Universität Stuttgart
Institut für Automatisierungstechnik und Softwaresysteme

Zukunft des Testens vernetzter Systeme in der Automatisierungstechnik

-

On the future of testing interconnected systems in automation

Prof. Michael Weyrich

Vector Testing Symposium (16. Mai 2017)

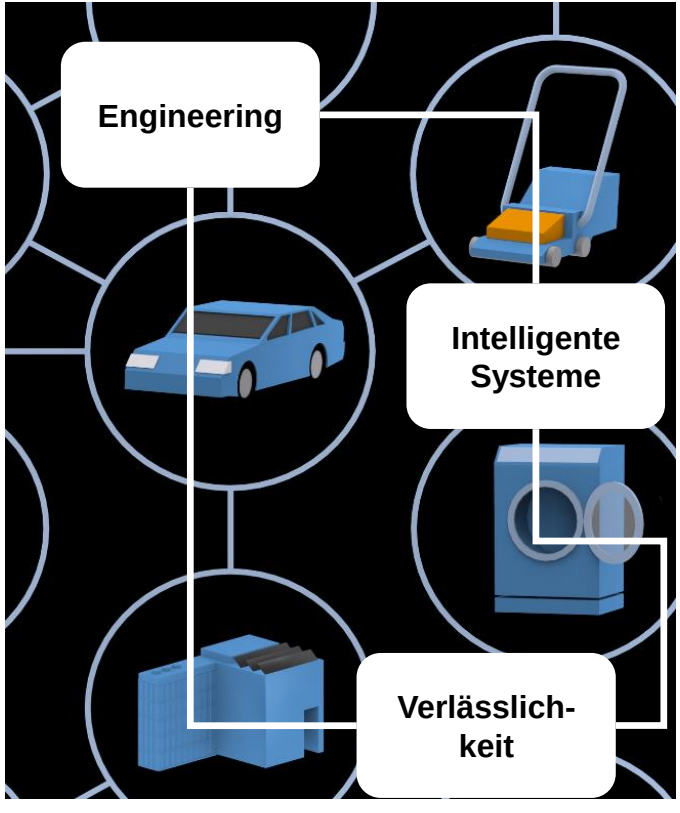
The Industrial Internet-of-Things

+++ Cyber-physical Systems +++ Industrie 4.0 +++ Cloud Computing +++
Networked System and Data are changing the way we do business …

“Industrie 4.0” is again the major theme at the Hannover Industrial Fair

PLATTFORM INDUSTRIE 4.0

HANNOVER MESSE



Trend: Over-the-Air updates

One important feature of connected cars are over-the-air updates.

WIRED Wired, Feb. 2014

PARTNER CONTENT ALEX BRISBOURNE, KORE

TESLA'S OVER-THE-AIR FIX: BEST EXAMPLE YET OF THE INTERNET OF THINGS?

Image: jurvetson/Flickr

trucknews.com, March 1, 2017:

Mack, Volvo offering over-the-air engine updates

March 1, 2017
by James Menzies

NASHVILLE, Tenn. – Mack and Volvo both announced at the spring meeting of the Technology & Maintenance Council that they'll be offering over-the-air software and parameter updates.

CES 2017 - Consumer Electronics Show

Aktualisierung auf Knopfdruck: Conti und Inmarsat zeigen Over-the-air-Updates

Jennifer Kallweit am 04. Januar 2017 um 16:30 Uhr

AUTOMOBIL PRODUKTION

Continental

Contents

- Interconnected systems
- Aspects of Testing
  - Architectures and Interfaces
  - Test Description Languages
  - Metrics
- Research projects

