
FRAUNHOFER FOKUS
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DIGITALIZATION
Not only the climate will change the world
Ina Schieferdecker, February 21, 2018, Potsdam
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WHAT CHANGES THE WORLD

People

Economic Systems

Social Systems

Technical Systems

Earth System

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DIGITALIZATION

2005

2013

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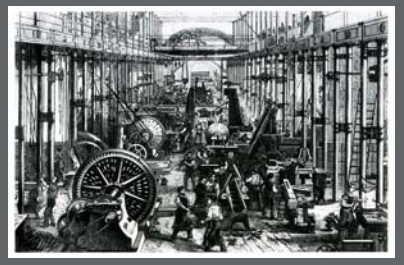
TECH REVOLUTIONS IN HUMAN KIND

Agricultural revolution

Source: Genetic Literacy Project

Industrial revolution



Source: Wikimedia

Digital revolution

Source: Industrial Insight

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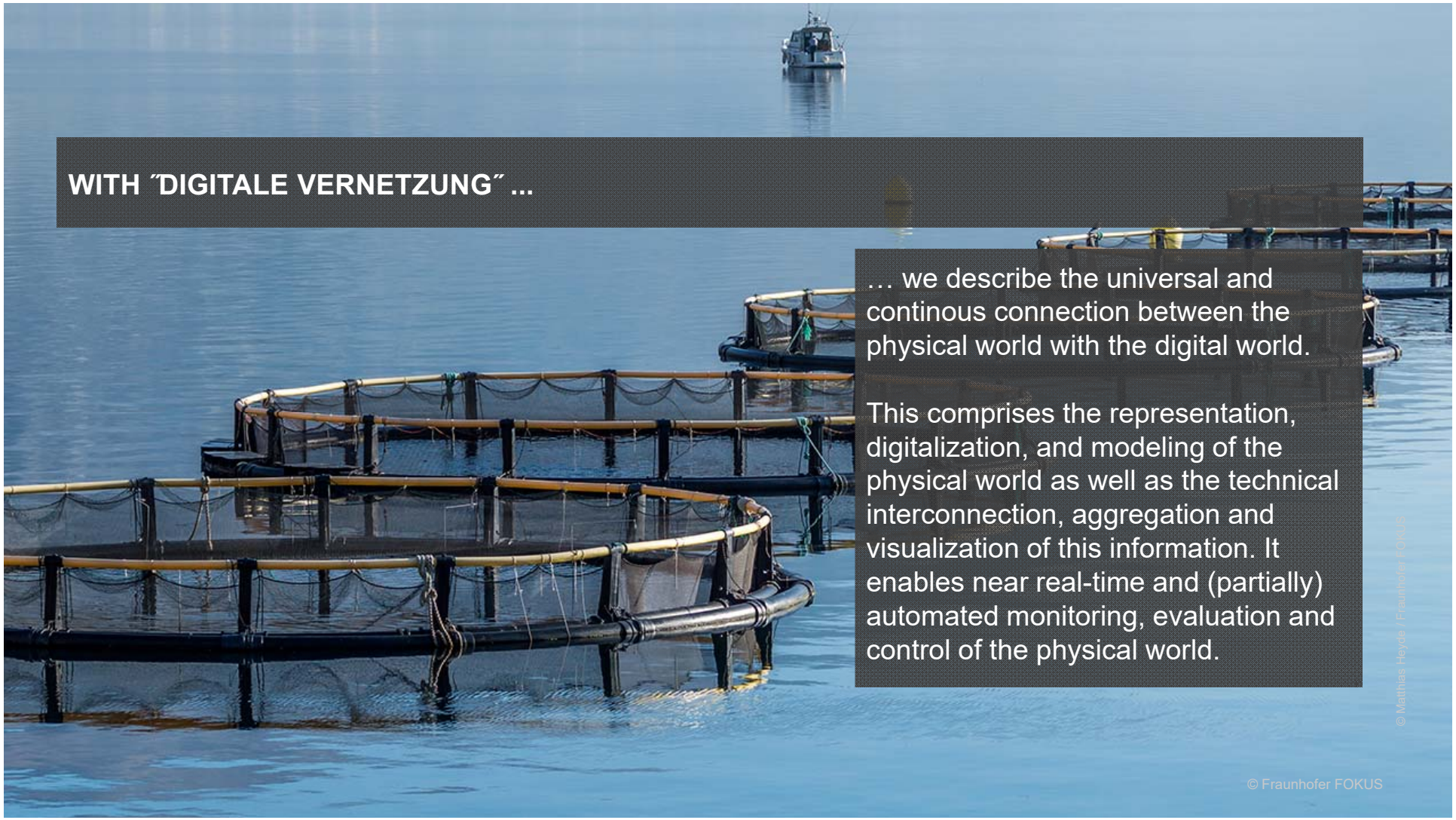


WITH ″DIGITALE VERNETZUNG″ ...

… we describe the universal and continous connection between the physical world with the digital world.

This comprises the representation, digitalization, and modeling of the physical world as well as the technical interconnection, aggregation and visualization of this information. It enables near real-time and (partially) automated monitoring, evaluation and control of the physical world.

INTERNET USERS IN THE WORLD

2017:

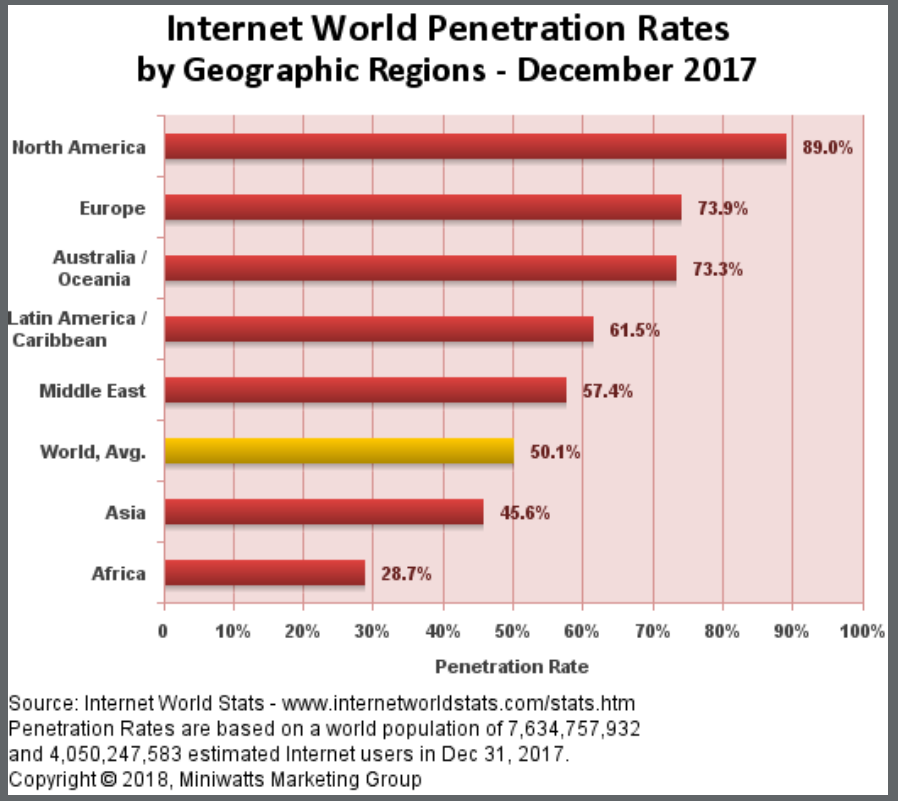
Over 50% of the world population has an Internet connection.

In 1995, it was less than 1%.

The number of internet users has increased tenfold from 1999 to 2013.

