VERIFICATION
VALIDATION
METHODS

PROJECT of the
PEGASUS
FAMILY

Final Event 21 / 22 November 2023

Design & Test Planning

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Assurance Framework
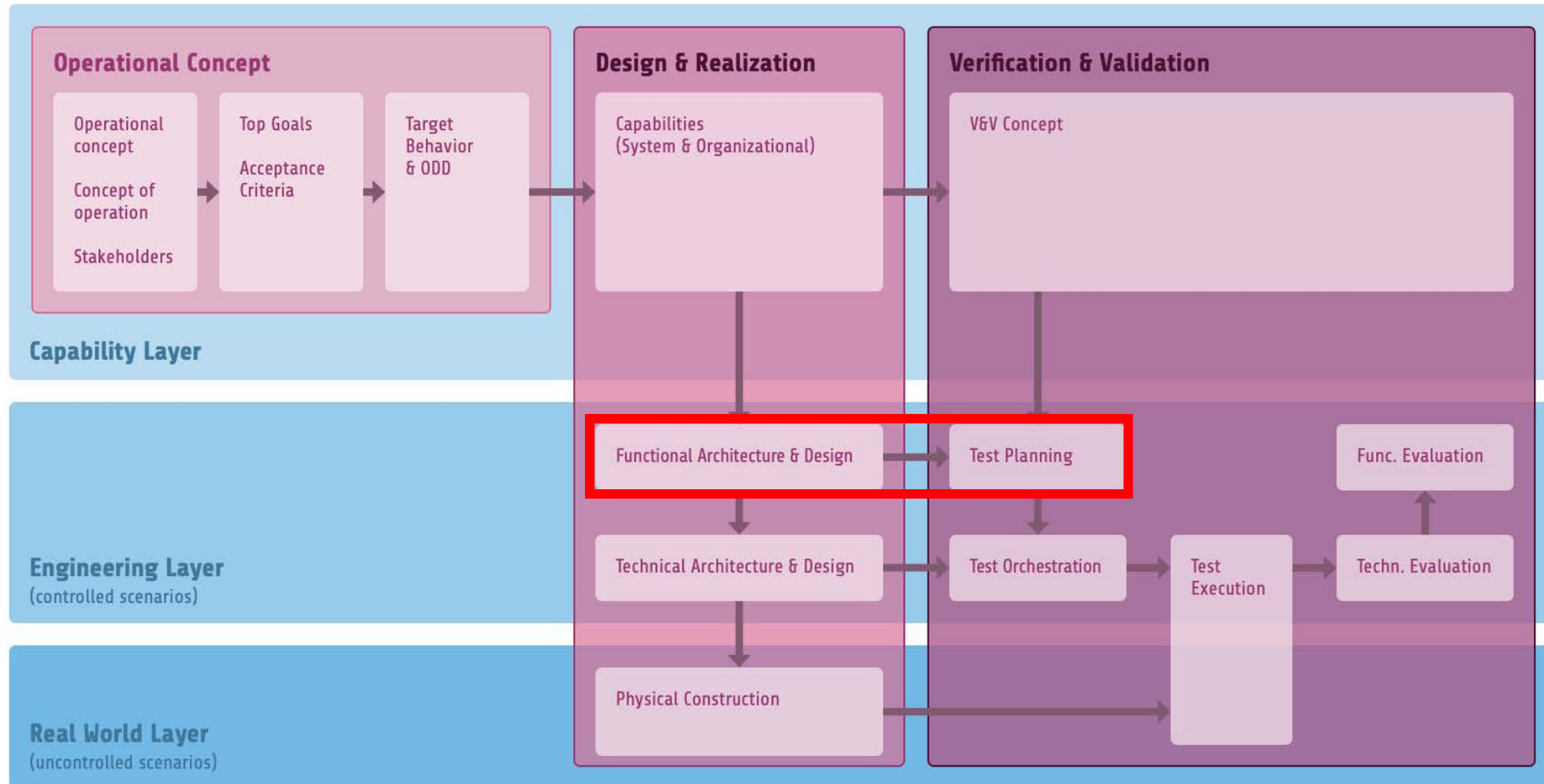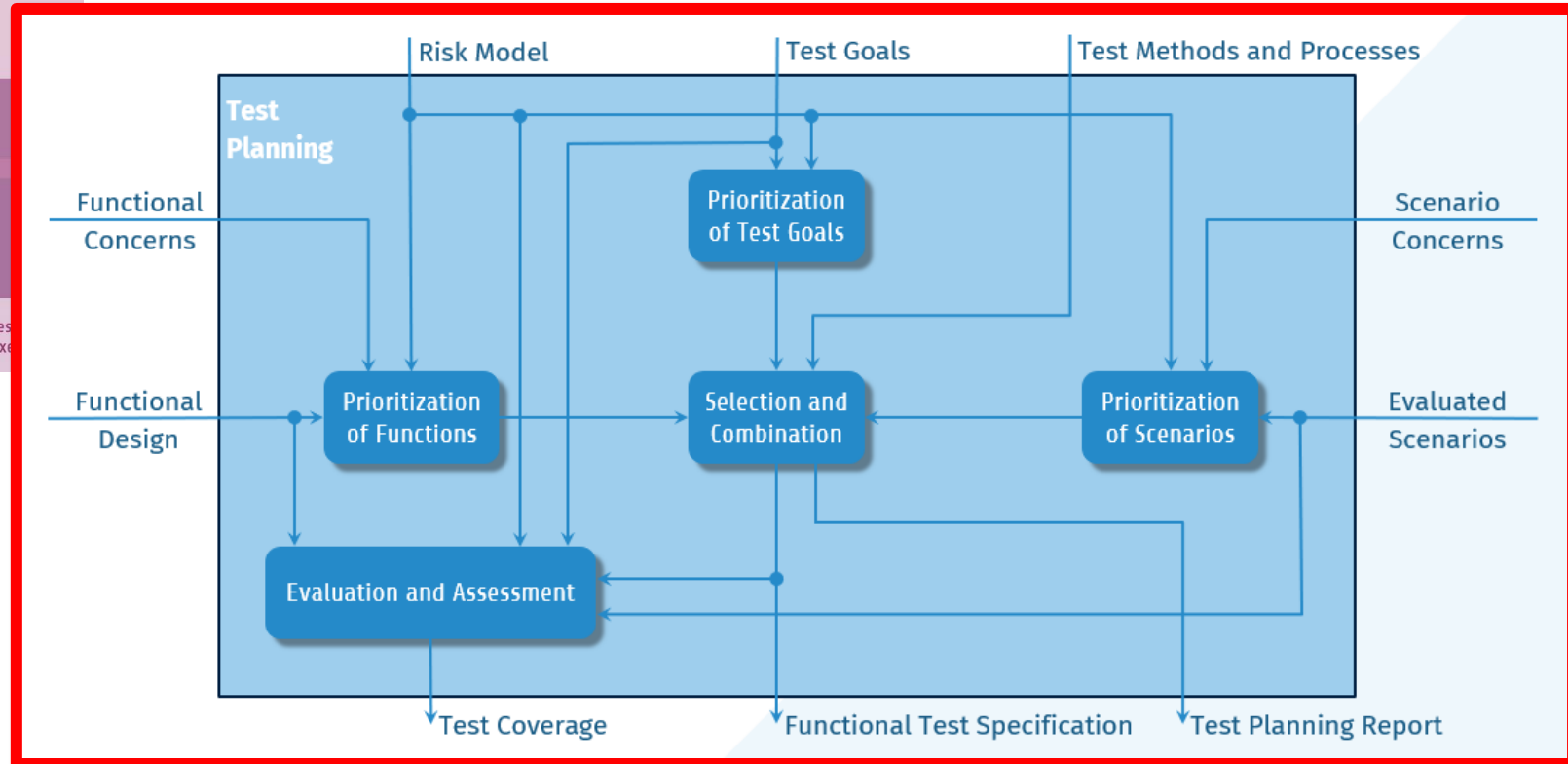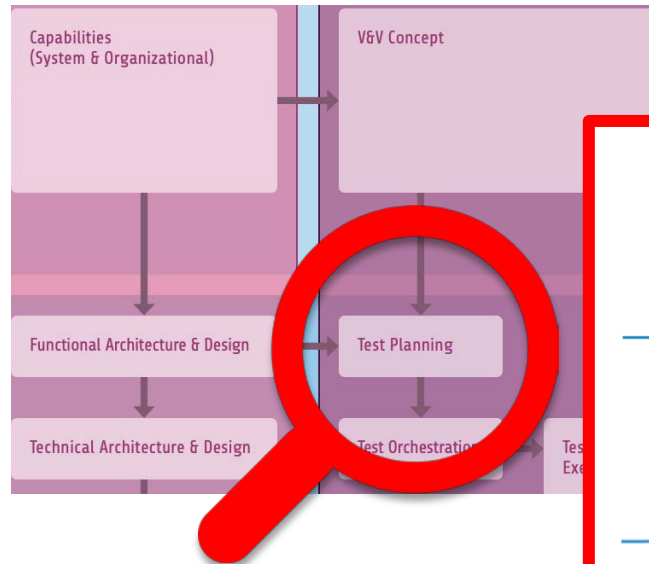
Role of the Test Planning

