

Mid-Term Presentation 15 / 16 March 2022

Technical Test Orchestration – Deriving technical test specifications and ensuring test automation

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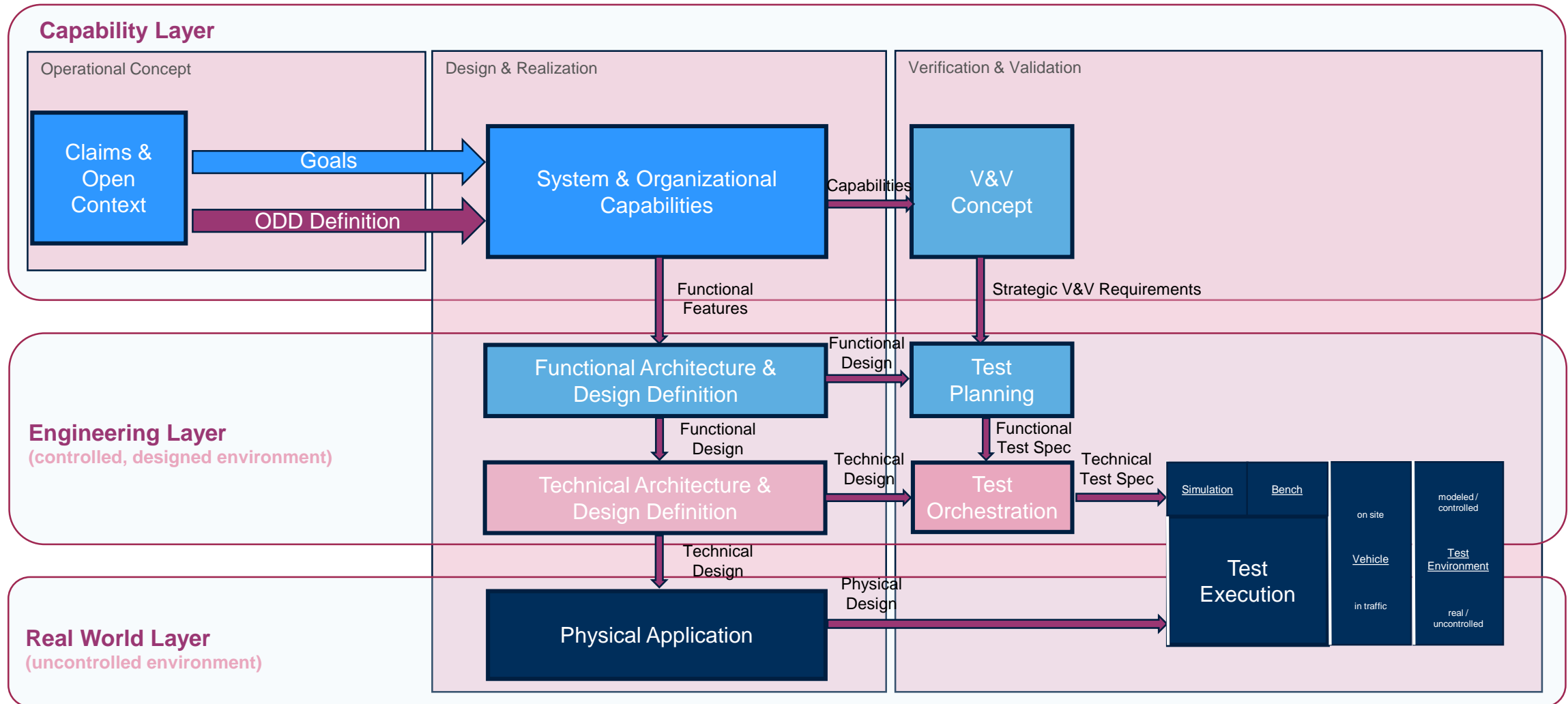
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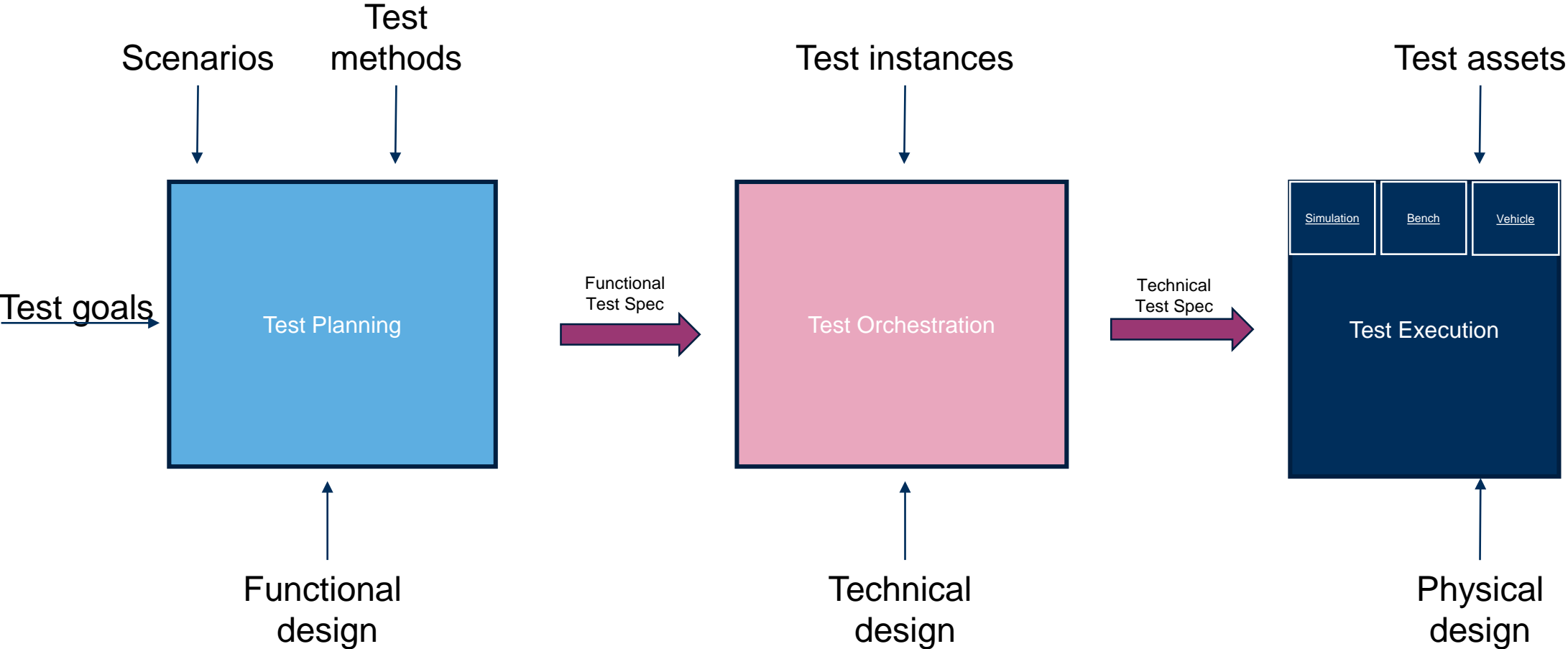
on the basis of a decision
by the German Bundestag