The first billion was reached in 2005. The second billion in 2010. The third billion in 2014.

Source: Internet Live Stats



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2014:

There are officially more mobile connections than people in the world.

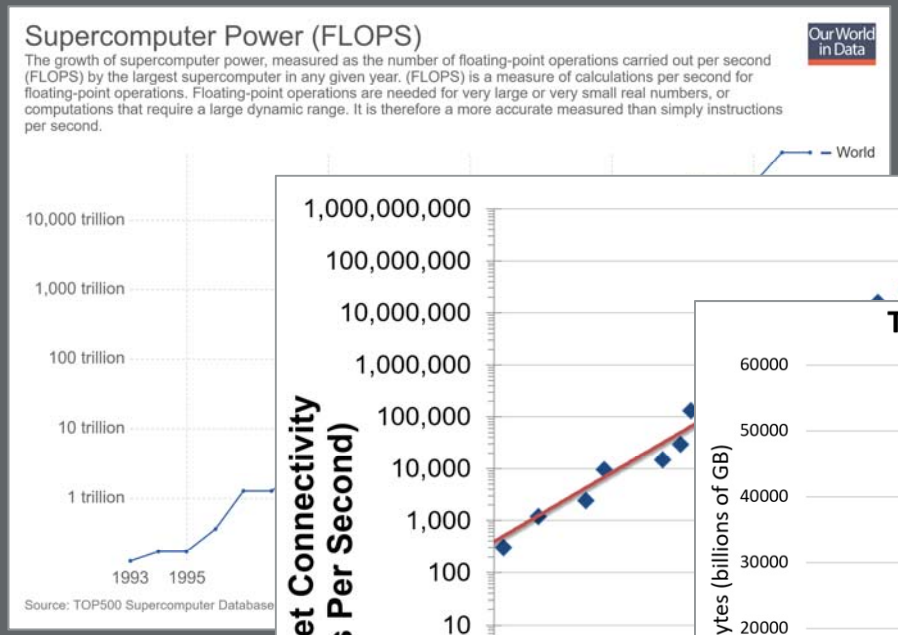
The world is home of 7.2 billion active SIM cards. They are multiplying five times faster than we are.

Source: GSMA Intelligence

Source: Open Source Studio

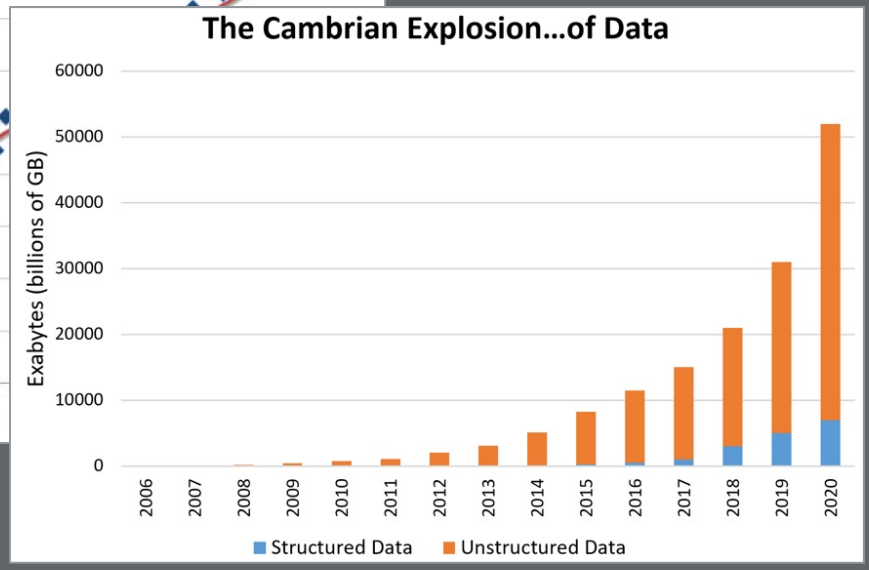
Internet of Things (IoT) sensors and devices are expected to exceed mobile phones as the largest category of connected devices in **2018**, growing at a 23% compound annual growth rate (CAGR) from 2015 to 2021.

Source: Ericsson



Source: Our World in

Source: NNgroup, 2017



Source: Patrick Cheesman, 2015

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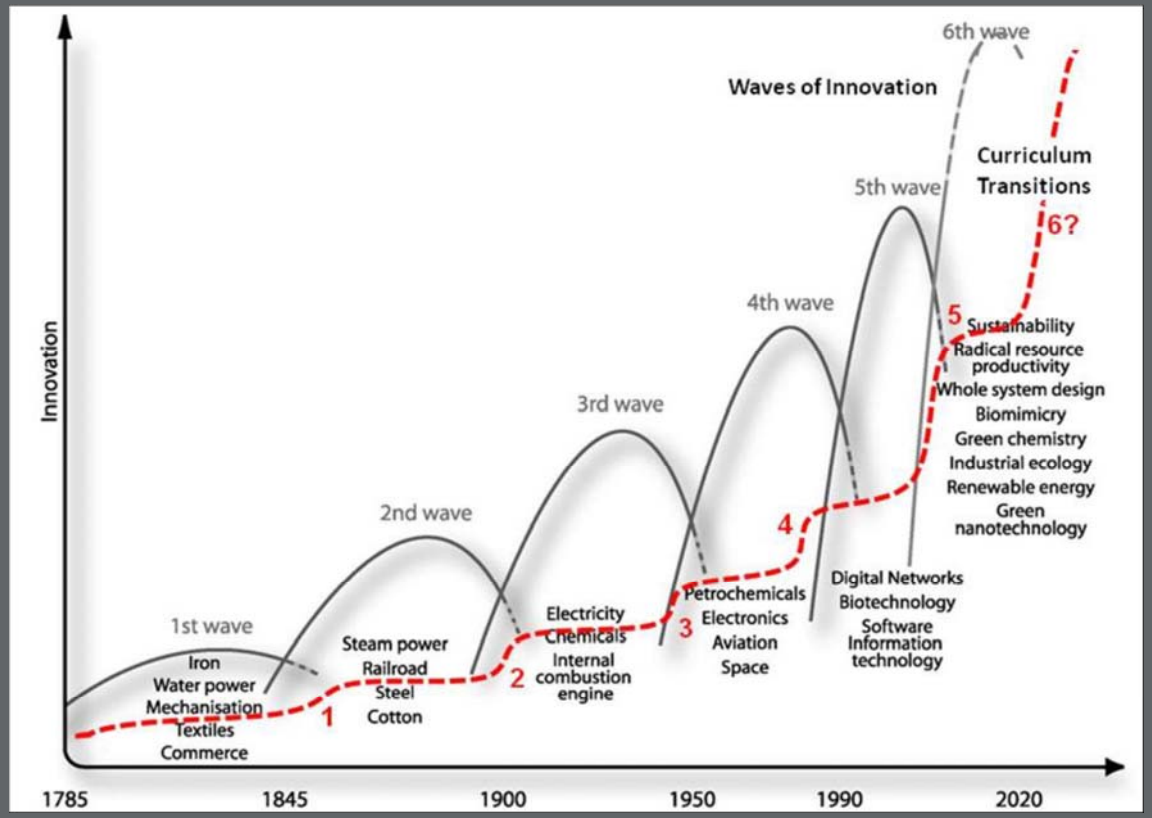

Sustainability 2014, 6(7), 4181-4199; doi:10.3390/su6074181: A Peaking and Tailing Approach to Education and Curriculum Renewal for Sustainable Development, Cheryl Desha and Karlson 'Charlie' Hargroves

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SOFTWARE FAILURES, OUTAGES, AND DOWNTIME