▶ During the test planning, the set of all functional test cases is defined

▶ A single or group of similar functional test cases is described by a **functional test specification**

▶ The functional test specifications represent the functional test space as the central output of the test planning.
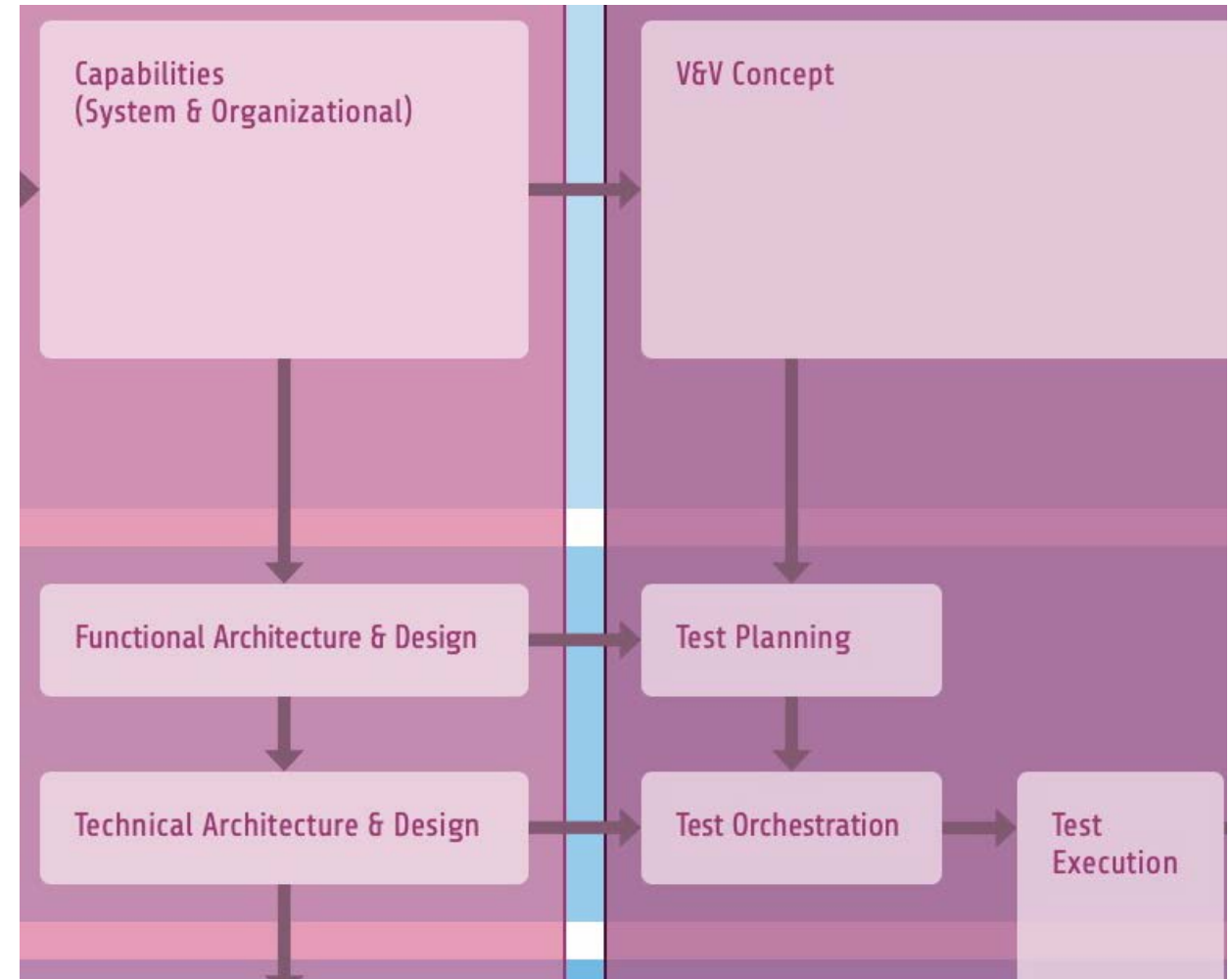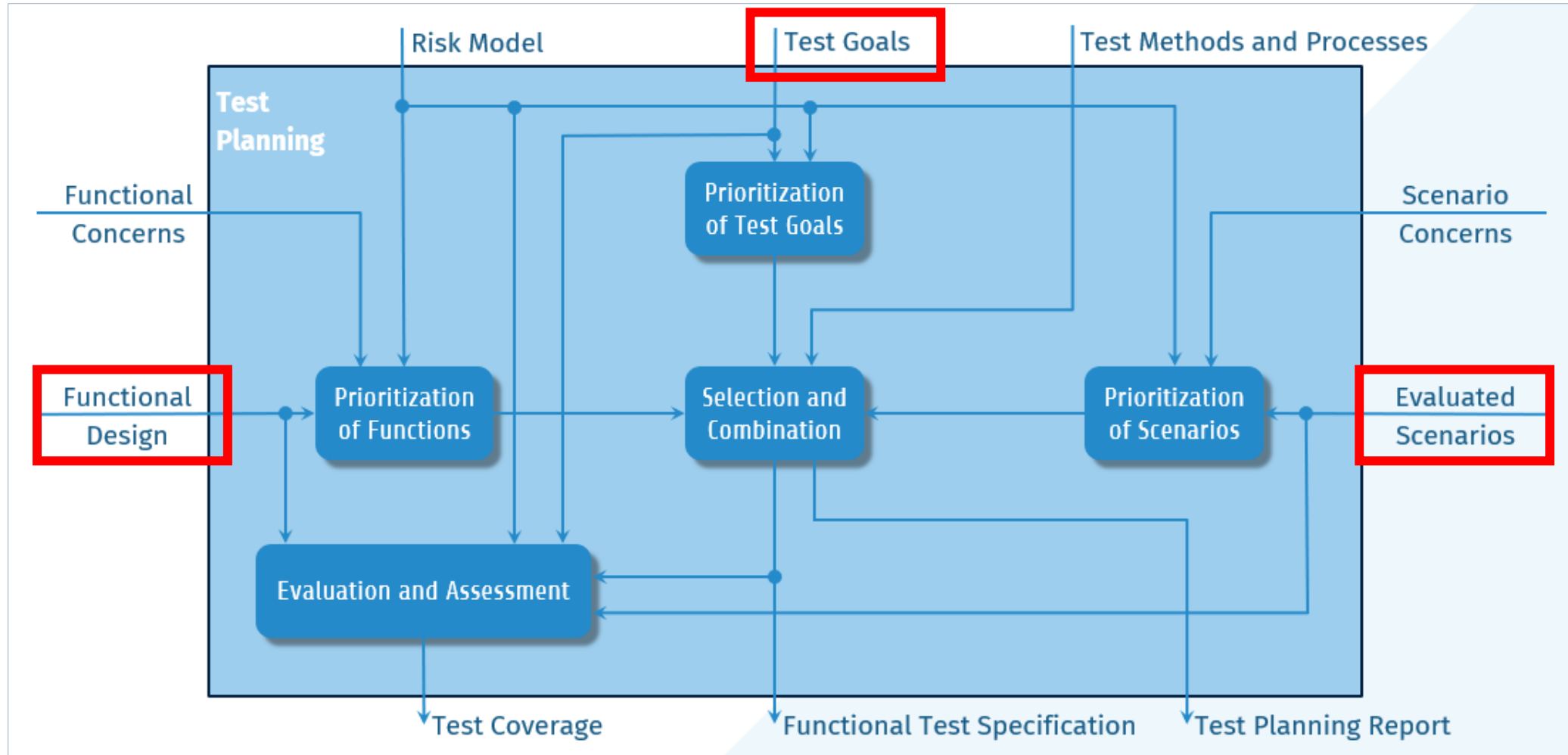