- ▶ Differentiate the **functional** test specification from the **technical** test specification.
 - ▶ The functional test specification cannot be conducted but provides a stable framework for developing the validation strategy.
 - ▶ The technical test specification is derived from the functional test specification taking into account the technical design.
- ▶ **Test orchestration** defines the distribution of tests to test instances.
- ▶ **Seamless testing** must ensure efficiency, consistency, complementarity and reuse of test assets along the whole validation toolchain.
- ▶ **Test automation** is the key to efficiently covering the test space. Prerequisites for test automation are identified and must be observed.

V&V Process in Assurance Framework

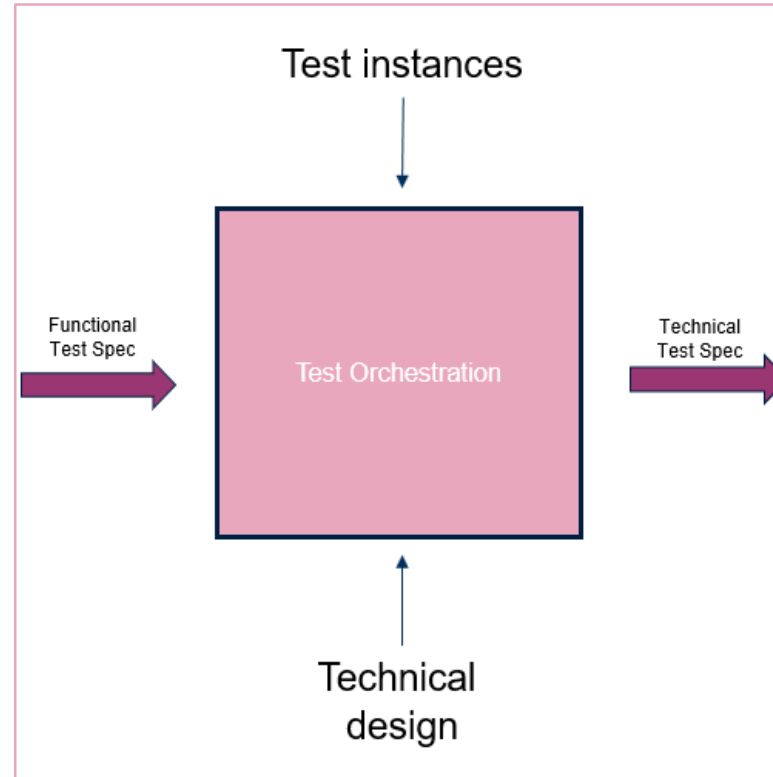


Test orchestration in the context of V&V



Input

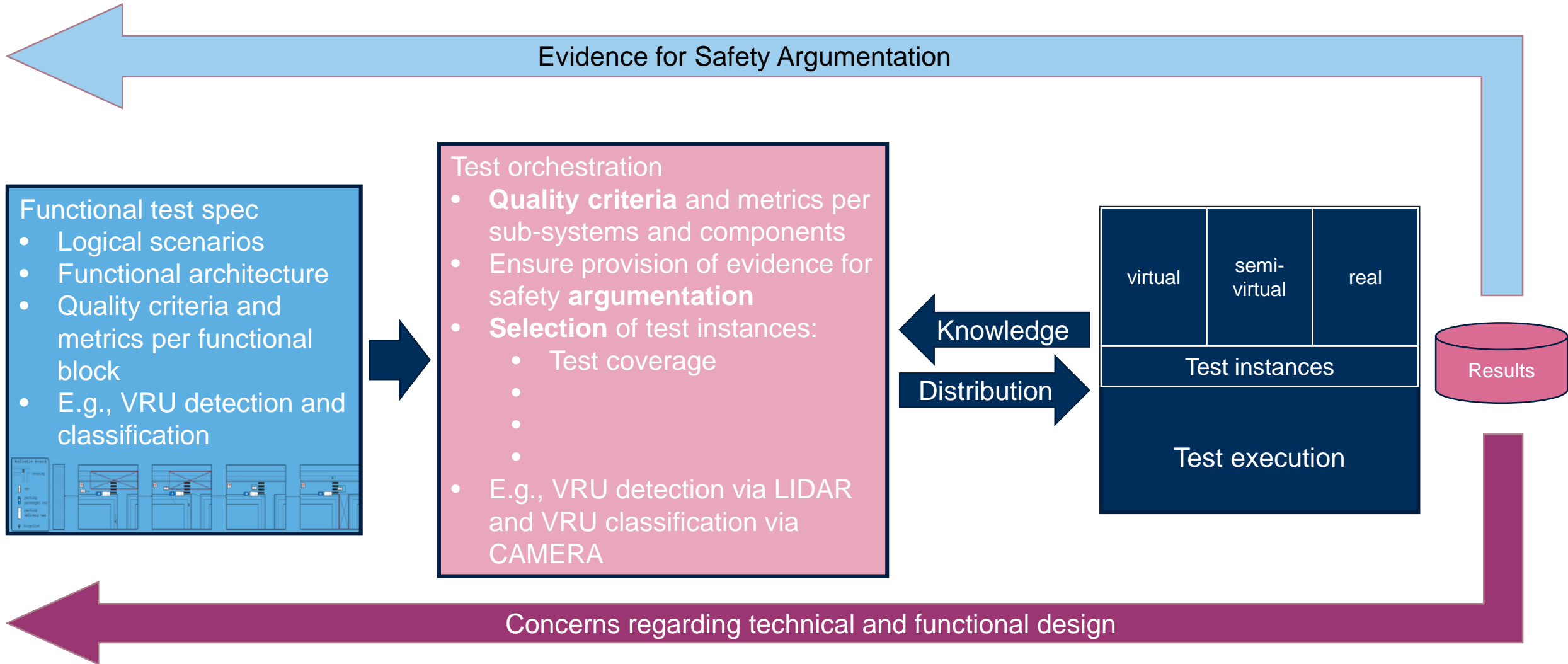
- **Functional test specification**
 - Output from high level ADS validation strategy
 - Dependent on functional architecture
 - Provides a stable framework for test planning
 - Non executable
 - Non competitively differentiating
- **Test instances knowledge & assessment**
- **Technical architecture**
- **Concerns**



