



Simulation as Tool

Continuous Software Testing with Simulation while Development Phase

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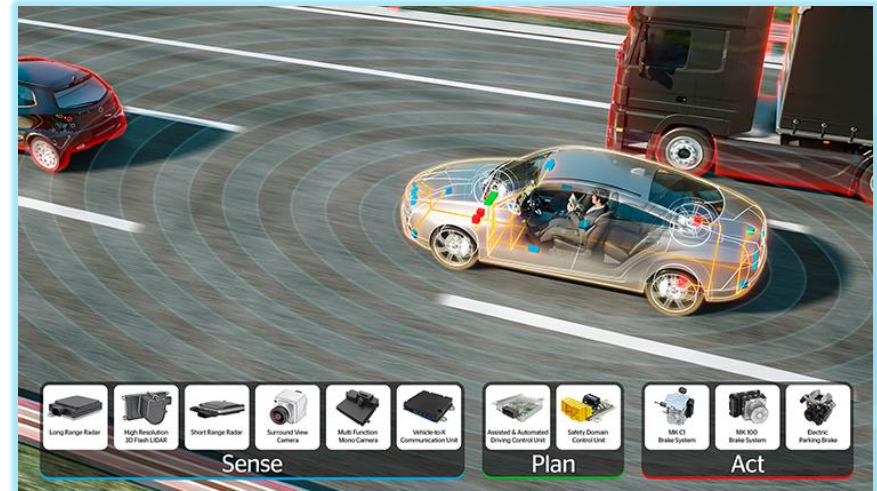
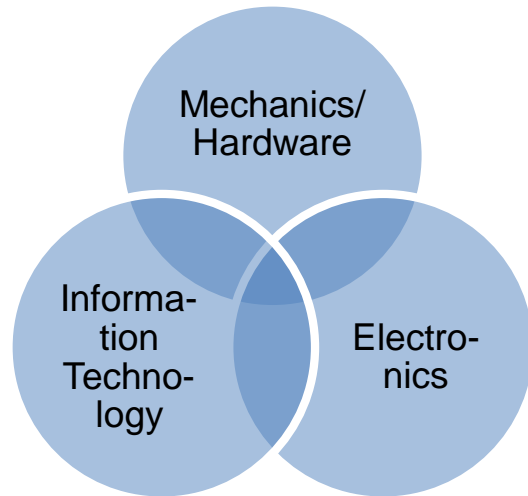
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Outline

- 1 Why software testing is important**
- 2 Simulation strategy: Continuous Testing**
- 3 Outcome and prerequisites**

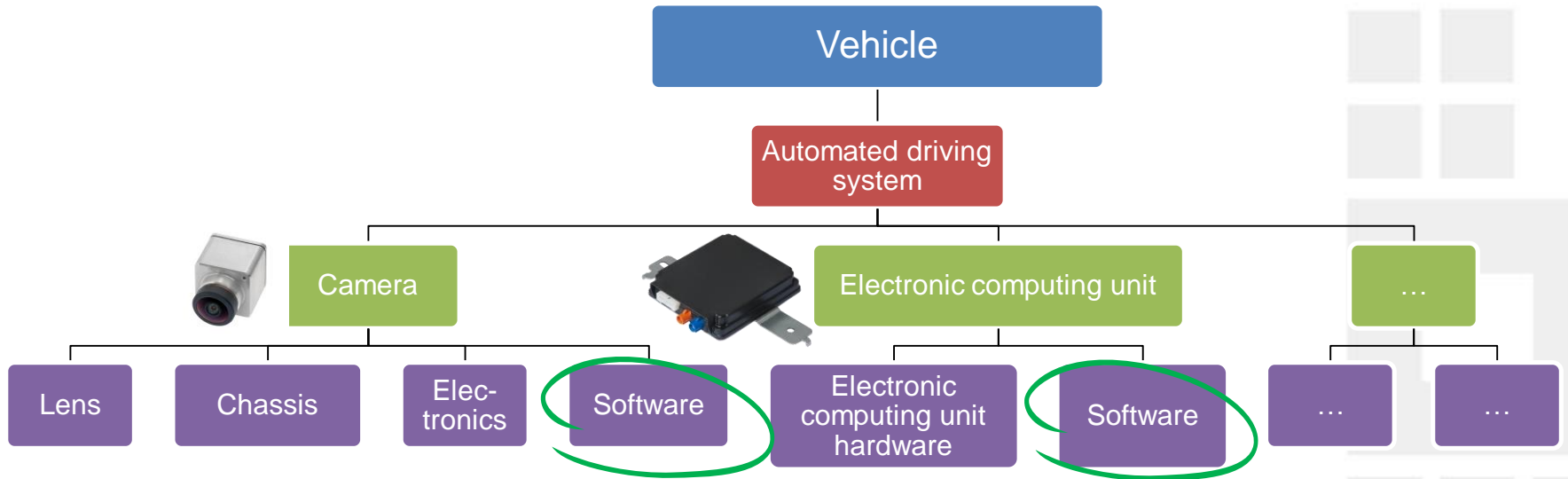
The role of software within development

- Mechatronic systems realize functions as e.g. braking, driver assistance systems or automated (cooperative) driving