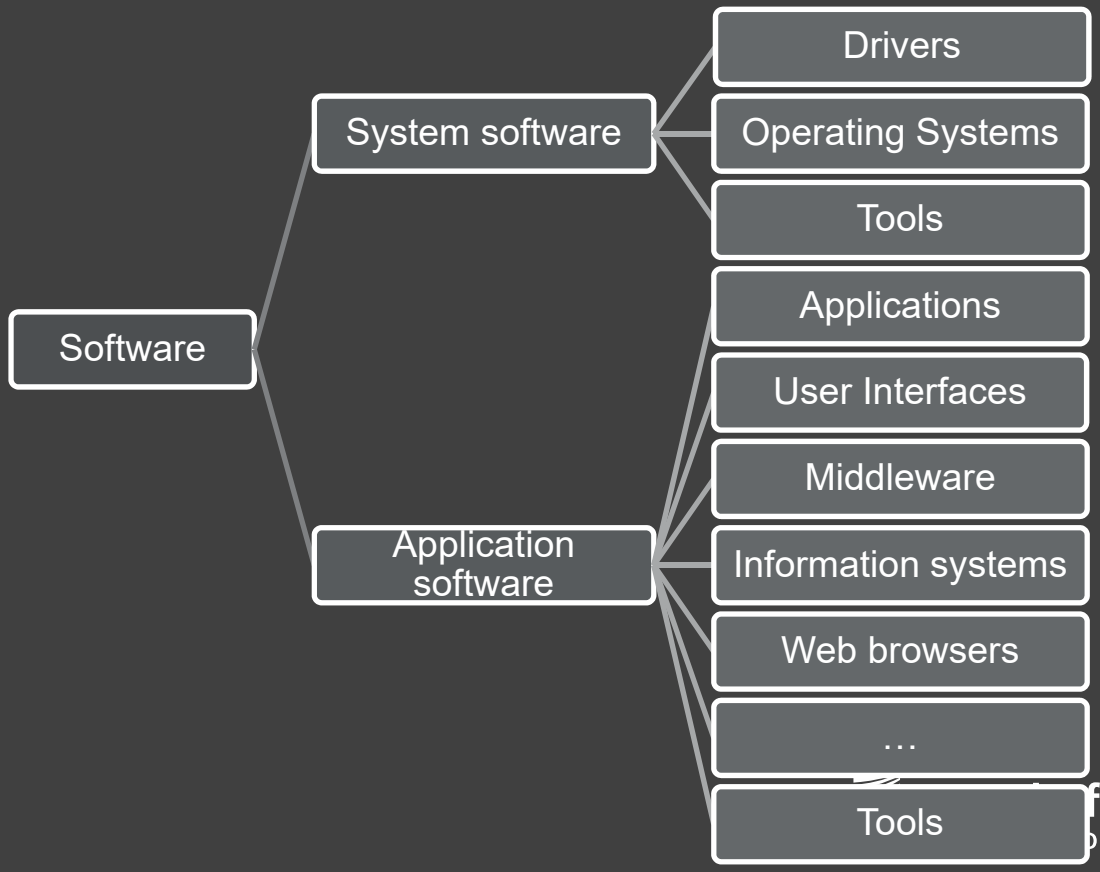
Yearly Cost Metrics	Best-in-Class	Industry Average	Laggards
Business interruption events	.9	3	3.5
Time per business interruption event (hours)	1.3	4.7	8.4
Total disruption (hours)	1.2	14.1	29.4
Average cost per hour of disruption	$60,000	$110,000	$98,000
Total cost of business interruption events	**$72,000**	**$1,550,000**	**$2,880,000**

Source: Aberdeen Group, Month 2010

SOFTWARE

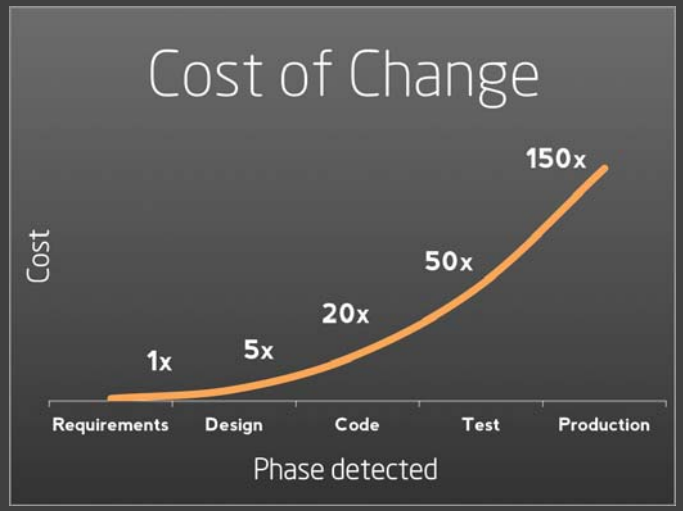
Software is the set of instructions that tells the computer what to do and how to do.

Software includes
- code (→ algorithms)
- data (→ digital representations, models, documentation)

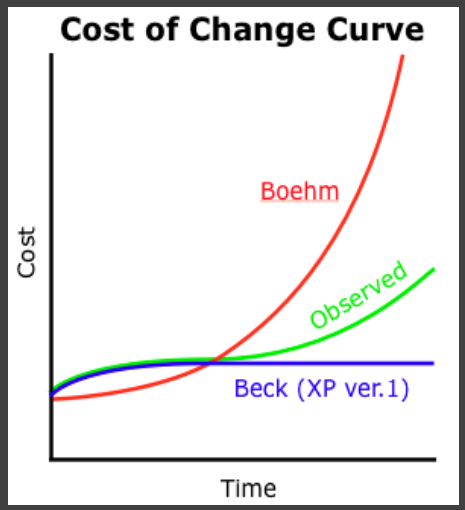


THE SOFTWARE-HORROR PICTURE SHOW

- 1996: Explosion of Ariane 5. 370 Mio US-Dollar loss.
- 1985-1987: radiation therapy machine Therac-25 gave its patients radiation doses that were hundreds of times greater than normal, resulting in death or serious injury. At least, 3 patients died.
- …
- 2017: Central computer outage at U.S. Customs and Border Protection, thousands of travellers waited for hours at immigration
- 2017: Vodafone total outage of Internet and phone connections for 1.8 Mio customers
- 2017: Toyota software update crashed navigation and entertainment systems of several car types
- …
- 2018: Microsoft patch day for CPU bug stopped
- ...



Source: Barry Boehm, 1980



Source: Michael James, Scrum Master, 2013

Quality costs.

Low quality costs a lot more.

Low quality means many software vulnerabilities.