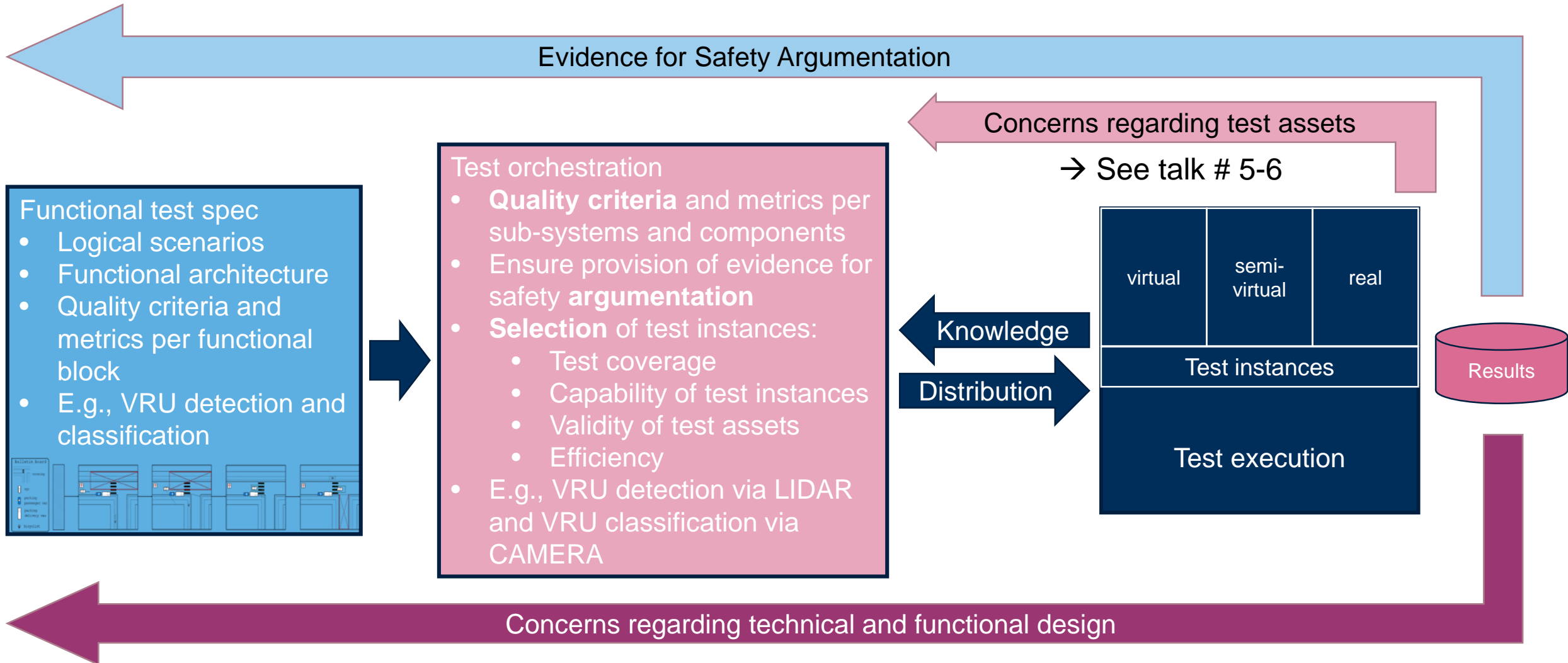
Output

- **Technical test specification**
 - Dependent on technical architecture
 - To be continuously adapted to technical changes
 - Executable
 - Competitively differentiating
- Ensuring seamless testing – complementarity derived from technical design and assessment of test instances

Technical test orchestration and concerns



Technical test orchestration and concerns



→ See talk # 5

Criteria for assessing test instances derived in VVM.

Kategorie	Hierarchisierung	Anforderungen für ET.1b aus AG Test Orchestrations	Motivation, Hintergrund
Befähigung zur Testausage	Technische Implementierung	Für jede Testinstanz muss bekannt sein, mit welcher Genauigkeit die Versuche durchgeführt werden	z.B. Abweichung von vorgegebener Trajektorie - Abweichung des Mittelwertes $\sum_{i=1}^n x_i $ zum Referenzwert (falls Referenzwert vorhanden) - Standardabweichung der Messwerte (zum Mittelwert) nach $\sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$ (falls Referenzwert vorhanden)