› Mechatronic System = Hardware + Electronics + Information Technology

Architecture: Divide and Conquer



How components are typically developed

- Each software is placed on a hardware component: Without hardware no execution of software is possible. **This is called context of software**
- For this reason, while developing software, it is meaningful to avoid changes of hardware which is in the context of the software. Best practice is to **freeze hardware development** while software development is ongoing.

Component development lifecycle



Simulation – What does this mean?

■ Definition of simulation:

“ Simulation is the implementation of a model or models in a specific environment that allows the model's execution or use over time. ”

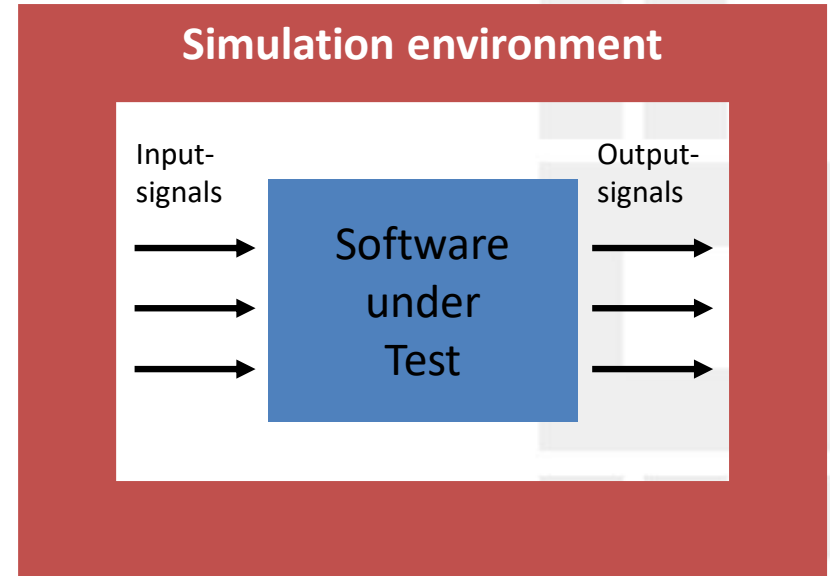
INCOSE: Systems Engineering Handbook; Wiley & Sons, Hoboken: 2015

■ Many reasons and characteristics to conduct simulation:

- Grades of model accuracy
- Architecture hierarchy level
- Purpose e.g. verification, validation or proof of design concept

Generic simulation approach

- The simulation environment consists of models that generate input or receive output of the System under Test (SuT e.g. a software component).
- Open loop vs. closed loop:
 - Closed loop considers feedback of the SuT
- Virtualization of the outer environment is utilized to test the SuT

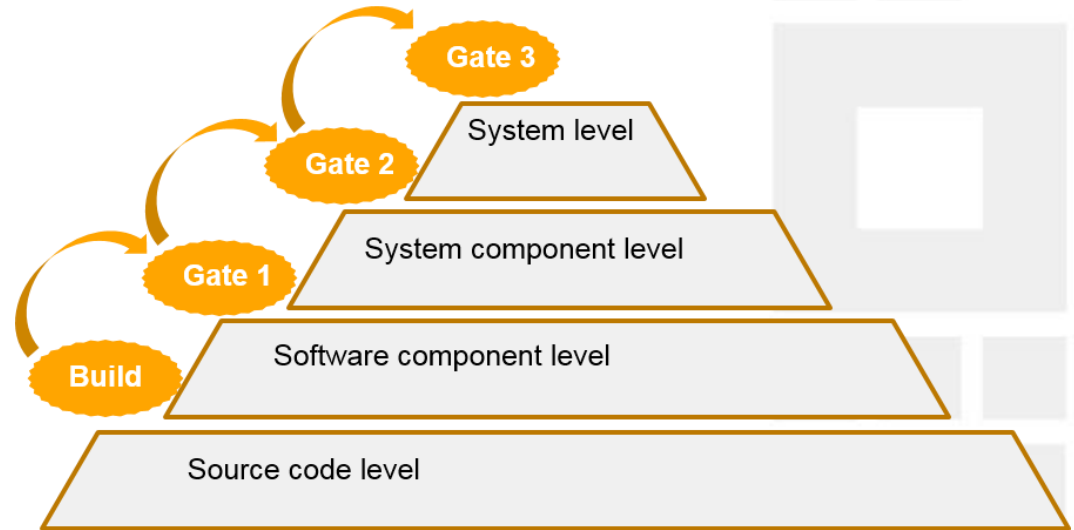


Purpose driven tailoring of simulation approaches

- Goals:
 - Enable **agile development** by a continuous testing environment
 - Show maturity of the vehicle system
 - Give **early feedback** to developers and stakeholders
 - Enable failure localization
- Election of simulation approaches according $\frac{\text{added value}}{\text{effort}}$
- Adapt simulation strategy to project boundary conditions: available
 - Manpower
 - Resources
 - Working process

