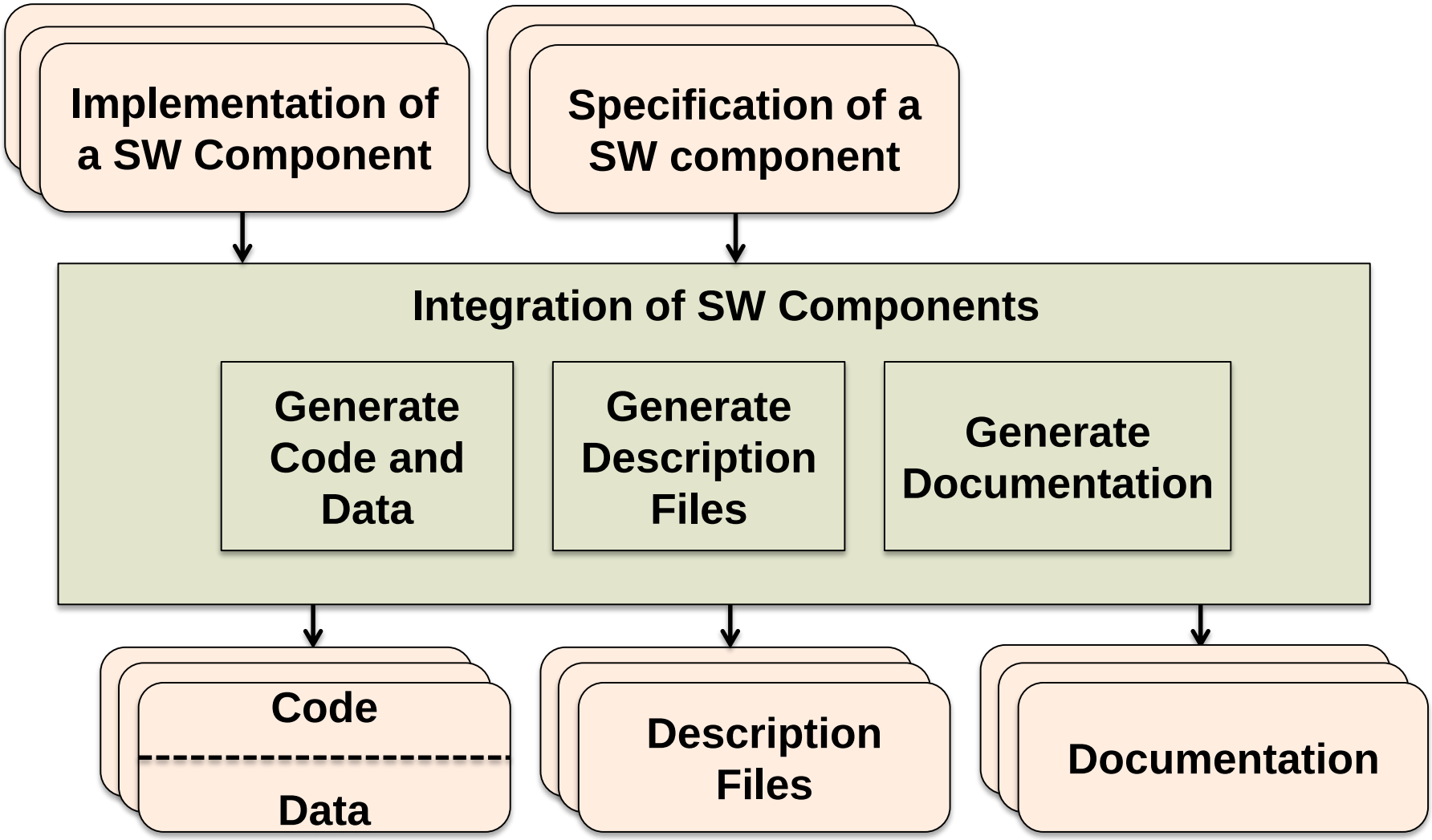




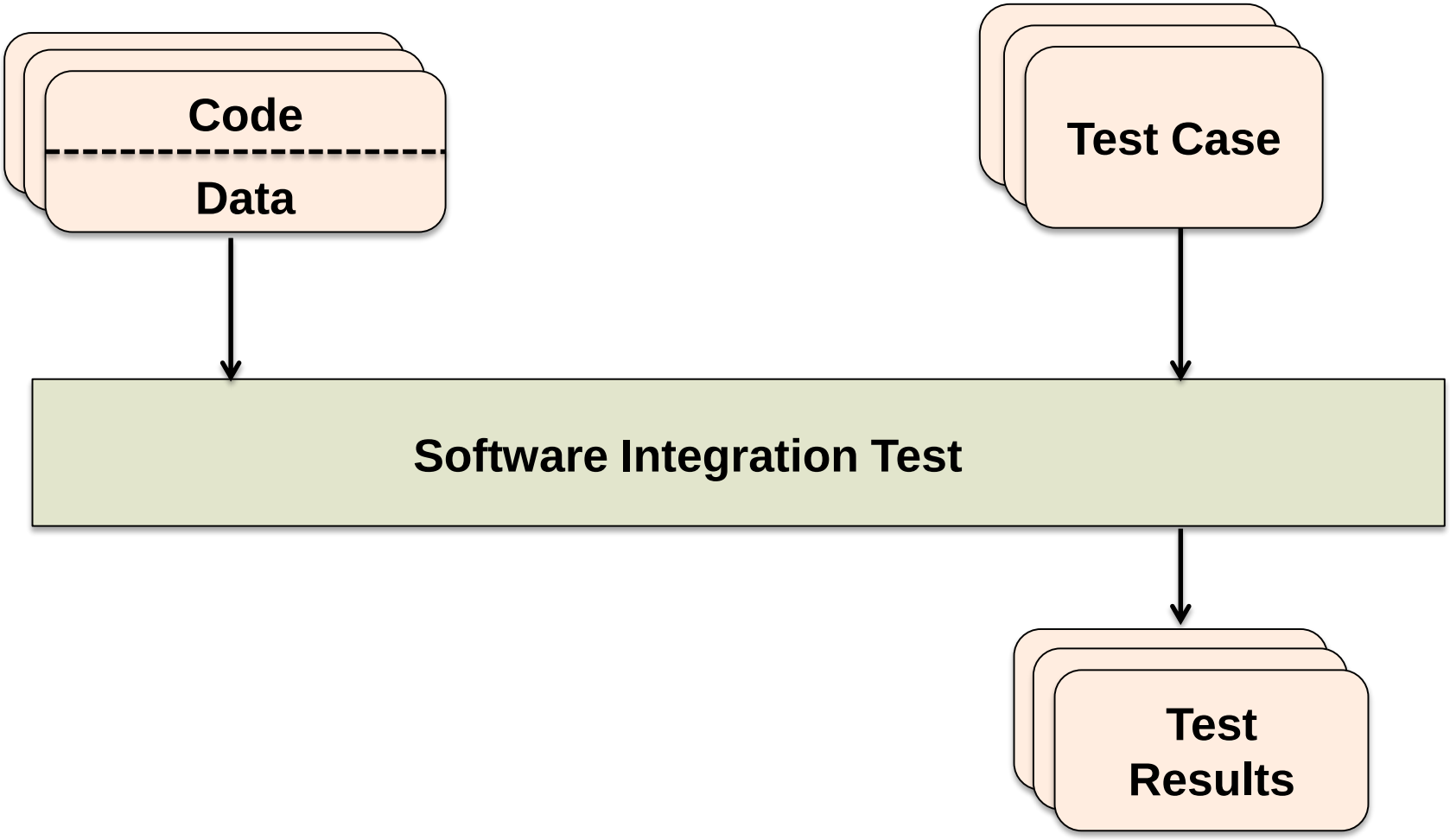
Testing SW Components



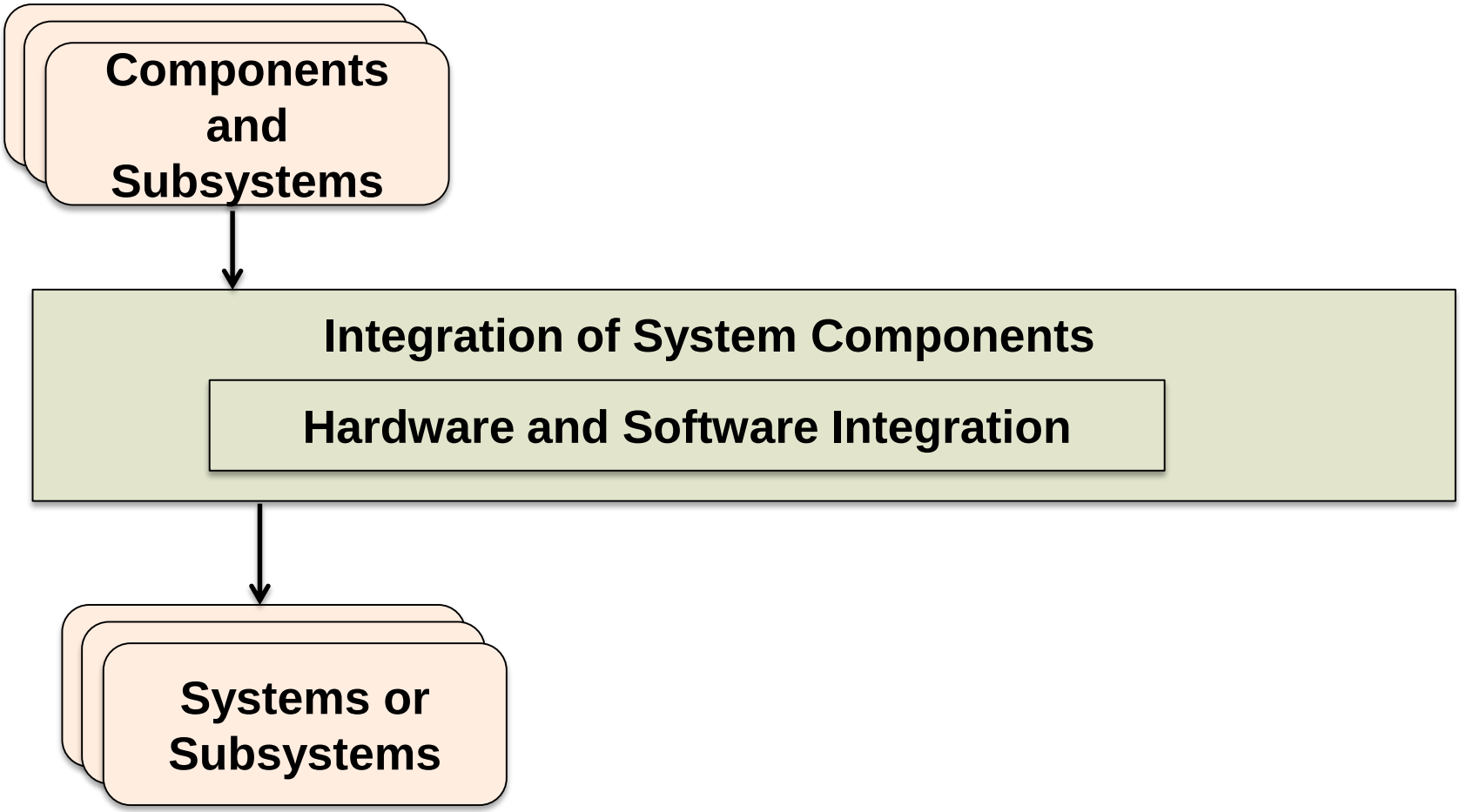