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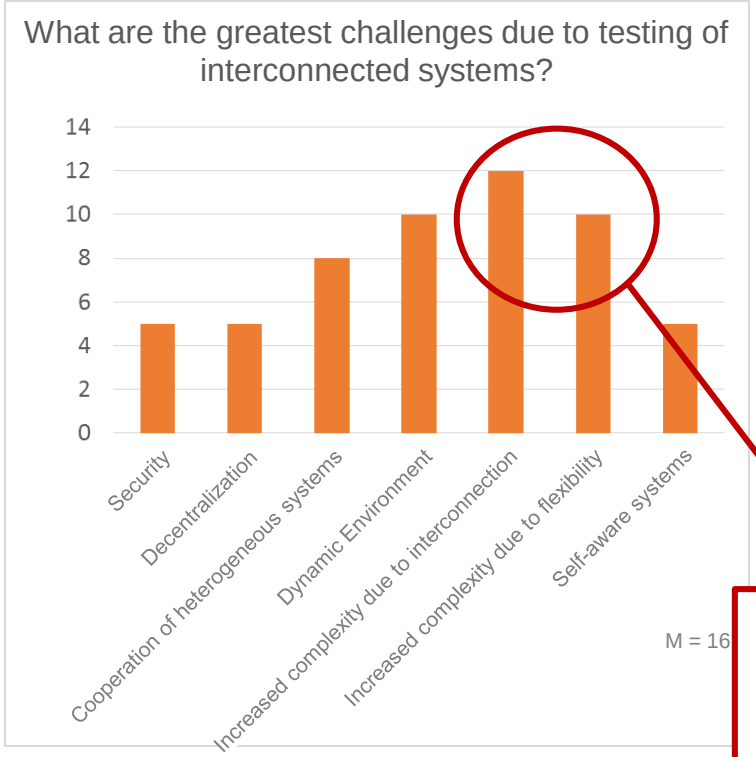
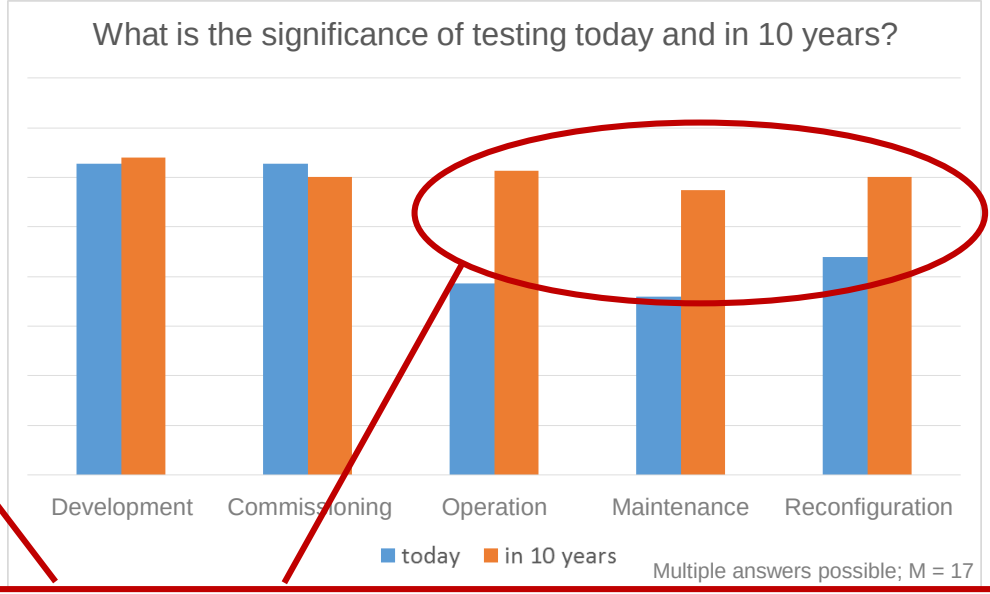
Experts' prediction of Challenges in Testing

Experts were interviewed and questioned on various aspects of the testing of interconnected systems.