Befähigung zur Testausage	Technische Implementierung	Für jede Testinstanz muss bekannt sein, ob und mit welcher Wiederholgenauigkeit die Versuche durchgeführt werden	z.B. Abweichung von Trajektorien mehrerer Versuchsdurchläufe - Standardabweichung der Messwerte einer Probe zum Mittelwert nach $\sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$
Aufwand	Technische Implementierung	Für jede Testinstanz muss bekannt sein, mit welchem Manuellen-Aufwand die Erstellung von Testfällen verbunden ist.	

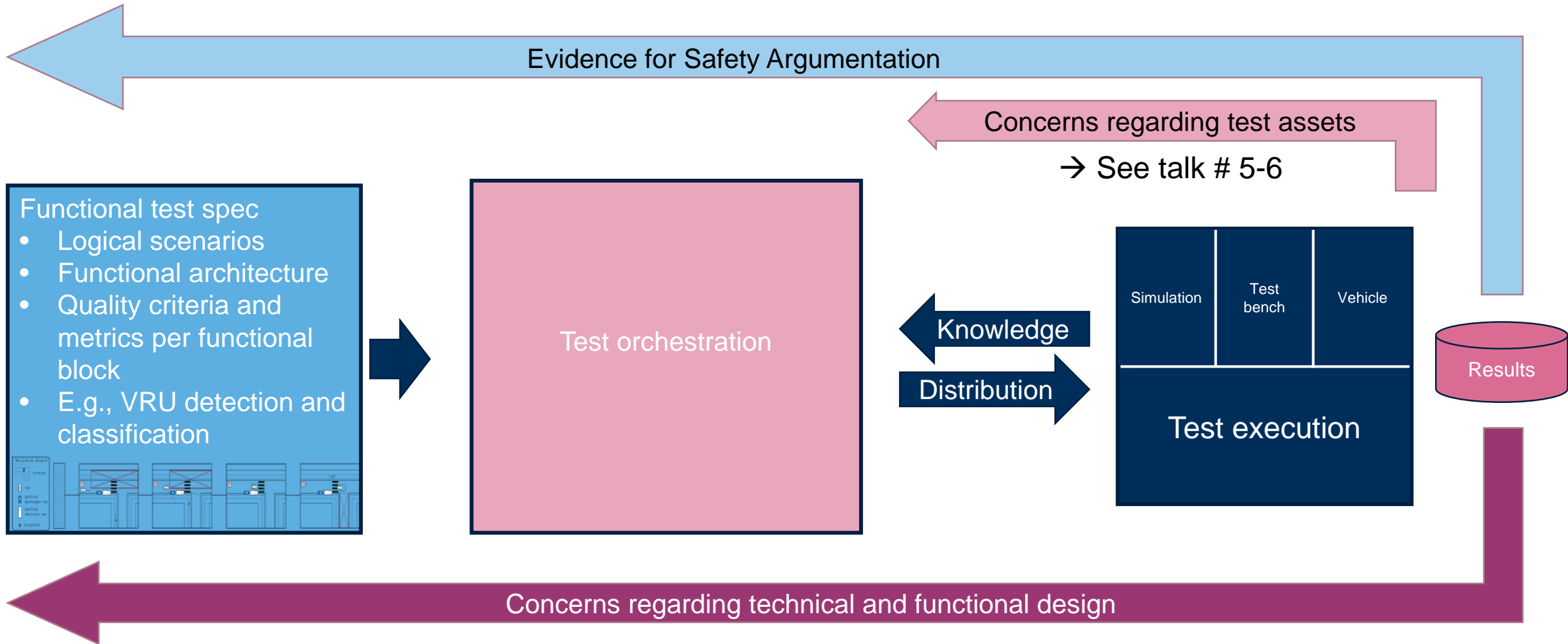


→ See talk # 6

	SiL	HiL	...	Proving Ground (robot)	Proving Ground (human)	FOT
Precision of trajectory repetition	+	+		+	0	-
Cost	+	0	+	-	0	-
Preparation effort	+	+		-	0	-
Vibration	-	-	+	+	+	+
Validity of virtual models	-	-		n/a	n/a	n/a
...						