Integrating SW Components



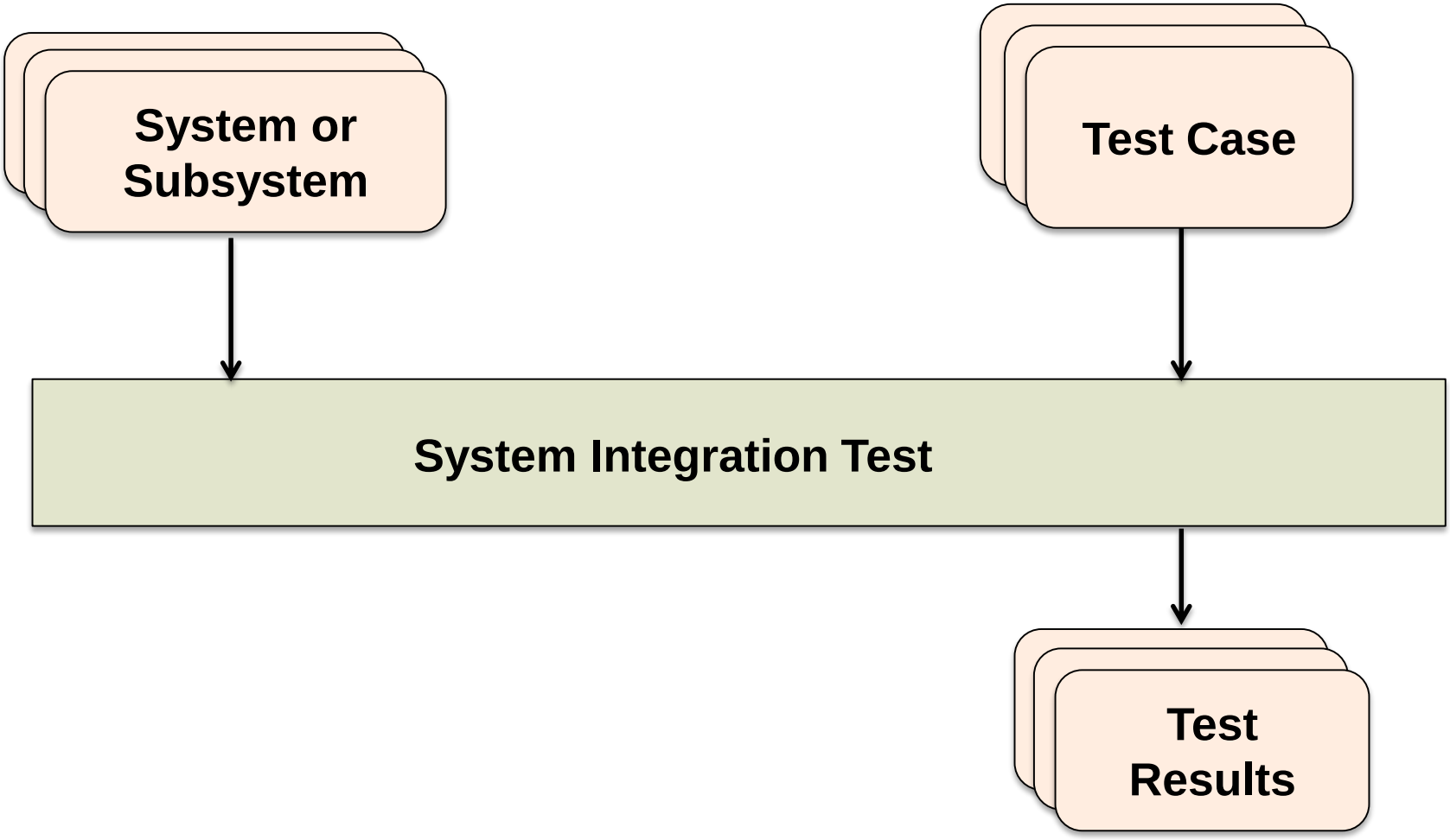
SW Integration Test



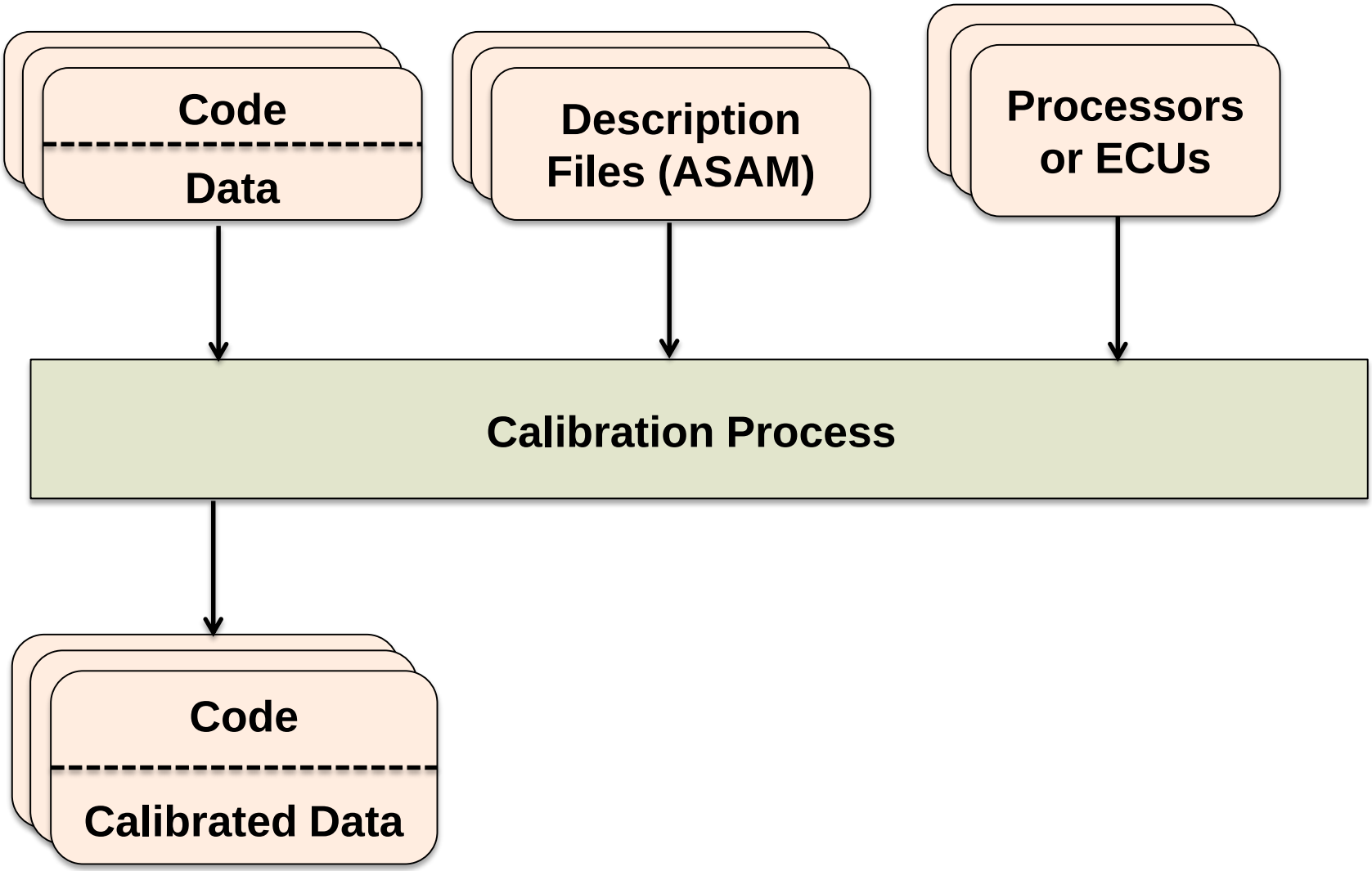