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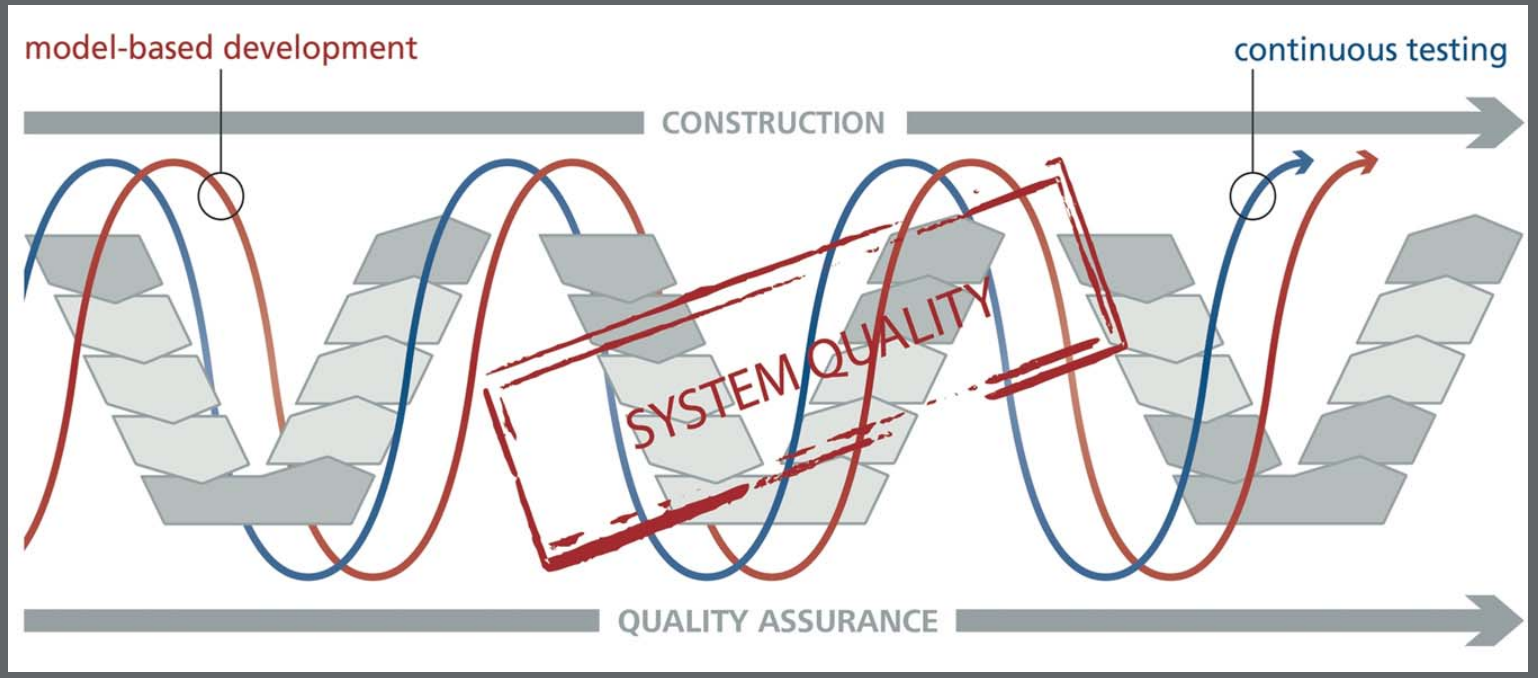
OUR SOFTWARE QUALITY APPROACH



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MODEL-DRIVEN SOFTWARE ENGINEERING

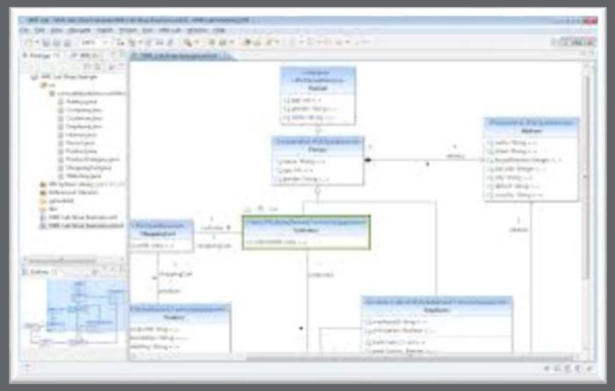
Correctness ?

Comprehensibility ?

Maintainability ?

Portability ?

Technology-Indepence ?



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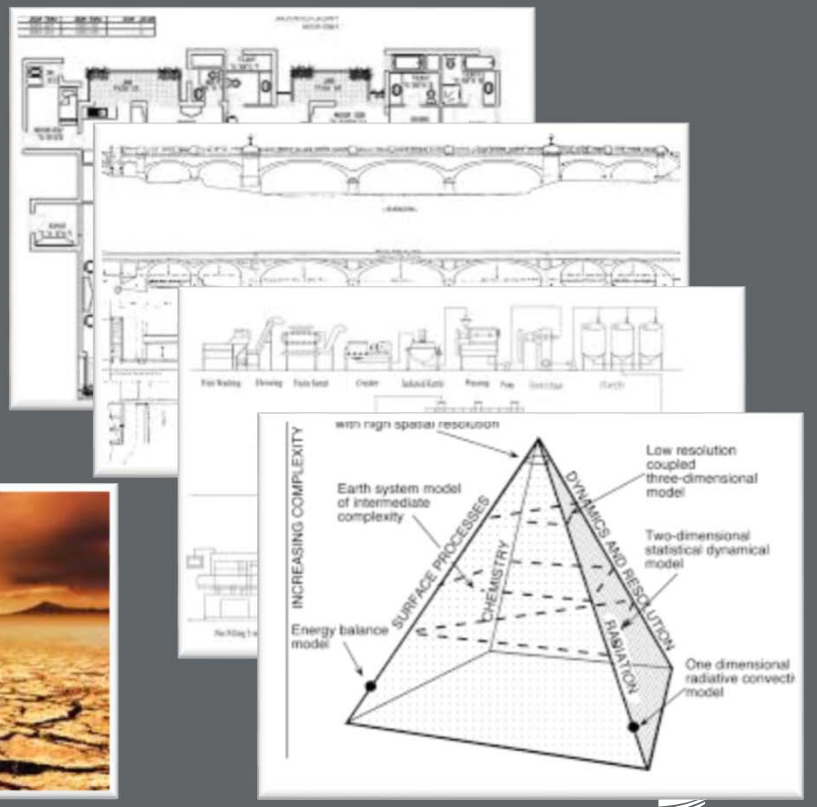
OTHER ENGINEERING AND SCIENCE FIELDS



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THE SOFTWARE MODEL …

… is the digital twin of the software!

MODELS

„A model is the simplified image of
a past, current or future something.”

A model can be the simplified image of a system.

A system can be designed and constructed with models.

A system can be verified and validated with models.

A model can be verified and validated with models.