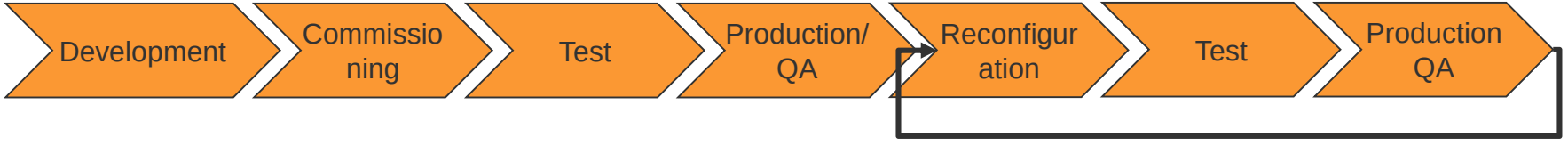
Expectations:

- > **Increase of Complexity**
- > Increasing **relevance** of testing **"in the field"**

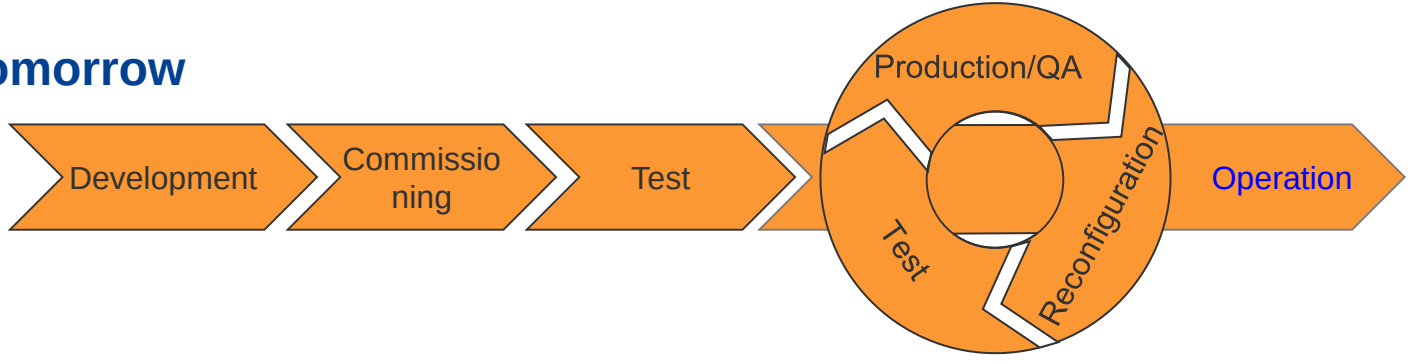
Test and Quality Assurance during Operation

Design and Testing moves from Engineering to Operation (Runtime) in the field due to reconfigurable autonomous systems