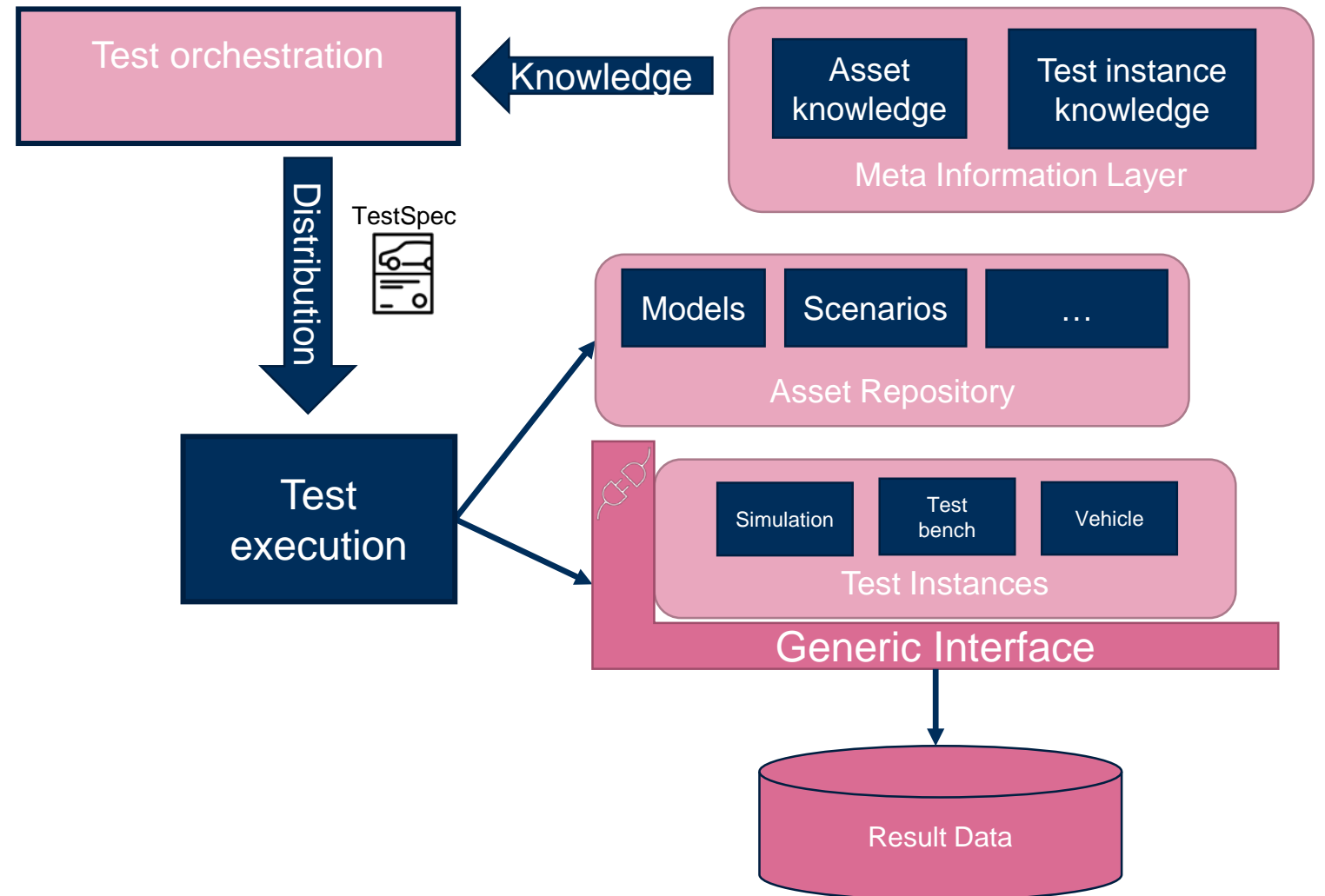
- It's not about being right or wrong, it's about being more or less appropriate.
- It's about your test goals and quality criteria. Which test instance can provide the evidence you need?
- It's about validity of your test assets.
- It's about efficiency: best results, reasonable costs, limited time frame.