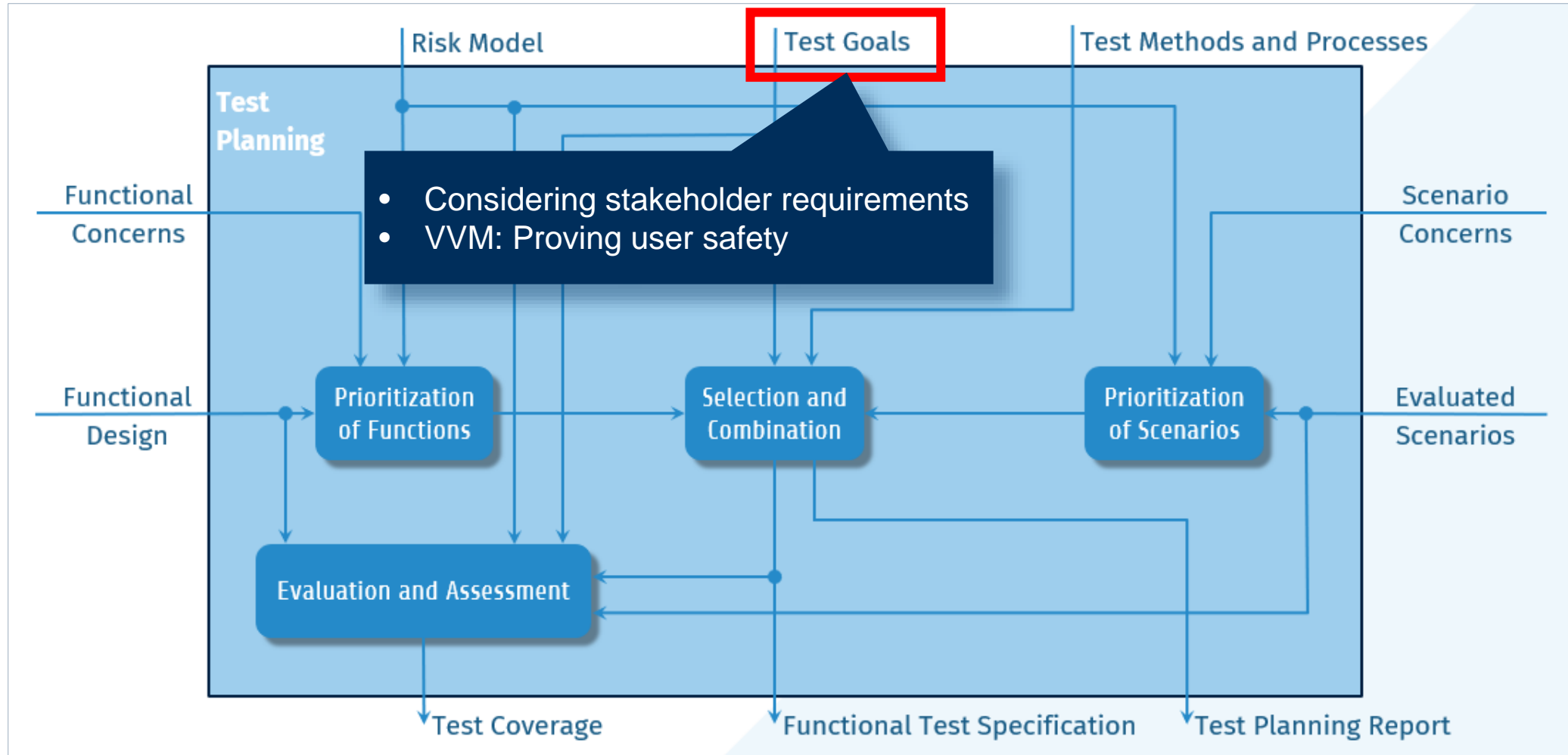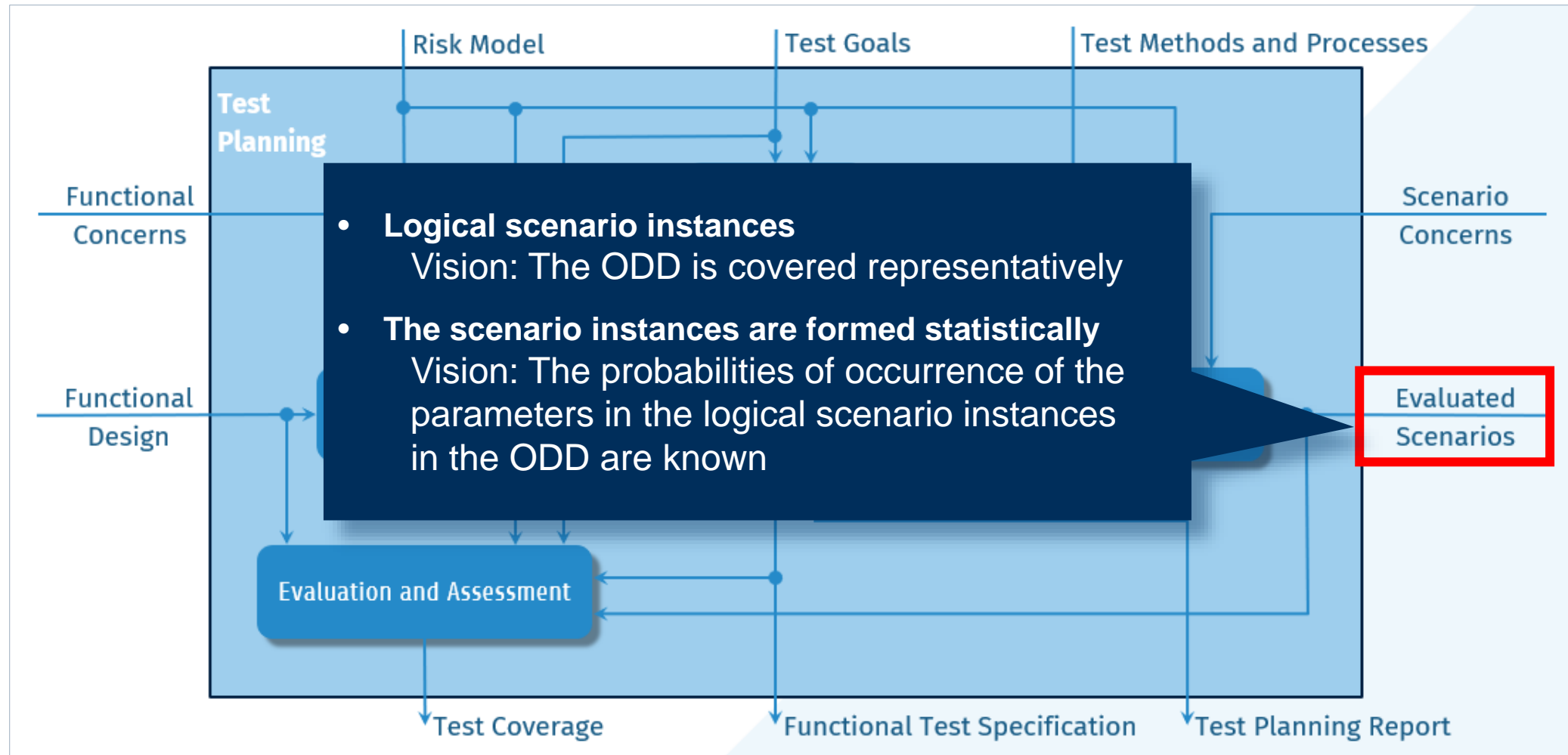
Structuring of the Test Planning
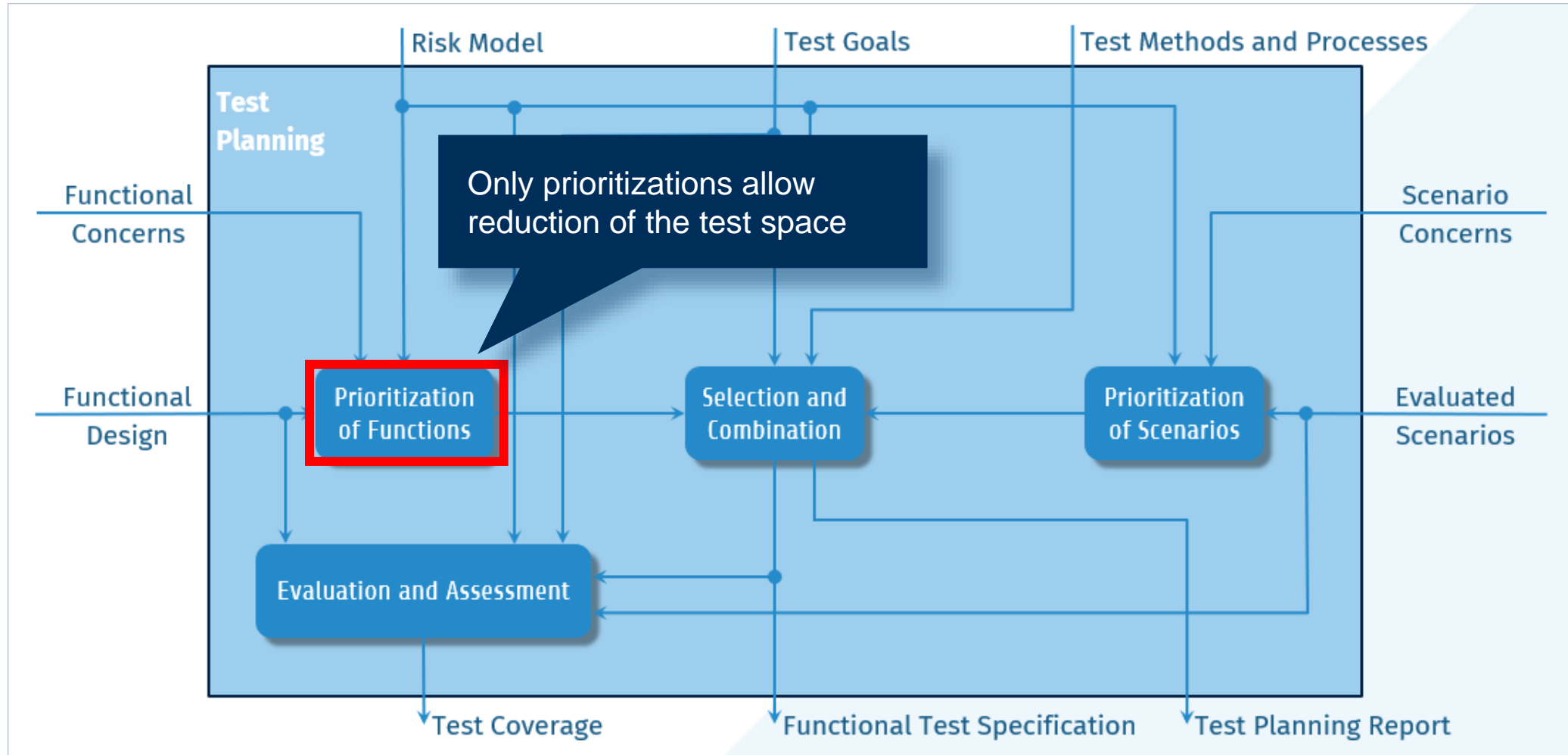
#13.4