today



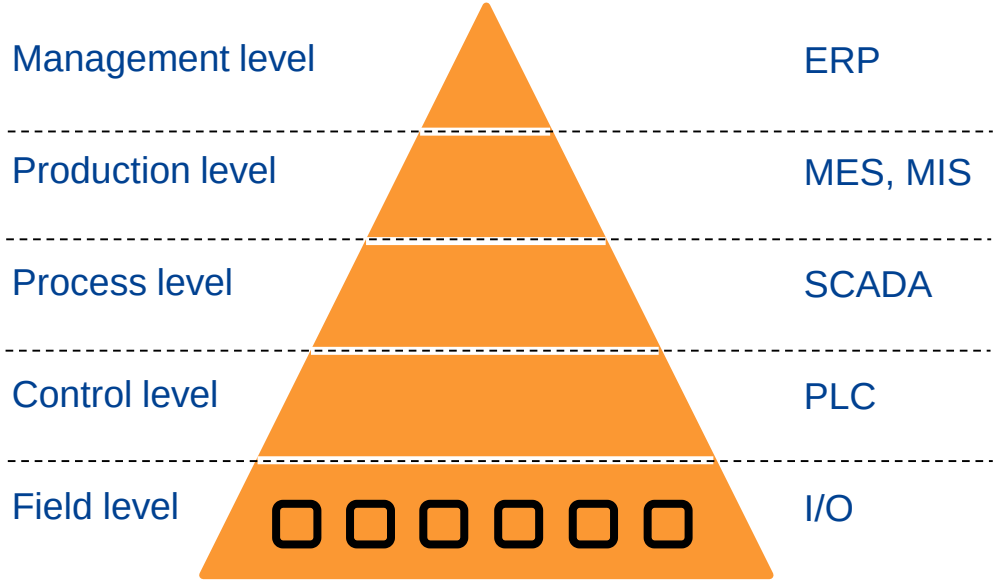
tomorrow



Manufacturing Automation is based on strict Hierarchies

The “Automation Pyramid” follows the level definitions of the ISA-95 Framework.
“Engineering” and “Operation / Runtime” are clearly separated

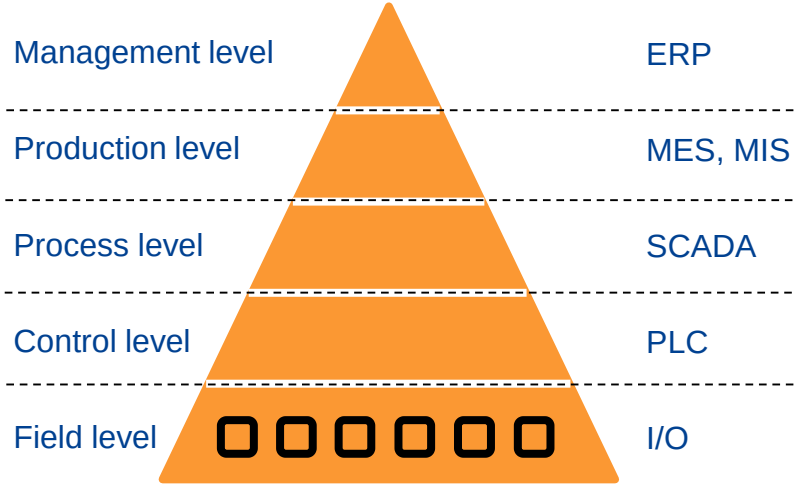
Bildquelle: basf.com



Automation Pyramid

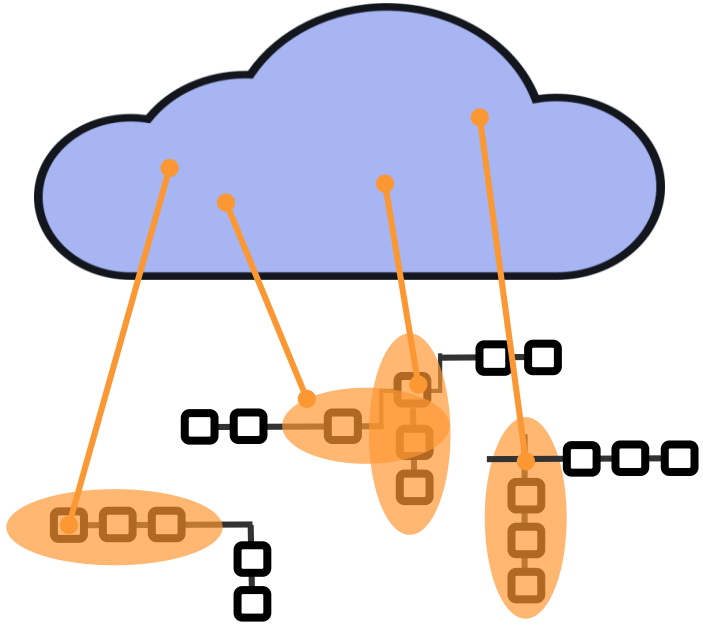
“Industrie 4.0” results in a new Automation Paradigm

The “Automation Pyramid” follows the level definitions of the ISA-95 Framework.
“Engineering” and “Operation / Runtime” are clearly separated



Automation Pyramid

Automation becomes “Cyber – Physical” as the IT can be distributed



Upcoming Changes to cope with …

Requirements of automated systems will change through interconnection, and new testing aspects have to be considered.