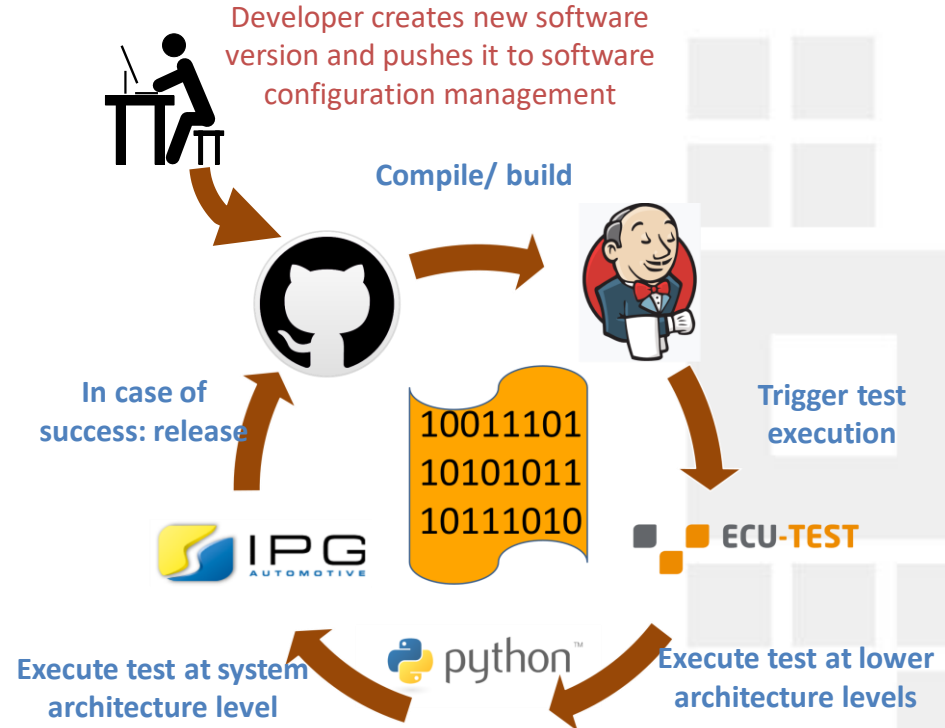
Simulation strategy

- Simulation is utilized at different architecture hierarchy levels:
After each successful test, the next higher level may be reached.
1. After software build, simulation is used to create **stimuli** for unit tests.
 2. At system component level simulation is used for an **integration test**.
 3. At system level a closed loop vehicle simulation is used to **verify functionality**.