Poster

Detailing of the Test Planning

Detailing of the Test Planning

Detailing of the Test Planning

- **Logical scenario instances**
  Vision: The ODD is covered representatively

- **The scenario instances are formed statistically**
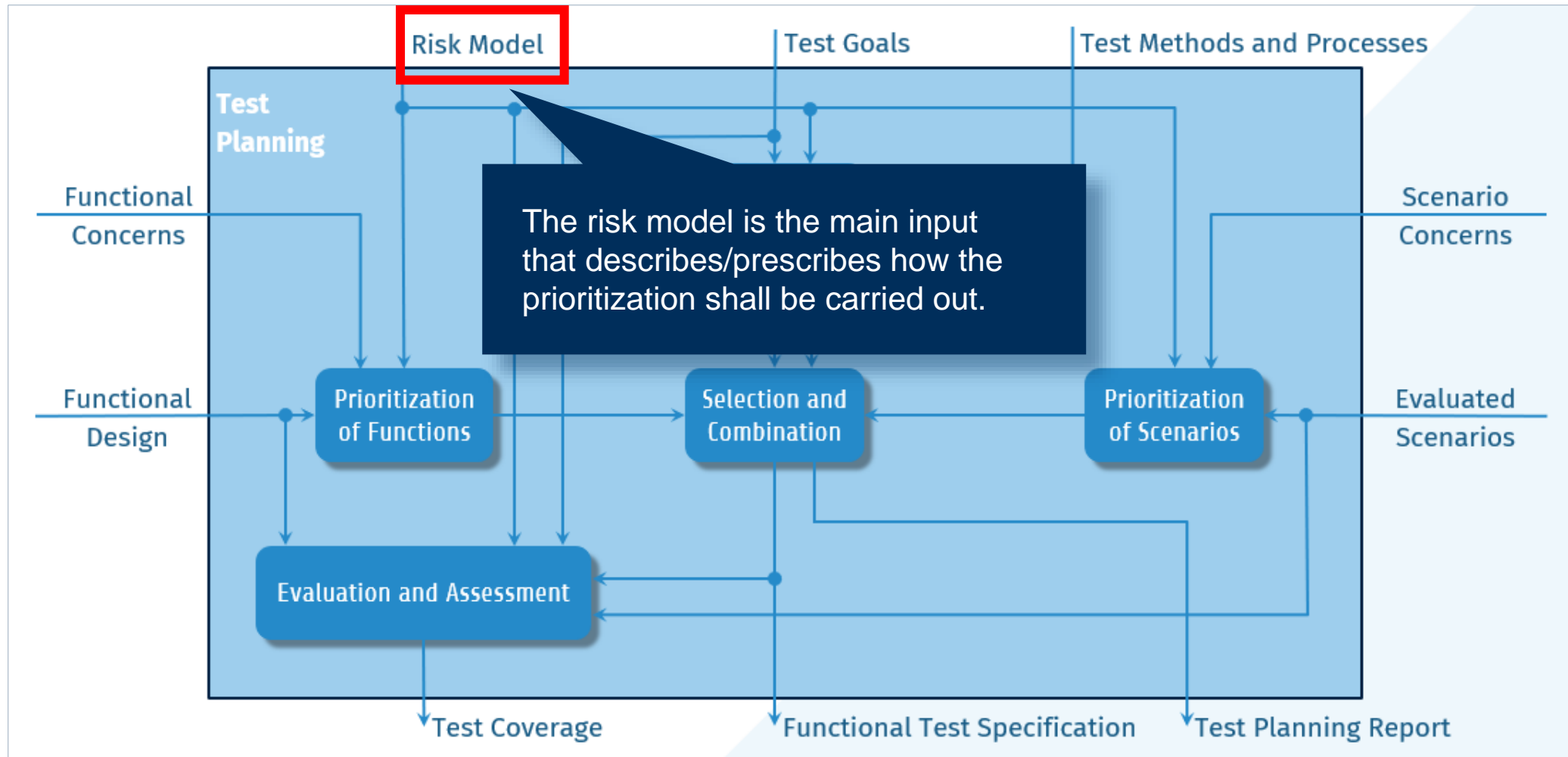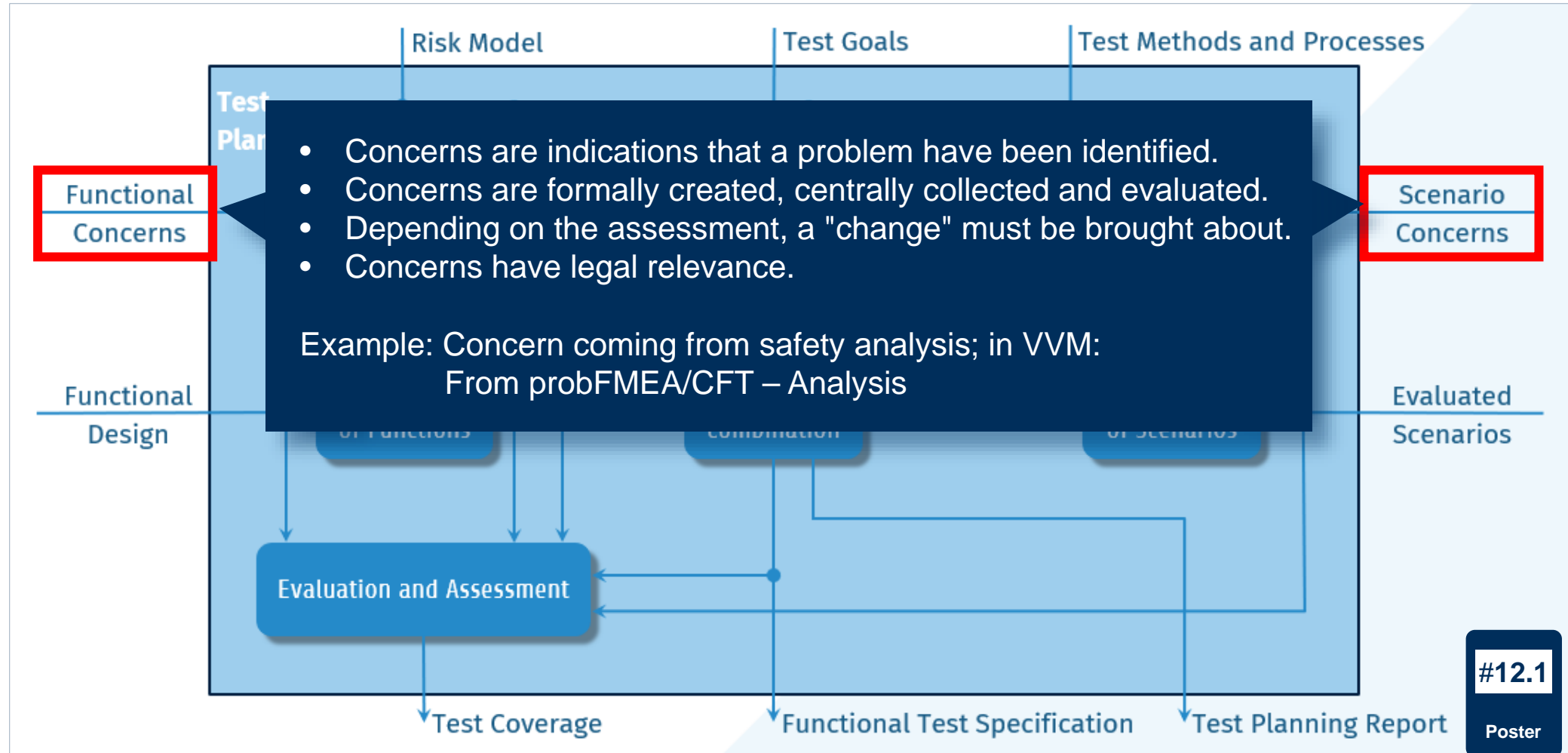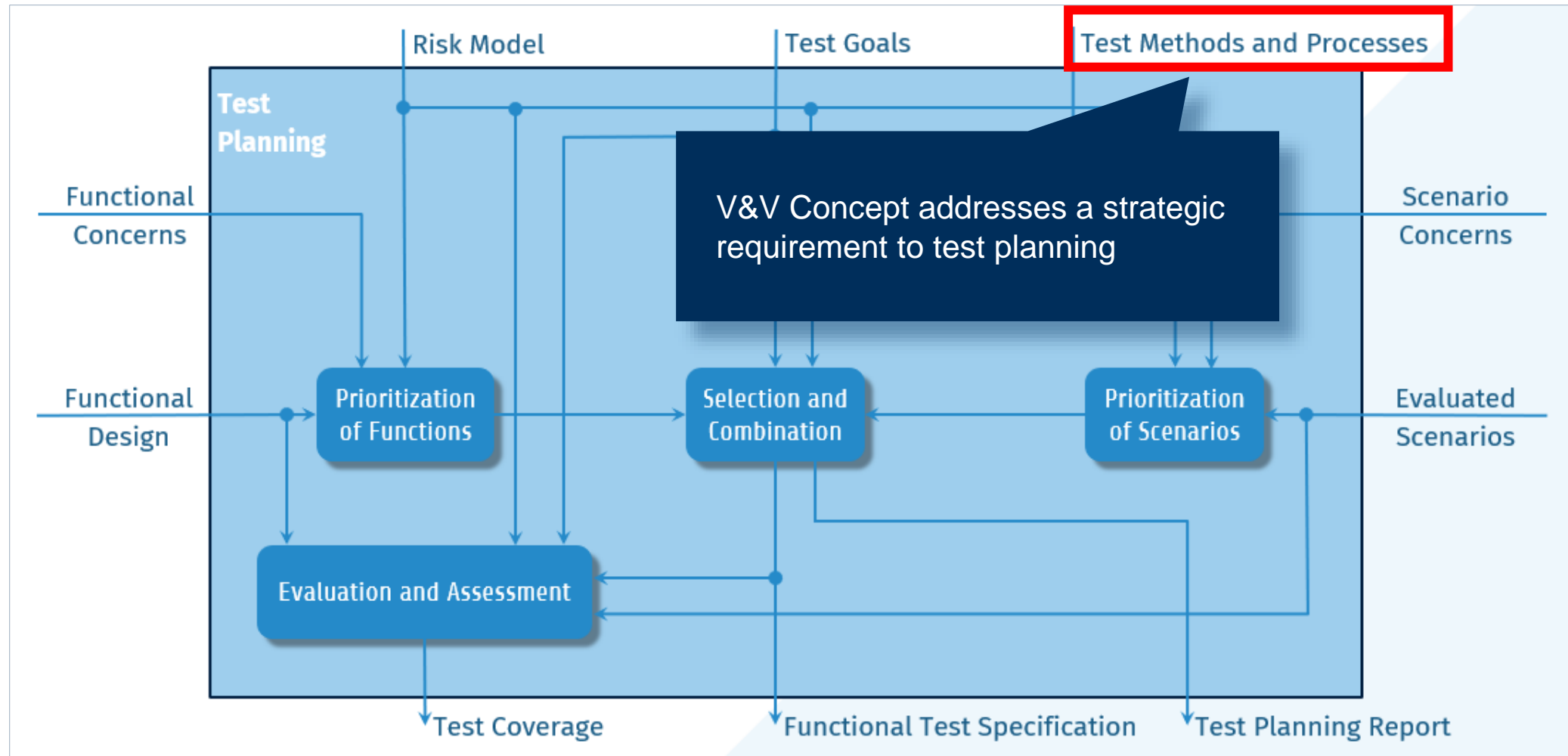 Vision: The probabilities of occurrence of the parameters in the logical scenario instances in the ODD are known