- **Heterogeneous systems** due to combination of various vendors, systems on multiple levels
- **Flexibility and Autonomy** based on the use of software in components
- **Distribution / Virtualisation** of software in extended system-of-systems
- **Ubiquitous networks** provide process data and information in real time

Required:
New ***standards*** for development and ***test methods*** to cope with the complexity

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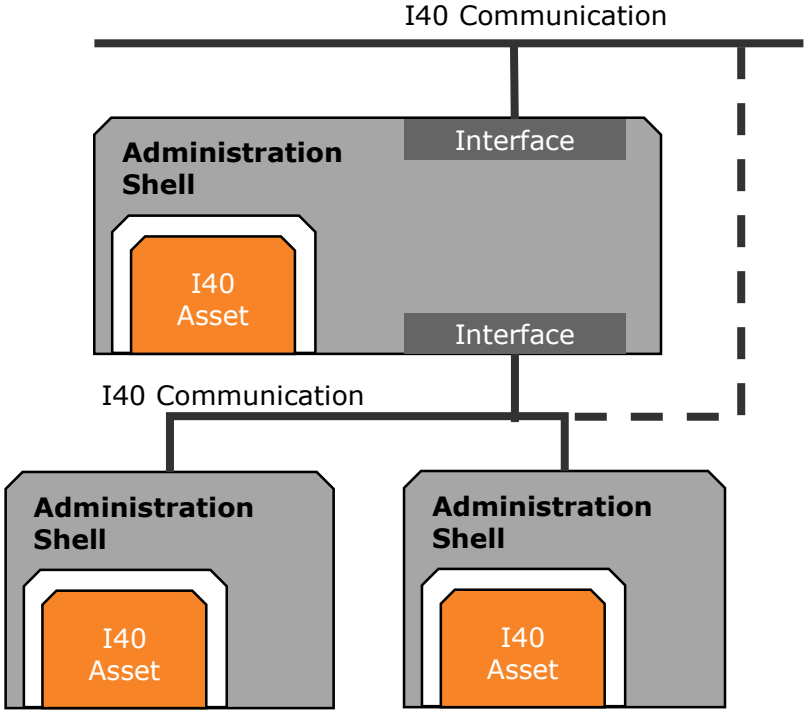
Interfaces for heterogeneous “Industrie 4.0”

Interconnected Components (Assets) require interface definitions in order to exchange information and enable test.