Technical test orchestration and concerns



Prerequisites for seamless integration of test instances

- ▶ Standardized **test specification** format must be used
- ▶ Test instances must conform to **interface contract**
- ▶ **Test instance knowledge** is provided
- ▶ Generic asset formats shall be used
 - ▶ **OpenScenario/OpenDrive**
 - ▶ **FMI**
 - ▶ **SSP**
 - ▶ **OSI**
- ▶ Consistent/comparable **result data format** must be used

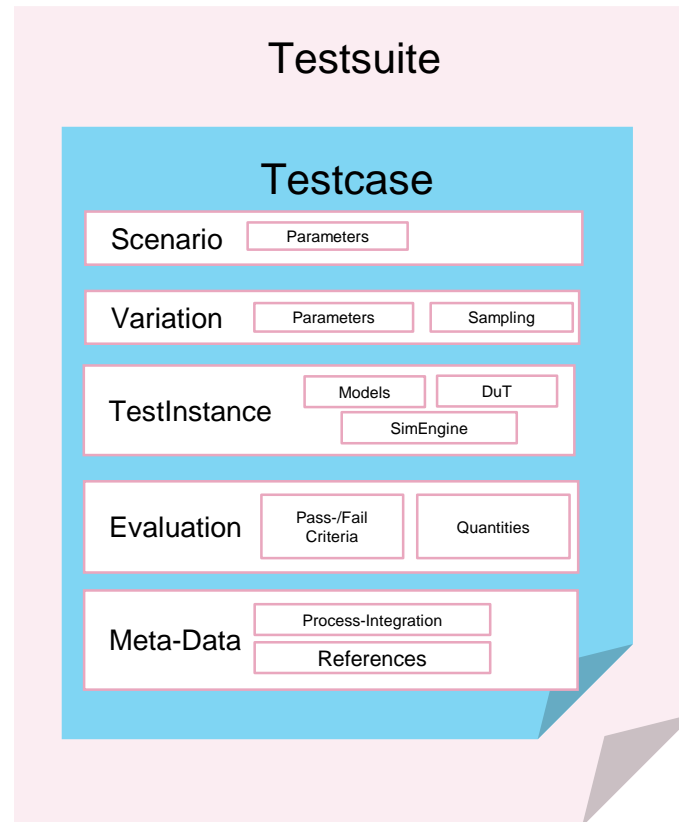


- ▶ Representation of test specifications
 - ▶ Machine readable
 - ▶ Declarative
- ▶ A test suite consists of several test cases
- ▶ Each test case must define all needed inputs for a simulation/test run:
 - ▶ Scenario
 - ▶ Test instance
 - ▶ Parameter variation
 - ▶ Evaluation
 - ▶ Metadata

TestSpec



Testsuite



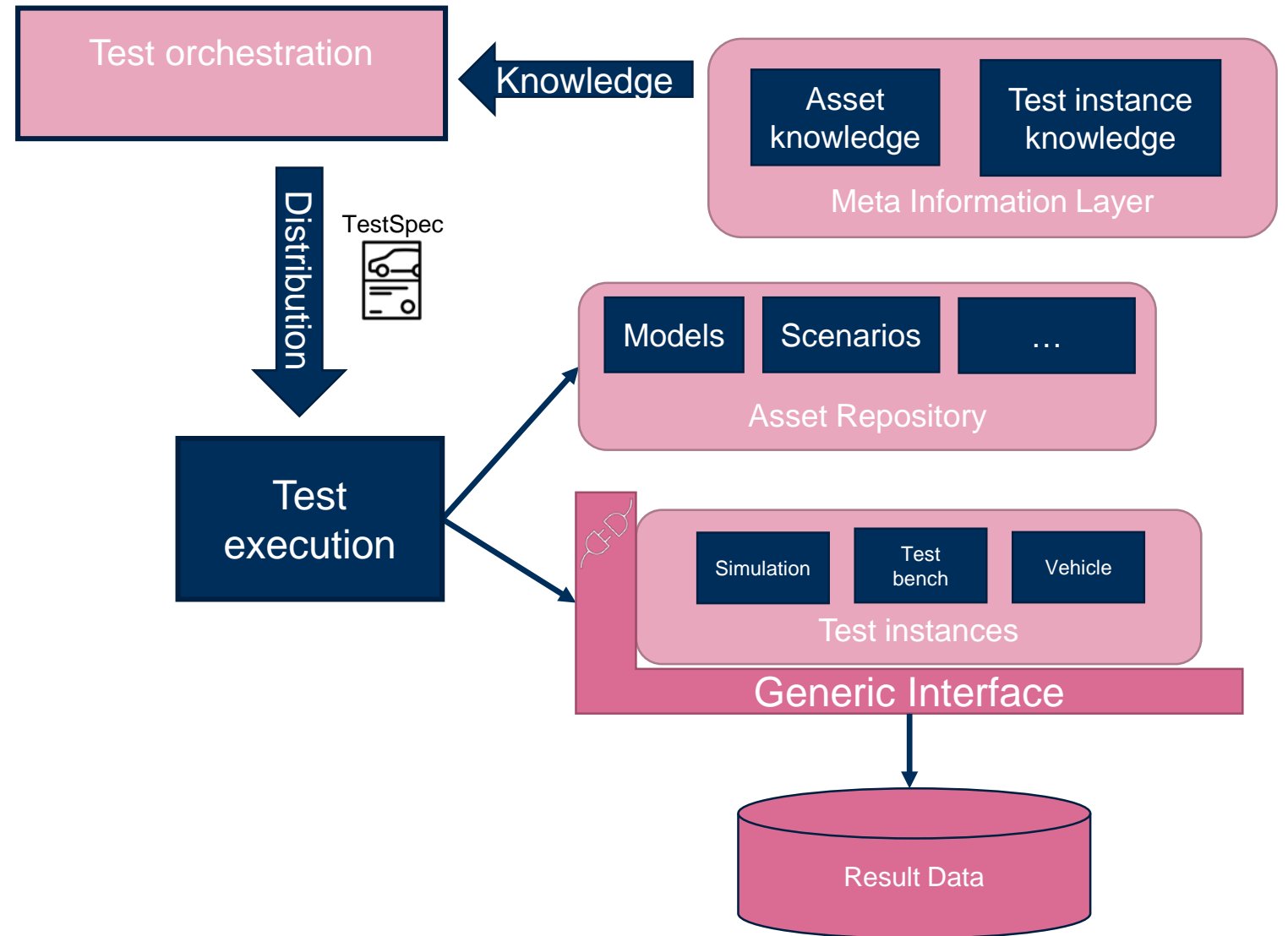
```
{
  "name": "NCAP",
  "test_goal": "Think component avoided every accident",
  "creation_date": "09-09-2021",
  "test_cases": [
    {
      "id": "1",
      "name": "euro-ncap-cbla",
      "test_goal": "deaccelerated and stand_still and distance bigger then 1",
      "creation_date": "31-08-2021",
      "logical_scenario": {
        "type": "scenarioRepresentatives",
        "scenario_representatives": [
          {
            "type": "carmakerScenario",
            "vsm_id": "1234",
            "name": "NCAP_CPNA25",
            "repository": "local",
            "category": "straightRoad"
          }
        ]
      },
      "parameters": [ ... ]
    },
    {
      "variation": { ... }
    },
    {
      "test_instance": { ... }
    },
    {
      "evaluation": { ... }
    },
    {
      "metadata": { ... }
    }
  ]
}
```