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MODEL-BASED ENGINEERING OF SOFTWARE-BASED SYSTEMS

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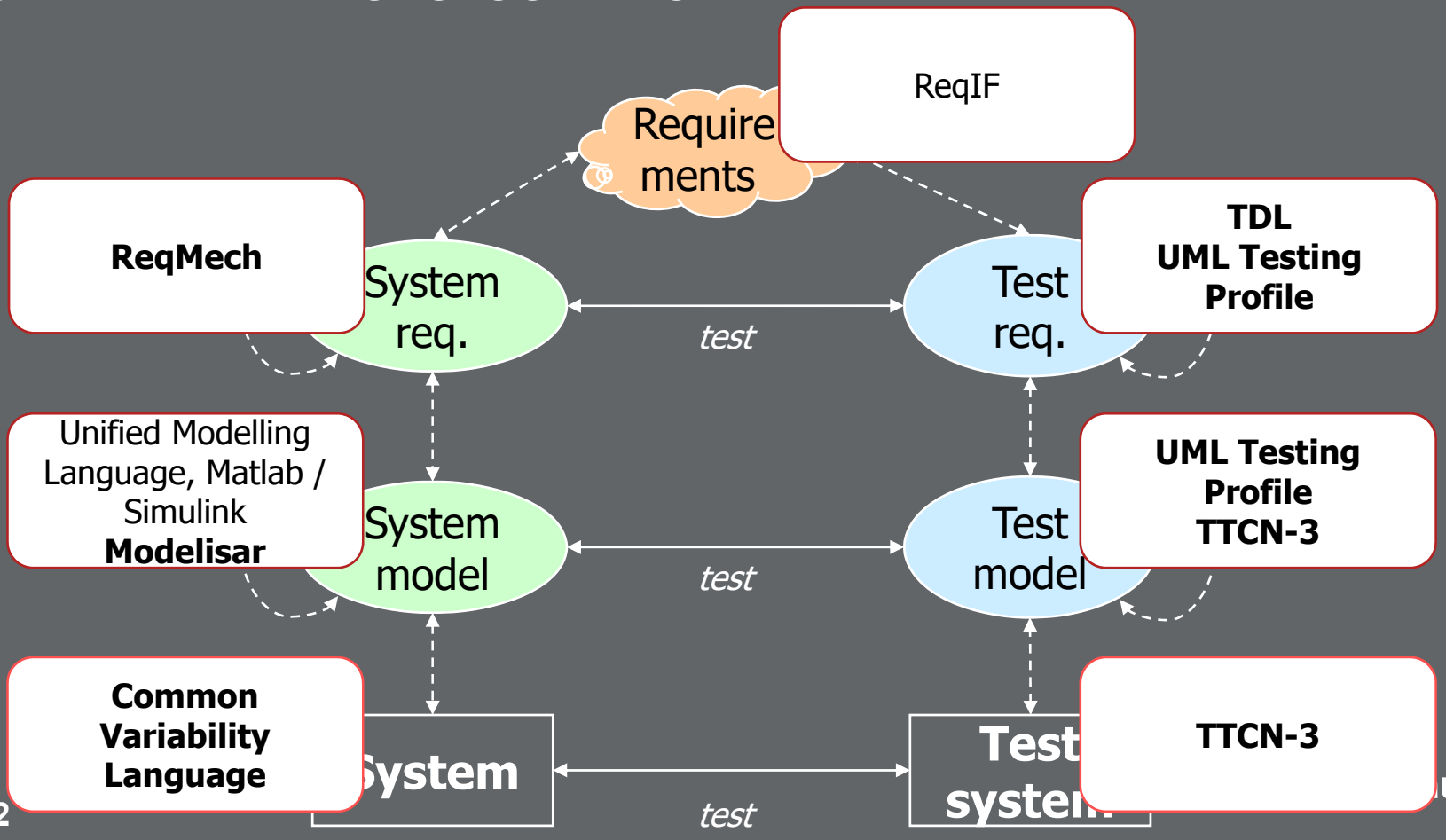
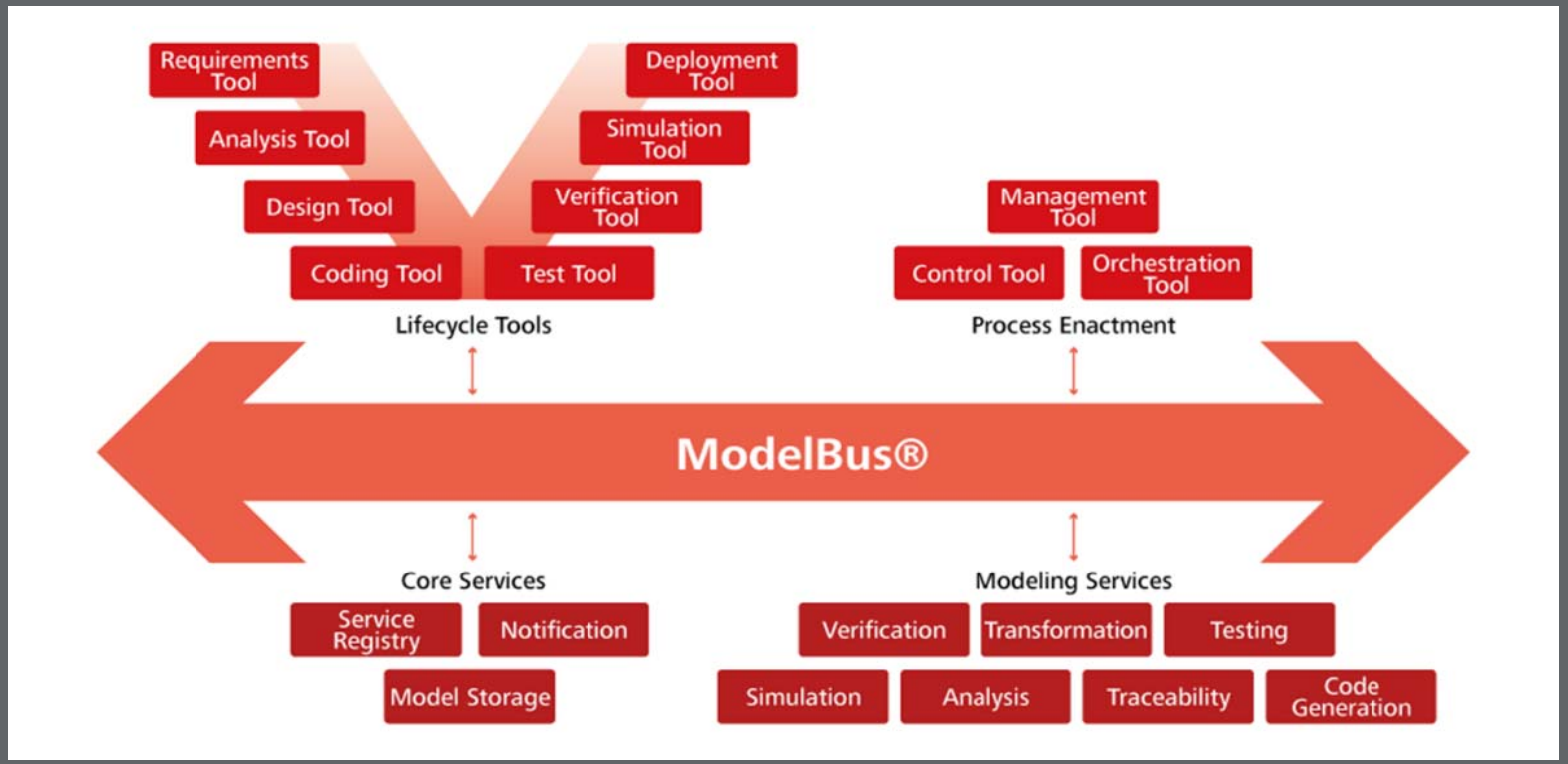
SIMPLIFIED METHODOLOGICAL OVERVIEW



MODEL-BASED TOOL CHAINS FOR AUTOMATED SOFTWARE PRODUCTION



I. Schieferdecker and T. Ritter, "Advanced Software Engineering," in Digitalisierung: Schlüsseltechnologien für Wirtschaft und Gesellschaft, R. Neugebauer, Ed. Berlin, Heidelberg: Springer Berlin Heidelberg, 2018, pp. 365–383.

MODELBUS®

- Connects tools and data coming from different teams
- Improves consistency in the development process
- Is independent of tool providers and prevents vendor lock-in
- Automates tedious tasks in software development and maintenance

- Offers collection of general purpose solutions for software measurements, tracking and tracing, requirements engineering and model-based testing

ModelBus®: http://www.modelbus.org
YouTube Channel: http://www.youtube.com/user/ModelBusOrg

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MODELBUS®

Selection of connected tools

- Eclipse based tools
- Topcased, Papyrus, ProR, …
- Sparx - Enterprise Architect
- IBM - Rational Software Architect
- IBM - Rational DOORS
- IBM - Rhapsody
- HP - Quality Center
- Borland - Caliber
- MathWorks - Simulink
- Microsoft - Office (Word, Excel)
- PTC - Integrity Modeler (Artisan Studio)
- AVL - InMotion
- Berner & Mattner

- MERAN, MESSINA, TESTONA
- Traceability with Traceino
- Requirements Engineering with Requino
- GIT, SVN, …
- OSLC-Compatibility

- Modelling Services
- QVT, ATL, OCL, Metric Computation, Report Generation, Model Repository, …

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THE TESTING AND TEST CONTROL NOTATION

- Internationally standardized testing language for formally defining test scenarios
- Designed specifically for testing


```
testcase Hello_Bob () {
        p.send("How do you do?");
        alt {
        []p.receive("Fine!");
                {setverdict( pass )};
        [else]
                {setverdict( inconc )}  //Bob asleep!
        }
}
```

J. Grabowski, I. K. Schieferdecker, and A. Ulrich, "History, status, and recent trends of the testing and test control notation version 3 (TTCN-3)," International Journal on Software Tools for Technology Transfer, vol. 16, no. 3, pp. 215–225, Jun. 2014.