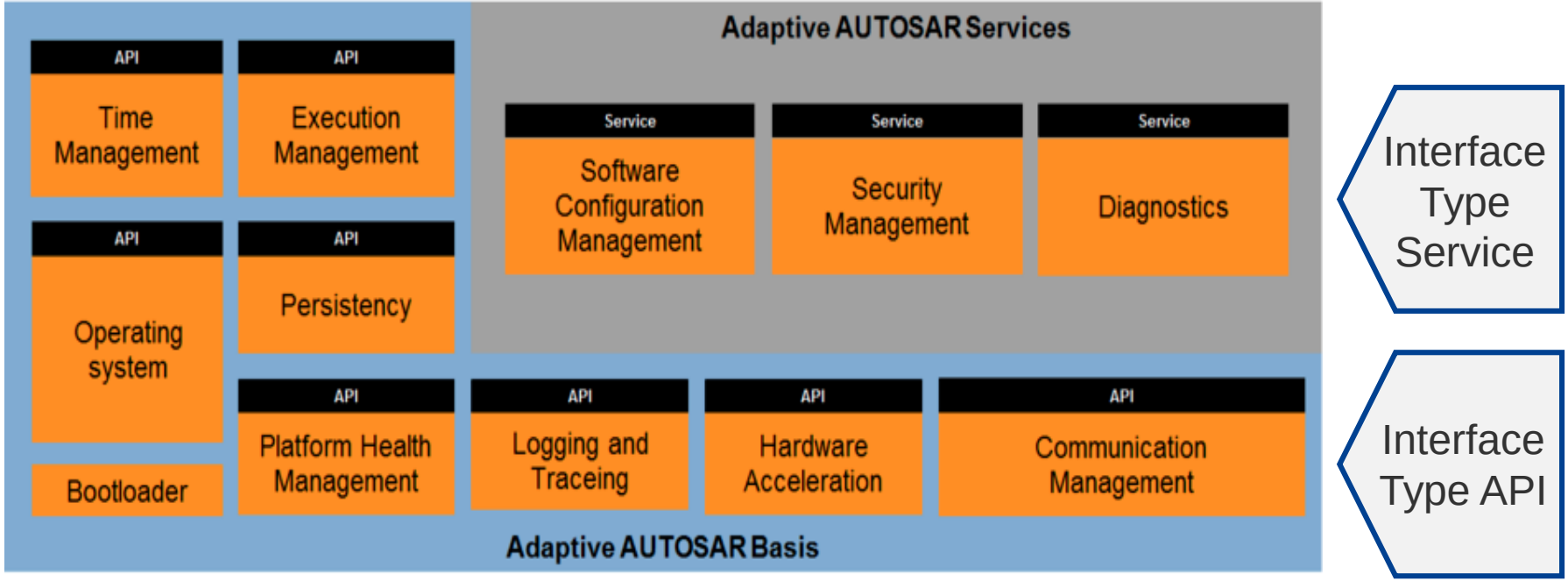
How is the standard for communication of “Industrie 4.0” assets and what should it entail?



Angelehnt an: DIN SPEC 91345: Referenzarchitekturmodell Industrie 4.0 (RAMI4.0), 2016

Role Model „Adaptive AUTOSAR“

Adaptive AUTOSAR was developed for Use-Cases like Car2X, autonomous driving and vehicle in the cloud.



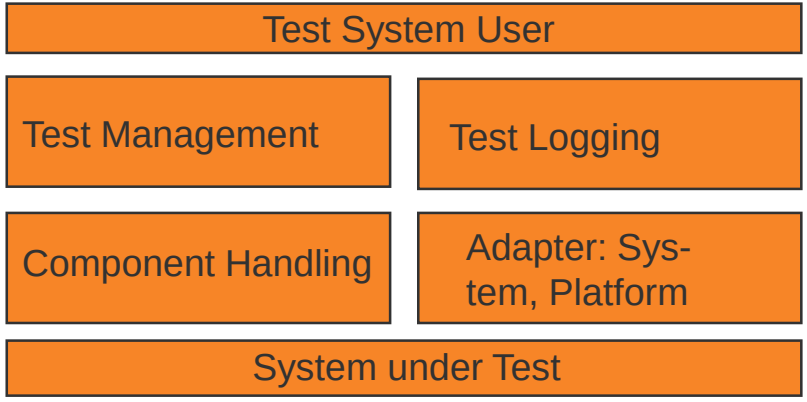
The AUTOSAR Adaptive Plattform AP R17-03 was released on March 31st 2017. Figure source and further information see: www.autosar.org/standards/adaptive-platform/

Automatic Test Management of distributed Systems

Existing Standards are a starting point for future test automation which should be interoperable, consistent, domain specific and suitable for real time.

How to advance existing test description languages?