Example test spec language from poster „Technical Test-Orchestration at ZF“

Seamless integration of test instances

Prerequisites for seamless integration of test instances

- Standardized **test specification** format must be used
- Test instances must conform to **interface contract**
- **Test instance knowledge** is provided
- Standardized asset formats shall be used
 - **OpenScenario/OpenDrive**
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- Consistent/comparable **result data format** must be used



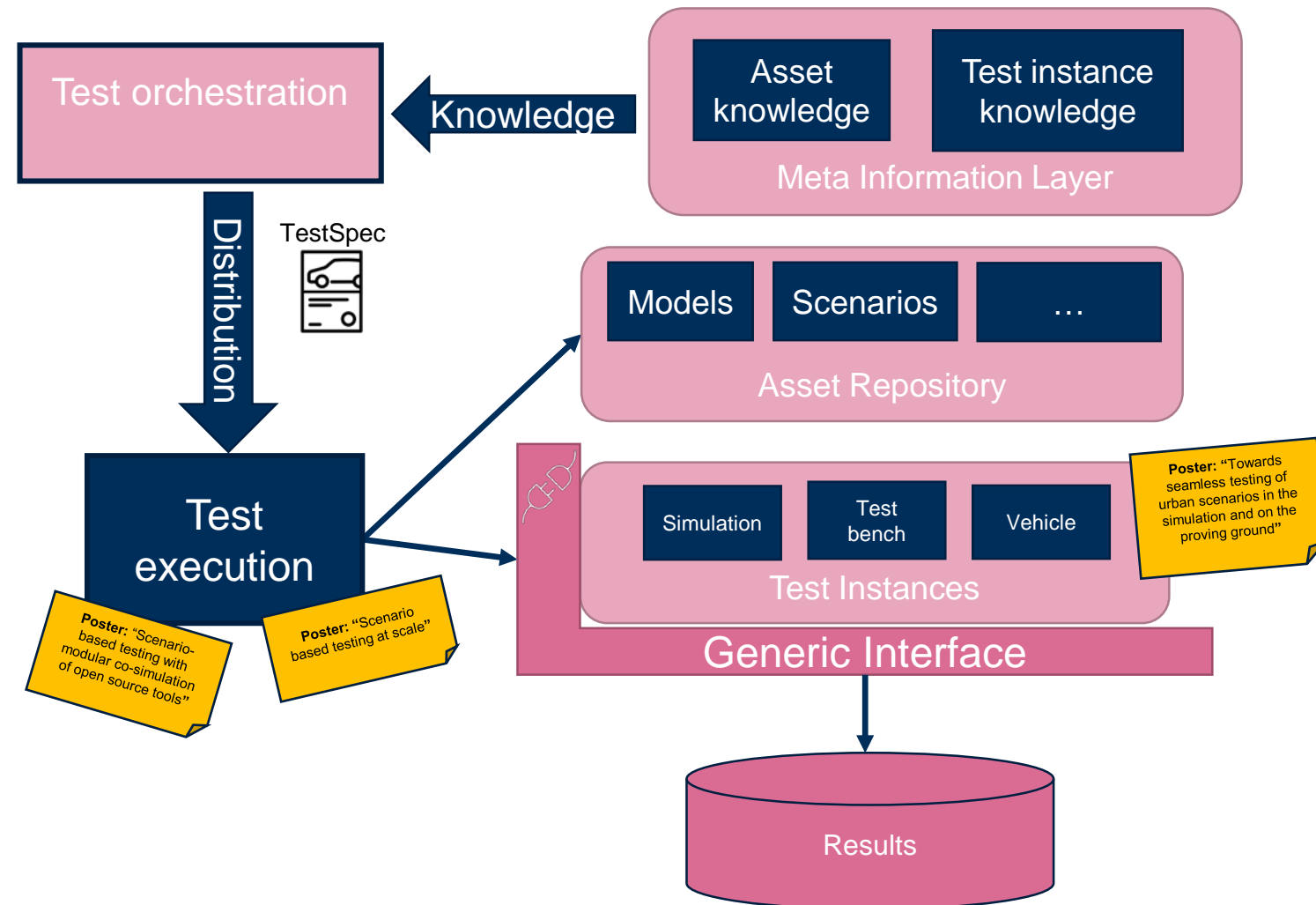
- ▶ Assessment of OpenScenario support for different simulation products
 - ▶ Performed in Q3/2021
- ▶ Findings:
 - ▶ Small differences in files for different tools, e.g., path
 - ▶ Good XODR support required
 - ▶ Detailed XOSC elements need further investigation. E.g., shapes
 - ▶ Controller definition currently tool specific
- ▶ Conclusion:
 - ▶ XOSC support is currently not complete
 - ▶ XOSC support is rapidly expanding