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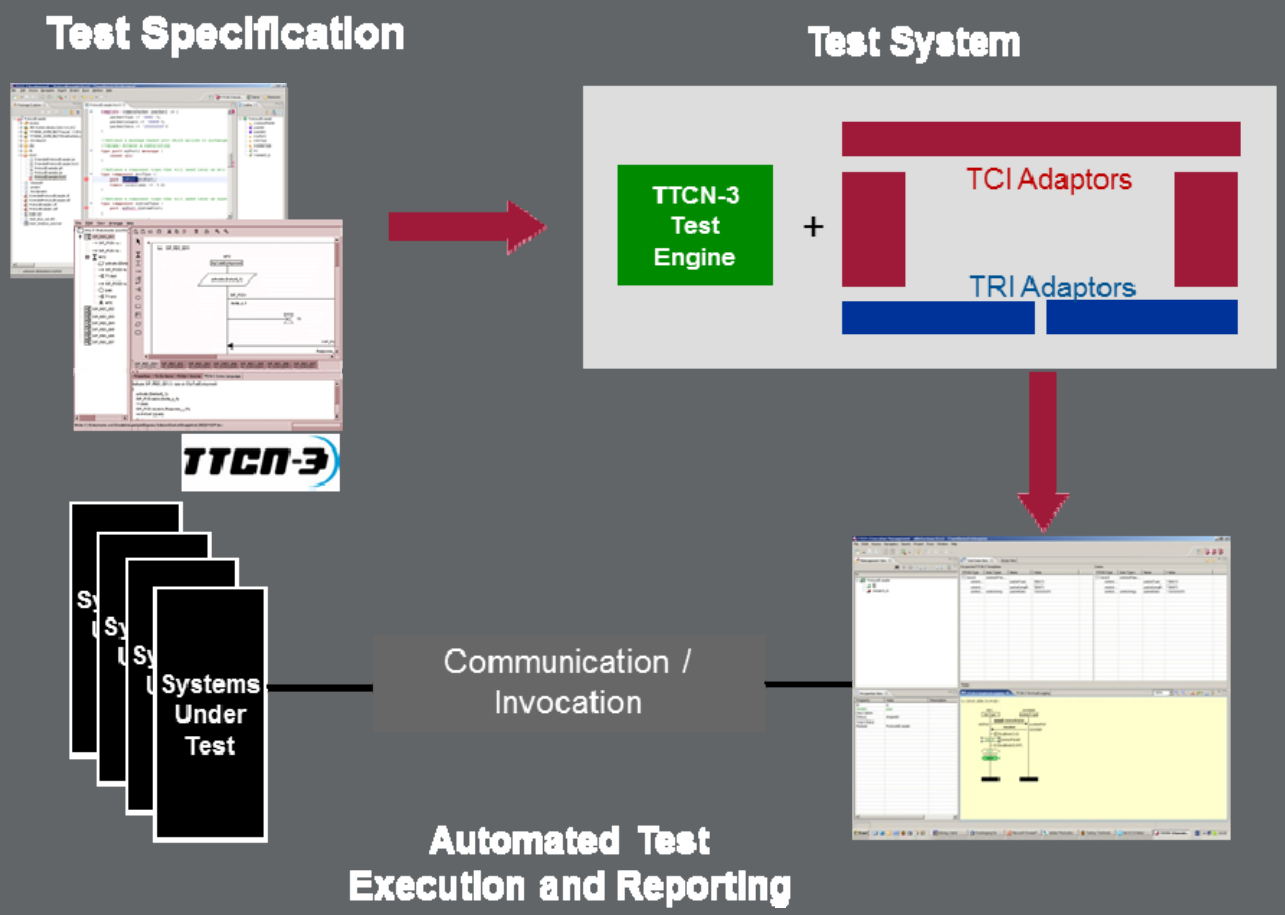
TEST EXECUTION



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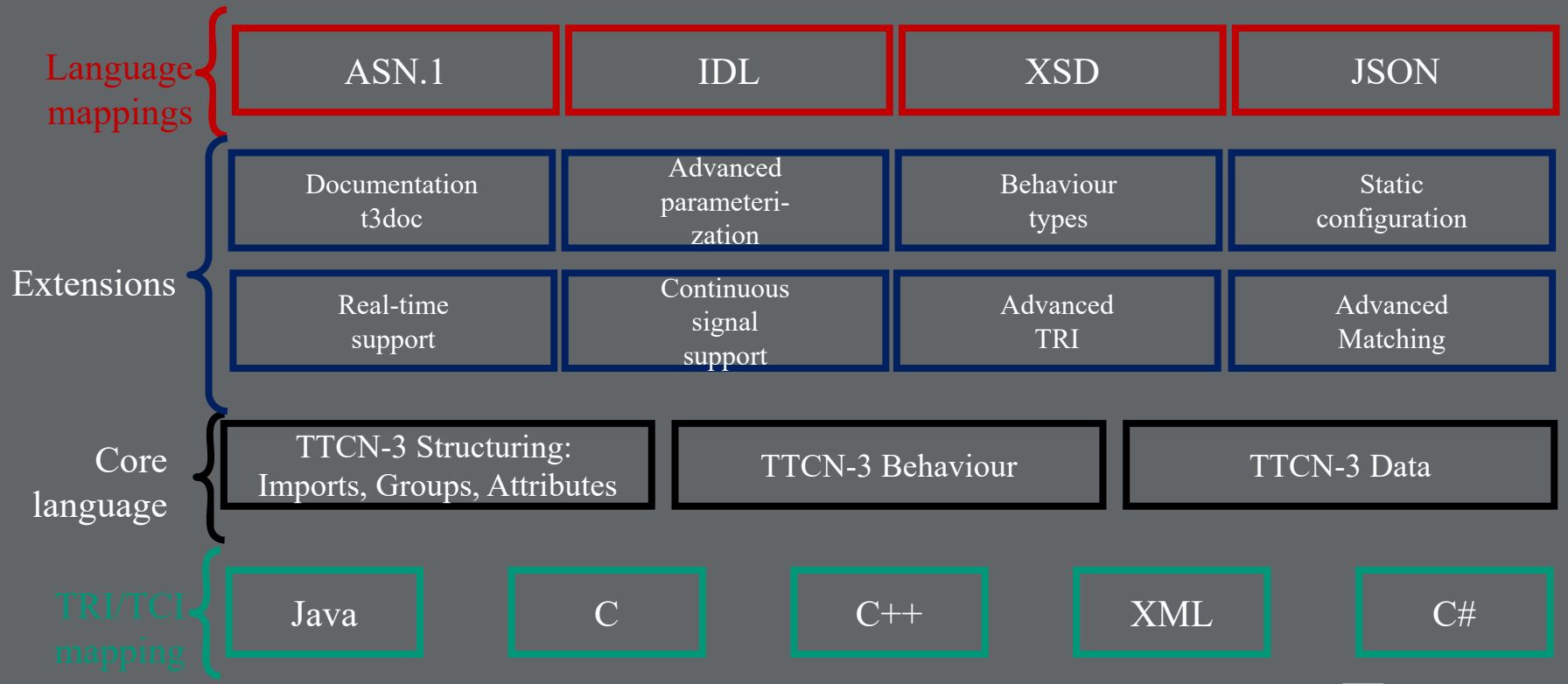
TTCN-3 TECHNOLOGY OVERVIEW