Standards for Test in Telecommunication



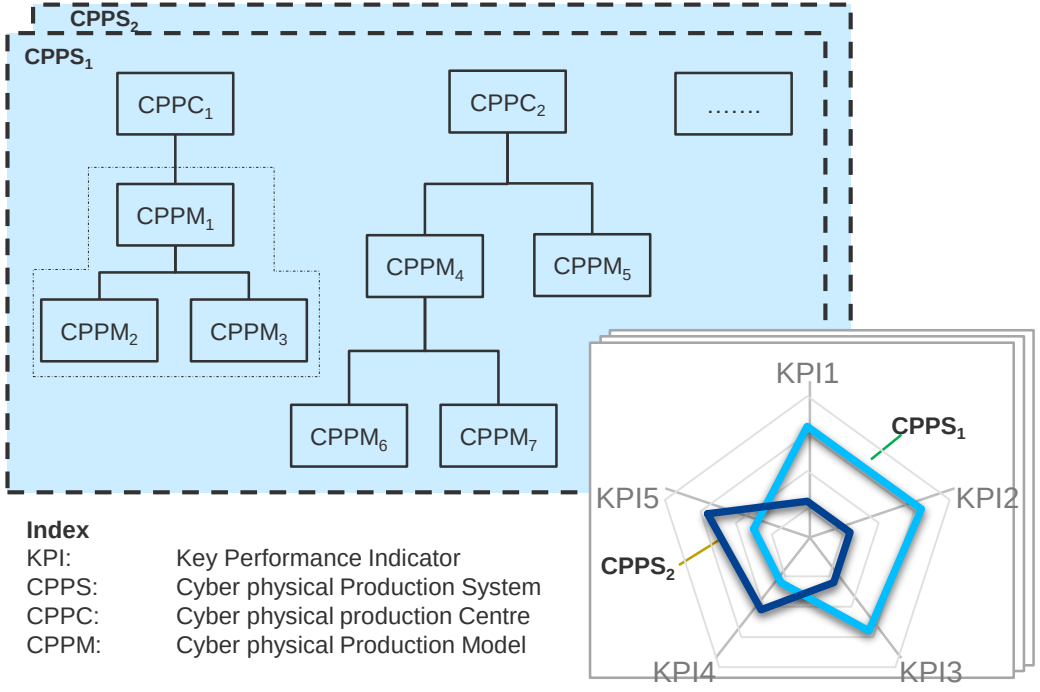
See: ETSI (European Telecommunications Standards Institute):

- Test Description Language (TDL) and
- Testing and Test Control Notation V3 (TTCN-3)

Metrics for Test flexible and autonomous Systems

Suitable metrics for testing in “Industrie 4.0” have to be developed.

How to deploy metrics for Performance and quality Test of Flexible and autonomous systems?



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KPI:	Key Performance Indicator
CPPS:	Cyber physical Production System
CPPC:	Cyber physical production Centre
CPPM:	Cyber physical Production Model

Further Reading of the IAS Stuttgart Evaluation Model see: http://www.ias.uni-stuttgart.de/?page_id=40&projekt_id=27