Detailing of the Test Planning

Detailing of the Test Planning

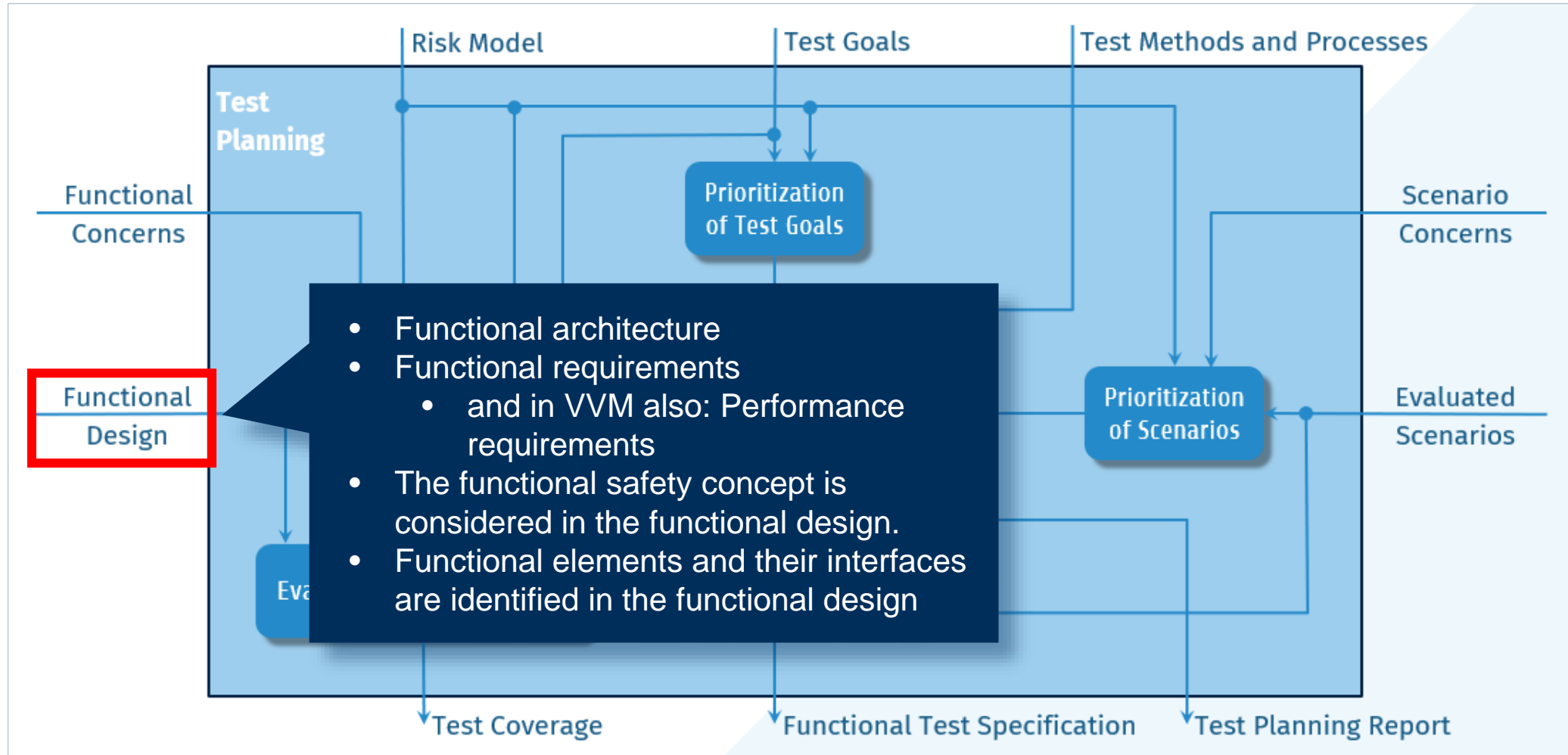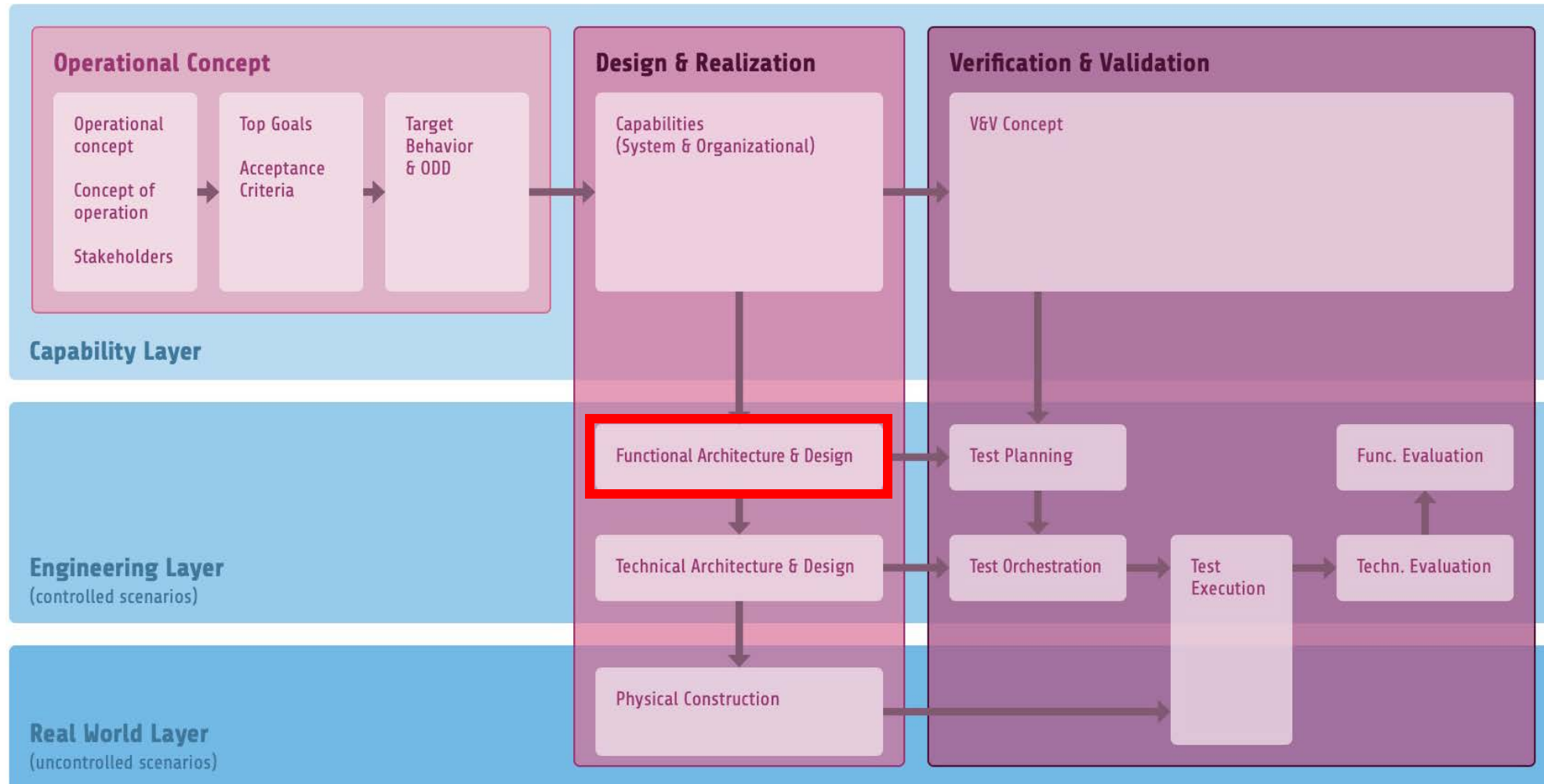The risk model is the main input that describes/prescribes how the prioritization shall be carried out.

#3.7
Poster

Detailing of the Test Planning

- Concerns are indications that a problem have been identified.
- Concerns are formally created, centrally collected and evaluated.
- Depending on the assessment, a "change" must be brought about.
- Concerns have legal relevance.

Example: Concern coming from safety analysis; in VVM:
From probFMEA/CFT – Analysis

Risk Model

Test Goals

Test Methods and Processes

Functional Concerns

Scenario Concerns

Functional Design

Evaluated Scenarios

Evaluation and Assessment

Test Coverage

Functional Test Specification

Test Planning Report

#12.1 Poster

#12.2 Poster

Detailing of the Test Planning

Detailing of the Test Planning

Test Planning

Risk Model

Test Goals

Test Methods and Processes

Functional Concerns

Prioritization of Test Goals

Scenario Concerns

Functional Design

- Functional architecture
- Functional requirements
  - and in VVM also: Performance requirements
- The functional safety concept is considered in the functional design.
- Functional elements and their interfaces are identified in the functional design

Prioritization of Scenarios

Evaluated Scenarios

Eva

Test Coverage

Functional Test Specification

Test Planning Report

#11.2

Poster

Assurance Framework

Detailing of Functional Architecture and Design

#11.2

Poster

Detailing of Functional Design - System Requirements

Stakeholder Needs are collected from various sources, like e.g. functional use cases, an item definition or customer functions.

Behavioral Requirements specify stakeholder requirements towards behavior in a scenario-specific context.

Safety Goals are top-level safety requirements as a result of the hazard analysis and risk assessment at vehicle level.

Behavioral Safety Requirements specify solution-independent safety-related behavior or solution-independent safety measures including their safety-related attributes

#10.4

Poster

Detailing of Functional Design – Quality Criteria

Quality criteria are derived by applying methods like the Goal/Question/Metric (GQM) method

on selected Functional Requirements, formulated as:

- **Functional Requirements** : statements that identify what results a product or process shall produce.
- **Performance Requirements** : measurable criteria that identify how well functional requirements

  shall be accomplished.