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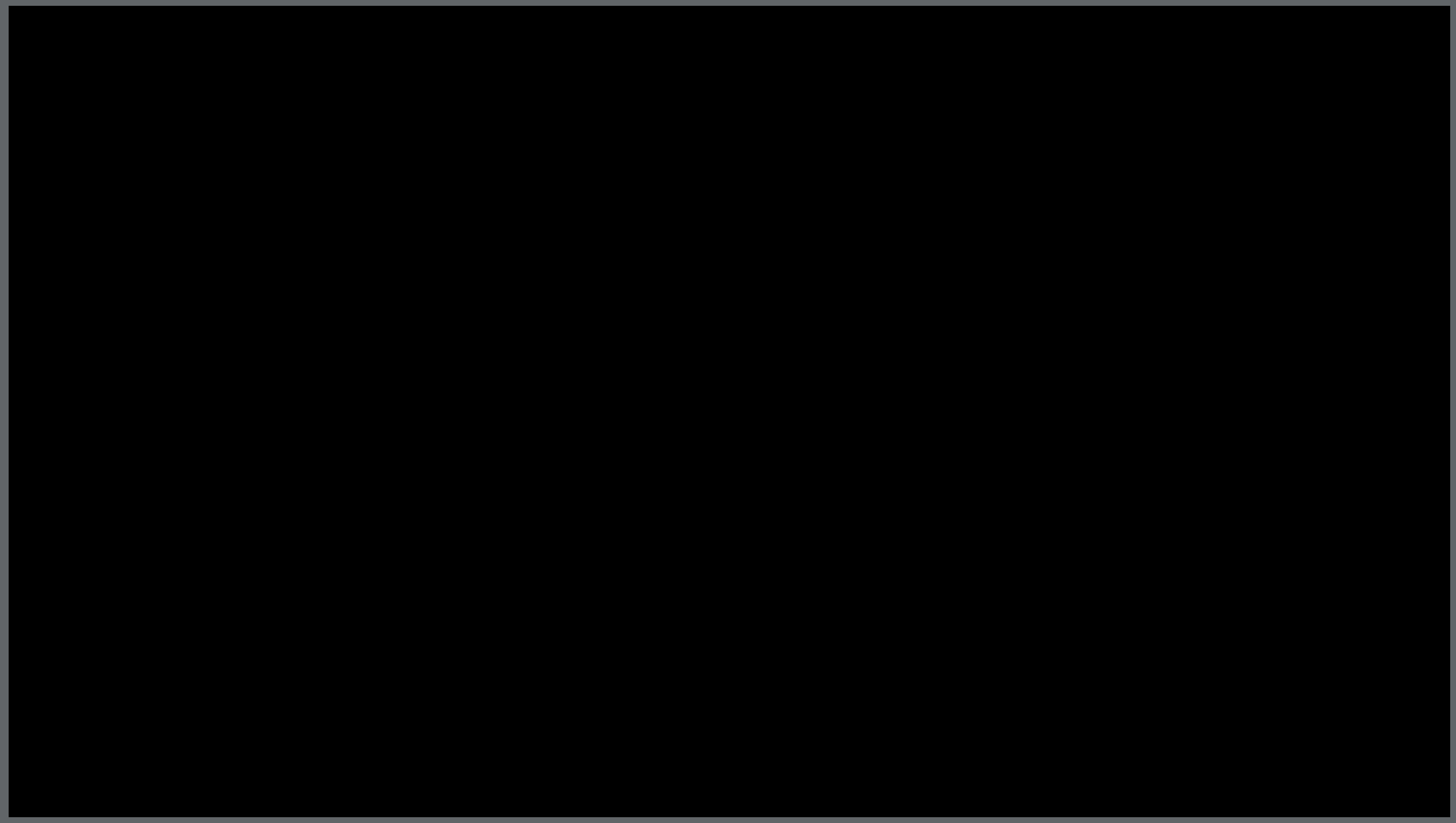
TTCN-3 AT WORK



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MODEL-BASED VERIFICATION AND VALIDATION

Giesecke & Devrient

M. Felderer and I. K. Schieferdecker, Eds., Risk-based testing, vol. 16, no. 5. Springer, 2014, pp. 559–642.

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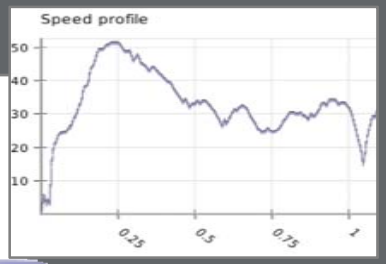
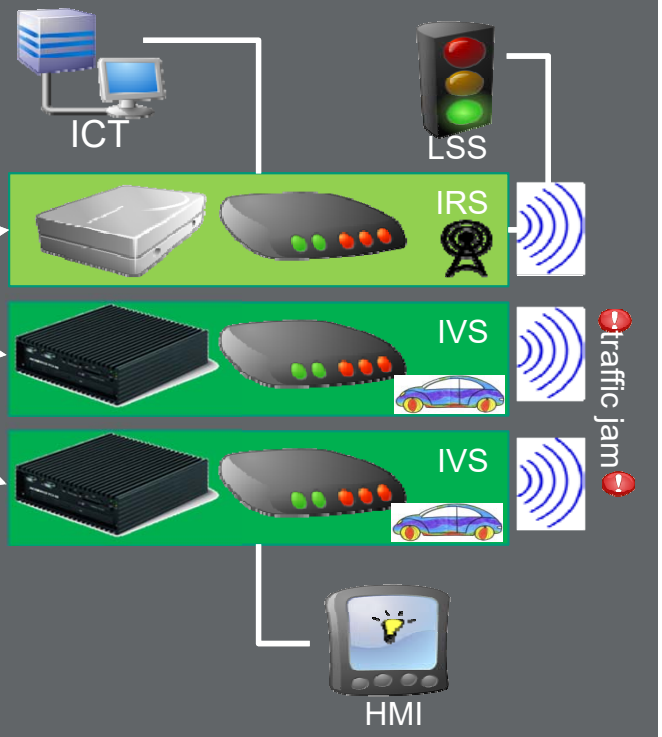
CONNECTED DRIVING TEST STAND

```
template V2XMessage c2xMessage(in
    id := sid,
    payload := {
      protoc
      actionI
      cancel
      genera
      validityDuration := 100,
      referencePosition := {longitude
      protocolMsg := pm
    }
  }
```