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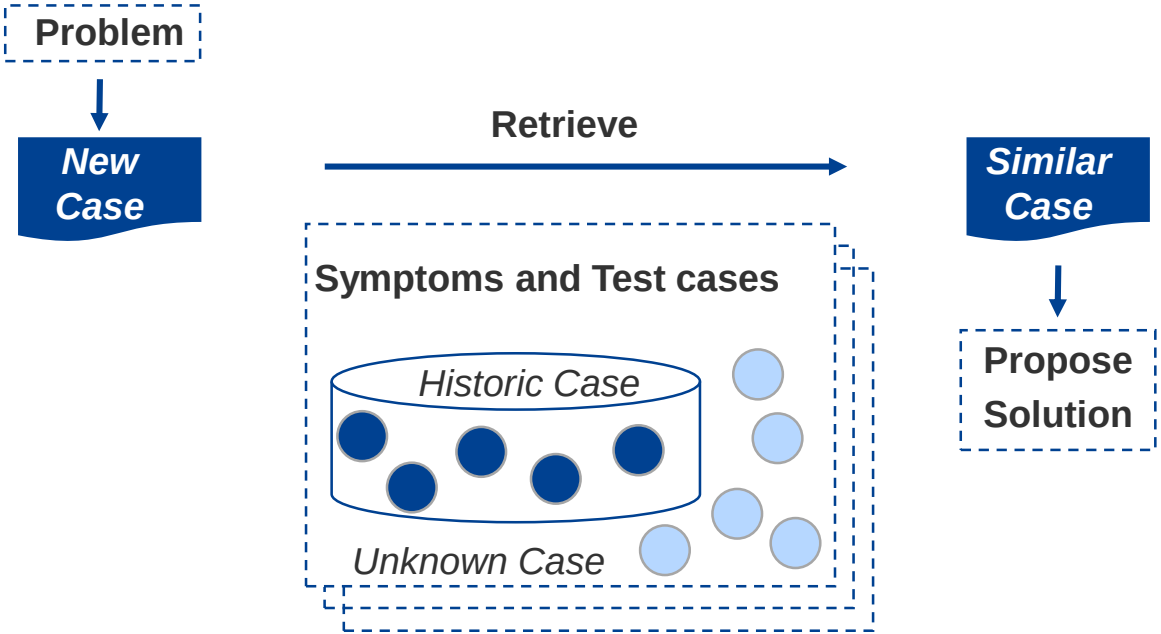
Example 1: Test of systems in **Ubiquitous Networks**

Determination of relevant test cases in interconnected systems by case-based reasoning based on error history.



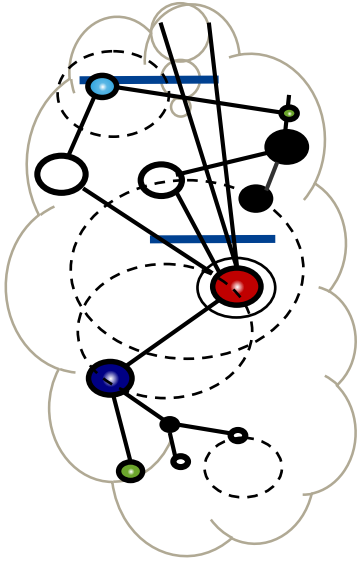
Scenario: End-of-Line Testing in automotive manufacturing

In order to identify a solution, the test case must previously have occurred in the same or similar way.

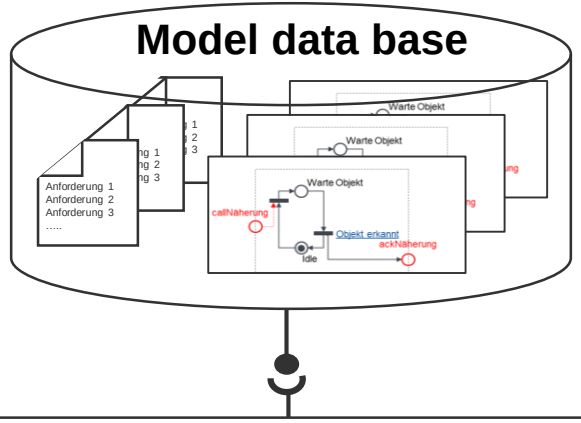
Example 2: Test of systems in **Ubiquitous Networks**

Testing of interconnected systems based on models allows a pre-assessment and identification of potential issues and test cases

Interconnected Automation System



Model data base



Automatic Test based on models

1. Access of information of systems and components
2. Determination of affected requirements
3. Composition of an appropriate behavioural model
4. Model-based test of requirements

Future Initiatives for Test of “Industrie 4.0” Systems

VDI/VDE Committee GMA 7.25 „Testing of “Industrie 4.0” Systems”

Goals of the Initiative:

- Create guideline
- Develop methods

Cyber-physical Research Environment

An Internet-of-Things Test Laboratory is being developed at the IAS to demonstrate test and verification for “Industrie 4.0”

Summary

- Why test interconnected systems?
- Aspects of Testing in “Industrie 4.0”
- Research projects

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