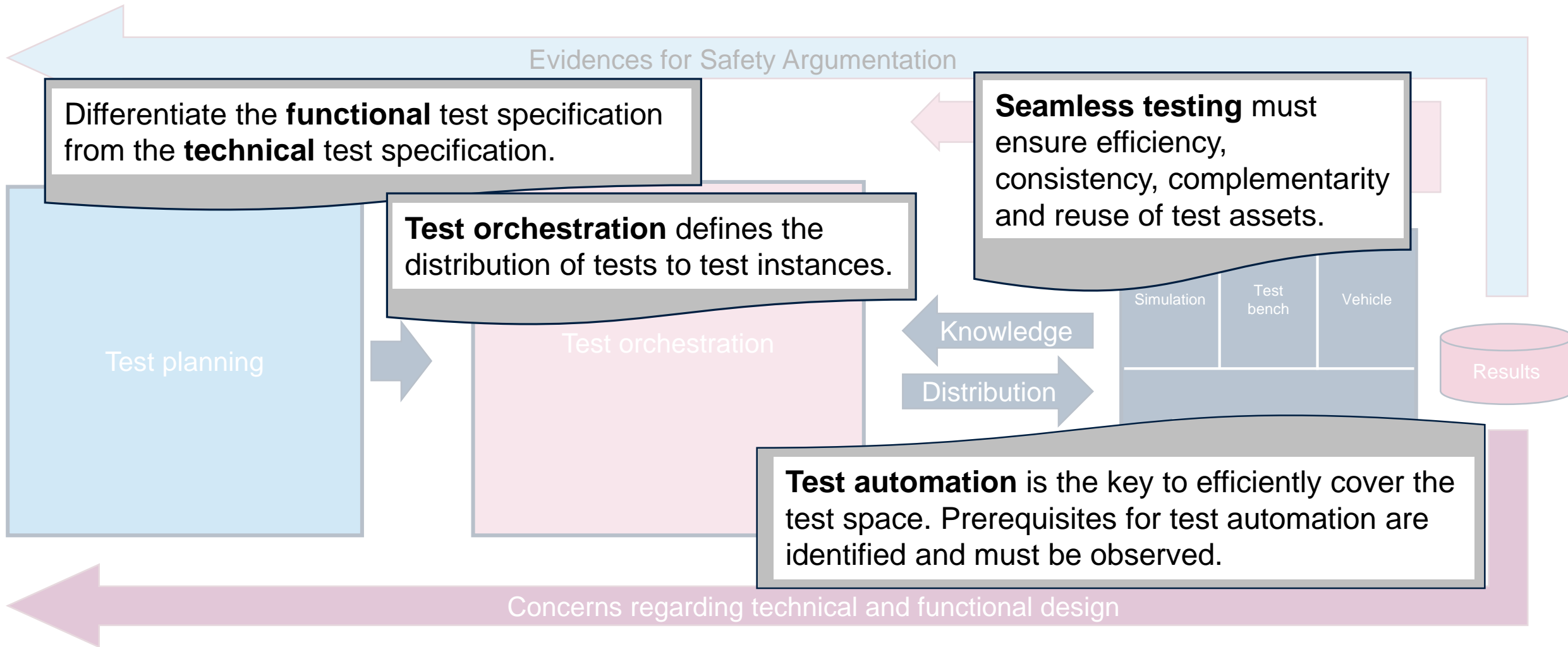
» Extract from results:

Feature/Product	Product 1	Product 2	Product 3	Product 4	Product 5
...
ControllerAction	Yes		No	Constraint	Yes
LaneChangeAction	Yes	Yes	Yes	Yes	Yes
LateralDistanceAction	No	Yes	No (planned)	No	No
LongitudinalDistanceAction	No	Yes	No (planned)	Yes	Yes
SpeedAction	Yes	Yes	Yes	Constraint	Yes
SynchronizeAction	No		No	Constraint	Yes
AcquirePositionAction	Yes	Yes	No	Yes	Yes
AssignRouteAction	Yes	No	No	Yes	Yes
FollowTrajectoryAction	No	Yes	Yes (with limitations)	Yes	Yes

Prerequisites for seamless integration of test instances

- ▶ Standardized **Test-Specification-format** has to be used
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 - ▶ **OpenScenario/OpenDrive**
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- ▶ Consistent/comparable **result data format** must be used





Thank you!

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A project developed by the
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