System Component Integration



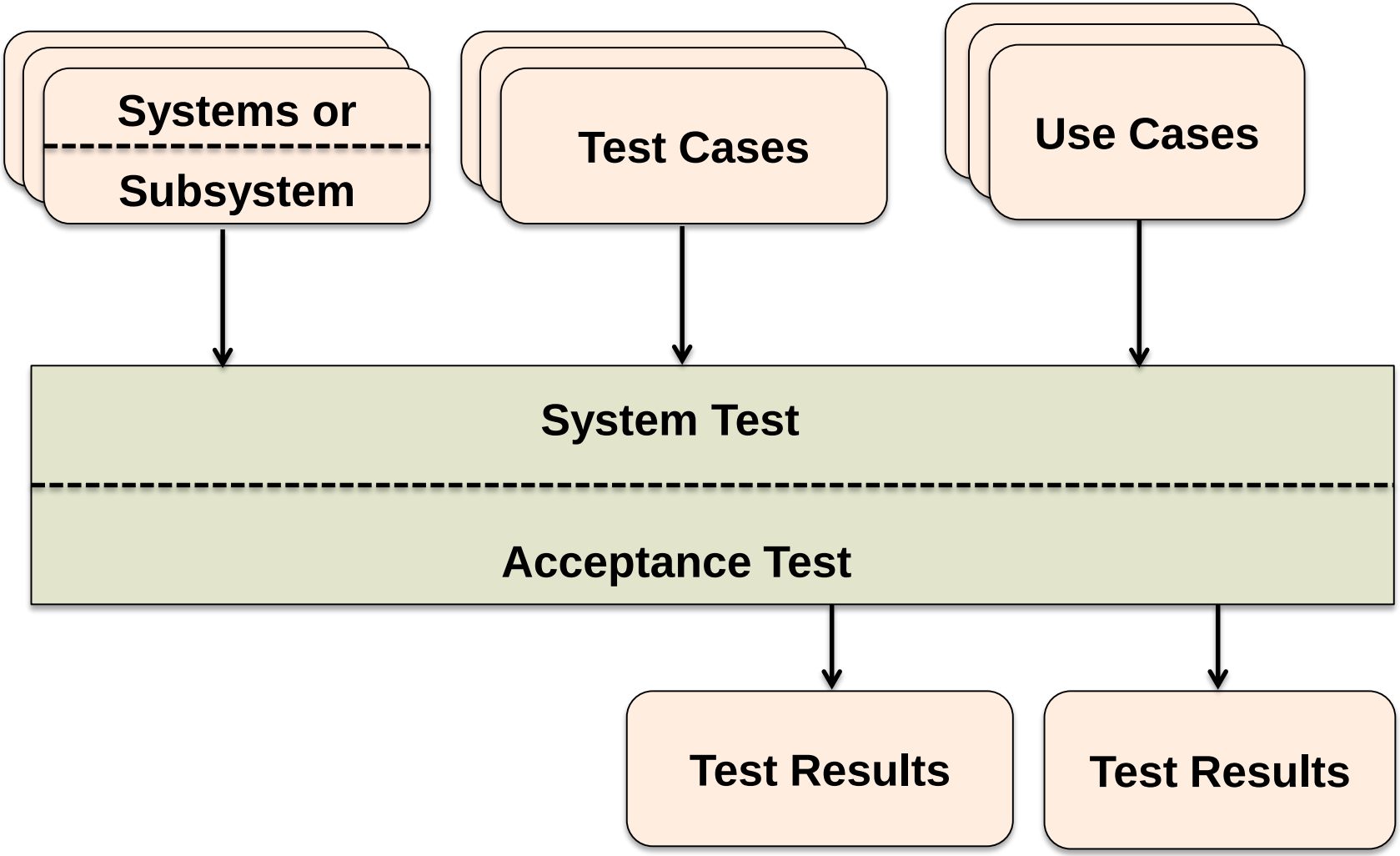
System Integration Test



Calibration



System and Acceptance Test



Summary

- **Main Development process: V-Model**
  - **Most used in the automotive domain**
  - **Two branches**
    - **Left-hand side: verification**
    - **Right-hand side: validation**
- **Need to consider non-functional requirements**
  - **Memory restrictions**
  - **Real-time, reliability, etc.**
- **Gap between design and implementation**
  - **A/D conversion, fixed-point and rounding**