TTCN-3 Testing & Test Control Notation



Test Control

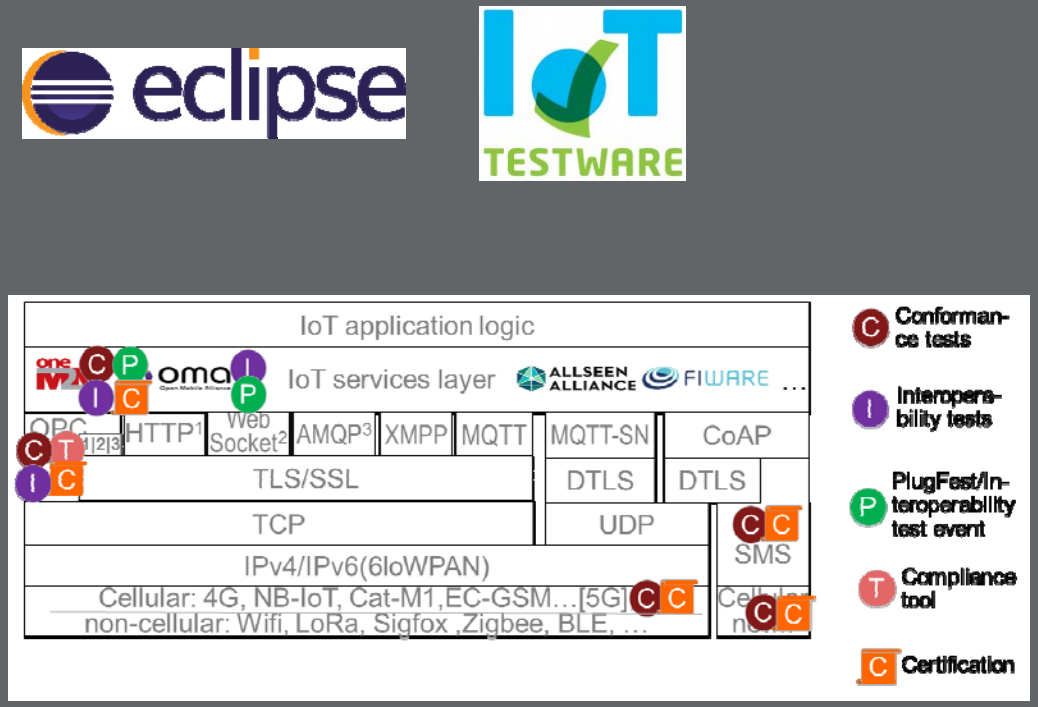


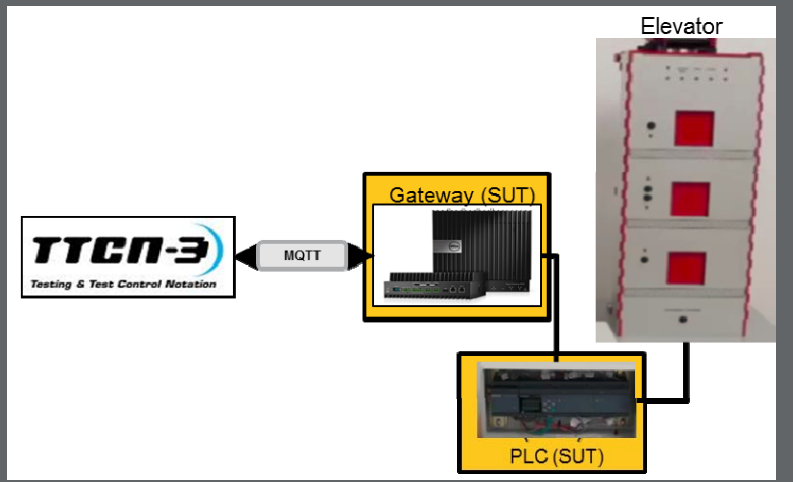
send traffic jam

received traffic jam

J. Grossmann, D. A. Serbanescu, and I. K. Schieferdecker, "Testing Embedded Real Time Systems with TTCN-3," in Second International Conference on Software Testing Verification and Validation, ICST 2009, Denver, Colorado, USA, April 1-4, 2009, 2009, pp. 81–90.

IOT-TESTWARE





I. Schieferdecker, S. Kretzschmann, A. Rennoch, and M. Wagner, "IoT-Testware - An Eclipse Project," in 2017 IEEE International Conference on Software Quality, Reliability and Security (QRS), 2017, pp. 1–8.

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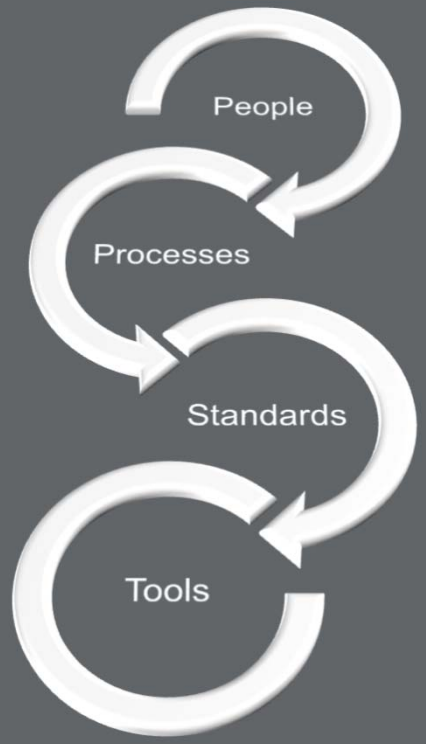
QUALITY NETWORK



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ASQF
Arbeitskreis Software-Qualität und -Fortbildung e.V.

iSQI
International Software Quality Institute

German Testing Board

ISTQB
International Software Testing Qualifications Board

ETSI
World Class Standards

OMG
OBJECT MANAGEMENT GROUP

TTCN-3

UML TESTING PROFILE

eclipse

MODEL BUS

IoT TESTWARE

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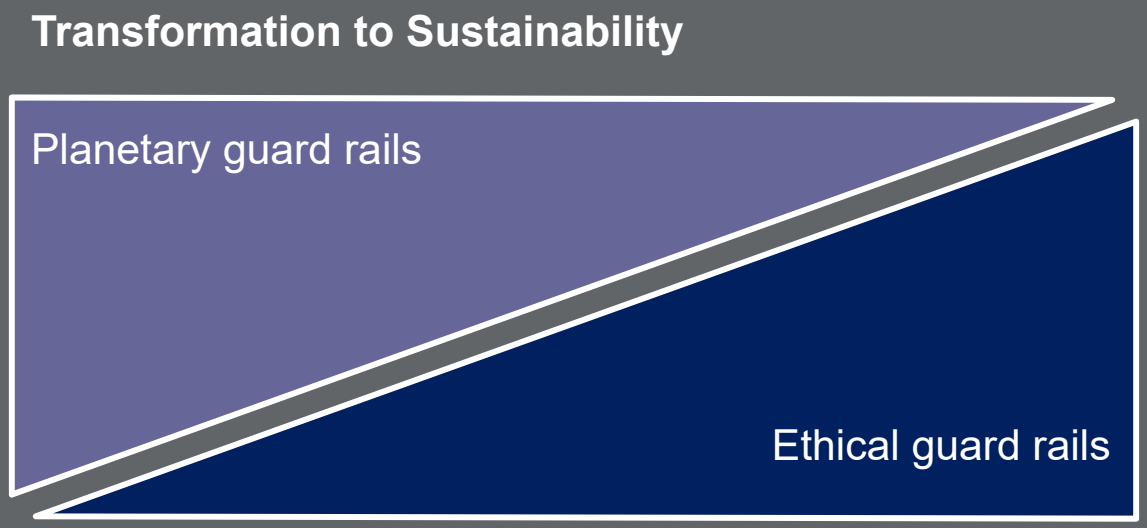
SUMMARY

CO-EVOLUTION OF DIGITALIZATION AND SUSTAINABILITY ?!



DRAFT GOALS ON DIGITALIZATION

1. Sustainability to become a central performance indicator of digital solutions
2. Preserving global digital commons
3. Enable real-time sustainability monitoring
4. Ensure digital inclusion
5. Ensure data protection and data sovereinity
6. Ensure IT security and safety
7. …

SUMMARY

- „Software is eating the world.“, Marc Andreessen, 2011
- Professional software engineering is essential
- Model-driven engineering of software-based systems is matured
- Needs to be continuously extended along new technological developments (machine intelligence, data analytics, augmented realities, …)

CONTACT

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