Detailing of Functional Design – Functional Architecture
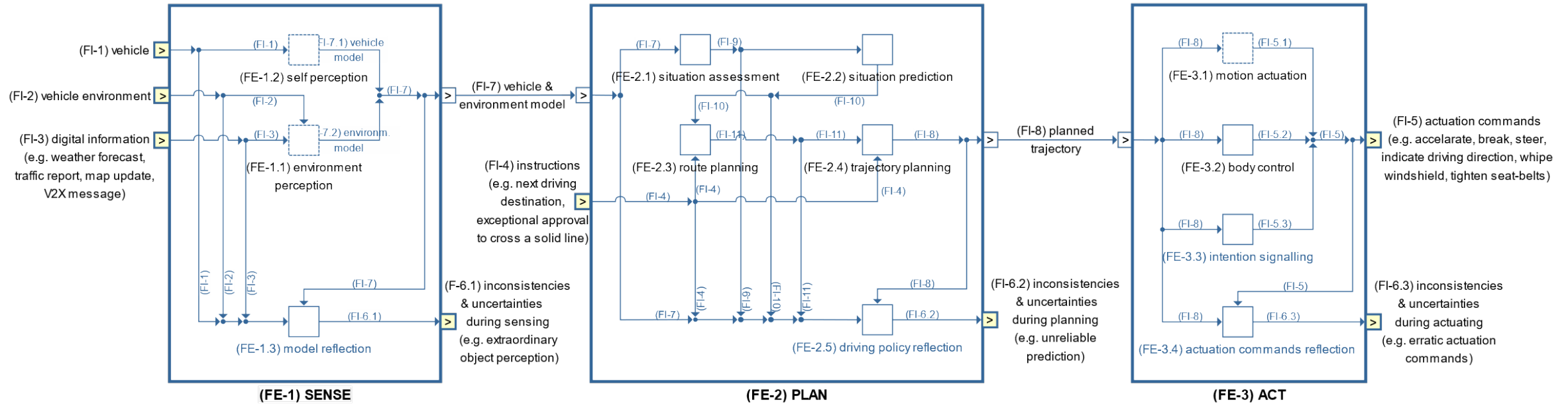
▶ A Functional Architecture satisfies the System Requirements by defining sufficient functionality.

▶ While elaborating the Functional Architecture, the System Requirements are refined in parallel.

Handover to Test Orchestration: Functional Test Specification
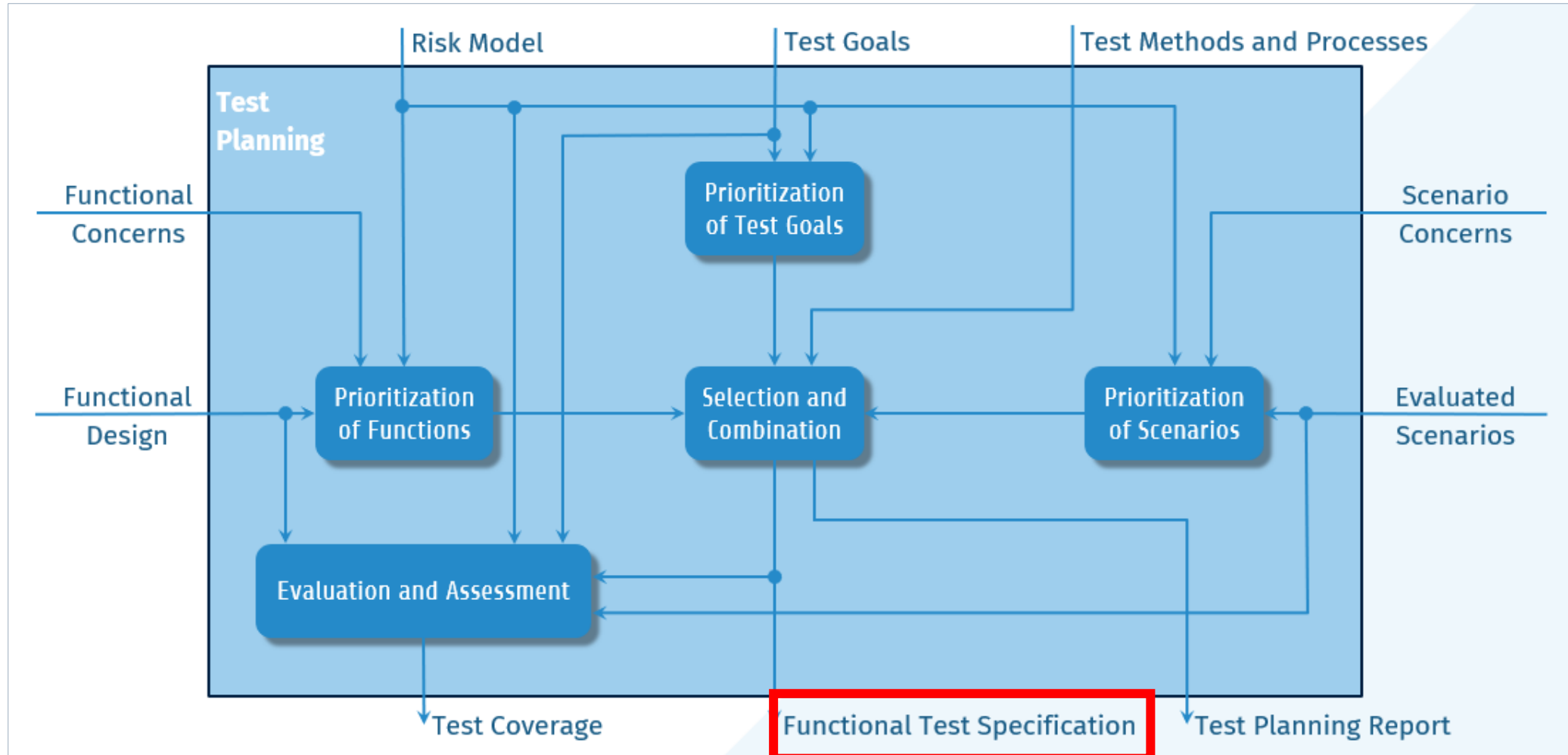
Functional Test Specification – Verification Part (Example)

Test object

▸ **Sense** (before/after fusion): Perception / recognition of ...lane boundaries, center line, T-junction, crosswalk, Traffic signs (30 km/h, crosswalk) Cyclists, pedestrians, parked vehicles

▸ **Plan**: keep lane, select speed

▸ **Act**: Decelerate, accelerate, change direction, displays

Test environment

▸ FUC 2.3

▸ Braking without swerving / changing lanes

Test objectives

▸ Purpose: (analysis), verification, validation

▸ Initial conditions: Positions, velocities, acceleration, (trajectories)

▸ End criteria: Standstill, collision, crossing crosswalk / T-junction

▸ Measured variables/metrics: Speeds (longitudinal, lateral), distances, time-to-collision, time-to-break, absolute positions, dimensions

Derivation of Validation Criteria
(limited to safety scope)

Claims

▶ **Operational Capabilities &**
Stakeholder Concerns (=Validation Criteria)

   ▶ Safety Capabilities

      ▶ Safety Requirements:

         ▶ Compliance with traffic regulations

         ▶ Maintain safe distances from other
           road users

         ▶ Maintain a safe distance from the
           traffic area boundary

         ▶ Do not endanger your own vehicle occupants

         ▶ Reduce the severity of unavoidable accidents

Handover to Test Orchestration

Functional test specification „**Verification**"

Functional test specification „**Validation** "

Thank you!

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Björn Filzek, Continental

Martin Mai, ZF

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VERIFICATION VALIDATION METHODS

PROJECT of the PEGASUS FAMILY

VDA LEITINITIATIVE

A project developed by the VDA Leitinitiative autonomous and connected driving