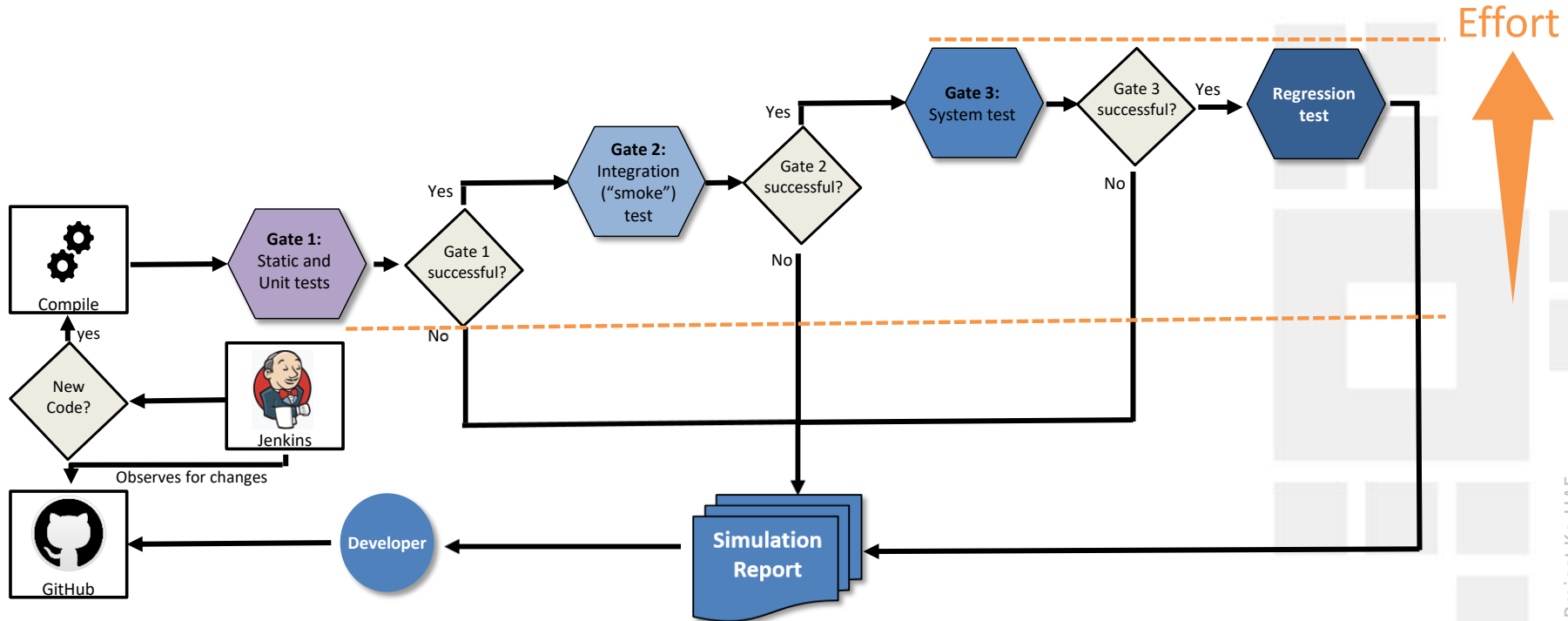


Continuous testing

- Continuous testing describes a method which aims to give early feedback about software development from source code level to product level
- Automated execution of
 - Software build
 - Tests
 - Analysis
 - Reporting to stakeholders

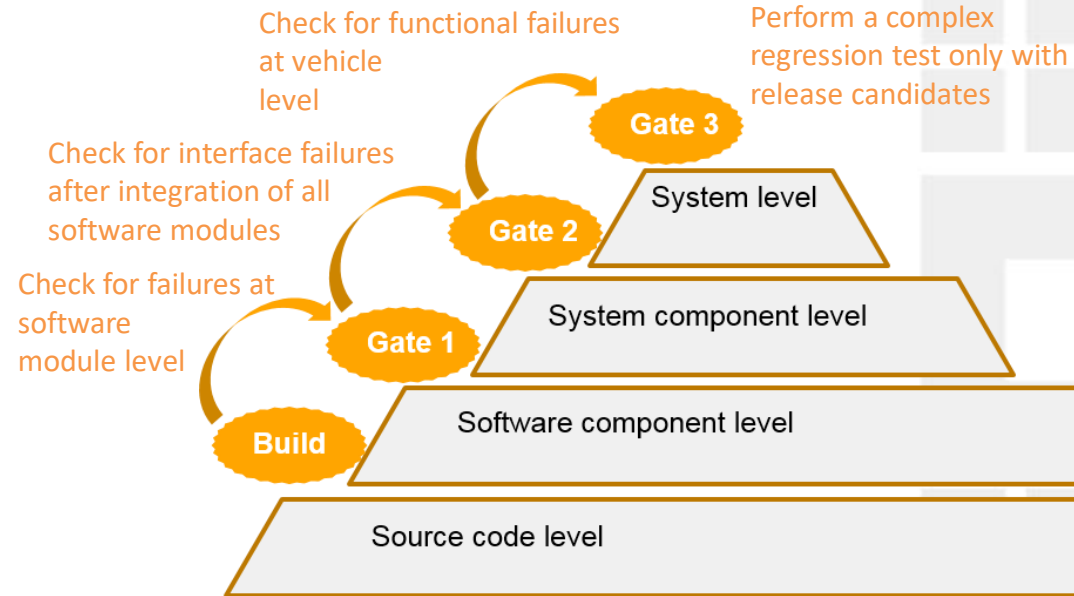


Continuous testing workflow



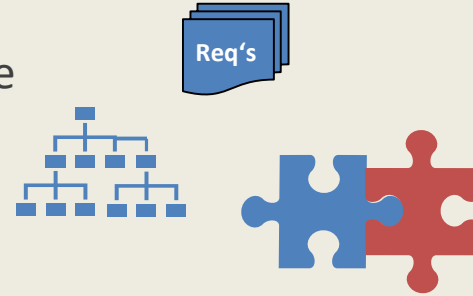
Outcome: How simulation can help

- By this approach early feedback could be given to developers
- Failures could be localized easier
- Real vehicle testing is done only with high mature software



Requirements to Continuous testing

- Enabler:
 - Requirements of System of Interest (SoI) available
 - Architecture of system available
 - Interfaces of System under Test (SuT) defined
- Simulation environments for all gate checks must be available
- Configuration management in order to manage code
- Automated evaluation and analysis of simulation results
- The process has to be lived by all project members





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